LAKE EDUCATION AND PLANNING SERVICES, LLC
PO BOX #26
CAMERON, WISCONSIN 54822

2024-28 AQUATIC PLANT MANAGEMENT PLAN

Lakes of the Town of Barnes, Eau Claire River, and the Eau Claire Chain of Lakes

BAYFIELD/DOUGLAS COUNTY

TOWN OF BARNES, BAYFIELD COUNTY, & TOWN OF GORDON, DOUGLAS COUNTY

AQUATIC PLANT MANAGEMENT PLAN

Base Plan and Amendable

March 2023

Prepared by:

Dave Blumer, Project Manager/Lakes Scientist

Acknowledgements:

Town of Barnes, Town of Gordon, Bayfield County, Douglas County, the Friends of the Eau Claire Lakes Area, members of the Eau Claire Lakes Property Owners Association, Town of Barnes Aquatic Invasive Species Committee, and others who contributed to discussions and recommendations presented in this plan.

Distribution List

No. of Copies	Sent to
1	Tom Renz, Chair Town of Barnes, Bayfield County
1	Kevin Shriver, President Friends of the Eau Claire Lakes Area
1	Pamela Toshner, Regional Coordinator Wisconsin Department of Natural Resources 810 W. Maple Street Spooner, WI 54801

Table of Contents

1.0 INTRODUCTION **9**

1.1 COVERAGE AREA PARTNERS 11

1.1.1 Town of Barnes *11*

1.1.2 Friends of the Eau Claire Lakes Area *11*

1.1.3 Eau Claire Lakes Conservation Club *11*

1.1.4 Towns of Gordon and Highland *12*

1.1.5 Bayfield and Douglas Counties *12*

2.0 WATERSHED **13**

2.1 WETLANDS 15

2.2 CRITICAL HABITAT 16

2.3 COARSE WOODY HABITAT 18

2.4 SHORELANDS 18

2.4.1 Protecting Water Quality *18*

2.4.2 Natural Shorelands Role in Preventing Aquatic Invasive Species *19*

2.4.3 Threats to Shorelands *19*

2.4.4 Shoreland Preservation and Restoration *19*

2.5 FISHERIES AND WILDLIFE 20

2.5.1 Fish Passage and Biotic Connectivity *21*

2.6 RECREATIONAL USE 22

3.0 WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY **23**

3.1 INTEGRATED PEST MANAGEMENT 23

4.0 MANAGEMENT ALTERNATIVES **25**

4.1 NO MANAGEMENT 25

4.2 HAND-PULLING/MANUAL REMOVAL 25

4.3 DIVER REMOVAL 26

4.4 DIVER ASSISTED SUCTION HARVEST 26

4.5 MECHANICAL REMOVAL 27

4.5.1 Large-scale Mechanical Harvesting *27*

4.5.2 Small-Scale Mechanical Harvesting *29*

4.6 HABITAT ALTERATION 30

4.6.1 Bottom Barriers and Shading *30*

4.6.2 Dredging *31*

4.6.3 Drawdown *31*

4.7 BIOLOGICAL CONTROL 31

4.7.1 Galerucella Beetles *31*

4.7.2 EWM Weevils *32*

4.7.3 Native Plant Restoration *33*

4.8 CHEMICAL CONTROL 33

4.8.1 Efficacy of Aquatic Herbicides *33*

4.8.2 Small-scale Herbicide Application *33*

4.8.3 Large-scale Herbicide Application *36*

4.8.4 Whole-Lake Application *36*

4.8.5 Common Aquatic Herbicides *37*

4.8.6 Pre and Post Treatment Aquatic Plant Surveying *38*

4.8.7 Chemical Concentration Testing *38*

5.0 AQUATIC INVASIVE SPECIES **39**

5.1 Non-native, Aquatic Invasive Plant Species 39
5.1.1 Eurasian Watermilfoil 39
5.1.2 Purple Loosestrife (Lythrum salicaria) 40
5.1.3 Yellow Flag Iris (Iris pseudacorus) 41
5.1.4 Curly-leaf Pondweed (Potamogeton crispus) 42
5.1.5 Narrow-leaf Cattail, Reed Canary Grass, Giant Reed Grass, and Japanese Knotweed 43
5.2 Non-native Aquatic Invasive Animal Species 45
5.2.1 Chinese and Banded Mystery Snails 45
5.2.2 Rusty Crayfish 46
5.2.3 Zebra Mussels 47
5.3 AIS Prevention Strategy 48

6.0 HEALTHY LAKES AND RIVERS INITIATIVE 49

6.1 Fish Sticks Installation 49
6.2 Rain Gardens 49
6.3 Native Plantings 50
6.4 Diversions 50
6.5 Rock Infiltration Trenches 51

7.0 POTENTIAL FUNDING – WDNR SURFACE WATER GRANT PROGRAM 52

8.0 AQUATIC PLANT MANAGEMENT PLANS 53

8.1 Implementation Goals 53

9.0 GOALS, OBJECTIVES, AND ACTIONS FOR ALL OF THE COVERAGE AREA 54

9.1 Goal 1 – Reduce the threat that a new aquatic invasive species will be introduced and go undetected in other Coverage Area lakes 54
9.2 Goal 2 - Improve the level of knowledge property owners and lake users have related to aquatic invasive species and their impact to the lake. 55
9.3 Goal 3 - Improve the level of knowledge property owners and lake users have related to how their actions impact the aquatic plant community, lake community, water quality. 56

10.0 WORKS CITED 57

Figures

Figure 1: Aquatic plant management Coverage Area 9
Figure 2: Lower, Middle, and Upper Eau Claire Lakes and other associated lakes 10
Figure 3: Central Barnes and Highland Township lakes 10
Figure 4: St. Croix Headwaters Watershed, including elevations (upper map) and villages and townships (lower map) 13
Figure 5: Upper St. Croix and Eau Claire Rivers Watershed land cover (NLCD, 2019) 14
Figure 6: Relative amount of impervious surface, by sub-basin, for the USCECR watershed 15
Figure 7: Wetland areas identified for USCECR watershed 16
Figure 8: Surface waters with Critical Habitat Mapping performed in the USCECR watershed 17
Figure 9: Healthy, AIS resistant shoreland (left) vs. shoreland in poor condition 20
Figure 10: Dam locations for conceptual fish passage plans 22
Figure 11: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020 23
Figure 12: Aquatic vegetation manual removal zone 26
Figure 13: DASH – Feeding EWM into the underwater Suction Hose (Marinette Co.); and a sample DASH Pontoon Boat (Beaver Dam Lake Management District) 26
Figure 14: How a mechanical harvester works (Engle, 1987) 27
Figure 15: WaterBug remote-controlled aquatic plant harvester (https://lakeweedharvester.com/waterbug/) 29
Figure 16: WaterGator remote-controlled aquatic plant harvester (https://lakeweedharvester.com/watergator/) 30
Figure 17: Galerucella Beetle 32
Figure 18: EWM weevil 32
Figure 19: Limno-curtain material on a roll before installation (photo from Marinette Co. LWCD) 35
Figure 20: Limno-curtain installed on Thunder Lake (photo from Marinette Co. LWCD) 35
Figure 21: Herbicide concentration results from 2020 Thunder Lake limno-curtain trial (Marinette Co LWCD) 36
Figure 22: EWM complete root and stem and floating fragment with adventitious roots 40
Figure 23: Purple loosestrife 41
Figure 24: Yellow flag iris 42
Figure 25: Diagram showing annual CLP life-cycle in northern lakes (Freshwater Scientific Services, 2008). 43
Figure 26: CLP plants and turions 43
Figure 27: Narrow-leaf cattail (upper left), Reed canary grass (upper right), Phragmites (lower left), and Japanese knotweed (lower right) 45
Figure 28: Chinese (left) and Banded (right) Mystery Snails 46
Figure 29: Rusty Crayfish and identifying characteristics 47
Figure 30: Zebra Mussels 47
Figure 31: Fishsticks installation (left) and after ice out (right) 49
Figure 32: Rain garden installation (left) and upon completion (right) 50
Figure 33: Completed native planting (photo from HealthyLakesWI.com) 50
Figure 34: Completed diversion (photo from HealthyLakesWI.com) 51
Figure 35: Rock Infiltration Set-up 51

TABLES

Table 1: Critical habitat sites and acreages for select water resources in the USCECR watershed.....................17

1.0 Introduction

The area of concern (Coverage Area) addressed by this plan includes all of the lakes in portions of the Town of Barnes located in southwest Bayfield County, and in portions of the Towns of Highland and Gordon in southeast Douglas County (Figure 1). Chief among these lakes is the Eau Claire Chain of Lakes (Lower, Middle, and Upper) and the lakes directly connected to them (Birch, Bony, Cranberry, Devils, Robinson, Shunenberg, Smith, and Sweet) (Figure 2). Also included are the lakes in the central portion of the Town of Barnes and Town of Highland including Sand Bar, Tomahawk, Beauregard, Island, George, Sand, Ellison, Loon and multiple smaller lakes (Figure 3). The purpose of this plan is three-fold. First, it provides general background data that is applicable to all of the lakes in the area. Second, it establishes several goals for Aquatic Invasive Species (AIS) that apply to all of the Town of Barnes and the rest of the Coverage Area. And third, it provides an amendable space to develop and/or update Aquatic Plant Management (APM) Plans for individual lakes starting with the big three Lower, Middle, and Upper Eau Claire.

The APM Plan for Sand Bar and Tomahawk Lakes has already been updated in a 2022 project. Once the APM Plans for the three Eau Claire Lakes have been updated, a similar format will be laid out for developing or updating APM Plans for the rest of the lakes in the Coverage Area with initial focus on those lakes with public access and those directly connected to the Eau Claire Chain. Each new APM Plan will be added to this larger document to be held on file by the Town of Barnes.

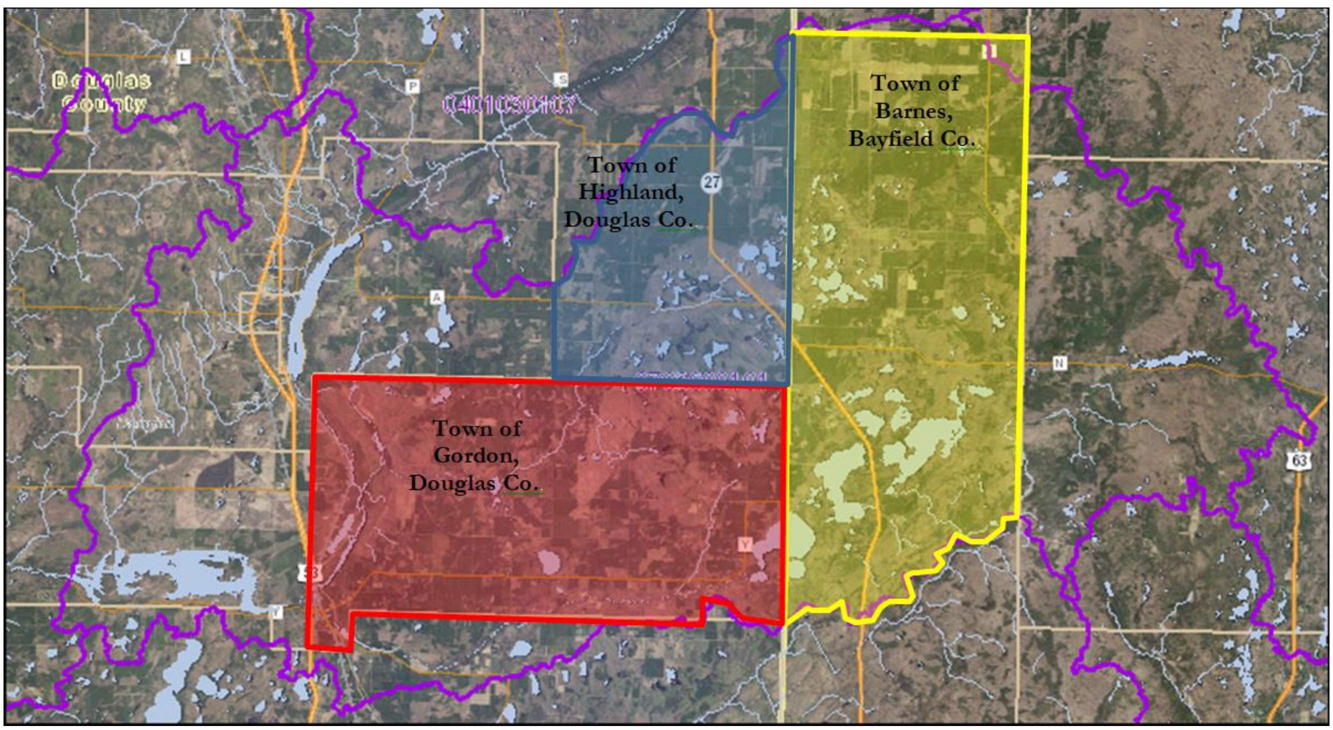

Figure 1: Aquatic plant management Coverage Area

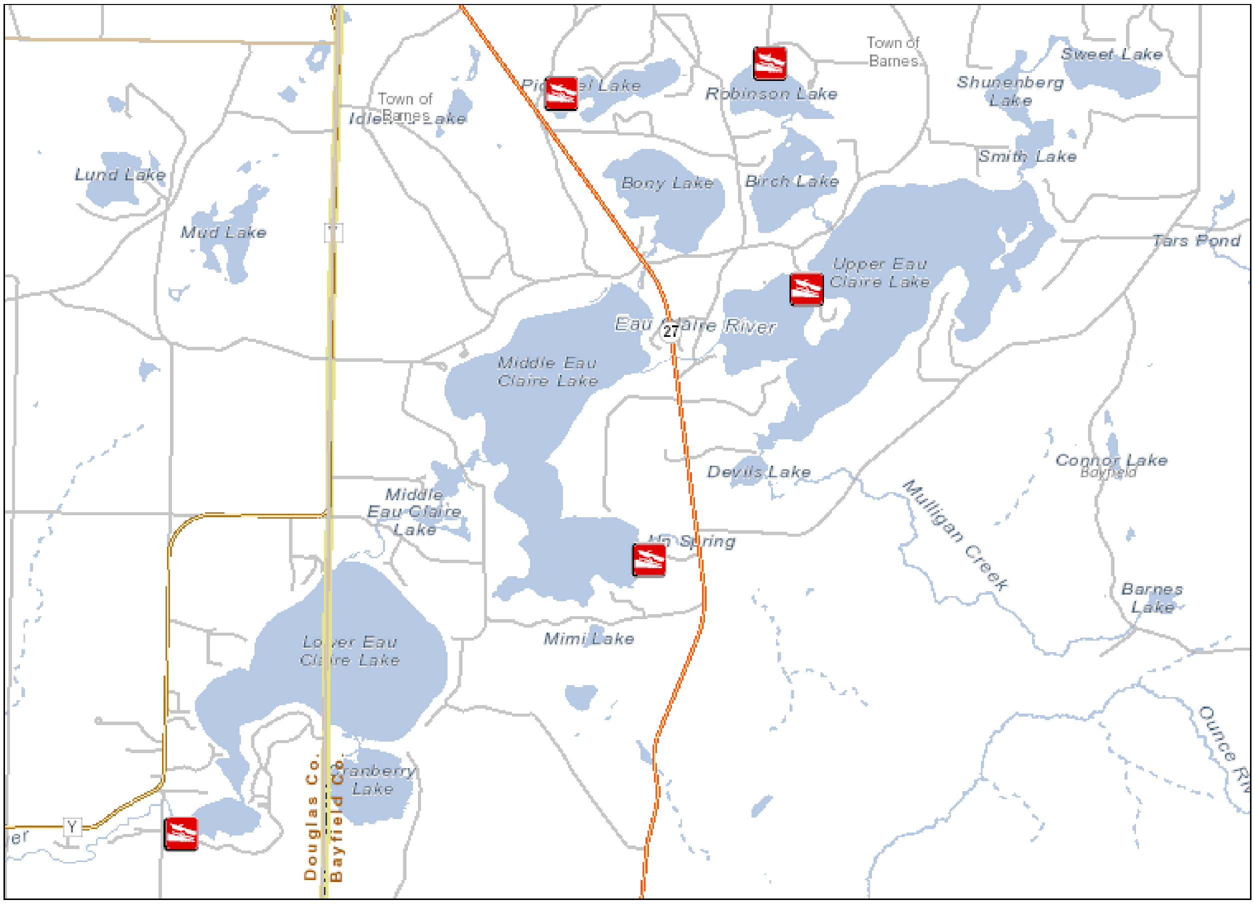

Figure 2: Lower, Middle, and Upper Eau Claire Lakes and other associated lakes

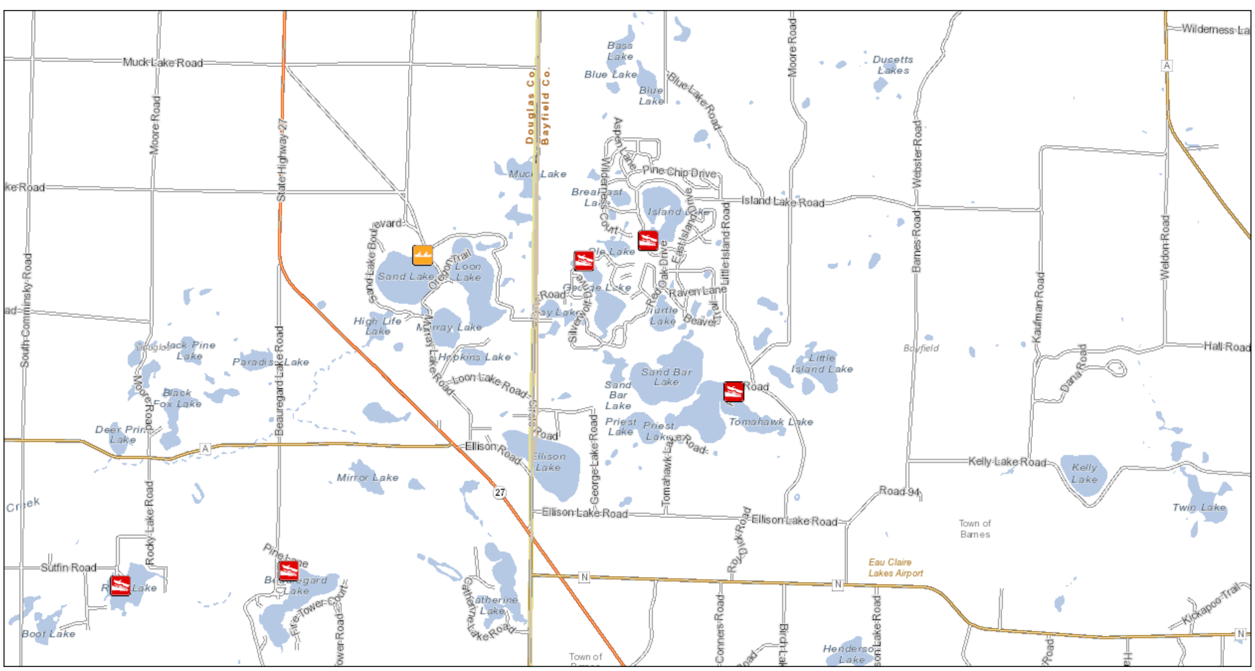

Figure 3: Central Barnes and Highland Township lakes

1.1 Coverage Area Partners

1.1.1 Town of Barnes

Throughout the Town of Barnes Comprehensive Land Use Plan, the term "northwoods character" appears several times. For the purposes of the Land Use Plan, northwoods character is defined as: "A combination of natural and manmade features that portray the traditional form and preserve the traditional function of the northwoods landscape. In the Town of Barnes, northwoods character is manifested in a backdrop of forests and fields, natural features such as creeks, lakes, and wetlands, and structures such as churches, cabins, and homes. These physical features support traditional northwoods activities such as farming, logging, and outdoor recreation that have been practiced for generations in the Town. Homes in the northwoods are either scattered at low densities or clustered together in small communities surrounded by open space."

1.1.1.1 AIS Committee

The Town of Barnes AIS Committee was first established as an Ad Hoc Committee in 2004 following the discovery of EWM in Sand Bar and Tomahawk Lakes. In 2006, the AIS Committee was officially recognized by the Town and has been helping to guide AIS education. Prevention, planning, and implementation ever since. The AIS Committee generally meets once a month during the open water season and at other times as necessary.

1.1.2 Friends of the Eau Claire Lakes Area

Organized in 1973, Friends of the Eau Claire Lakes Area (FOECLA) is a voluntary group of year-round and seasonal residents and visitors interested in preserving the beautiful environment of the Eau Claire Lakes area. Their mission is to "protect, preserve and improve the environmental and aesthetic qualities of the Eau Claire Lakes Area watershed, including its lakes, rivers and streams, shorelands, wetlands, forests and attendant wildlife resources." This mission has been embraced by others all over the Eau Claire Lakes Area and membership continues to grow.

Since its earliest years, FOECLA has provided leadership in raising awareness of the impacts of aquatic invasive species (AIS) on area lakes. They helped construct the BAISS boat that is used annually to remove Eurasian water-milfoil and curly-leaf pondweed from area lakes. They encouraged the development of and continue to serve on an AIS Committee created by the Town of Barnes to address AIS issues on area lakes.

FOECLA developed and funds an award-winning educational program with the Drummond Public School District that takes middle school students outdoors for hands-on learning. FOECLA sponsors programs and seminars for adults in the community about everything from cooking, to successful fishing, to maintaining septic systems. FOECLA works cooperatively with the Town of Barnes to maintain and fund an effective boat landing watercraft inspection program to protect the lakes from invasive species. FOECLA members volunteer to inspect the shoreline for any signs of invasive species and work with the Wisconsin Department of Natural Resources (WDNR) in control efforts when needed.

1.1.3 Eau Claire Lakes Conservation Club

The Eau Claire Lakes Conservation Club has been active in Barnes and Gordon for 60 years. The organization is devoted to maintaining the area's natural resources for all to enjoy. Each year the club initiates and participates in projects to preserve, protect and promote the land and waters of the Eau Claire Lakes area. In 2021 and 2022, the Conservation Club was instrumental in the construction of a limno-curtain to be used to improve management of AIS in the lakes. It was installed for the first time in 2022 to aide EWM management in Tomahawk Lake.

The Club is also involved in building Kids Don't Float life jacket boxes, building duck and bluebird houses, installation of trail benches is several locations, walleye stocking, and were the driving force behind the installation of an ADA accessible fishing pier at the Tomahawk Lake Park.

The club offers volunteer opportunities for men and women interested in conservation-focused projects in the Eau Claire Lakes area. More information about the club's activities can be found at https://townofbarneswi.gov/page.cfm/122.

1.1.4 Towns of Gordon and Highland

The Town of Gordon, guided by its Parks and Recreation Committee is diligently working to develop a family oriented focus within the community. They would like to offer various recreational areas and events that will encourage families, from near and far, to enjoy the lifestyle imagined of a small, rural town in Northern Wisconsin. They continue to strive to make the community complete with parks and green spaces, and to provide residents and visitors with healthy options for entertainment. With pride and local/surrounding community, efforts to develop parks and outdoors space in the Town has jumped back to life.

With just over 50,000 acres which include several lakes, Town of Highland residents and visitors enjoy some of the most relaxing living found in the state. The North Country National Scenic Hiking Trail runs through the Town and is a great place to get out and experience nature. The Town of Highland has recently completed a Comprehensive Planning Report; however it is not yet accessible to the general public.

1.1.5 Bayfield and Douglas Counties

Land and water resources are very important to Bayfield County. Water quality exceeds the EPA minimum standards in most areas of Bayfield County, allowing focus on resource protection rather than restoration activities. The county has taken the lead in resource protection by implementing rigorous protection standards. The LCC and the LWCD staff enjoy a high level of professional respect among clients, citizens, and partners. The Land and Water Resource Management Plan reflects citizen interest in local priorities, encourages local leadership, and supports partner participation in protecting the natural resources of Bayfield County. This plan empowers the Land Conservation Committee to provide the local leadership and focus needed to coordinate a wide spectrum of conservation activities along with a diverse group of partners.

Douglas County Land Conservation administers the Douglas County Land & Water Conservation Program to meet local priorities and the needs of Douglas County at the direction of the Land Conservation Committee implementing the Douglas County Land & Water Resource Management Plan and utilizing the Wisconsin Soil & Water Resource Management Program to conserve the County's natural resources. Other activities the Land Conservation Department is responsible for include:

- Establish goals and standards for conservation of soil and water resources
- Provide for cost-sharing, technical assistance, and educational programs to conserve soil and water resources
- Encourage coordinated soil and water conservation planning and program implementation
- Enable the regulation of harmful land use and land management practices by county ordinance
- Preparation of a Land and Water Resource Management Plan

2.0 Watershed

The area included in this plan is part of the Upper St. Croix and Eau Claire Rivers (USCECR) Watershed that extends from south central Douglas County into southeastern Bayfield County (Figure 4). It contains portions of two counties and nine different townships (Figure 4). The watershed is 177,850 acres in size and drained by 153 miles of streams and rivers with the St. Croix and the Eau Claire Rivers being the major waterways. There are 197 lakes covering 7,654 acres. Of these, 70% are seepage lakes (lakes with no surface inflow or outflow, like Sand Bar and Tomahawk), 17% are spring/groundwater drainage lakes (lakes with surface outflow, like Robinson and Sweet), 9% are drainage lakes (lakes with surface flow in and out of the lake, like the Eau Claire Lakes), and 4% are reservoir/impoundments (like the St. Croix Flowage). All of the St. Croix drainage from above the Gordon dam is included in this watershed.

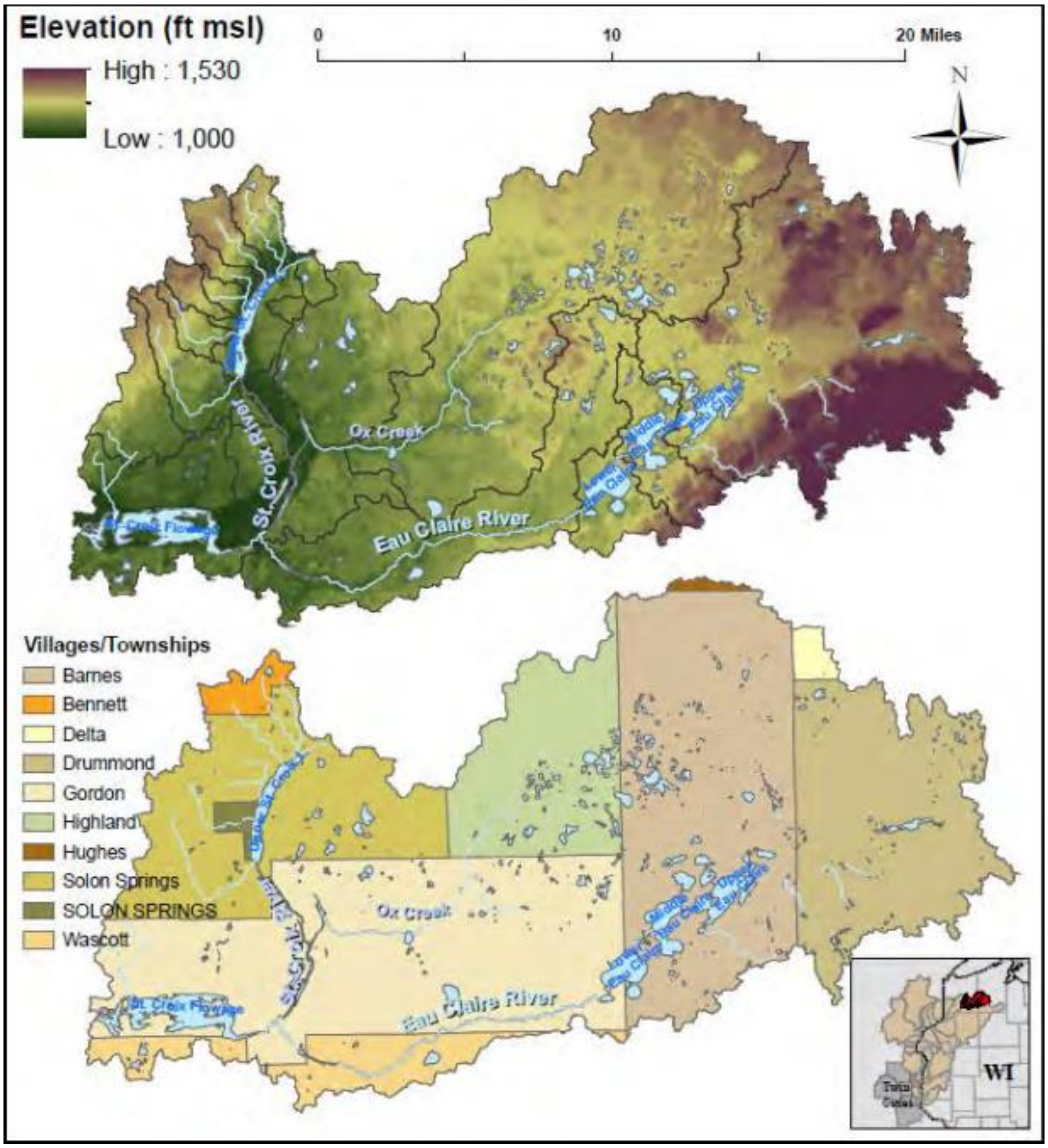

Figure 4: St. Croix Headwaters Watershed, including elevations (upper map) and villages and townships (lower map)

The USCECR watershed is located within two ecological landscapes in northwestern Wisconsin. The Northwest Sands Ecological Landscape covers approximately the western two-thirds of the watershed. It consists of flat plains or terraces along glacial melt water channels and pitted outwash plains containing kettle lakes. The soils are deep sands with little organic material and nutrients. The vegetation is dominated by jack pine and scrub oak forest and barrens with some white and red pine forests. The forest in these areas has undergone several changes since the early logging era. The North Central Forest Ecological Landscape occupies about one-third of the eastern portion of the watershed. This area is generally characterized by ground moraines, pitted outwash plains, and bedrock outcrops.

The watershed is mostly forested (83.90%) with some wetlands (9.49%) and some developed and agricultural land (6.69%) and is ranked low for nonpoint source issues affecting groundwater (Figure 5). Another important land use is the presence and influence of impervious surfaces. Impervious surfaces, such as roads, rooftops and compacted soils, can reduce or prevent the infiltration of runoff. Impervious surfaces can also increase the amount of stormwater flowing directly to lakes and streams. This can negatively impact water quality and aquatic habitat.

The Center for Watershed Protection (CWP; Zielinski, 2002) correlated watershed imperviousness with stream quality, identifying levels of degradation with impervious thresholds of 10% and 25%. Watersheds with less than 10% imperviousness have a "sensitive" watershed classification and are characterized by high quality streams, stable channels, and excellent habitat. Watersheds with imperviousness greater than 10 % show signs of deterioration whereby sensitive stream elements are lost from the system. Watersheds with greater than 25% imperviousness have an "impacted" classification. These are characterized by poor water quality, stream instability, and having poor biodiversity.

In the 2013 study of the USCECR watershed, impervious surface was estimated to better assess overall development and disturbance within the basin. It estimated that the USCECR includes approximately 1.2% of its total area as impervious surface. Relative levels of imperviousness are low across the watershed, with levels generally ranging from 1% to 2% in various sub-watersheds (Figure 6).

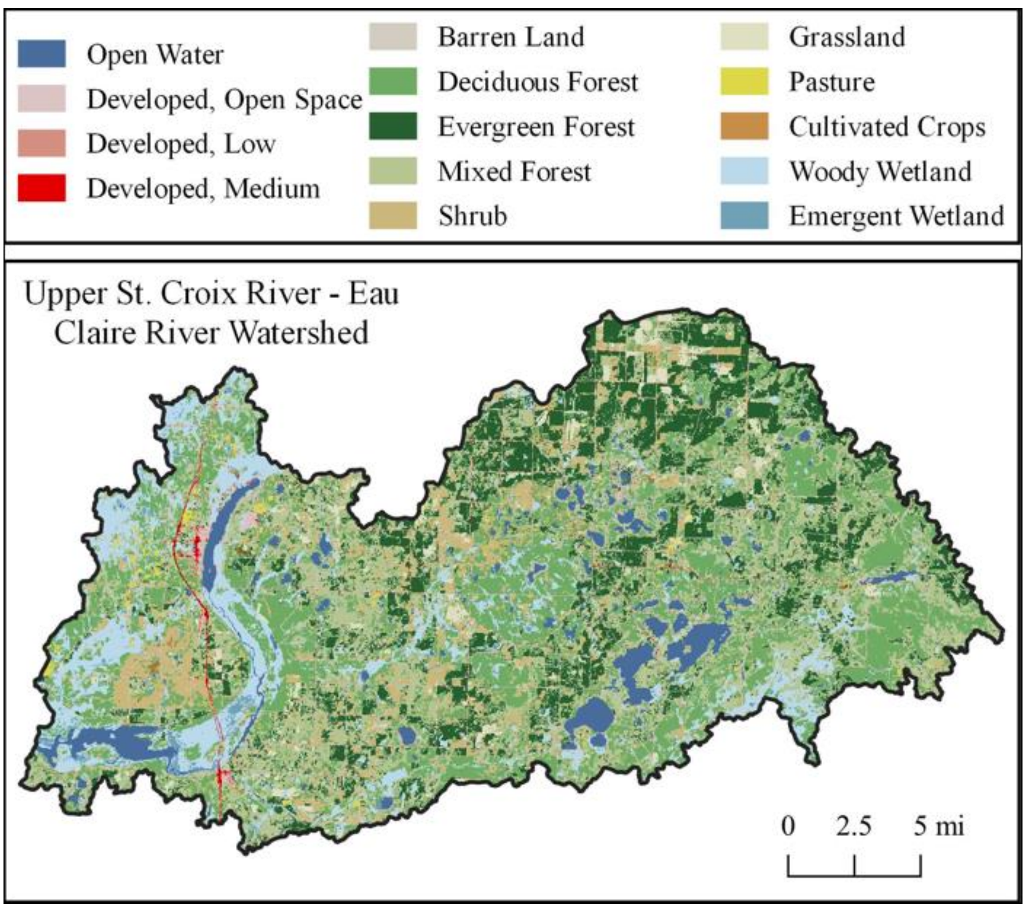

Figure 5: Upper St. Croix and Eau Claire Rivers Watershed land cover (NLCD, 2019)

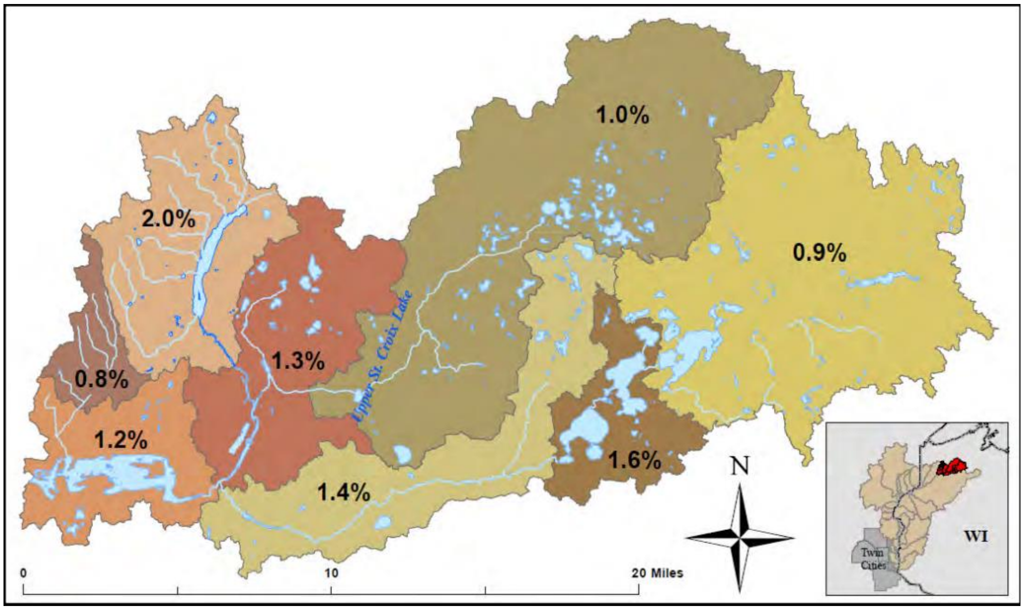

Figure 6: Relative amount of impervious surface, by sub-basin, for the USCECR watershed

2.1 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 within the USCECR watershed. In the 2013 watershed study, a functional assessment of the wetlands was performed through collaboration of stakeholders, and local and regional wetlands experts familiar with the study area. These experts collaboratively identified wetland functions of greatest interest:

- Surface Water Detention – storage of runoff from rain events and spring melt waters which attenuates peak flood levels downstream.
- Surface Water Maintenance – this is often referenced as stream flow maintenance. During drought conditions and periods of low discharge, wetlands provide a source of water to keep streams from drying up.
- Nutrient Transformation – wetlands through natural chemical processes break down nutrients from both natural sources as well as fertilizers and other pollutants essentially treating the runoff.
- Sediment Retention – wetlands act as filters to physically trap sediment particles before they are carried further downstream.
- Carbon Sequestration – wetlands serve as carbon sinks that help trap atmospheric carbon.
- Shoreline Stabilization – wetland plants help hold the soil to prevent erosion.
- Fish Habitat – wetlands serve as habitat for a variety fish. Within this function is a special category containing those factors such as stream shading that keeps water temperatures low enough for cold water species such as trout.
- Waterfowl Habitat – wetlands serve as habitat for waterfowl, and other water birds such as coots and loons.
- Shorebird Habitat – wetlands serve as habitat for shorebirds, such as herons, egrets, and sandpipers.
- Amphibian Habitat – wetlands serve as habitat for amphibians such as frogs, toads and salamanders.
- General Wildlife Habitat – wetlands serve as habitat for a variety of other animals from songbirds to turtles to larger mammals such as deer and raccoons.

Figure 7 reflects the wetland areas within the watershed. Much of it is in the western half of the watershed, outside of the area of interest in this document; however, those wetlands within the area of concern should be protected and enhanced.

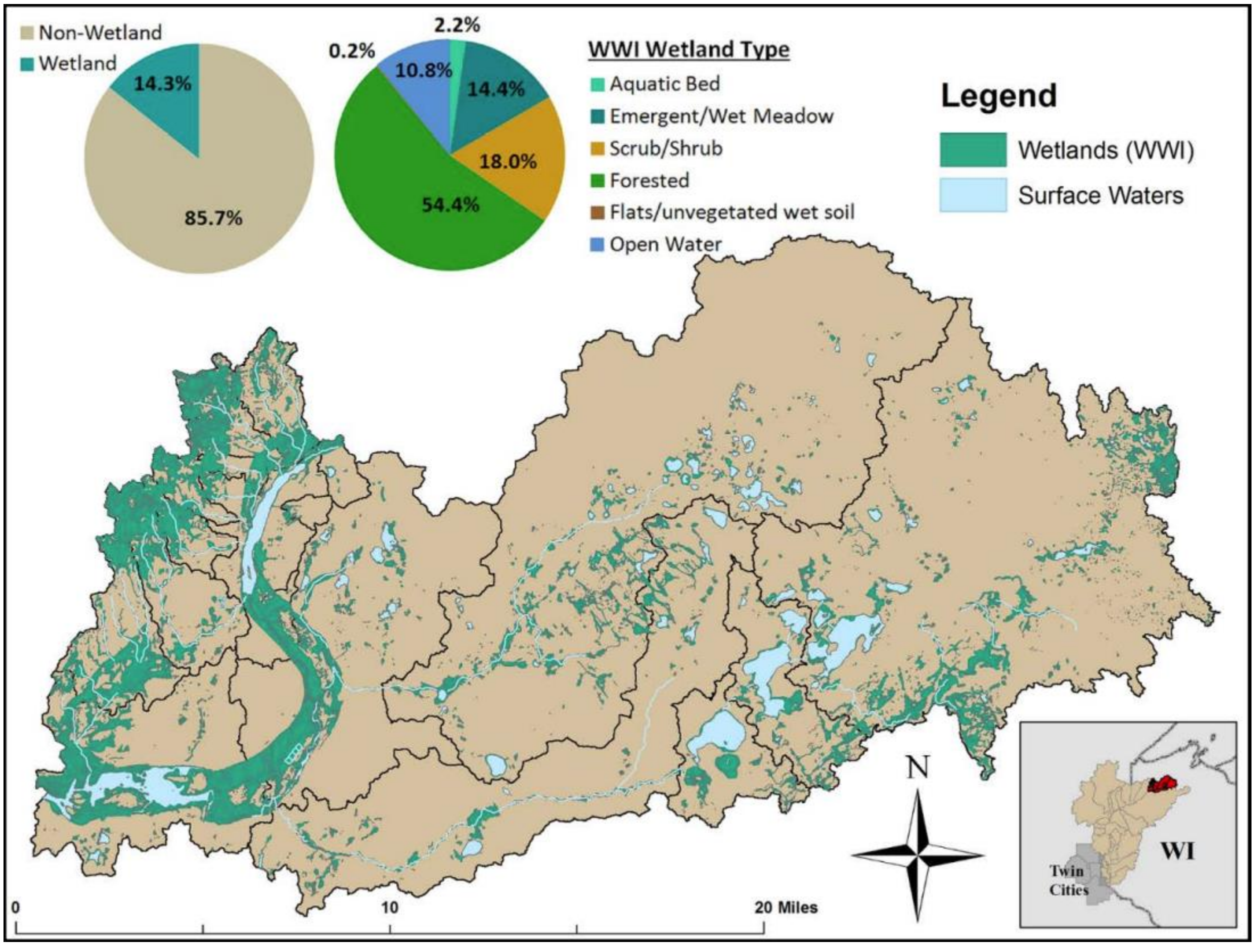

Figure 7: Wetland areas identified for USCECR watershed

2.2 Critical Habitat

Critical Habitat Designation is a program that includes formal designations of areas considered important to fish and wildlife. Critical Habitat is classified into three categories: sensitive areas, public rights features, and resource protection areas (uplands within the shoreline zone). These three elements combine to provide regulatory and management advice to the State of Wisconsin, counties, local units of governments, and others who are interested in protecting and preserving these unique habitats for future generations.

Designation of Critical Habitat aims to serve four primary purposes: 1) Resource protection through science based regulatory review. 2) Community-based resource protection through community education, planning and zoning. 3) A guide to land-trusts and others acquiring land and conservation easements. 4) A mechanism to track long-term changes in these habitats. Critical habitat evaluations were performed on 14 different waterbodies in the USCECR watershed (Figure 8). The critical habitat designations completed in the watershed in 2013 focused on lakes and rivers of particular interest, including those of greatest size, public use, known habitat concerns, and other reasons.

A brief overview summary of critical habitat by waterbody is included in Table 1. Complete assessment of critical habitat areas, including a report for each waterbody evaluated, is included as Appendix C. These reports include detailed maps indicating all critical habitat areas and types. Each report also includes management recommendations for habitat protection. This includes General Lakewide Recommendations for protection of the entire lake, as well as Specific Site Recommendations for the protection of each Critical Habitat Area. These reports can be used in the development of additional APM Plans for other waterbodies in the area of concern.

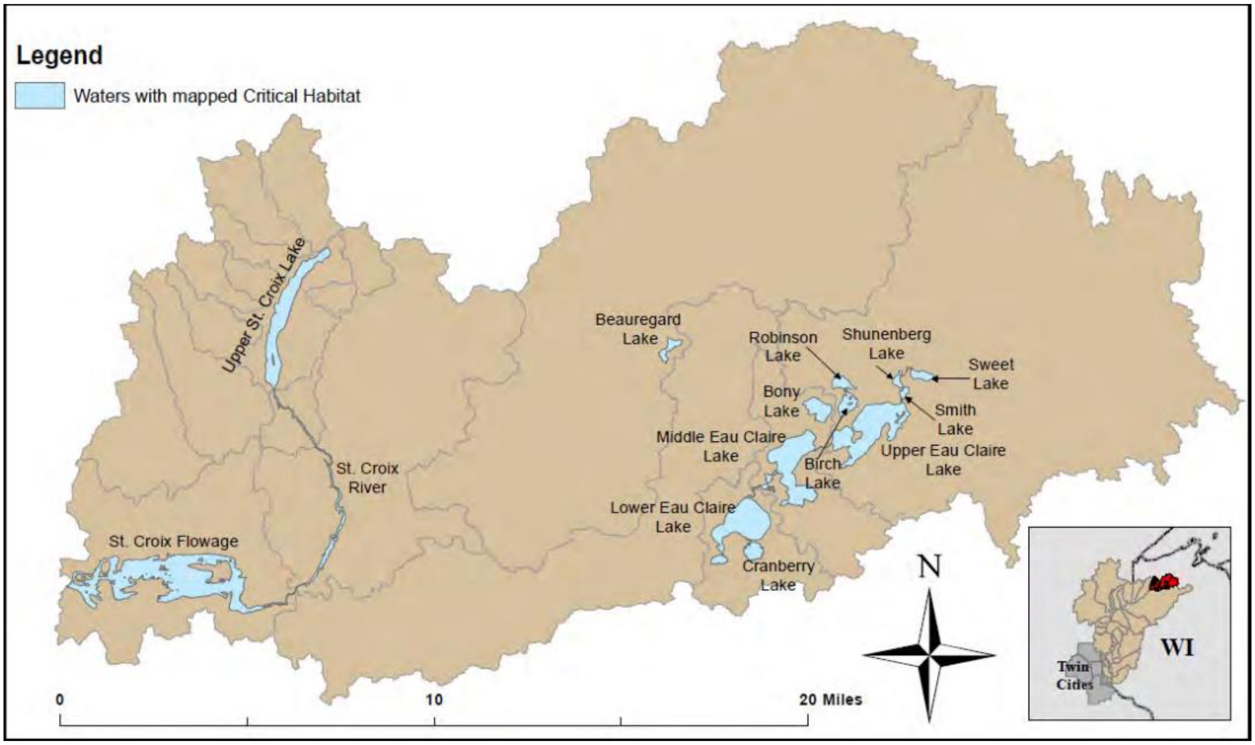

Figure 8: Surface waters with Critical Habitat Mapping performed in the USCECR watershed

Table 1: Critical habitat sites and acreages for select water resources in the USCECR watershed

Waterbody	Total Critical Habitat Areas	Total Critical Habitat Acreage (Ac)
Beauregard Lake	11	32.2
Birch	8	36
Bony	13	26.4
Cranberry	8	112.5
Lower Eau Claire	9	112.5
Middle Eau Claire	16	235.5
Robinson	5	71.6
Shunenberg	1	44.3
Smith	2	33.7
St. Croix Flowage	1	3596
St. Croix River	2	1,161.1
Sweet	9	39.3
Upper Eau Claire	22	145.8
Upper St. Croix Lake	22	145.8

2.3 Coarse Woody Habitat

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. The presence of CWH has also been shown to prevent suspension of sediments, thereby improving water clarity. 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 (Wolter, 2012). 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. 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 (Wolter, 2012).

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.

2.4 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 aquatic invasive species 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. 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, 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, and 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 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.

2.4.1 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 will help water soak (infiltrate) into the ground. Water that soaks into the ground is less likely to damage lake quality and recharges groundwater that supplies water to many of Wisconsin's 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.

2.4.2 Natural Shorelands Role in Preventing Aquatic 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 may fill the voided space before natives can return.

2.4.3 Threats to Shorelands

When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, 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.

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.

2.4.4 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 9 shows the difference between a natural and unnatural shoreline adjacent to a lake home.[1]

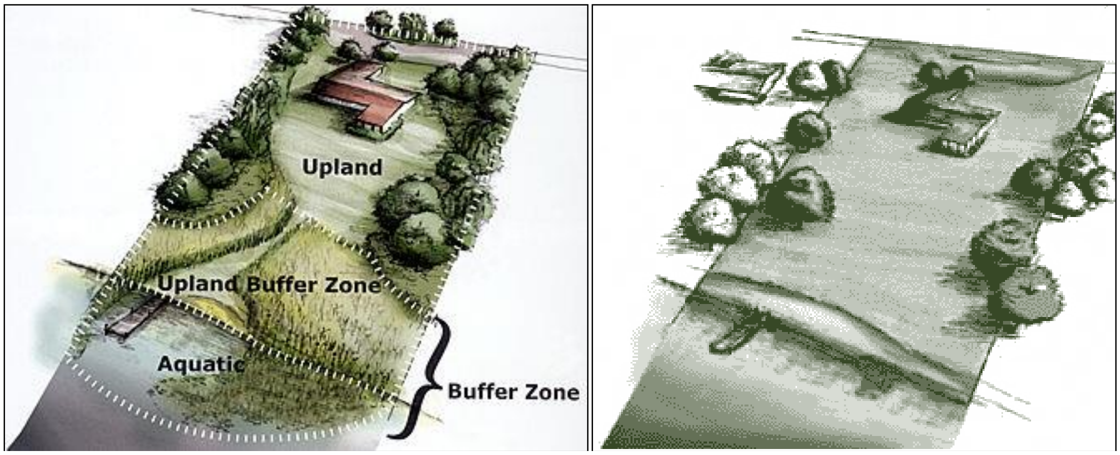

Figure 9: Healthy, AIS resistant shoreland (left) vs. shoreland in poor condition

Despite there being homes and cabins all around the two lakes, much of the shoreland is still in a natural state, a credit to the property owners. However, where there is mowed lawn to the edge of the lake, cleared lots, driveways, and other impervious surfaces, property owners should evaluate whether or not improvements can be made. Fluctuating water levels will always impact the shores of both lakes. Most property owners are aware that they can only do a minimal amount of clearing on the exposed lake bed under low water conditions, similar to what could be done if it were still under water. During periods of high water, more concern is placed on what can be done to protect the shore and upland areas from erosion caused by waves. For many, the answer lies in placing rock riprap along their shore. While this practice is logical and viable and is generally supported by those who work to protect lakes, there are ways to do it that are more environmentally and lake sensitive.

2.5 Fisheries and Wildlife

Fisheries resources in the watershed include a diverse mix of lake and riverine habitat. Riverine habitat includes cold-water streams, the majority of which are found in the headwaters of the St. Croix River. The St. Croix River within the watershed is a slow-moving, warm-water river that includes a mix of species typical of both lakes and warm-water rivers. The Eau Claire River is a small, warm-water river originating from the Eau Claire Chain of Lakes.

The WDNR has previously performed assessments of stream health within the USCECR watershed using observations of fish diversity. This approach, using an "Index of Biotic Integrity" (IBI), characterizes stream health based on its fish community characteristics. Spring Creek and Park Creek, two tributaries to Upper St. Croix Lake, had IBI scores indicating quality cold-water habitat. Park Creek had a single station that was characterized as "good" habitat during 2006, while Spring Creek had six different locations monitored over multiple years (2001 and 2004), with IBI scores ranging from "fair" to "excellent."

By comparison, fish observations from Upper Ox Creek in the central area of the watershed had an IBI ranking of Fair (single station sampled in 2003). Observations from the Eau Claire River had IBI rankings ranging from Poor to

[1] More information about healthy shorelines and how they can be restored can be found at the following websites (last accessed 8-26-2021):
https://www.cleanlakesalliance.org/shoreline-health/
https://dnr.wi.gov/topic/ShorelandZoning/documents/WT-748.pdf

Excellent. The Poor ranking occurred immediately below the Eau Claire River hydropower dam, while the sites with Fair to Excellent observations occurred upstream between the impoundment and Lower Eau Claire Lake (five stations sampled during 2007).

In addition to observations on fish abundance and diversity, similar observations on mussel communities were made at several locations in the watershed during 2008 and 2009. This included mussel sampling on the St. Croix River above the St. Croix Flowage, as well as sampling from several sites on the Eau Claire River and Upper and Lower Ox Creek. Observations generally suggest there are healthy mussel populations within the watershed with a range of abundance and diversity. Reproduction also was evident with multiple size classes evident at several sampling sites.

2.5.1 Fish Passage and Biotic Connectivity

Connectivity is an important attribute of aquatic habitat for river fishes. Fish have evolved migratory strategies to take advantage of complex river habitats. Fish undergo migrations for many reasons, including: food availability, spawning, overwintering, refuge during extreme hydrologic events (floods, droughts) or other reasons. Dams and similar structures reduce the connectivity of aquatic habitat by restricting movement of river fish. This can limit the extent and quality of habitats they can occupy. Fish passage could benefit a wide range of fish species, as well as mussels.

The lake sturgeon is of special interest to the WDNR in terms of potential fish passage benefits. In many instances dams have played a role in diminished populations of lake sturgeon (Aadland et al 2005; Daugherty 2006). The WDNR has been stocking lake sturgeon in the upper St. Croix River since 2002 in anticipation that eventually fish passage could be restored to the extent that would provide a mix of habitat types that would enable a self-sustaining population to be restored. Lake sturgeon also has been observed below Gordon Dam periodically over the past 10 years.

This effort comprehensively looked at barriers to fish migration and potential fish passage projects at several dams in the watershed. This included Gordon Dam, the Eau Claire River Hydroelectric Dam, Ward Dam, Mooney Dam, Middle Eau Claire Lake Dam, and Upper Eau Claire Lake Dam (Figure 10). Basic fish passage options were considered for each location, including discussion of potential benefits. Considerations were given as to whether any federal action might be warranted through an ecosystem restoration project under this authority, or the USACE Continuing Authorities Program Section 206. However, it quickly became apparent that none of the sites would have been good candidates given project scale, potential cost and limited benefits. However, it is possible that the recommendations contained herein could be used by the project sponsor, or local interests, to implement fish passage in the future. It should be noted the thoughts and plans expressed here are highly conceptual and would require detailed review and design. Detailed drawings or cost estimates were not prepared. Real Estate interests, including discussions with dam owners, also would need to occur. It is possible that property owner interest may preclude the conceptual alternatives provided here.

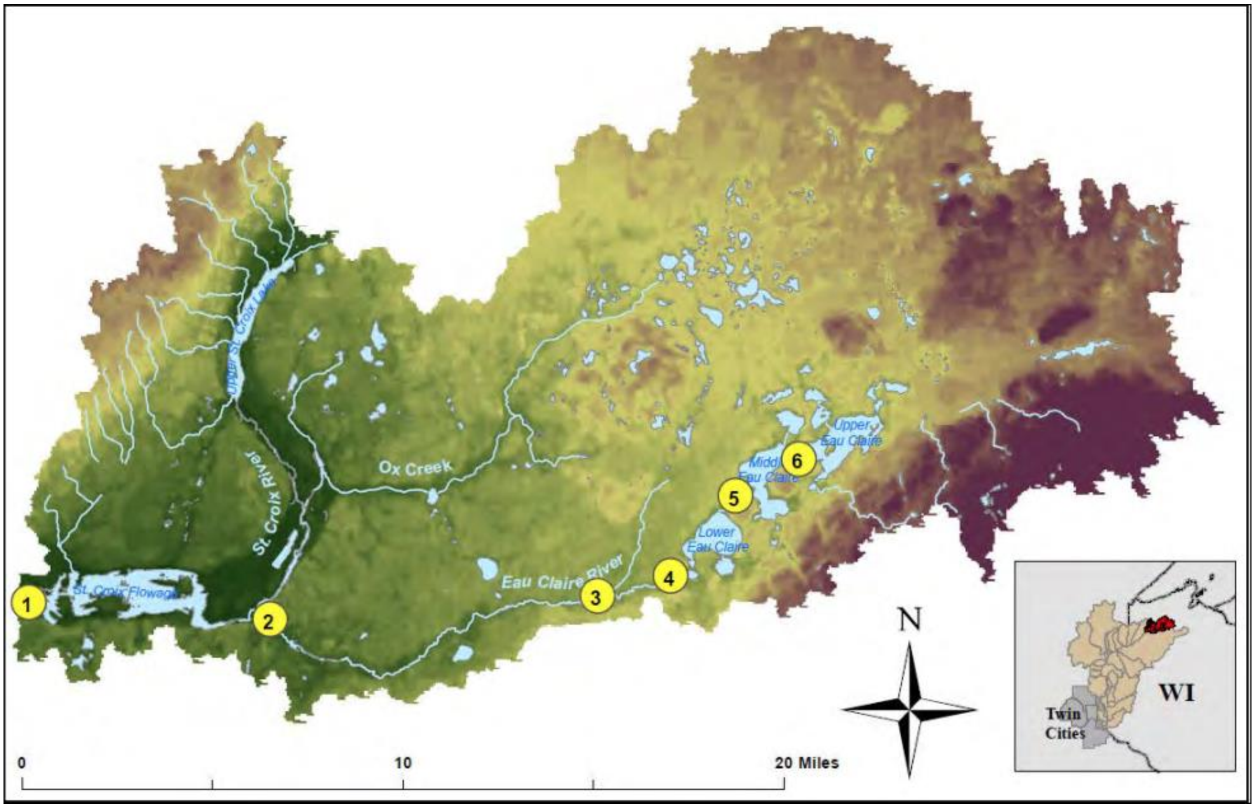

Figure 10: Dam locations for conceptual fish passage plans

Some of the individual lakes within the area of concern covered in this plan have additional fisheries data. Where the data exists, it should be included in the development of APM Plans for those lakes.

2.6 Recreational Use

Recreational use is extremely important in the watershed, providing social and related economic values. Social uses surveys have been performed for certain focused lake areas in the watershed and help characterize values associated with surface waters in the basin (Flowage Survey 2008; Lakes Survey 2006). Recreational activities most frequently identified include boating, swimming, fishing, scenery or wildlife observations and canoeing/kayaking. Surveys also suggest strong environmental interest with a desire to have quality lake environments. The survey of recreational interests for the St. Croix Flowage demonstrates local concern with high abundance of aquatic vegetation. This is not surprising since control of submerged vegetation is often an issue of discussion on mid-western lakes. St. Croix Flowage has particularly abundant vegetation given its shallow depths and clear water.

3.0 Wisconsin's Aquatic Plant Management Strategy

There are many techniques for managing 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. Because aquatic plants are recognized as a natural resource to be protected, managed, and used wisely, 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 often required by the State of Wisconsin.

The Public Trust Doctrine is the driving force behind all management, plant or other, in Wisconsin lakes. Protecting and maintaining Wisconsin's lakes for all of Wisconsin's people are at the top of the list in determining what is done and where. Two other factors that reflect Wisconsin's changing attitude toward aquatic plants. One is a growing realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem; and the other is the concern over the spread of AIS.

3.1 Integrated Pest Management

Integrated Pest Management (IPM) is an ecosystem-based management strategy that focuses on long-term prevention and/or control of a species of concern. Adapted for aquatic plant management, IPM considers all the available control practices such as: prevention, biological control, biomanipulation, nutrient management, habitat manipulation, substantial modification of cultural practices, pesticide application, water level manipulation, mechanical removal and population monitoring (Figure 11). In addition to monitoring and considering information about the target species' life cycle and environmental factors, groups can decide whether the species' impacts can be tolerated or whether those impacts warrant control. Then, an IPM-based plan informed by current, comprehensive information on pest life cycles and the interactions among pests and the environment can be formed. If control is needed, data collected on the species and the waterbody will help groups select the most effective management methods and the best time to use them.

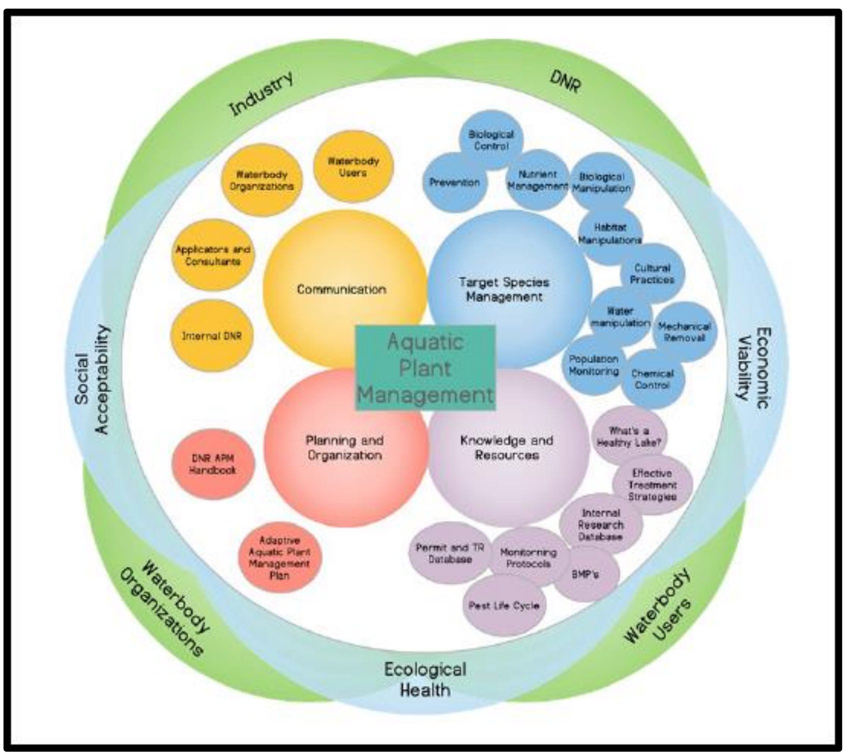

Figure 11: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

The most effective, long-term approach to managing a species of concern is to use a combination of methods. Approaches for managing pests are often grouped in the following categories:

- **Assessment** – is the use of learning tools and protocols to determine a waterbodies' biological, chemical, physical and social properties and potential impacts. Examples include: point-intercept (PI) surveys, water chemistry tests and boater usage surveys. This is the most important management strategy on every single waterbody.
- **Biological Control** – is the use of natural predators, parasites, pathogens and competitors to control target species and their impacts. An example would be beetles for purple loosestrife control.
- **Cultural controls** – are practices that reduce target species establishment, reproduction, dispersal, and survival. For example, a Clean Boats, Clean Waters program at boat launches can reduce the likelihood of the spread of species of concern.
- **Mechanical and physical controls** – can kill a target species directly, block them out, or make the environment unsuitable for it. Mechanical harvesting, hand pulling, and diver assisted suction harvesting are all examples.
- **Chemical control** – is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Groups should use the most selective pesticide that will do the job and be the safest for other organisms and for air, soil, and water quality.

IPM is a process that combines informed methods and practices to provide long-term, economic pest control. A quality IPM program should adapt when new information pertaining to the target species is provided or monitoring shows changes in control effectiveness, habitat composition and/or water quality.
While each situation is different, eight major components should be established in an IPM program:

1. Identify and understand the species of concern
2. Prevent the spread and introduction of the species of concern
3. Continually monitor and assess the species' impacts on the waterbody
4. Prevent species of concern impacts
5. Set guidelines for when management action is needed
6. Use a combination of biological, cultural, physical/mechanical and chemical management tools
7. Assess the effects of target species' management
8. Change the management strategy when the outcomes of a control strategy create long-term impacts that outweigh the value of target species control.

4.0 Management Alternatives

Nuisance aquatic plants can be managed a variety of ways in Wisconsin. The best management strategy will be different for each lake and depends on which nuisance 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 such as CLP and 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
- 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. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant. It is illegal to put any chemical into waters of Wisconsin without a chemical application permit from the WDNR. Some forms of physical removal, specifically suction harvest and mechanical harvesting also require 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 WDNR permits. They may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Informed decision-making related to 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.

4.1 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 CLP and 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 J. , 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 J. , 2000).

4.2 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. As a general rule though, these activities can only occur in a zone that is no more than 30-ft wide and adjacent to a pier or lake use area (Figure 12). 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 habits, it also creates open areas for non-native species to establish.

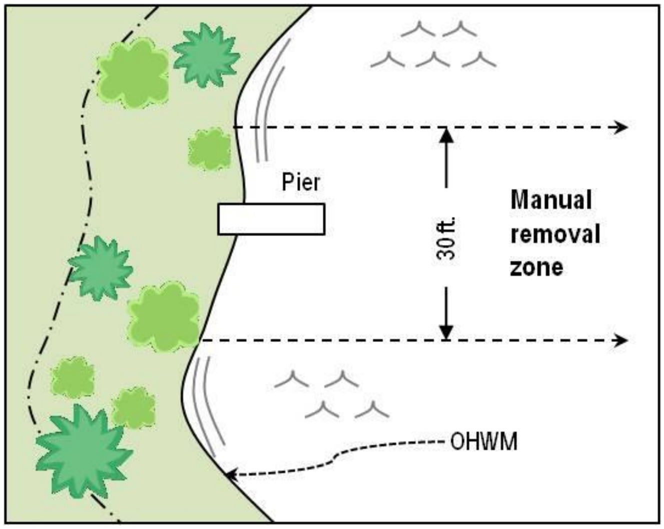

Figure 12: Aquatic vegetation manual removal zone

Physical removal of aquatic plants does require 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.

4.3 Diver Removal

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 AIS infestation within a lake when done properly.

4.4 Diver Assisted Suction Harvest

Diver Assisted Suction Harvesting (DASH) is a hand removal method that requires a diver to handfeed the offending vegetation into an underwater suction tube once removed from the lake bottom. DASH is considered mechanical harvesting as it requires the assistance of a mechanical system to implement (Figure 13). DASH increases the ability of a diver to remove the offending vegetation from a larger area, faster, but also requires a Mechanical Harvesting permit from the WDNR. The cost to implement DASH is also more expensive than employing a diver alone. A DASH boat consists of a pontoon boat equipped with the necessary water pump, catch basin, suction hose, and other apparatus (Figure 13). Estimates to build a custom DASH boat, range from $15,000.00 to $20,000.00. Contracted DASH services usually run in the $2,000.00 to $3,000.00 per day range.

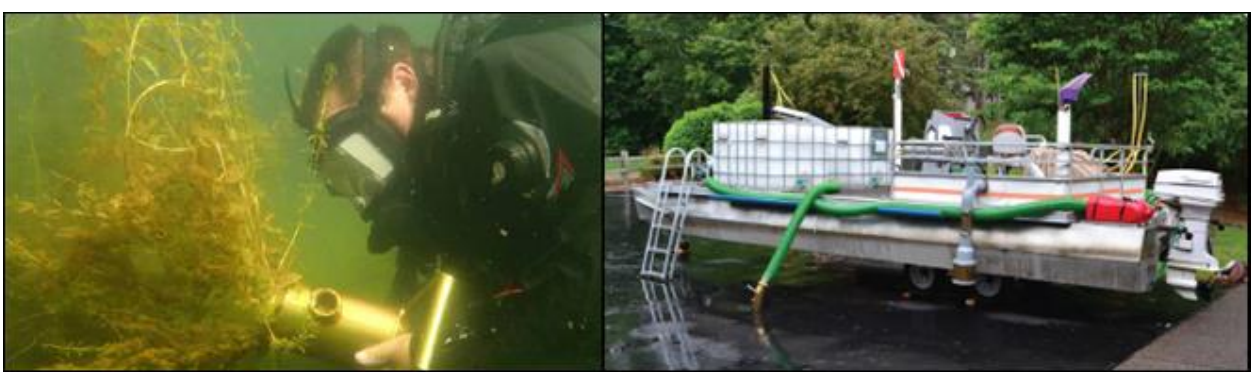

Figure 13: DASH – Feeding EWM into the underwater Suction Hose (Marinette Co.); and a sample DASH Pontoon Boat (Beaver Dam Lake Management District)

4.5 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. Diver Aided Suction Harvest (DASH) is considered mechanical removal. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control permit is required annually, although the WDNR is now offering multi-year harvesting permits in some instances. The permit application is reviewed by the WDNR and other entities and 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.

4.5.1 Large-scale Mechanical Harvesting

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 14). 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 depending on the machine, 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). An average harvester can cut between 2 and 8 acres of aquatic vegetation per day. The average lifetime of a mechanical harvester is 10 years.

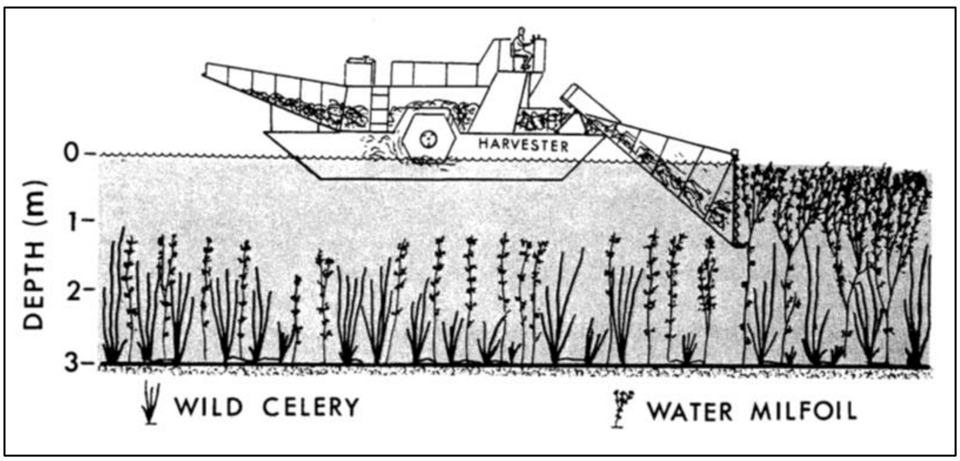

Figure 14: How a mechanical harvester works (Engle, 1987)

Harvesters can remove thousands of pounds of vegetation in a relatively short time period. They are not, however, species specific. Everything in the path of the harvester will be removed, including the target species, other plants, macro-invertebrates, semi-aquatic vertebrates, forage fishes, young-of-the-year fishes, and even adult game fish found in the littoral zone (Booms, 1999). Plants are cut at a designated depth, but the root of the plants is often not disturbed. Cut plants will usually grow back after time, and re-cutting several times a season is often required to provide adequate annual control (Madsen J. , 2000).

Harvesting activities in shallow water can re-suspend bottom sediments into the water column releasing nutrients and other accumulated compounds (Madsen J. , 2000). Even the best aquatic plant harvesters leave some cutting debris in the water to wash up on the shoreline or create loose mats of floating vegetation on the surface of the lake. This "missed" cut vegetation can potentially spread offending vegetation as it floats around the lake and establishes in new sites. Floating mats of "missed" cut vegetation can pile up on shorelines creating another level of nuisance that property owners may have to deal with.

A major benefit of aquatic plant harvesting however, is the removal of large amounts of plant biomass from a water body. This large-scale removal can help reduce organic material build up in the bottom of the lake over time and even help to improve water clarity and reduce phosphorus loading. Also, once a permit for mechanical harvesting has been approved, harvesting can occur in the approved areas as often as necessary to manage the vegetation.

The results of mechanical harvesting - open water and accessible boat lanes - are immediate, and can be enjoyed without the restrictions on lake use which follow some 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 build-up of organic material that normally occurs as a result of the decaying of this plant matter is reduced. Additionally, repeated harvesting may result in thinner, more scattered growth.

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 and 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 or other plant parts with them, and facilitate the spread of aquatic invasive species from one body of water to another.

Large-scale mechanical harvesting is commonly used for control of CLP, and in the absence of other management alternatives or conditions that prevent the use of other management alternatives, can also be an effective way to reduce EWM biomass in a water body.

4.5.1.1 Harvesting Totals and Estimated Costs (Owning versus Contracting Services)

Costs per acre vary with numbers of acres harvested, accessibility of disposal sites to the harvested areas, density and species of the harvested plants, and whether a private contractor or public entity does the work. Costs as low as $250 per acre have been reported. Private contractors generally charge $500 to $800 per acre or $2000 to $3000 per day. The purchase price of new harvesters ranges from $75,000 to $300,000. There are several harvester manufacturers in the United States (including at least two in Wisconsin) and some lake groups may choose to operate and purchase their own machinery rather than contracting for these services.

In the last several years, more companies have started offering contracted mechanical harvesting, DASH, and physical removal services. Several companies are located in the northern half of Wisconsin including TSB Lakefront Restoration and Diving (New Auburn, WI) and Aquatic Plant Management (Minocqua, WI). Several other companies exist in southeastern WI, the Twin Cities area, and even in northern Illinois. Most of the services they offer run about $2,500-$3,500.00 per day.

There are benefits and drawbacks for both contracted harvesting and purchasing a harvester outright. With contracted harvesting, the cost per acre can vary depending on vegetation density, distance between the area being harvesting and the off-loading site, and the distance to the designated disposal site. Another issue is timing. When contracted harvesting takes place, is likely going to be dependent on the availability of the contractor, not necessarily on when the best time to complete harvesting is. There are many benefits to contracted harvesting, the biggest one being the reduced costs associated with contracting. There is no large outlay of funds for purchasing a harvester, no maintenance and storage costs, no insurance costs, and there are reduced costs or no costs if, in any given year, there is less or no harvesting completed.

Purchasing is the more expensive option due to not only the initial cost of purchase, but also insurance, storage, maintenance, and an operator's salary (unless volunteer operated). However, there are many benefits to purchasing.

Purchasing a harvester eliminates the potential for new AIS to be introduced to the lake from the harvester, the cost per acre tends to go down the longer a harvester is operational, and these costs will not increase dramatically if the amount of vegetation being harvested increases. This also allows harvesting to be done during the best times as well as providing a way to maintain navigation channels throughout the summer. The biggest drawbacks to purchasing a harvester are the increased up-front cost and the annual costs associated with maintaining the harvester. Even during years with less harvesting, the maintenance, storage, and other miscellaneous costs will remain around the same as those costs would be during years that require large amounts of harvesting.

4.5.2 Small-Scale Mechanical Harvesting

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. Using a weed rake or cutter that is run by human power is allowed without a permit, but the use of any device that includes a 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 actively used 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.

A more recent option for small-scale mechanical harvesting of aquatic plants is using a "mini" harvester that is remote-controlled. Weeders Digest currently offers two versions of a remote controlled mini mechanical harvester, the WaterBug and the WaterGator.

The WaterBug (Figure 15) is 5.4' wide by 11' 9" long but weighs only 370 lbs. and boasts a storage bunk capacity of 600 lbs. This makes it easy for one person to use as it fits on a compact trailer that can be pulled behind a 4-wheeler or garden tractor. It floats in as little as 4" of water and can cut and skim 34" wide, is adjustable to 15-16" water depth by remote control (can be set manually to a depth of 24"), and features long-lasting batteries that can operate 5 hours on a single charge.

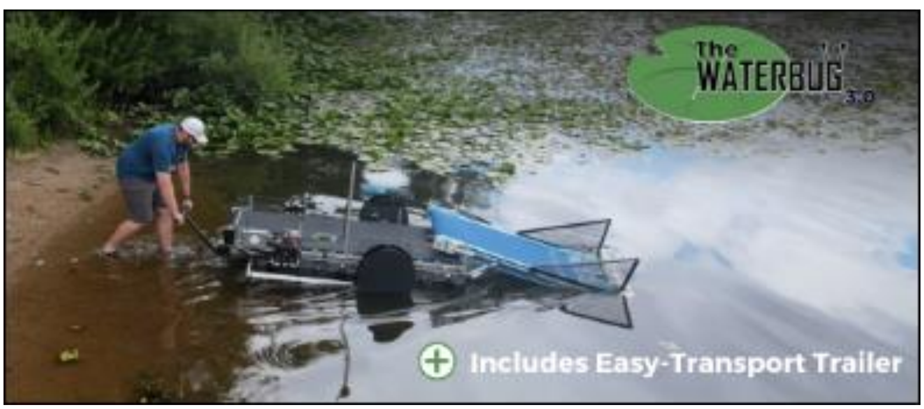

Figure 15: WaterBug remote-controlled aquatic plant harvester (https://lakeweedharvester.com/waterbug/)

The WaterGator (Figure 16) features the same technology as the WaterBug including a harvesting camera that shows the operator what the WaterGator sees on the remote viewing screen. The WaterGator cuts, skims, and collects aquatic vegetation. It is easy for any user to operate, and it is extremely versatile, with a cutting range reaching 3-1/2 feet deep, and a generous cutting and skimming width of 42 inches. It has a storage bunk capacity of 1,200 lbs. double that of the WaterBug. The WaterGator is battery powered, and provides the operator with 8-plus hours of run time on a single charge. The WaterGator is designed for larger ponds, lake shores, channels, and other medium size bodies of water.

The cost of a WaterBug is estimated at around $17,000.00. The cost of a WaterGator is about double that at $35,000.00. Table 2 compares the two different machines.

Figure 16: WaterGator remote-controlled aquatic plant harvester (https://lakeweedharvester.com/watergator/)

One Lake District in Barron County, WI purchased a WaterGator in 2022 to help them implement an aquatic plant harvesting program, in their case, navigation and access lanes through dense growth watershield and other native vegetation. Prior to the purchase of a WaterGator, this group used a pontoon-mounted, cutting bar to cut vegetation, and then used rakes to collect the cut material. After a full season of use, the main operator had this to say about the WaterGator.

"The harvester worked well, given how its' made but it could easily use some improvements. The paddle wheels seem undersized in that they don't seem to really bite the water as efficiently as they might so it takes too long to get from one location on the lake to another and it flounders around when there's a breeze. But maybe a better operator could help. One time I took the pontoon boat and pushed the harvester across the lake and I've rigged a harness for towing. I'd like to see us putting on an operator's platform. With the glare from the sky, it's hard to see where to cut, with the view through the TV camera in many instances. And I have to wonder if the relatively smooth belt is as efficient as a different type might be. No problem picking up lilies but watershield seems to pile up in front of the take-up belt so at times I stop and tilt the belt up in order to get the watershield to load onto it and consequently get dumped into the storage bunk/belt. So it's not everything I hoped for but a definite step in the right direction."

Joel Meyer, Kirby Lake Management District.

The company that builds and markets both the WaterBug and WaterGator is located in the Twin Cities area of MN. They promote the two mini harvesters as able to "cut, skim, and collect" aquatic vegetation. If permitted by the WDNR, either machine could provide some level of nuisance relief for CLP, removal of surface mats of filamentous algae, and aesthetic improvements of a shoreline.

4.6 Habitat Alteration

4.6.1 Bottom Barriers and Shading

Physical barriers, fabric or other, placed on the bottom of the lake to reduce the growth of AIS would likely eliminate all plants, inhibit fish spawning, affect benthic invertebrates, and could cause anaerobic conditions which may release excess nutrients from the sediment. Gas build-up beneath these barriers can cause them to dislodge from the bottom and sediment can build up on them allowing AIS to re-establish. Bottom barriers are typically used for very small areas and provide only limited relief. Currently the WDNR does not permit this type of control.

Creating conditions in a lake that may serve to shade out plant growth has also been tried with mixed success. The general intention is to reduce light penetration in the water which in turn limits the depth at which plants can grow. Typically dyes have been added to a small water body to darken the water.

4.6.2 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 CLP 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. It should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen J. , 2000).

4.6.3 Drawdown

Dropping the lake level to allow for the desiccation, aeration, and freezing of lake sediments has been shown to be an effective aquatic plant management technique. Repeated drawdowns lasting 4 to 6 months that include a freezing period are the most effective.

Control of aquatic plants in these cases can last a number of years. The low lake levels may negatively affect native plants, provides an opportunity for adventitious species such as annuals, often reduces the recreational value of a waterbody, and can impact the fishery if spawning areas are affected. The cost of a drawdown is dependent on the outlet of the lake; if no control structure is present, pumping of the lake can be cost prohibitive whereas costs can be minimal if the lake can be lowered by opening a gate.

4.7 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. There are no biological controls available for the management of CLP.

4.7.1 Galerucella Beetles

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 17). 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 17: 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 many of the public wetlands around Wisconsin. Because rearing these beetles requires the cultivation of a restricted species, a permit is necessary. Raising Galerucella beetles is not difficult and can be done by individual volunteers, schools, and other groups.

4.7.2 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 18). 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 et al. (1996).

Figure 18: 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. If it has not been done already, a weevil survey could be completed on both Sand Bar and Tomahawk Lakes. If weevils are already present, it is not inconceivable that a weevil rearing project could be instigated.

4.7.3 Native Plant Restoration

A healthy population of native plants might slow invasion or reinvasion of non-native aquatic plants. It should be the goal of every management plan to protect existing native plants and restore native plants after the invasive species has been controlled. In many cases, a propagule bank probably exists that will help restore native plant communities after the invasive species is controlled (Getsinger et al (1997).

4.8 Chemical Control

Aquatic herbicides are granular 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.

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 Department 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 mean that, in most cases, the herbicide will be degraded and gone by the time peak recreation on the water starts.

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application, 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).

4.8.1 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 (chemical reactions caused by sunlight exposure) processes.

4.8.2 Small-scale Herbicide Application

Small-scale herbicide application involves treating areas less than 10 acres in size. Small-scale chemical application is usually completed in the early season (April through May). Research related to 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. As such, chemically treating areas less than 5.0 acres in size is generally not recommended.

4.8.2.1 Small-scale Use of Herbicides to Control AIS

Concern on the part of the WDNR regarding the use of small-scale herbicide applications to control CLP or EWM has been expressed for several years. As an example, during the most recent Aquatic Plant Management Industry Meeting held January 31, 2023 concerns were expressed specifically to the use of Aquathol K (liquid endothall) and Aquathol Super K (granular endothall) at lower rates for spot treatments due to rapid dissipation of the product(s). This is especially true when the effects of dilution are great enough to affect contact times. There are concerns that when CLP distribution is sporadic throughout a lake, treatment sizes are so small that the efficacy of Aquathol K and Aquathol Super K may be compromised due to rapid dilution.

Back in 2013, United Phosphorus, Inc. (UPI), the makers of Aquathol K and Super K, met with the WDNR to discuss some basic strategies for the use of Aquathol K and Aquathol Super K in Wisconsin Lakes (Meganck, Skogerboe, & Adrian, 2013). UPI suggested using a minimum threshold of five acres for Aquathol K and Aquathol Super K when controlling CLP when employed in managing it on a whole lake basis. Several key points were agreed upon based on recent research involving the application of Aquathol products for CLP spot treatments where herbicide concentrations were monitored over time:

1) Identifying the spatial distribution of CLP is important to proper whole-lake management scenarios. The success of a CLP management project can hinge on whether treatments are applied in the appropriate areas. Therefore, accurate and up-to-date information is needed to assure that product selection and dosage is appropriate.

2) Split applications may be needed on spot treatments rather than one application to assure product has sufficient contact time. Ex: A smaller 3 acre shoreline treatment, apply 1.5ppm in first part of treatment, and 1.5ppm in second part of treatment, either hours later or following day depending on risk of dissipation.

3) When applying herbicide on spot treatments, treatment size must be sufficient to counter dilution effects. Spot treatments may need to be expanded to minimum 5 acre treatment polygons when target species are sporadically located. Spot treatments that are greater than five percent of the total lake area, whole-lake herbicide concentrations should be calculated.

4) When the goal is a whole-lake treatment, application of product should not be applied at a rate higher than the suggested rate of control for non-target species, if they are present. Application rates can be applied at higher rates over weed beds, if natives are not present.

5) Aquathol Super K will not hold the herbicide in the area longer, and is not more effective than Aquathol K. Dissipation of both products is similar in the lake environment.

Similar views have been expressed about the use of 2,4D or triclopyr based aquatic herbicides for control of EWM. Small-scale applications tend to dissipate rapidly minimizing effective results, granular herbicides do not provide any greater contact time than liquid herbicides, and large-scale and whole-lake applications with long target species contact time expected should require a lower application rate. Like endothall and CLP, areas to be treated with 2,4D or triclopyr projects should be at least 5 acres in size. Smaller treatment areas are likely to be less effective, and possibly denied by the WDNR when considering chemical permit applications and/or requests for grant funding. For both endothall and 2,4D-based aquatic herbicides, the desired target species contact time is between 18 and 36 hours, with the greater contact times more desirable.

ProcellaCOR, used more and more for the control of EWM, requires a much lower target species/herbicide contact time – down to only 2-4 hours. Even so, treatment areas of at least an acre are recommended by the WDNR.

4.8.2.1 Small-scale Limno-Barrier Application

Small-scale herbicide applications can be made more effective by installing a limno-barrier or curtain around a treatment area to help hold the applied herbicide in place, longer. By doing so, the herbicide/target species contact time is increased. The curtain is generally a continuous sheet of plastic that extends from the surface to the bottom of the lake (Figure 19). The surface edge of the curtain is generally supported by floatation devices. The bottom of the curtain is held in place by some form of weighting. The curtain or barrier, sometimes thousands of feet of it, is installed around the proposed treatment area with the purpose of holding the herbicide in place longer by preventing dilution and drift away from the treated area (Figure 20).

Figure 19: Limno-curtain material on a roll before installation (photo from Marinette Co. LWCD)

Figure 20: Limno-curtain installed on Thunder Lake (photo from Marinette Co. LWCD)

In the Thunder Lake, Marinette County limno-curtain trial completed in 2020, a curtain was installed around two small areas (0.9 and 2.9 acres) of dense growth EWM prior to chemical treatment. Liquid 2,4-D was applied at 4.0ppm inside the barrier. The barriers stayed in place until 48 hours after treatment. Herbicide concentration testing was completed within the treated areas to determine how long the herbicide stayed in place and at what concentration. Figure 21 reflects what happened to the herbicide that was applied. Herbicide concentrations stayed relatively high for a longer period of time (48 hrs). Once the curtain was removed, the herbicide dissipated rapidly.

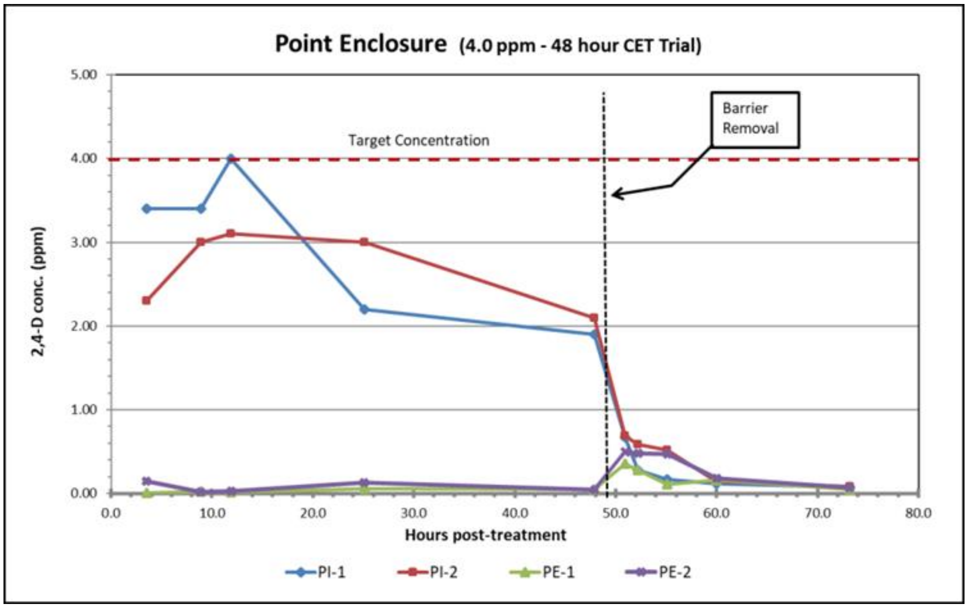

Figure 21: Herbicide concentration results from 2020 Thunder Lake limno-curtain trial (Marinette Co LWCD)

4.8.3 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 CLP or EWM while minimizing impacts on native species. It is generally accepted that with large-scale applications 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.

4.8.4 Whole-Lake Application

Whole-lake or whole-basin treatments are those where the herbicide may be applied to specific sites, but the goal of the strategy is for the herbicide to reach a target concentration when it equally distributes throughout the entire volume of the lake (or lake basin). The application rate of whole-lake treatments is dictated by the volume of water in with which the herbicide will reach equilibrium. Because exposure time is expected to be so much longer, effective herbicide concentrations for whole-lake treatments are significantly less than required for spot treatments. Whole-lake treatments are typically conducted when the target plant is spread throughout the majority of the lake or basin.

If the herbicide exposure time of the target aquatic plant can be extended, the concentration of the herbicide applied can be lowered. If the contact time between the applied herbicide and the target plant in a whole body of water or protected bay can be increased to, or is already expected to be several days to a week or more, the concentration of herbicide like 2,4-D can be in the range of 0.25-0.5 ppm instead of the 2-4 ppm that is typically used in small-scale, spot, or micro treatments.

The method used to implement whole-lake treatments changes with the type of lake. Herbicide applied to a shallow, mixed lake is expected to mix throughout the entire volume of the lake. In deep water lakes that stratify herbicide can be applied at such a time when it is expected that it will only mix with the surface water above the thermocline in an area known as the epilimnion.

4.8.4.1 Concerns Related to Large-scale/Whole-lake Chemical Treatments

In 2020, the WDNR published a paper (Mikulyuk, et al., 2020) comparing the ecological effects of the invasive aquatic plant EWM with the effects of lake-wide herbicide treatments used for EWM control using aquatic plant data collected from 173 lakes in Wisconsin, USA. First, a pre–post analysis of aquatic plant communities found significant declines in native plant species in response to lake-wide herbicide treatment. Second, multi-level modeling using a large data set revealed a negative association between lake-wide herbicide treatments and native aquatic plants, but no significant negative effect of invasive EWM alone. Taken together, their results indicate that lake-wide herbicide treatments aimed at controlling EWM had larger negative effects on native aquatic plants than they did on the target of control-EWM.

While this study only included lakes that were chemically treating to control EWM, it does reveal an important management tradeoff and encourages careful consideration of how the real and perceived impacts of invasive species and the methods used for their control are balanced, likely even for CLP.

4.8.5 Common Aquatic Herbicides

ProcellaCOR® is a relatively new systemic, selective herbicide that can be used to target EWM with limited impact to most native species. It is also very fast acting, making it an effective control measure on smaller beds that may be too large for DASH, especially ones in high boat traffic areas and/or deeper water. In addition, applications rates are measured in ounces, not gallons as is common with almost all other liquid herbicides. And while it is more expensive to use than 2,4-D equivalents, it has been shown to provide two or more years of control without re-application.

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. Sonar is generally applied during a whole-lake application and is expected to be in the lake at very low concentrations for weeks or months once applied.

2,4-D and triclopyr are active ingredients in several selective herbicides including 2,4-D Amine 4®, Navigate®, DMA 4®, Renovate®, and Renovate Max G®. 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, glyphosate, 2,4-D, and triclopyr are all considered systemic. When applied to the treatment area, plants in the treatment area 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.

Aquathol® whose active ingredient is endothall and Reward® whose active ingredient is diquat 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. Neither of these is considered selective and has 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 CLP 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. Endothall based herbicides are the most commonly used herbicides for CLP control, but diquat can be used under the appropriate circumstances.

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.

4.8.6 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 may require pre and post chemical application aquatic plant surveying. 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 is done in the same year as the chemical treatment was completed or in the year after a chemical treatment was completed, sometimes both. A post-treatment survey should be scheduled when native plants are well established, generally mid-July through mid-August. For the post-treatment survey, the same points sampled in the pre-treatment survey will again be sampled. For whole-lake scale treatments, a full lake-wide PI survey should be conducted.

Continued implementation of pre and post-chemical treatment aquatic plant surveying is an important tool in determining the impacts of management actions on both the target and non-target species. It is equally important that APM Plans for a given lake identify specific goals for non-native invasive species and native plants species. Such goals for AIS 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.

4.8.7 Chemical Concentration Testing

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used. Concentration testing can help 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, days, weeks, or even months following chemical application.

5.0 Aquatic Invasive Species

To date, only EWM has been identified in both lakes. There are several other plant and animal non-native invasive species that volunteers and users of the lakes should be aware of. Most of these species are considered aquatic, although some are also considered shoreland or wetland type invasive species.

5.1 Non-native, Aquatic Invasive Plant Species

Eurasian watermilfoil is the most problematic non-native, aquatic invasive species in the lakes. It is a submerged vegetation species (rooted to the bottom of the lake and growing under the surface of the water) that has the potential to outcompete more desirable native aquatic plants. Curly-leaf pondweed is another submerged aquatic invasive species that is problematic in some lakes. It has not been identified in Sand Bar or Tomahawk Lake to date. Purple loosestrife, yellow flag iris, and reed canary grass are shoreland or wetland plants not generally problematic within the lake, but can be very problematic on the shores and in the wetlands adjacent to the lake. More information is given for each non-native species in the following sections.

5.1.1 Eurasian Watermilfoil

EWM (Figure 22) is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety 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; and 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 22: EWM complete root and stem and floating fragment with adventitious roots

5.1.2 Purple Loosestrife (*Lythrum salicaria)*

Purple loosestrife (Figure 23) 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.

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.

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 or shoreland area. 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 has not been identified in or around either lake, but volunteers should continue to be vigilant in looking for it. It has been identified on the Eau Claire Lakes.

Figure 23: Purple loosestrife

5.1.3 Yellow Flag Iris (Iris pseudacorus)

Yellow flag iris (Figure 24) is a showy perennial plant that can grow in a range of conditions from drier upland sites, to wetlands, to floating aquatic mats. A native plant of Eurasia, it can be an invasive garden escapee in Wisconsin's natural environments. Yellow flag iris can produce many seeds that can float from the parent plant, or plants can spread vegetatively via rhizome fragments. Once established it forms dense clumps or floating mats that can alter wildlife habitat and species diversity. All parts of this plant are poisonous, which results in lowered wildlife food sources in areas where it dominates. This species has the ability to escape water gardens and ponds and grow in undisturbed and natural environments. It can grow in wetlands, forests, bogs, swamps, marshes, lakes, streams and ponds. Dense areas of this plant may alter hydrology by trapping sediment and/or blocking flow.

Yellow iris has broad, sword-shaped leaves that grow upright, tall and stiff. They are green with a slight blue-grey tint and are very difficult to distinguish from other ornamental or native iris species. Flowers are produced on a stem that can grow 3-4 feet tall among leaves that are usually as tall or taller.

The flowers are showy and variable in color from almost white to a vibrant dark yellow. Flowers are between 3-4 inches wide and bloom from April to June. Three upright petals are less showy than the larger three downward pointing sepals, which may have brown to purple colored streaks.

Seeds are produced in fruits that are 6-angled capsules, 2-4 inches long. Each fruit may have over 100 seeds that start pale before turning dark brown. Each seed has a hard outer casing with a small air space underneath, which allows the seeds to float.

The roots are thick, fleshy pink-colored rhizomes spread extensively in good conditions, forming thick mats that can float on the surface of the water.

When not flowering, yellow flag iris could be easily confused with the native blue flag iris (*Iris versicolor*) as well as other ornamental irises that are not invasive. Blue flag iris is usually smaller and does not tend to form as dense clumps or floating mats. When not flowering or showing fruiting bodies, yellow flag iris may be confused with other wetland plants such as cattails (*Typha* spp.) or sweet flag (*Acorus* spp.) species.

Small populations may be successfully removed using physical methods. Care should be taken if hand-pulling plants as some people show skin sensitivity to plant sap and tissues. All parts of the plant should be dug out – particularly rhizomes and disposed of in a landfill or by burning. Cutting the seed heads may help decrease the plant spreading. Aquatic formulas of herbicides may be used to control yellow flag iris, however, permits may be needed. Foliar spray, cut stem/leaf application and hand swiping of herbicide have all shown effectiveness. It is unknown if there is any yellow flag iris on the shores of the two lakes, but monitoring for it will occur.

Figure 24: Yellow flag iris

5.1.4 Curly-leaf Pondweed (Potamogeton crispus)

Curly-leaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. 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. By early July, the plant completes its life cycle, dies, and drops to the lake bottom (Figure 25). 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.

CLP spreads through burr-like winter buds (turions), which are moved among waterways (Figure 26). 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 26). To date, no CLP has been found in either lake.

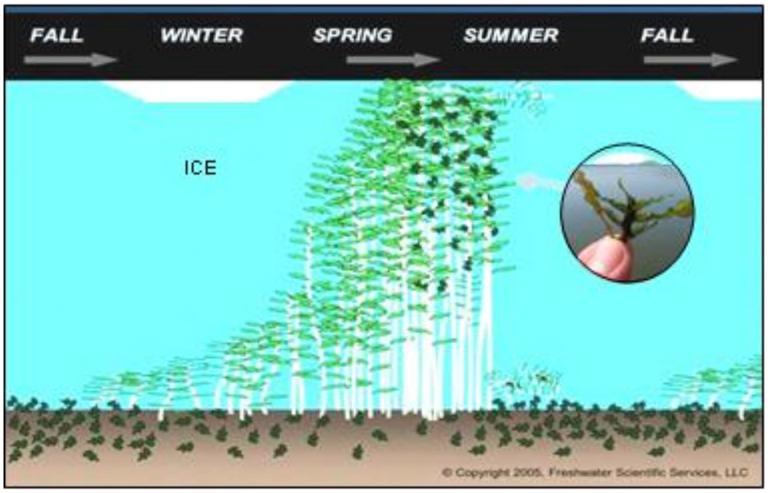

Figure 25: Diagram showing annual CLP life-cycle in northern lakes (Freshwater Scientific Services, 2008).

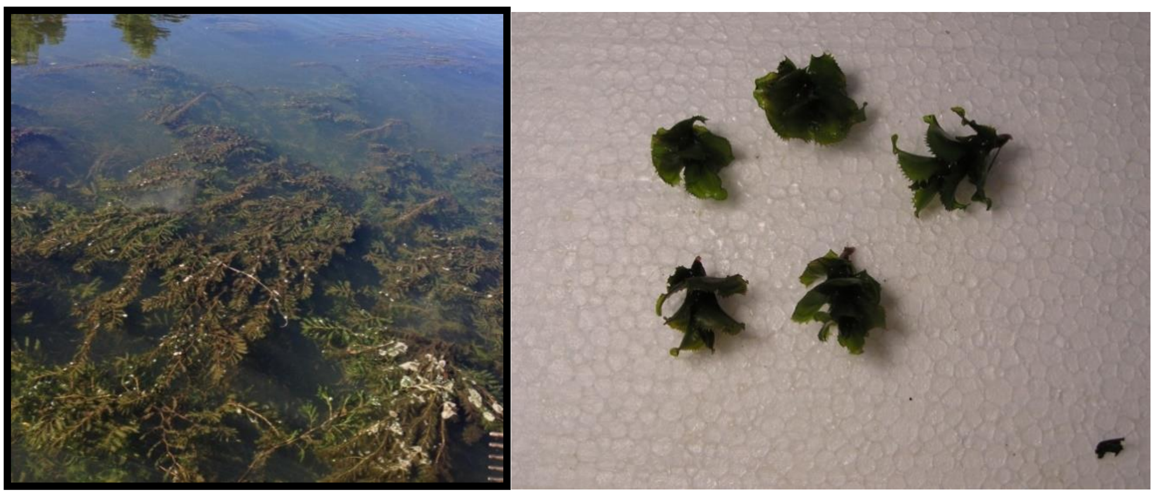

Figure 26: CLP plants and turions

5.1.5 Narrow-leaf Cattail, Reed Canary Grass, Giant Reed Grass, and Japanese Knotweed

The following species could be introduced to the lake and should be monitored for (Figure 27).

5.1.5.1 Narrow-leaf Cattail (*Typha angustifolia*)

Narrow-leaf cattails have leaves that are erect, linear, and flat. The leaf blades are 0.15-0.5" wide, and up to three feet long. About 15 leaves emerge per shoot that are dark green in color and rounded on the back of the blade. The top of the leaf sheath has thin, ear-shaped lobes at the junction with the blade that usually disintegrates in the summer. Numerous tiny flowers are densely packed into a cylindrical spike at end of the stem that is divided into the upper section of yellow, male flowers and the lower brown, sausage-shaped section of female flowers. The gap between male and female sections is about 0.5-4" in narrow-leaved cattail. They flower in late spring. These plants also reproduce vegetatively by means of starchy underground rhizomes that form large colonies.

For more information about narrow-leaf cattail including how to control it, go to: https://dnr.wisconsin.gov/topic/Invasives/fact/NarrowLeavedCattail.html.

5.1.5.2 Reed Canary Grass (*Phalaris arundinacea*)

Reed canary grass is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades. Blades are flat and have a rough texture on both surfaces. Single flowers occur in dense clusters from 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.

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.

For more information about reed canary grass including how to control it, go to: https://dnr.wisconsin.gov/topic/Invasives/fact/ReedCanaryGrass.html.

5.1.5.3 Common Reed Grass (*Phragmites australis*)

Often just called phragmites, common reed grass is a perennial wetland grass that grows three to 20 feet tall with dull, very slightly ridged, stiff and hollow stems. It creates dense clones where canes remain visible in winter. Leaf sheaths tightly clasp the stem, are difficult to remove, and stay on throughout the winter. Its flowers are bushy, light brown to purple plumes that are composed of spikelets that bloom July-September. The plumes are 7.5-15 inches long and resemble feather dusters. It roots are stout, oval rhizomes that can reach up to six feet deep into the ground and 10 feet horizontally.

For more information about common reed grass including how to control it, go to: https://dnr.wisconsin.gov/topic/Invasives/fact/Phragmites.html.

5.1.5.4 Japanese Knotweed *(Fallopia japonica or Polygonum cuspidatum)*

Japanese knotweed is an herbaceous perennial that forms large colonies of erect, arching stems (resembling bamboo). Stems are round, smooth and hollow with reddish-brown blotches. Plants reach up to 10’ and the dead stalks remain standing through the winter.

New infestations of Japanese knotweed often occur when soil contaminated with rhizomes is transported or when rhizomes are washed downstream during flooding. It poses a significant threat to riparian areas where it prevents streamside tree regeneration and increases soil erosion. Root fragments as small as a couple of inches can resprout, producing new infestations. The plant can disrupt nutrient cycling in forested riparian areas, and contain allelopathic compounds (chemicals toxic to surrounding vegetation).

For more information about reed canary grass including how to control it, go to: https://dnr.wisconsin.gov/topic/Invasives/fact/JapaneseKnotweed.html.

Figure 27: Narrow-leaf cattail (upper left), Reed canary grass (upper right), Phragmites (lower left), and Japanese knotweed (lower right)

5.2 Non-native Aquatic Invasive Animal Species

Several non-vegetative, aquatic, invasive animal species could be introduced to the lakes, but have not been identified at the present time. It is important for lake property owners and users to be knowledgeable of these species in order to identify them if and when they show up.

5.2.1 Chinese and Banded Mystery Snails

Banded mystery snails have been identified in Tomahawk Lake. Chinese snails have not been identified in either lake, but have been identified in the Eau Claire Lakes.

The Chinese mystery snails and the banded mystery snails (Figure 28) 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 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 algae and phytoplankton. Thus removal of plants in your 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.

Many lake residents are worried about mystery snails being 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.

Figure 28: Chinese (left) and Banded (right) Mystery Snails

5.2.2 Rusty Crayfish

Rusty crayfish have not been identified in either lake, but are in the Eau Claire Lakes.

Rusty crayfish (Figure 29) 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.

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.

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.

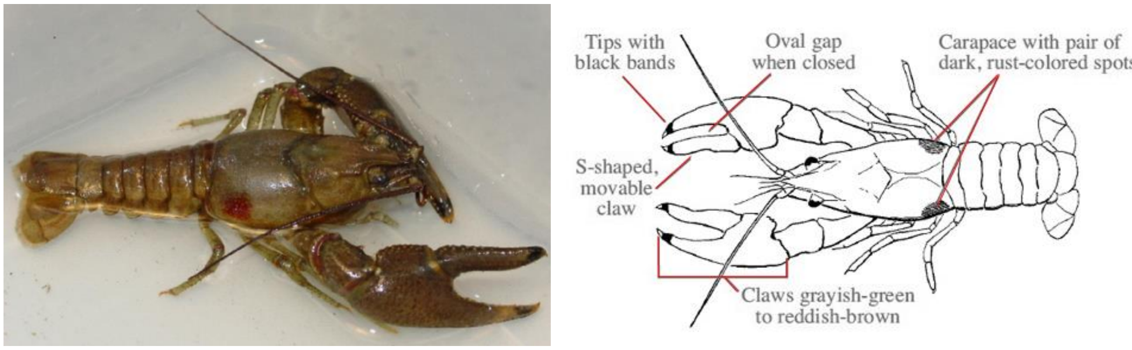

Figure 29: Rusty Crayfish and identifying characteristics

5.2.3 Zebra Mussels

Zebra mussels have not been identified in either lake. The closest populations of zebra mussels are in Lake Superior and Big and Middle McKenzie lakes on the Burnett/Washburn County line just a few miles west of Spooner, WI.

Zebra mussels (Figure 30) 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 the 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.

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. Recently, the WDNR has supported the installation of Decontamination Stations at public boat landings. The main purpose for these stations is to prevent the spread of zebra mussels by encouraging boaters to spray their watercraft down with a light bleach and water combination. Draining all water from the boat and livewells is also important.

Figure 30: Zebra Mussels

5.3 AIS Prevention Strategy

In 2020, Bayfield County passed an Ordinance (Title 16, Chapter 2 Aquatic Invasive Species) for the purpose of establishing a local program to prevent the spread of aquatic invasive species in Bayfield County. The Ordinance requires that boaters do the following:

- No person may transport any watercraft and its associated trailer or boating equipment from navigable waters onto a public highway if aquatic plants or animals are attached, or to do so in violation of an order from a law enforcement officer who has reason to believe that aquatic plants or animals are attached, except as provided in Section 16-2-4.
- If a decontamination station is available for use at a public or private access, the boater shall decontaminate per posted directions and/or inspection protocol using the decontamination station provided.
- This section shall not apply to bait used on that particular waterbody in accordance with Wisconsin Department of Natural Resources (DNR) rules and regulations.

Bayfield County also has a county-wide AIS Coordinator who works with area lake groups to complete monitoring, education and training, and management planning and implementation support.

The Town of Barnes created an AIS Committee in 2006 that helps guide AIS management planning and implementation in approximately 27 lakes within the confines of the Town of Barnes, and in several adjacent lakes in neighboring counties. The Committee is made up of both Town of Barnes officials and representatives from the area lakes.

The Friends of the Eau Claire Lakes Area provide volunteer and monetary support for both water quality and AIS monitoring, have representation on the Barnes AIS Committee, and conduct educational and informational activities for students and adults the live in or visit the area.

Sand Bar and Tomahawk currently have EWM. EWM was documented in George Lake more than a decade ago, but with active management, has not been found in the lake since. The Eau Claire Lakes have several different AIS including curly-leaf pondweed, rusty crayfish, Chinese and banded mystery snails, and purple loosestrife. However there are many more AIS that could be introduced to the area lakes. The Town of Barnes and the other entities mentioned will continue to implement a watercraft inspection and AIS Signage program at the public access point on area lakes. Information will be shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program will be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network Aquatic Invasive Species Monitoring program.

Additionally, having an educated and informed lake constituency is the best way to keep non-native aquatic invasive species at bay in area lakes. To foster this, lake community events including AIS identification and management workshops; distribution of education and information materials to lake property owners and lake users; newsletters, webpage postings, and general mailing will be completed annually.

6.0 Healthy Lakes and Rivers Initiative

The Healthy Lakes Initiative is a program that has been set up by the WDNR to provide support through information and grant funding to small scale projects that will help improve both shoreline habitat and lake health. The grants available for these projects are intended for fairly small, inexpensive projects, so there is $1000 limit in grant funding per project. This program is focused on helping individual property owners improve their shoreline. There are five projects that are eligible for Healthy Lakes Grants. The projects that qualify for these grants are installing fish sticks, rain gardens, native plantings, diversions, and rock infiltrations.

6.1 Fish Sticks Installation

Fish Sticks involve taking trees from the inland area of the lake, and installing them in the lake to mimic shore trees that will eventually fall into the lake (Figure 31). The trees used must be taken from a minimum of 35 feet inland and are then secured to the shore with cables for approximately 3 years. This provides habitat for fish, birds, and many other animals. In addition to providing habitat, fish sticks help protect the shoreline from bank erosion. Fish sticks project costs range anywhere from $100 to $1000, averaging about $500. These are very low maintenance because it is only necessary to occasionally check the cables to ensure they are secure. Despite the presence of abundant "standing" trees along the shore due to high water, adding larger trees that reach out past this area, would benefit lake habitat even in periods of lower water.

Figure 31: Fishsticks installation (left) and after ice out (right)

6.2 Rain Gardens

Rain gardens are shallow depressions that contain loose soil and native plants (Figure 32). These are intended to capture the runoff, allowing the water to be filtered, naturally through the ground instead of flowing directly into the lake. Rain gardens are designed to allow the rainwater to soak into the ground with 1-2 days, to prevent any of the issues created by standing water. The project cost for rain garden range anywhere from $500 to $9,500, but this is very dependent on the size of the rain garden. The maintenance is fairly low, only requiring watering for about two weeks, until the plants have established, and weeding is occasionally needed during the first year. This project is best suited to parcels on a smaller incline to catch rainwater runoff that would otherwise run into the lake.

Figure 32: Rain garden installation (left) and upon completion (right)

6.3 Native Plantings

Native plantings (Figure 33) are intended to establish a buffer zone between the developed portion of a parcel and the lake. The buffer helps filter and slow rainwater runoff so much of it filters into the ground. This buffer zone is created by changing a strip of turf grass, at least ten feet wide, along the shoreline to a natural area composed of native shoreline plants. Similar to rain gardens, these are fairly low maintenance requiring water only until the plants have become established. The only ongoing maintenance is the removal of any invasive species that find their way into the planting. On average, native plantings cost around $1000. This project will work for almost any developed parcel that does not have a sand beach as the primary frontage.

Figure 33: Completed native planting (photo from HealthyLakesWI.com)

6.4 Diversions

Diversions (Figure 34) are placed across a sloping path or driveway to divert runoff water to an area where it can be absorbed into the ground instead of flowing directly into the lake. In addition to helping improve lake health, these can also reduce the effects of erosion on the paths that the diversions are installed on. Diversions are created by entrenching a log or creating a small earthen berm approximately 30 degrees from the angle of the slope. The cost of these range anywhere from $25 to $3,750, but the average diversion costs $200. These are very low maintenance, and only require some debris removal that could get stuck in the diversion and occasionally ensuring everything is still secure and in place. This practice does not work well for the purposes of this particular survey, but it is mentioned here as a nod to projects that could be completed further inland than this survey was meant to assess.

Figure 34: Completed diversion (photo from HealthyLakesWI.com)

6.5 Rock Infiltration Trenches

Rock infiltrations (Figure 35) are meant for relatively low traffic areas as a way to catch rainwater runoff and divert it into the ground. These consist of a pit which is no more than five feet deep. This pit is lined with filter fabric and filled with small rock. More filter fabric is placed on top and larger rock is then placed over that to hold everything in place. These range in price from $500 to $9,500, on average costing $3800. This requires some maintenance to function properly. It is necessary to remove any debris such as leaves or pine needles that may collect. It is also necessary to occasionally clean out the rock as it collects sediment. This works well around building that can be seen in the riparian zone. The rock infiltrations allow for rainwater coming off of the roof to be collected and filtered without damaging the building it surrounds.

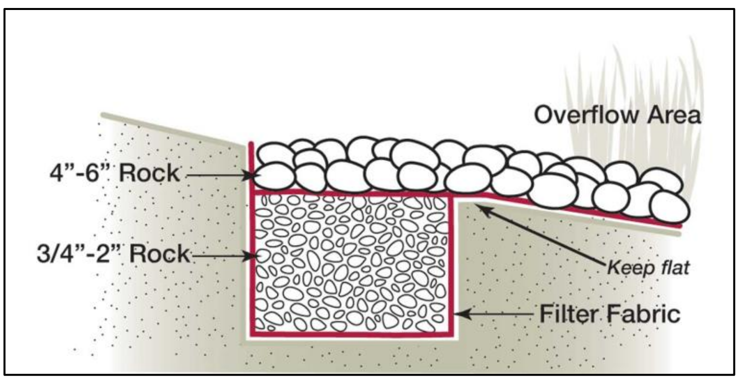

Figure 35: Rock Infiltration Set-up

7.0 Potential Funding – WDNR Surface Water Grant Program

There are several WDNR grant programs that may be able to assist the Town of Barnes in implementing portions of this APM Plan, both for individual lakes, and for the larger Coverage Area. AIS grants are specific to actions that involve education, prevention, planning, and in some cases, implementation of AIS management actions. Lake Management Planning grants can be used to support a broad range of management planning and education actions. Lake Protection grants can be used to help implement approved management actions that would help to improve water quality.

For more information about WDNR Surface Water Grants go to: https://dnr.wisconsin.gov/aid/SurfaceWater.html

8.0 Aquatic Plant Management Plans

APM Plans for individual lakes will be added to this document over time. Each individual lake APM Plan will include the following list of information if applicable:

- Lake Characteristics
- Water Quality
- Fish and Wildlife
- Aquatic Plant Community
- AIS Management History
- Need for Management/Management Discussion
- Management Recommendations (Goals, Objectives, and Actions)

APM Plans developed for northern Wisconsin lakes are evaluated according to Northern Region APM Strategy goals developed by the WDNR. APM Plans and the associated management permits (chemical or harvesting) are reviewed by the WDNR. Additional review may be completed by the Voigt Intertribal Task Force (VITF) in cooperation with the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). WDNR aquatic plant management planning guidelines, the Northern Region Aquatic Plant Management Strategy, and the goals of the lakes constituency, in conjunction with the current state of the lake, form the framework for the development of APM Plans. As APM Plans are developed, they are designed to be implemented over the course of five years. These APM Plans will support sustainable practices to protect, maintain and improve the native aquatic plant community, the fishery, and the recreational and aesthetic values of the lakes, while at the same time, managing AIS (if applicable) following current and appropriate guidelines. Each APM Plan is intended to be a living document that will be evaluated annually to determine if it is meeting stated goals and community expectations.

8.1 Implementation Goals

Most of the APM Plans developed will have the following goals for aquatic plant management:

- **Native Aquatic Plant Protection**
- **AIS Management** - Limit the spread of AIS through environmentally responsible methods to benefit the native plant community while maintaining AIS at manageable levels.
- **Education and Awareness** - Continue to educate property owners and lake users on aquatic invasive species through public outreach and education programs to help contain EWM within the lake and prevent its spread further in the lake, as well as to other water bodies.
- **Research and Monitoring** - Develop a better understanding of the lake and the factors affecting lake water quality through continued and expanded monitoring efforts.
- **Adaptive Management** - Follow an adaptive management approach that measures and analyzes the effectiveness of control activities and modify the management plan as necessary to meet goals and objectives.

Or, more in line with the Integrated Pest Management strategy for aquatic plant management, there will be goals related to:

- **Planning and Organization**
- **Communication**
- **Target Species Management**
- **Knowledge and Resources**.

The first APM Plans to be added will be for Lower Eau Claire, Middle Eau Claire, and Upper Eau Claire lakes.

9.0 Goals, Objectives, and Actions for all of the Coverage Area

APM Plans for individual lakes will have goals, objectives, and actions specific to those lakes. However, there are several goals that are applicable to all of the lakes and other waterways in the Coverage Area. The following goals are above and beyond any individual lake's goals and should be practiced across the Coverage Area

9.1 Goal 1 – Reduce the threat that a new aquatic invasive species will be introduced and go undetected in other Coverage Area lakes

Sand Bar and Tomahawk are source lakes for the introduction of EWM into other lakes not only in the Town of Barnes but in all other waters that people may travel to and from. They are not the only sources of AIS that could be introduced into any of the lakes in the Coverage Area, specifically those with public access or connected to the Eau Claire Chain of Lakes, as many lakes in the northwest region of the state. The Town of Barnes and its Partners will continue to implement a watercraft inspection program according to WDNR/UW-Extension Lakes protocol. This program will either be paid for by the Town of Barnes and/or their partners or through a small-scale CBCW grant. Watercraft inspection data will be entered into the WDNR SWIMS database annually.

Appropriate AIS signage will be maintained at all public accesses in the Coverage Area to improve the AIS awareness of many lake users.

AIS monitoring to track the AIS already present in many Town of Barnes lakes and to monitor for possible new AIS in other lakes will be completed following WDNR/UW-Extension Lakes protocol through the Citizen Lake Monitoring Network (CLMN) AIS Monitoring Program. EWM, CLP, zebra mussels, spiny waterflea, hydrilla, banded mystery snails, and other species will be watched for and survey data entered into the WDNR SWIMS database annually.

Objective 1: Implement a Clean Boats Clean Waters (CBCW) water craft inspection program annually.

Action Item: Apply for small-scale CBCW grants annually to support watercraft inspection efforts.

Objective 2: Maintain current and complete AIS Signage at all public accesses in the Coverage Area annually.

Action Item: Inspect public accesses for appropriate AIS signage annually.

Action Item: Repair, replace, and/or install current WDNR AIS signs at the public accesses.

Objective 3: Reduce the likelihood that new AIS go undetected in lakes in the Coverage Area and monitor the spread of AIS already identified in lakes.

Action Item: Participate in CLMN AIS Monitoring at least monthly between May and October each year.

9.2 Goal 2 - Improve the level of knowledge property owners and lake users have related to aquatic invasive species and their impact to the lake.

The Town of Barnes and its Partners will continue efforts to educate and inform property owners and lake users about AIS that are already in the lakes, and AIS not already in the lakes. Efforts will include annual education events; distribution of AIS publications, and discussion forums of various types related to management actions and alternatives.

Objective 1: Plan, coordinate, and implement an annual AIS education event(s) alone or in cooperation with other Stakeholders or Partners.

Action Item: Seek out other stakeholders/partners to explore cooperative education and information events.

Objective 2: Distribute information and education materials to property owners and lake users.

Action Item: Research AIS and lake stewardship materials with little or no cost to attain and make available at events including but not limited to Annual Meetings, Lake Fairs, Summer Picnic, etc.

Objective 3: Solicit public input and review of annual AIS management planning efforts.

Action Item: Complete preliminary AIS management planning by the end of February each year and post on the Town of Barnes' and other Stakeholders' Facebook and webpages, local newspapers, postings, and other informational sources for public comment.

Action Item: Provide a summary of coming year AIS management plans in a spring newsletter or other media outlets prior to April 30 each year.

Action Item: Present current year AIS management actions at the Annual Meeting(s) held each year.

9.3 Goal 3 - Improve the level of knowledge property owners and lake users have related to how their actions impact the aquatic plant community, lake community, water quality.

An important part of controlling undesirable aquatic plant growth and the production of algae is reducing the amount of nutrients (mainly phosphorus) that enters a given lake or waterway. The Town of Barnes and its Partners will attempt to reduce the amount of disturbed shoreline around the lakes in the Coverage Area by promoting and encouraging the implementation of simple and generally inexpensive best management practices included in the WDNR Healthy Lakes and Rivers Program.

The Town of Barnes and their Partners will continue to collect water quality data through the WDNR Long-term Trend Monitoring and CLMN Expanded Water Quality Monitoring programs on those lakes already included, but also strive to identify volunteers to collect water quality data on other lakes that may at one time have been included in the CLMN program, or that have never been included in the CLMN program.

Objective 1: Reduce the amount of shoreland without a natural buffer in place by 10% through shoreland restoration and other best management practices.

Action Item: Distribute shoreland improvement education and information materials to lake property owners through the newsletter, webpage, and general mailings.

Action Item: Host and/or sponsor annual lake community events that encourage land owner participation in best management practices.

Action Item: Support property owners who wish to complete shoreland restoration or habitat improvement projects through sponsorship of Healthy Lakes grant applications.

Action Item: Recognize property owners who participate in and/or complete shoreland restoration and habitat improvement projects in the newsletter, on the webpage, in local news publications, and/or at the site of the project.

Objective 2: Continue collecting long-term trend water quality data on lakes included in the Coverage Area.

Action Item: Identify new volunteers to get involved in the CLMN water quality data collection program.

Action Item: Collect CLMN water quality data (water clarity, total phosphorus, chlorophyll a, and dissolved oxygen and temperature) at the appropriate level (regular or expanded) in lakes included in the Coverage Area.

10.0 Works Cited

Berg, M. S. (2021a). *Warm-water Point-intercept Macrohyte Survey sand Bar Lake - WBIC 2494900 Bayfield County, Wisconsin.* St. Croix Falls: Endangered Resources Services, LLC.

Berg, M. S. (2021b). *Warm-water Point-intercept Macrphyte Survey Tomahawk Lake - WBIC 2501700 Bayfield County, Wisconsin.* St. Croix Falls: Endangered Resource Services, LLC.

Booms, T. (1999). Vertebrates removed by mechanical weed harvesting in Lake Keesus, Wisconsin. *Journal of Aquatic Plant Management*, 34-36.

Carlson, R. (1977). A trophic state index for lakes. *Limnology and Oceanography*, 361-369.

Christensen, D., Hewig, B., Schindler, D. E., & and Carpenter, S. (1996). Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. *Ecological Applications 6 (4)*, 1143-1149.

Engle, S. (1987). *Concepts in Lake Management: Restructuring Littoral Zones.* Madison: Wisconsin Department of Natural Resources.

Gettsinger, K., Turner, E., Madson, J., & and Netherland, M. (1997). Restoring native vegetation in a Eurasian water milfoil dominated plant community using the herbicide triclopyr. *Regulated Rivers: Research and Management 13*, 357-375.

Gettsinger, K., Turner, E., Madson, J., & Netherland, M. (1997). Restoring native vegetation in a Eurasian water milfoil dominated plant community using the herbicide triclopyr. *Regulated Rivers: Research and Management 13*, 357-375.

Jennings, M., Emmons, E., Hatzenbeler, G., Edwards, C., & and Bozek, M. (2003). Is littoral habitat affected by residential development and land use in watersheds of Wisconsin lakes? *Lake Reservoir Management, 19 (3)*, 272-279.

Madsen, J. (1997). *Methods for management of nonindigenous aquatic plants.* New York: Springer.

Madsen, J. (2000). *Advantages and disadvantages of aquatic plant management techniques.* Vicksburg, MS: US Army Corps of Engineers Aquatic Plant Control Research Program.

Madsen, J. (2000). *Advantages and disadvantages of aquatic plant management techniques.* Vicksburg, MS: US Army Corps of Engineers Aquatic Plant Control Research Program.

Madsen, J. (2000). *Advantages and disadvantages of aquatic plant management techniques.* Vicksburg, MS: US Army Corps of Engineers Aquatic Plant Control Research Program.

Manz, C. (2004a). *Fisheries Information Survey Sand Bar Lake Bayfield County.* WDNR.

Manz, C. (2004b). *Fisheries Information Survey Tomahawk Lake Bayfield County.* WDNR.

Meganck, J., Skogerboe, J., & Adrian, G. &. (2013, January 31). Meeting with UPI and WDNR for the use of Aquathol K and Aquathol Super K for early-season Curly-leaf Pondweed Treatments. Wisconsin Rapids, WI, USA: United Phosphorus, Inc.

Mikulyuk, A., Kujawa, E., Nault, M. E., Van Egeren, S., Wagner, K. I., Barton, M., et al. (2020, May 28). Is the cure worse than the disease? Comparing the ecological effects of an invasive aquatic plant and the herbicide treatment used to control it. *FACETS: A Multidisciplinary Open Access Science Journal*, pp. 353-366.

Nault, M. E., Netherland, M. D., Mikulyuk, A., Skogerboe, J. G., Asplund, T., Hauxwell, J., et al. (2014). Efficacy, selectivity, and herbicide concentrations following a whole-lake 2,4-D application targeting Eurasian watermilfoil in two adjacent northern Wisconsin lakes. *Lake and Reservoir Management*, p. 11.

Newman, R., Holmberg, K., Biesboer, D., & and Penner, B. (1996). Effects of the potential biological control agent, Euhrychiopsis lecontei, on Eurasian watermilfoil in experimental tanks. *Aquatic Botany 53*, 131-150.

Nichols, S. (1999). Floristic Quality Assessment of Wisconsin Lake Plant Communities wiht Example Applications. *Journal of Lake and Reservoir Management*, 133-141.

Peterson, S. (1982). Lake Restoration By Sediment Removal. *Journal of American Water Resources Association*, 423-436.

Sebolt, D. (1998, January). *Galerucella calmariensis and G. pusilla:Biological Control Agents of Purple Loosestrife*. Retrieved January 3, 2017, from Midwest Biological Control News Online: http://www.entomology.wisc.edu/mbcn/kyf501.html

Tobiessen, P., Swart, J., & Benjamin, S. (1992). Dredging to control curly-leaf pondweed: a decade later. *Journal of Aquatic Plant Management 30*, 71-72.

Wolter, M. (2012). *Lakeshore Woody Habitat in Review.* Hayward, WI: Wisconsin Department of Natural Resources.