# Aquatic Plant Management Plan
# Apple River Flowage

Polk County, Wisconsin

September 2017

Sponsored By
Apple River Flowage Protection and Rehabilitation District

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# Executive Summary

This Aquatic Plant Management Plan for the Apple River Flowage (the flowage) presents a strategy for managing aquatic plants by improving navigation while protecting native plant populations, managing curly leaf pondweed, and preventing establishment of invasive species through the year 2021. The plan includes data about the plant community, watershed, and water quality of the flowage. It also reviews a history of aquatic plant management on the flowage.

Endangered Resource Services completed an aquatic plant point intercept survey in the summer of 2010 and again in 2016. The aquatic plant survey found little difference between the two survey period results. The flowage has heavy growth of native plants that impede navigation during summer months. These same native plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of non-native invasive plants – all critical functions. The non-native plant, curly leaf pondweed, is present in many locations. Eurasian water milfoil, an invasive plant of concern, was not found in the 2010 or 2016 survey.

This Aquatic Plant Management Plan, developed with input from an advisory committee including flowage property owners, will help the Apple River Protection and Rehabilitation District update methods to meet aquatic plant management goals. The implementation plan describes the actions that will be taken toward achieving these goals.

A special thank you is extended to the aquatic plant advisory committee for assistance with plan development. The membership will review both the plan and the budget at the meeting held August 19, 2017.

## Plan Goals

Improve water quality on the Apple River Flowage and downstream on the Apple River.

Prevent the introduction of aquatic invasive species.

Maintain navigation for fishing, boating, and access to lake residences.

Maintain native aquatic plant functions.

Minimize environmental impacts of aquatic plant management.

# Introduction

The Aquatic Plant Management Plan for the Apple River Flowage (the flowage) is sponsored by the Apple River Protection and Rehabilitation District (ARPRD). This plan presents a strategy for managing aquatic plants by improving navigation while protecting native plant populations, managing curly leaf pondweed, and preventing establishment of invasive species through the year 2021. The plan includes data about the plant community, watershed, and water quality of the flowage. It also reviews a history of aquatic plant management on the flowage. Based on this data and public input, goals and strategies for the sound management of aquatic plants are presented. This plan will guide the ARPRD and the Wisconsin Department of Natural Resources in aquatic plant management over the next several years (from 2017 through 2021).

## Public Input for Plan Development

The ARPRD Aquatic Plant Management (APM) Advisory Committee provided input for the update of this plan which was first developed in 2011. The APM Advisory Committee met three times. At the first meeting on May 17, 2017, the committee reviewed aquatic plant management goals, plant survey results, existing management efforts, and discussed aquatic plant management concerns. At a second meeting on May 31, 2017 and a third meeting on June 14, 2017, the committee updated objectives and action steps. The APM Advisory Committee concerns are reflected in the goals and objectives for aquatic plant management in this plan.

The ARPRD board announced the availability of the draft Aquatic Plant Management Plan for review with a public notice in the Amery Free Press the weeks of **July 31 and August 7, 2017**. Copies of the plan were made available to the public on the ARPRD web site: arprd.org and at the Amery Area Public Library. **Comments were accepted through August 31, 2017 including at the ARPRD annual meeting August 19, 2017.** No comments were received from the public.

**Tribal Interests**

Native American Tribal representatives have special interest and rights related to aquatic plant management in the Apple River Flowage because of the wild rice present. The Apple River Flowage is located within Tribal ceded territories. Draft and final copies will be distributed to the St. Croix Tribe Environmental Department and the Great Lakes Indian Fish and Wildlife Commission.

When Ojibwe tribes living in the western Great Lakes region ceded lands by treaty to the United States, they retained the right to fish, hunt, trap, and gather resources from the lands they ceded. These treaties and the agreements in them have been upheld by modern courts, and remain in effect today. In Wisconsin, roughly the northern third of the state (including all of Polk County but the southwest corner) consists of ceded territory where tribal rights were retained. On these lands, the state has the legal obligation to provide

consultation with the tribes whenever a permit, decision, or management action may affect the wild rice resources upon on which their harvest rights depend.

**Resident Concerns**
The APM Committee expressed a variety of concerns that are reflected in plan goals and objectives for aquatic plant management. Management concerns included considering options for curly leaf pondweed management, maintaining navigation in common channels and to individual properties, optimizing the harvesting operations, and providing aquatic invasive species information for lake residents.

**Flowage District Resident Survey** (LWRD, June 2013)
A property owner survey was not completed as part of this planning process. However, the Polk County Land and Water Resources Department mailed a resident survey to two hundred twenty five residences of the Apple River Flowage Protection and Rehabilitation District in late June 2012 as part of the Apple River Flowage Lake Management Plan. The survey was designed to gather information from residents concerning property ownership and use, land use, flowage use, concerns for the flowage, water quality, algae, shoreline vegetation, management practices for improvement of the flowage, and website use.

Ninety two surveys were returned (41% response rate) and data was entered and analyzed. Ninety one percent of respondents own shoreline property on the Apple River Flowage; whereas the remaining 9% do not.

<u>Concerns for the Apple River Flowage</u>
Survey respondents were asked to rank their top three concerns for the Apple River Flowage. To analyze this data each concern that ranked first received 3 points, each concern that was ranked second received 2 points, and each concern that ranked third received 1 point. Total points were then added to determine the ranking of concerns for the flowage. Invasive species ranked as the 1$^{st}$ concern, followed by aquatic plants in 2$^{nd}$, and algae blooms in 3$^{rd}$.

*Table 1. Survey Results: Concerns for the Apple River Flowage*

| | Rank | Points |
|---|---|---|
| Invasive species (Eurasian water milfoil, zebra mussels, curly leaf, purple loosestrife) | 1st | 113 |
| Aquatic plants (not including algae) | 2nd | 87 |
| Algae blooms | 3rd | 63 |
| Pollution (chemical inputs, septic systems, agriculture, erosion, storm water runoff) | 4th | 60 |
| Property values and/or taxes | 5th | 50 |
| Water clarity (visibility) | 6th | 39 |
| Quality of fisheries | 7th | 29 |
| Quality of life | 8th | 28 |
| Water levels (loss of lake volume) | 9th | 24 |
| Development (population density, loss of wildlife habitat) | 10th | 13 |
| Water recreation safety (boat traffic, no wake zone) | 11th | 10 |
| Other, please describe (geese, muskrats, sediment buildup, navigation) | 12th | 10 |

# Flowage Information

## The Flowage

The Apple River Flowage (WBIC 2624200) is located in central Polk County, Wisconsin in the town of Lincoln and within the city limits of Amery. The flowage has a surface area of 639 acres, a maximum depth of 15 feet and an average depth of 6 feet. Most of the bottom sediments are organic muck. Combined with the shallow waters of the flowage, these mucky sediments promote heavy aquatic plant growth. In fact, aquatic plants cover nearly the entire surface of the flowage bottom with plants growing to a depth of 13.5 feet.[2] The Apple River Flowage is a very nutrient rich water body with summer Secchi depths averaging only 5.2 feet in 2016.

The flowage is created by a dam within the city limits of Amery. The flowage extends about 7 miles upstream. Operation of the dam has raised the normal water level of the river approximately 8 or 9 feet at the dam-site. Lowering of flowage water levels up to 6 feet can be readily accomplished with the present dam configuration.[3]

*Table 2. Flowage Information*

| | |
|---|---|
| Size (acres) | 639 |
| Mean depth (feet) | 6 |
| Maximum depth (feet) | 15[4] |
| Littoral zone depth (feet) | 14 |
| Average summer secchi depth (feet) | 3.5 |

A flowage map is found on the following page as Figure 1. This map shows two public access sites on the flowage. One landing is located at the end of Birch Street in the city of Amery and the second is north of Amery at the end of River Shore Lane. There are no public access points to the north and west of Highway 46. The box culvert under Highway 46 restricts access to large boats because of low clearance. North Park on the north side of Amery has frontage on the flowage. There are also city-owned park lands just above the dam.

[2] Berg, Matthew. Endangered Resource Services. Curly-leaf pondweed (*Potamogeton crispus*) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Apple River Flowage - WBIC: 2624200 Polk County, Wisconsin. 2016.

[3] Wisconsin Department of Natural Resources. Office of Inland Lake Renewal. *Apple River Flowage Polk County. Feasibility Study Results; Management Alternatives.* 1979.

[4] The Wisconsin Lakes Book reports depths to 18 feet. However, plant surveyors found depths only up to 15 feet.

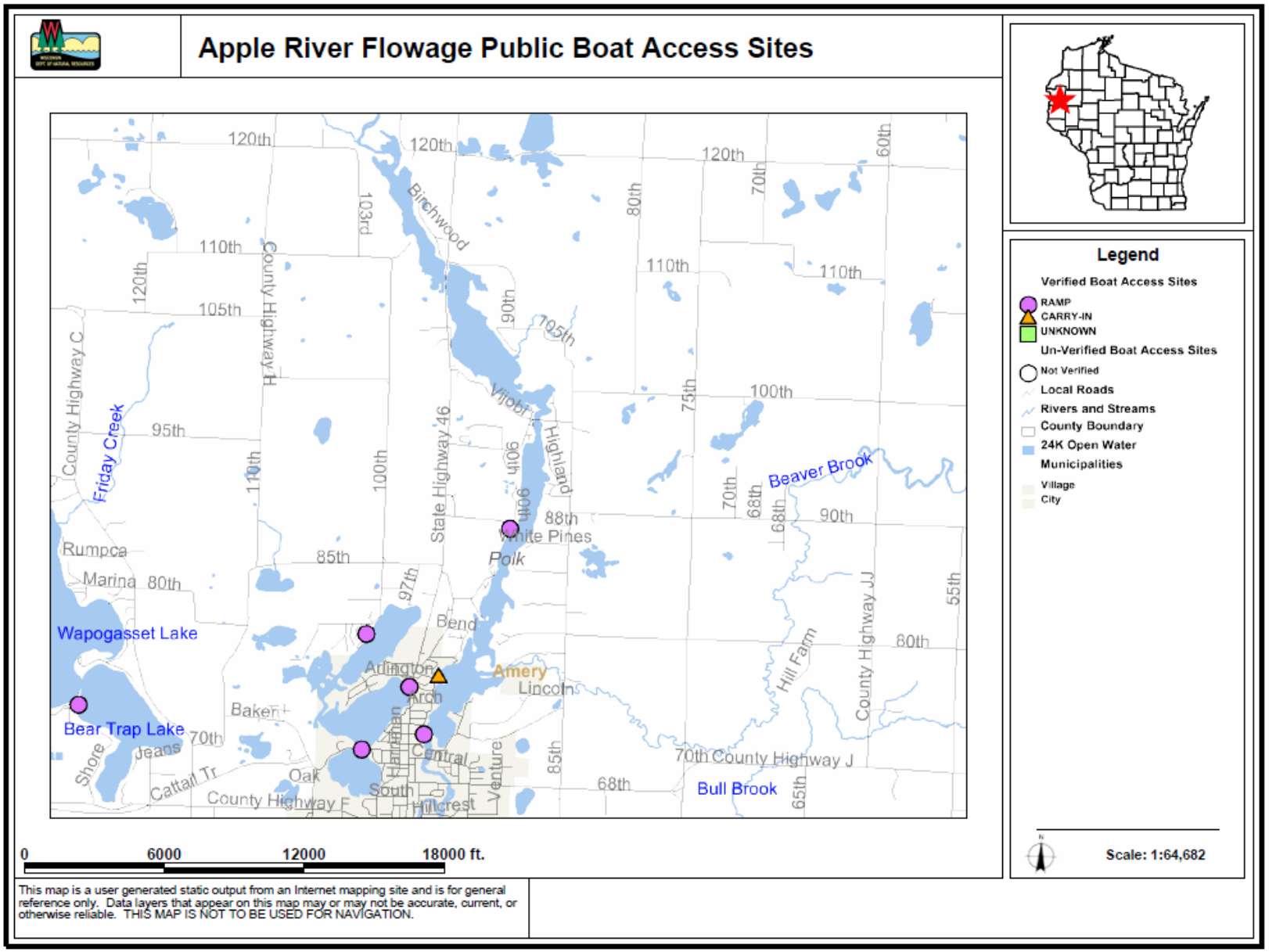



*Figure 1. Apple River Flowage Public Access Sites*

## Water Quality

Water quality is frequently reported by the trophic state or nutrient level of the lake. Nutrient-rich lakes are classified as eutrophic. These lakes tend to have abundant aquatic plant growth and low water clarity due to algae blooms. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms. Oligotrophic lakes are nutrient-poor with little growth of plants and algae.

Secchi depth readings are one way to assess the trophic state of a lake. The Secchi depth is the depth at which the black and white Secchi disk is no longer visible when it is lowered into the water. Greater Secchi depths occur with greater water clarity. Secchi depth readings, phosphorus concentrations, and chlorophyll measurements can each be used to calculate a Trophic State Index (TSI) for lakes. TSI values range from 0 – 110. Lakes with TSI values greater than 50 are considered eutrophic. Those with values in the 40 to 50 range are mesotrophic. Lakes with TSI values below 40 are considered oligotrophic.

The Apple River Flowage is a eutrophic system by all measurements. A eutrophic TSI usually suggests decreased clarity, fewer algal species, oxygen-depleted bottom waters during the summer, evident plant overgrowth, and only warm-water fisheries (pike, perch, bass, etc.).[4] Since 1994 lake volunteers have measured water clarity, dissolved oxygen, total phosphorus, and chlorophyll. Citizen lake monitoring volunteers have collected Secchi data from the flowage annually since 1986. Average July and August Secchi depths have ranged between 3 and 8 feet with the highest water clarity from about 1995 to 2004.

*Table 3. Citizen Lake Monitoring Results 2016*

| | **2016** |
|---|---|
| **Secchi Depth** (ft) | 5.2 |
| **Total Phosphorus** (µg/l) | 76.3 |
| **Chlorophyll** (µg/l) | 27.1 |
| **Trophic State Index** (TSI) | 60 |
| **TSI Classification (based on Chl.)** | Eutrophic |

Figure 2 illustrates the Secchi depth averages for the flowage. Figure 3 graphs the Trophic State Index, based upon Secchi depth, chlorophyll, dissolved oxygen, and total phosphorus results.

[4] Reports and Data: Polk County. WDNR website. February 2016. http://dnr.wi.gov/lakes/CLMN/Station.aspx?id=493104

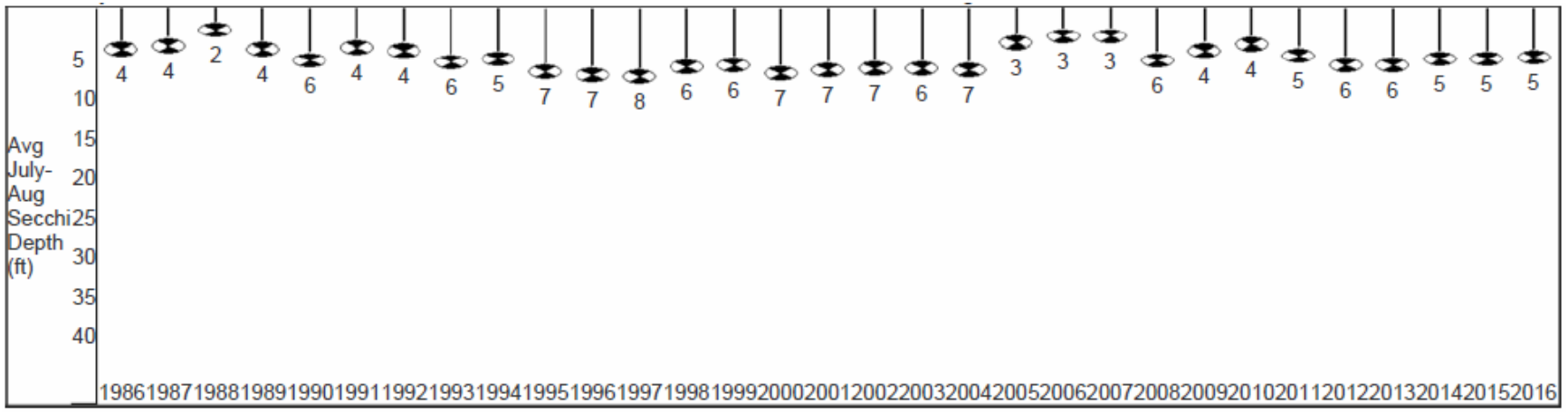



*Figure 2. Deep Hole Basin Summer Average Secchi Depths 1986-2016*

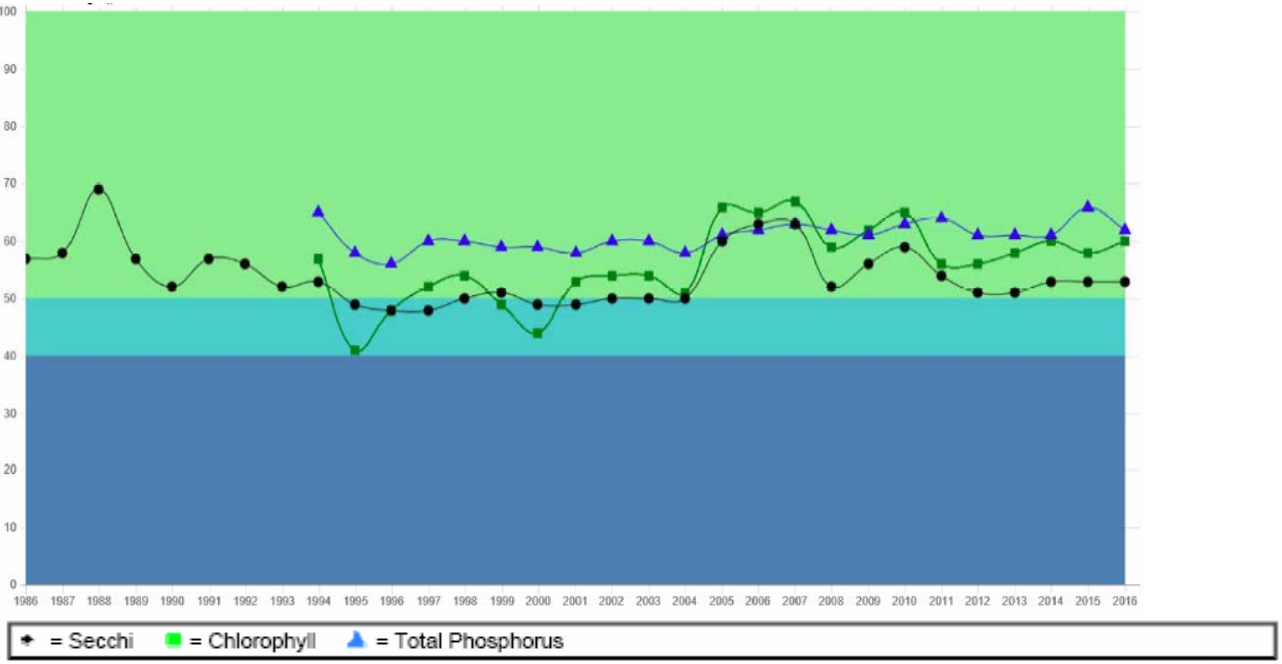



*Figure 3. Deep Hole Trophic State Index 1986-2010*

The Apple River Flowage cannot be expected to have the water quality of nearby lakes in the city. Management strategies must take these differences into account and set realistic expectations appropriate to the water body. Flowages (also called impoundments) tend to have characteristics different from natural lakes. The table below illustrates general water quality differences between impoundments and natural lakes.

One factor that influences water quality difference is that watershed area of flowages is generally large when compared to lake size. For example the 639-acre Apple River Flowage has a watershed size of 125,074 acres (Polk LWRD 2013), a 195:1 watershed to lake ratio. Pike Lake in contrast has a watershed size of 399 acres for the 159 acre lake, a 2.5:1 ratio. North Twin has an even smaller ratio with a 178 acre watershed to a 135 acre lake. This is a 1.3:1 watershed to lake size ratio. A larger watershed provides many more nutrients and sediment to a water body. Since the flowage is a much shallower basin than the lakes, these effects are intensified.

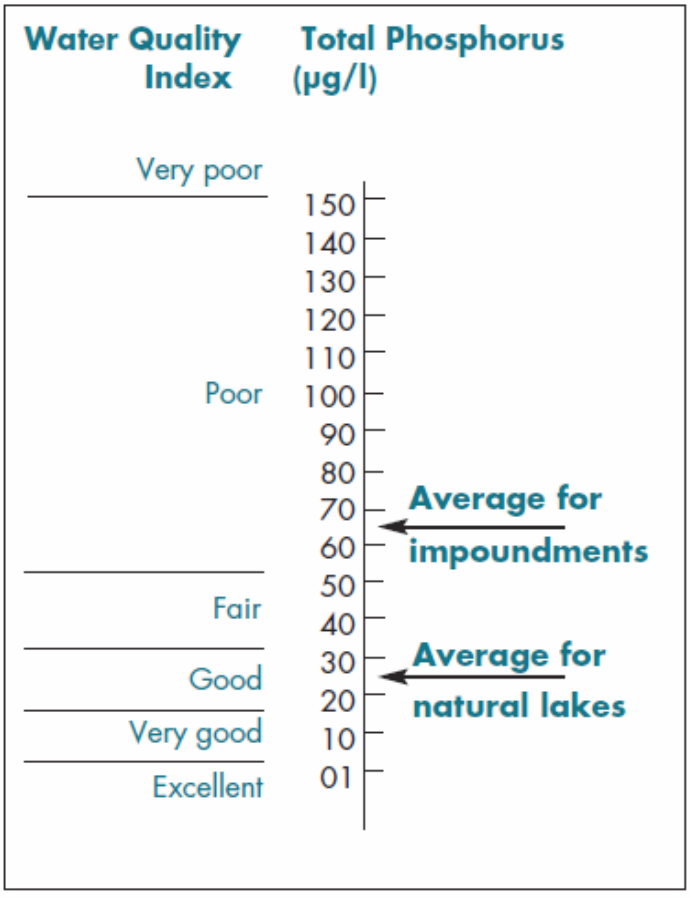



*Figure 4. Total Phosphorus Concentrations for Wisconsin's Natural Lakes and Impoundments.*[5]

[5] *Adapted from Lille and Mason, 1983 from Understanding Lake Data. Shaw, Mechenich, and Klessig.*

Impoundments also tend to have short retention times. This means water that enters the flowage tends to leave relatively quickly. The retention time for the Apple River Flowage is estimated to be around 14 days.[6] Its characteristics mimic lakes with short retention times described in the table below.

*Table 4. Characteristics of Lakes with Different Retention Times (adapted from Lillie and Mason, 1983)*

| Retention time in days | 0-14 | 15-60 | 61-180 | 181-365 | 366-730 | >730 |
|---|---|---|---|---|---|---|
| Mean depth (ft.) | 6 | 8 | 11 | 11 | 13 | 23 |
| Max. depth (ft.) | 16 | 21 | 25 | 27 | 35 | 57 |
| Mean total phosphorus (µg/l)* | 94 | 85 | 56 | 48 | 33 | 25 |
| Mean DB:LA ratio** | 1166 | 142 | 42 | 15 | 8 | 6 |

*Summer values; µg/l = micrograms per liter or parts per billion
**DB:LA = Drainage basin/lake area

*From Understanding Lake Data. Shaw, Mechenich, and Klessig.*

It is important to note that aquatic plants play a critical role in maintaining water quality in the Apple River Flowage. This is a system with a large watershed, high volume of accumulated sediments, and high nutrient levels. Without aquatic plants present, nutrient-rich sediments will be re-suspended and water clarity can be expected to decrease dramatically. The figure below illustrates that for shallow-water lakes and flowages, an aquatic plant dominated system is highly preferable to a flowage without aquatic plants. In fact, restoration efforts for shallow lakes frequently focus on re-establishing aquatic plants in order to improve water clarity.

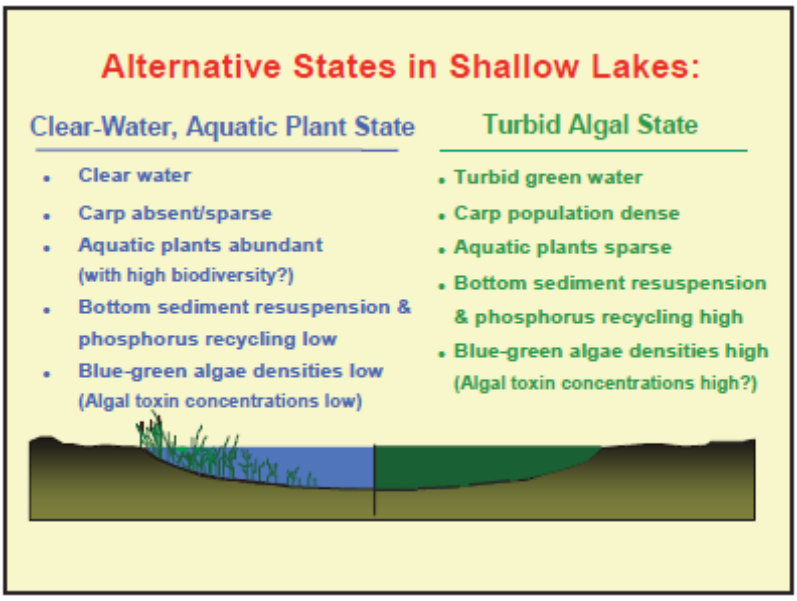



*Figure 5. Alternative States in Shallow Lakes*

*From Lake Wingra presentation adopted from Sheffer 1990.*

[6] 2012 flow data was used to determine an outlet discharge of 255.87 acre feet/day, which divided into the acre feet of water for the Flowage (3624 acre feet) gives a residence time of 14.2 days (Polk LWRD, 2013).

Nearby White Ash Lake provides an example of a lake system with declining water clarity that has accompanied declining levels of aquatic plants in the lake. Adjacent North White Ash Lake has maintained high levels of both aquatic plants and clear water. When plant surveys were completed in 1997, both South and North White Ash Lakes were similar in their plant diversity and distribution (the south lake had a little more open area). Currently the two lakes are strikingly different in their plant make-up. North White Ash Lake has excessive native plant growth throughout the season along with higher water clarity. The South White Ash Lake suffers from very poor water quality conditions as early as late May or June and limited native plant growth through the rest of the season (S E H 2010). Recent citizen lake monitoring results confirm relative water quality remains better in North White Ash than in South White Ash.[7]

Aquatic plant growth and light levels influence each other. With high water clarity, more light is available for plants to grow. With more plant growth, nutrients are tied up and unavailable for plant growth. With poor water clarity, light levels are poor and aquatic plant growth can be severely limited. When aquatic plant growth is limited, nutrients are available to fuel algae blooms.

## Watershed Description

The Upper Apple River Watershed (SC06) drains to the Apple River Flowage. Because the Apple River ultimately drains to the St. Croix River, the 125,074-acre Apple River watershed is part of the larger St. Croix River Basin. The 2013 lake management plan identified 37,125 acres that constitute a focused lake management area. The largest land uses in the management area were row crop (32%) and forest (31%), with row crop contributing the greatest phosphorus load to the flowage (74%).

### Phosphorus from Watershed Runoff

Phosphorus is a primary nutrient, essential for healthy plant and algae growth. However, increased phosphorus levels speed up the process of eutrophication - where excess nutrients stimulate plant growth and cause extensive algae blooms. Prolific plant growth may lower dissolved oxygen levels when plants decay and consume oxygen.

Phosphorus loading in the Upper Apple River watershed is the result of non-point sources. Non-point sources include rain falling on the flowage and runoff from the watershed. Phosphorus can be dissolved in the runoff water as well as carried in soil particles that erode from bare soil.

The amount of phosphorus runoff from the watershed is determined by land use in the watershed along with watershed soils and topography. Shoreland areas are particularly important areas of a watershed, especially if the remaining watershed is relatively small. Agricultural and residential development tends to increase runoff and the amount of phosphorus that makes its way to the lake as a result. Land maintained in a natural, vegetated state, on the other hand, is beneficial to soil and water quality. With natural vegetation, soil erosion is reduced and fewer pollutants are able to enter and impact water

[7] http://dnr.wi.gov/lakes/clmn/reports/tsigraph.aspx?stationid=493079

quality via runoff. Tall vegetation slows the flow of water, while forest groundcover and fallen leaves allow runoff water to soak into the soil.

### Tributary Phosphorus Contributions

The Apple River inlet is contributing the greatest amount of phosphorus to the Apple River Flowage (8,442 pounds on an annual basis). The Beaver Brook inlet is contributing 2,580 pounds of phosphorus on an annual basis. Total phosphorus concentrations were elevated on the east branch of the Beaver Brook Inlet (0.2472 mg/L). (LWRD, June 2013)

### Apple River Flowage Lake Management Plan

The Polk County Land and Water Resources Department completed a lake management study and plan for the flowage in 2013. The plan includes:

- comprehensive information about the lake
- results of a public opinion survey
- lake level and precipitation data
- chemical and physical data for the flowage
- zooplankton and phytoplankton (algae) sample results
- shoreline survey results
- tributary monitoring results
- watershed land use and phosphorus loading
- lake modeling results.

Management goals are selected and an implementation plan developed to implement the following goals:

Goal 1: Reduce excessive watershed nutrient inputs to the flowage to improve water quality

Goal 2: Minimize the release of nutrients from within the Apple River Flowage to improve water quality

Goal 3: Protect, maintain, and enhance fish and wildlife habitat

Goal 4: Maintain and enhance the natural beauty of the Apple River Flowage

Goal 5: Evaluate the progress of lake management efforts through monitoring and data collection

Goal 6: Provide information and education opportunities to residents and users

Goal 7: Develop partnerships with a diversity of people and organizations

Goal 8: Implement the Aquatic Plant Management Plan

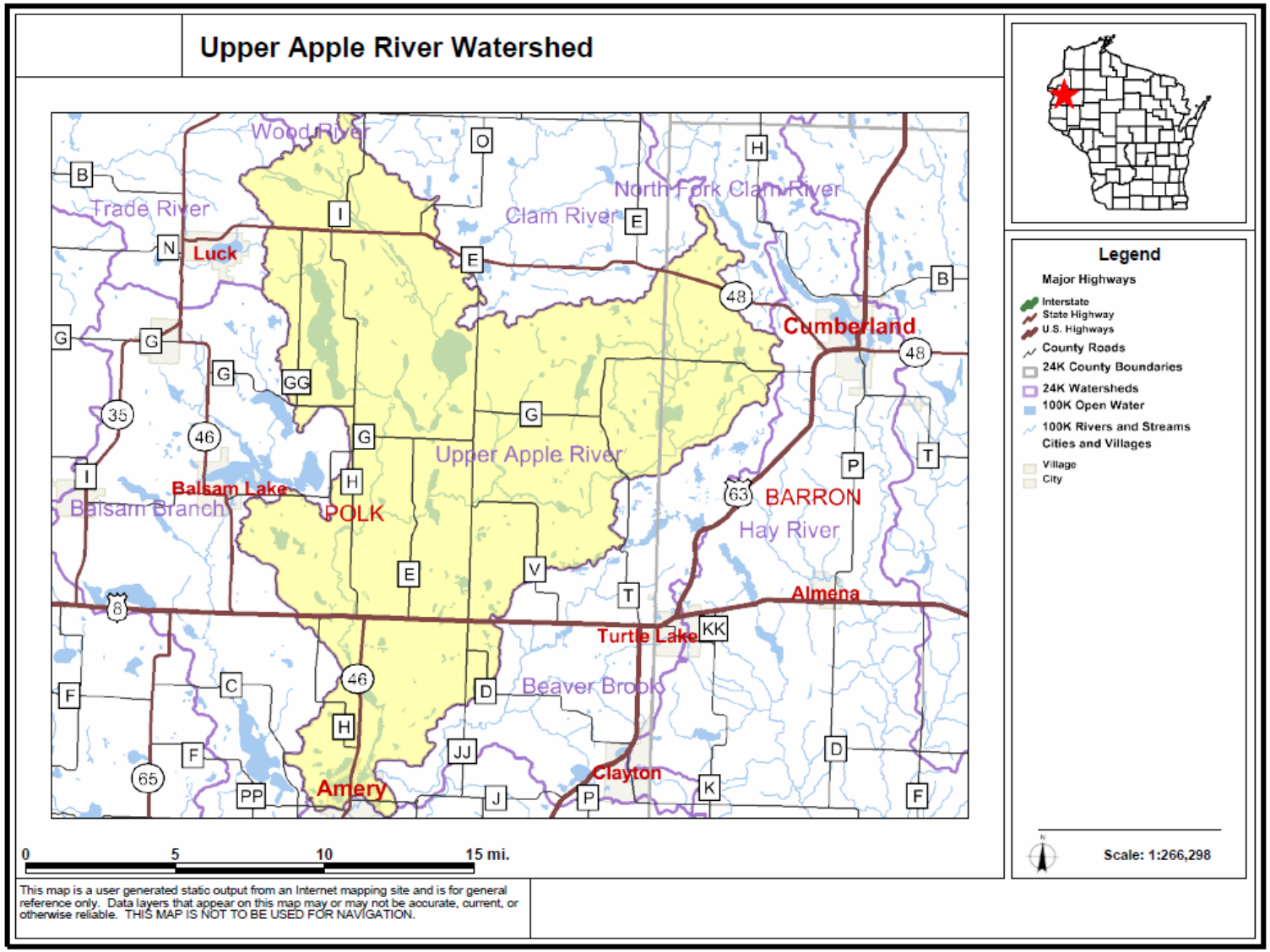



*Figure 6. Upper Apple River Watershed*

## Flowage Feasibility Study

A study completed in 1979 provided comprehensive information about the flowage at that time. The report documented erosion and feedlot concerns from 1977 and 1978, which were low at the time. Water flow rates at the dam ranged from 50 to 385 cubic feet per second (cfs) in 1977 (a low precipitation year) and from 100 to nearly 600 cfs in the first half of 1978 (a high precipitation year).

Aquatic plants were found at 94 percent of sample points in late June and 96 percent of sample points in mid-August. Maximum depth of plant growth was 12 feet. While curly leaf pondweed was not reported, it would not have been expected to be abundant in either late June or mid-August. The report mentions an increase in coontail and northern water milfoil replacing more desirable plants such as the native pondweeds and wild rice following a major drawdown.

Sediment depths and characteristics were surveyed as part of the study. The upper basin began at the Apple River inlet and extended to the Highway 46 Bridge. Sediments here were reported as a mixture of sand, silt and organic material. The central basin extended from the Highway 46 Bridge nearly to the Beaver Brook inlet. Here the sediments had higher water content. The lower basin to the dam had soft surface material with lower water content and less organic material than that of the central basin. A delta of sediment was reported at the mouth of Beaver Brook which explained sediment accumulation above this point. Sediment accumulation, measured at various points of the flowage, ranged from 16 – 25 inches in the period from 1954 to 1977.

Recommendations from this study included dredging to remove sediment, aquatic plant removal using herbicides or harvesting, and no management. A cost estimate for dredging was presented at a board meeting in June 1981. The cost for dredging the Beaver Brook delta was estimated to be $92,000 at that time.

## The Dam[8]

The Amery dam on the Apple River Flowage was first constructed in 1888 to run a saw-mill and facilitate log driving on the river. In its long history, the dam was repaired four times in 1892, 1939, 1958 and 1974. From the early 1900's through 1974, the dam was owned by Northern Supply Company (a subsidiary of Hubbard Milling Company) and used primarily to run a gristmill. For a short period of time, the dam was also used to generate electricity which Northern Supply sold to the Amery Electric Light Company. Late in 1974 the ownership of the dam was transferred from Northern Supply to a co-ownership arrangement between the City of Amery and the Town of Lincoln.

During the time the dam was privately owned, water levels on the flowage were fluctuated in response to milling needs. In the early years of the flowage, shoreline development was sparse and water level fluctuations were of little concern. However, in the late 1940's the flowage gained a reputation as a first rate fishery which triggered a gradual increase in shoreline development and recreational use. Frequent water level

[8] Office of Inland Lake Renewal 1979.

fluctuations, that went relatively unnoticed in the past, brought increasing complaints from shoreline property owners and others using the flowage for recreation. Interestingly, this use conflict was resolved, not by establishment of a minimum-maximum water level, or negotiation, but rather by an unexpected and controversial drawdown.

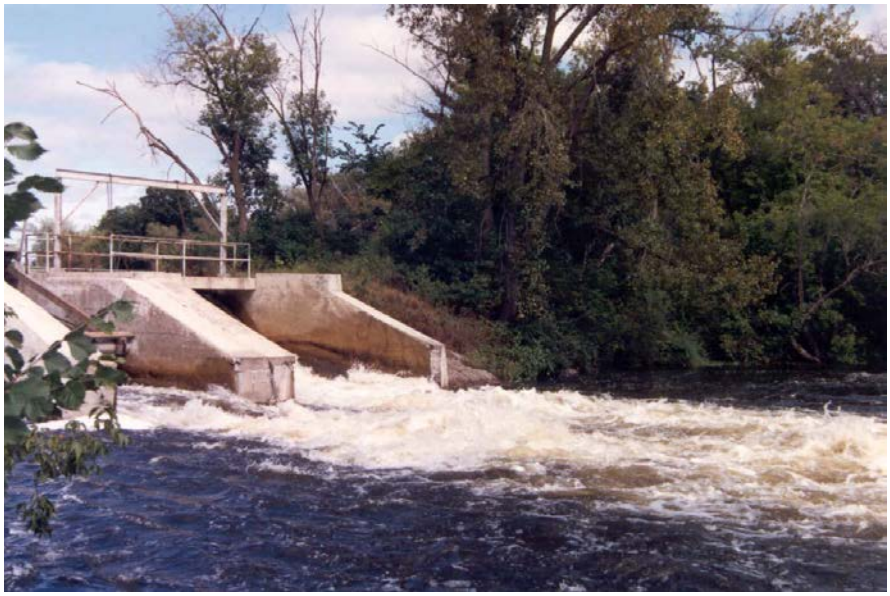


*Figure 7. The Amery Dam*

In an attempt to determine the nature of the leak under the Amery dam, the Department of Natural Resources ordered the flowage drawn down in September 1973. After the inspection, the Department declared the dam unsafe and in need of extensive repairs before the flowage could be refilled. Since the estimated cost of the repair was substantial, Northern Supply Company initiated proceedings to abandon the dam. However, local sentiment was strongly in favor of repairing the dam and re-flooding the flowage. Consequently, in 1974, arrangements were made by the City of Amery and the Town of Lincoln to secure ownership and repair the dam. With a grant of $6,000 from Polk County and a gift of $27,500 from Hubbard Milling, a contract was awarded in the amount of $76,500 for accomplishing the structural repairs ordered by the Wisconsin Department of Natural Resources. Actual transfer of ownership took place late in the year, and by the spring of 1975, the repairs to the dam were complete.

The drawdown lasted twenty months and caused a decline in a variety of fish species and an increase in algae and undesirable aquatic plant growth. The drawdown also caused some long-lasting changes in the aquatic plant community. Most notably, desirable stands of wild rice were replaced by cattails. Filamentous algae also began appearing in nuisance levels as it grew across the top of other submergent plants.

The dam was also updated in 1992 when DNR inspectors identified need for repairs. Concrete was placed along the north side of the dam structure to seal the base and the river bed. The wooden tainter gate formerly used to maintain water levels was replaced

with a new steel gate and drive system. The abandoned gate went to the Mabel Tainter Museum in Menomonie.[9]

The dam is now used exclusively to maintain water levels on the flowage. Its use today provides a wide range of recreational uses from boating, fishing, canoeing and other water activities.

Operation of the dam raises the normal water level of the river eight feet at the dam-site according to DNR records. Lowering of flowage water levels up to 6 feet can be readily accomplished with the present dam configuration. Thus, rehabilitation plans involving water draw down of the flowage can be accomplished without dam alteration.

### Upstream Dam

The Woodley Dam upstream of the flowage north of US Highway 8 was removed in August of 2009.[10] This removal occurred following concern about the safety of the dam following high water in 2001. Dam removal included dredging a channel to remove accumulated sediments behind the dam, placement of rip rap to stabilize the stream channel, and removal of the structure.

Residents expressed concerns at the 2011 ARPRD annual meeting about the impact of dam removal. They reported increased floating vegetation and organic muck in 2011 which they believe was caused by the dam removal.

[9] Personal communication. John Frisco, former city of Amery Public Works Supervisor, February 2011.
[10] Email communication. Debbie Peterson, Director, Polk County Parks and Buildings. March 2011.

## Apple River Protection and Rehabilitation District

In November 1975 following the problems brought to the forefront with the drawdown, the Polk County Board passed a resolution forming the Apple River Protection and Rehabilitation District in accordance with Chapter 33 of the Wisconsin Statutes. Flowage district parcels are shown in the map below. The district consists of 415 parcels. On August 25th, 1990 a new set of bylaws were passed titled "By-Laws Apple River Protection and Rehabilitation District."

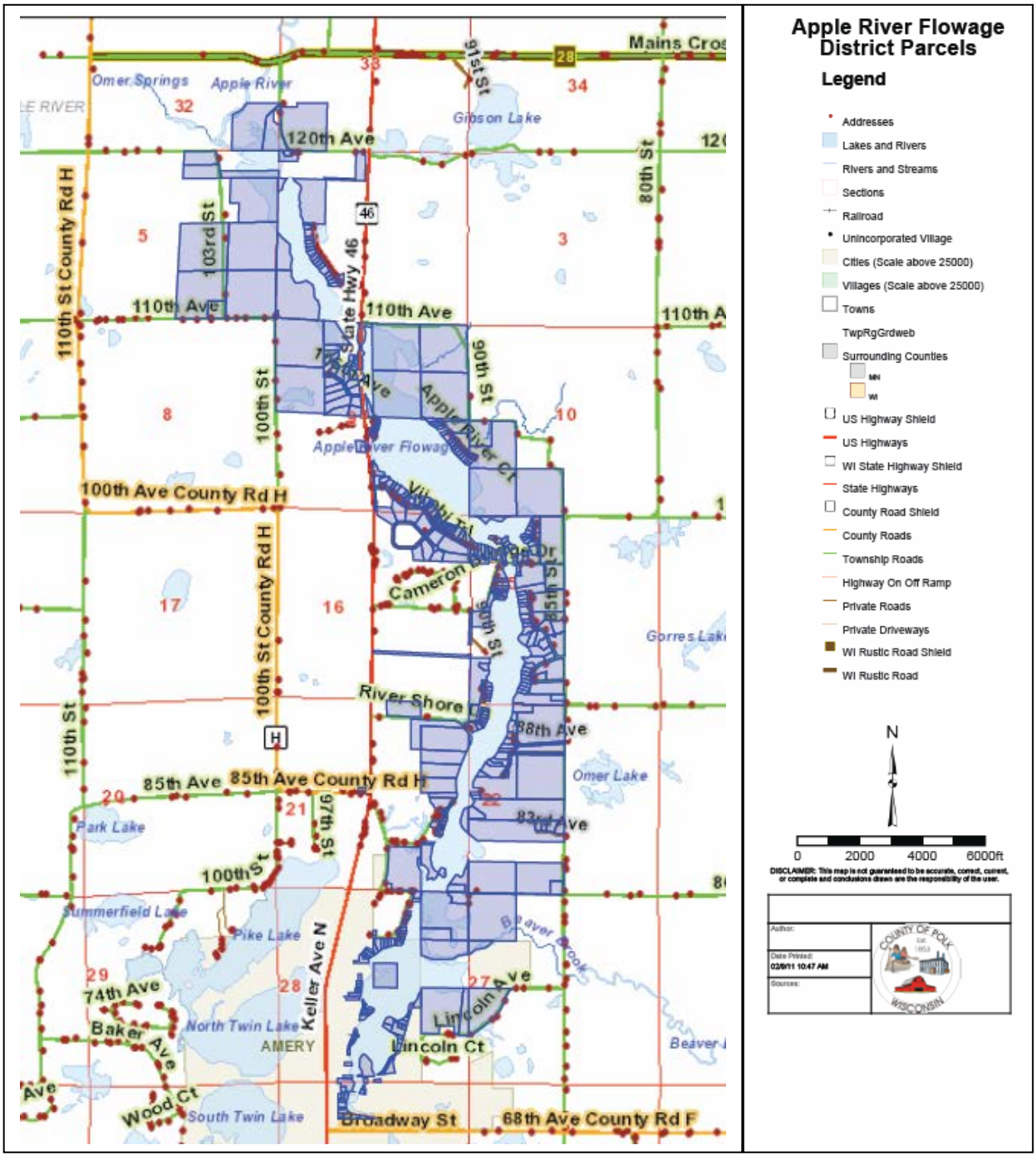



Figure 8. *Apple River Protection and Rehabilitation District Parcels*

**Flyover Project**
The P&R District contracted with AW Research Labs in 1991 to take infrared and color aerial photos for the purpose of identifying nonpoint sources of pollution. Photos were taken in the summer of 1992. The Water Committee formed in 1993 to ground truth the flyover results, and committee members were trained in 1994. Forms to collect septic system information from flowage residents were sent in 1994 and 1995. Of the 230 questionnaires sent out, 23 were returned in 1994 and 27 were returned in 1995. This was a lower than expected return rate.

## The Apple River Downstream of the Amery Dam

The Apple River is a free-flowing river downstream of the Amery dam for about 4 river miles or to about one mile south of the city limits where the river crosses State Highway 46. The Black Brook Flowage begins at this point. The Black Brook Dam holds back a height of 25 feet of water to create a 98 acre flowage.[11]

Below the Black Brook Flowage the river is classified as a Class II Trout Stream. There is also a Class II segment beginning on the north end of the Village of Star Prairie and extending to where the river flows beneath County CC in St. Croix County. Class II trout waters may have some natural reproduction, but not enough to utilize available food and space. Therefore, stocking is required to maintain a desirable sport fishery. These streams have good survival and carryover of adult trout, often producing some fish larger than average size.[12]

*Figure 9. The Black Brook Dam*

[11] DNR Web View On-Line Mapping http://dnrmaps/wisconsin.gov
[12] DNR Web Site. http://dnr.wi.gov/fish/species/trout

# Aquatic Habitats

## Primary Human Use Areas

The Apple River Flowage is a popular fishing destination for both summer and winter fishing. Residential development follows road development around the flowage. Waterfront property owners and the general public utilize the flowage for a wide variety of activities including fishing, boating, swimming, and viewing wildlife.

## Functions and Values of Native Aquatic Plants

Naturally occurring native plants are extremely beneficial to the flowage. They provide a diversity of habitats, help maintain water quality, sustain fish populations, and support common lakeshore wildlife such as loons and frogs.

### Water Quality

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algal growth. Some plants can even filter and break down pollutants. **Plant roots and underground stems help to prevent re-suspension of nutrient-rich bottom sediments. In the flowage, this is particularly important.** Stands of emergent plants (whose stems protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline. The rush, reed, and rice populations around the flowage are particularly important for reducing erosion along the shoreline, but these populations are also vulnerable to the nutrient loading and the resultant algae growth in the lakes. Dense wild rice is found near the Apple River inlet north and west of the Highway 46 Bridge, and scattered growth occurs in other areas.

### Fishing

Habitat created by aquatic plants provides food and shelter for both young and adult fish. Invertebrates living on or beneath plants are a primary food source for many species of fish. Other fish, such as bluegills, graze directly on the plants themselves. Plant beds in shallow water provide important spawning habitat for many fish species.

### Waterfowl

Plants offer food, shelter, and nesting material for waterfowl. Birds eat both the invertebrates that live on plants and the plants themselves.[13]

### Protection against Invasive Species

Non-native invasive species threaten native plants in Northern Wisconsin. The most common are Eurasian water milfoil (EWM) and curly leaf pondweed (CLP). These species are described as opportunistic invaders. This means that they take over openings in the lake bottom where native plants have been removed. Without competition from other plants, these invasive species may successfully become established and spread in

[13] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.

the lake. This concept of opportunistic invasion can also be observed on land, in areas where bare soil is quickly taken over by weeds.

Removal of native vegetation not only diminishes the natural qualities of a lake, but it increases the risk of non-native species invasion and establishment. The presence of invasive species can change many of the natural features of a lake and often leads to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native plants may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.[14]

### Aquatic Invasive Species Status

Purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), curly leaf pondweed (*Potamogeton crispus*), and narrow-leaved cattail (*Typha angustifolia*) were observed on the Apple River Flowage in the 2016 plant survey. Purple loosestrife was found at a single location on the eastern shoreline just south of the Highway 46 Bridge. Reed canary grass is well established around the perimeter of the flowage. Curly leaf pondweed is found throughout the flowage. Narrow-leaved cattail is native to southern Wisconsin.[15]

Eurasian water milfoil was not found on the flowage in 2016, but there is a high risk that Eurasian water milfoil and other aquatic invasive species may become established. As described previously, the flowage is a fishing destination. Many fishermen travel from the Twin Cities, Minnesota area, and access the lake at the boat landings. With Eurasian water milfoil present in many urban Twin Cities lakes, the danger of transporting plant fragments on boats and motors is very real.

In Polk County, EWM is found in Long Trade, Horseshoe, Pike and Cedar Lake. Department of Natural Resource scientists have also found Eurasian water milfoil in the nearby Wisconsin counties of Burnett (Ham, Shallow, and Round Lakes), Barron (Beaver Dam, Horseshoe, Sand, Kidney, Shallow, Duck, and Echo Lakes), and St. Croix (Bass Lake, Goose Pond, Little Falls Lake, Lake Mallalieu, and Perch Lake).

### Sensitive Areas

The Wisconsin Department of Natural Resources completed sensitive area surveys to designate areas within aquatic plant communities which provide important habitat for game fish, forage fish, macroinvertebrates, and wildlife, as well as important shoreline stabilization functions. The Department of Natural Resources has transitioned to designations of *critical habitat areas* that include both *sensitive areas* and *public rights features*. The *critical habitat area* designation provides a holistic approach to ecosystem assessment and protection of those areas within a lake that are most important for preserving the very character and qualities of the lake. Protecting these *critical habitat areas* requires the protection of shoreline and in-lake habitat. The *critical habitat area*

[14] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.
[15] Berg 2016.

designation provides a framework for management decisions that impact the ecosystem of the lake.

*Critical habitat areas* include *sensitive areas* that offer critical or unique fish and wildlife habitat (including seasonal or life stage requirements) or offer water quality or erosion control benefits to the area (Administrative code 107.05(3)(1)(1)). The Wisconsin Department of Natural Resources is given the authority for the identification and protection of sensitive areas of the lakes. *Public rights features* are areas that fulfill the right of the public for navigation, quality and quantity of water, fishing, swimming, or natural scenic beauty.

**Sensitive Area Study**

A draft sensitive area study was completed by the Department of Natural Resources in the late 1990s / early 2000s and is included in the 2003 DNR/Polk County *Apple River Flowage Aquatic Plant Survey Report*. The sensitive area study is not included in DNR records, and it is not clear if results will be used for permitting in the flowage. Results are included for information in Appendix A.

## Rare and Endangered Species Habitat

The Natural Heritage Inventory (NHI) map of Polk County indicates occurrences of aquatic listed species in the sections where the flowage is located. A species list is available to the public only by town and range. The Apple River Flowage is located in the town of Lincoln (T33N, R16W). The proposed actions within the plan are not anticipated to affect wildlife including the natural heritage species shown in Table 4.

*Table 5. Natural Heritage Species in the Town of Lincoln*

| Scientific Name | Common Name | Status |
|---|---|---|
| *Etheostoma micorperca* | Least Darter | SC/N |

WDNR and federal regulations regarding special concern species range from full protection to no protection. The current categories and their respective level of protection are as follows:
**SC/N** = no laws regulating use, possession, or harvesting
**SC/P** = fully protected

## Apple River Flowage Fishery

The fishery of Apple River Flowage consists of bluegill, black crappie, pumpkinseed, yellow perch, largemouth bass, smallmouth bass, rock bass, muskellunge, and northern pike.[16]

The most recent fisheries survey was completed in 2011. Results of the survey indicated abundant bluegill, black crappie, and pumpkinseed populations with average size structure; a moderate density largemouth bass population with good size structure; and moderate density muskellunge and northern pike populations with good size structure.

When considering fish in flowage aquatic plant management, the following should be considered:[17]

1. Black crappie spawn when the water temperature is the same as that generally recommended for CLP treatment. Early season CLP herbicide treatment would need to be timed accordingly prior to crappie spawning.

2. Since northern pike spawn when water temperatures are in the 40's F, and herbicide treatments occur when the water temperatures are higher, herbicide application should not coincide with or disrupt northern pike spawning.

*Table 6. Spawning Temperatures and Substrate Needs*

| **Fish species[18]** | **Spawning Temp in °F** | **Spawning substrates** |
|---|---|---|
| Black crappie | Upper 50's to lower 60's | Build nests in 1- 6 feet on hard bottom |
| Bluegill, Largemouth bass and Pumpkin seed | Mid 60's to lower 70's | Build nests in less than 3 feet on hard bottom |
| Northern pike | Upper 30's to mid-40's soon after ice-out | Broadcast eggs onto vegetation (eggs attach) |
| Smallmouth bass | Usually between 62 and 64 but recorded as low as 53 | Nests in circular, clean gravel |
| Walleye | Low 40's to 50 degrees | Gravel/rocky shoals with moving or windswept water 1-6 feet deep |
| Yellow perch | Mid 40's to lower 50's | Broadcast eggs in submergent vegetation or large woody debris |

[16] Wisconsin Lakes Book. 2009.
[17] From *Aquatic Plant Management Plan Lake Wapogasset and Bear Trap Lake.* Ecological integrity Services. August 2009.
[18] Information from Aaron Cole. Wisconsin DNR Fisheries Biologist. 2017

# Plant Community

## Aquatic Plant Survey Results

Three aquatic macrophyte (plant) surveys were conducted in 2016 according to standard Wisconsin Department of Natural Resource methods. Endangered Resource Services completed early-season CLP point-intercept and bed mapping surveys May 8, 18-19, and 21. These were followed by a warm-water point-intercept survey of all aquatic plants from July 17-19. The results discussed below, are summarized or taken directly from the aquatic macrophyte survey results.

The survey and data analysis methods and results for the aquatic macrophyte surveys are found in the following report: *Curly-leaf pondweed (Potamogeton crispus) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Apple River Flowage - WBIC: 2624200. Polk County, Wisconsin*, conducted and prepared by Matthew S. Berg of Endangered Resource Services, LLC.

Using a standard formula based on a lake's shoreline shape and length, islands, water clarity, depth, and size, the Wisconsin Department of Natural Resources (WDNR) generated the sampling point grid of 672 points. Figure 10 below shows the distribution of the sampling points in 2010.

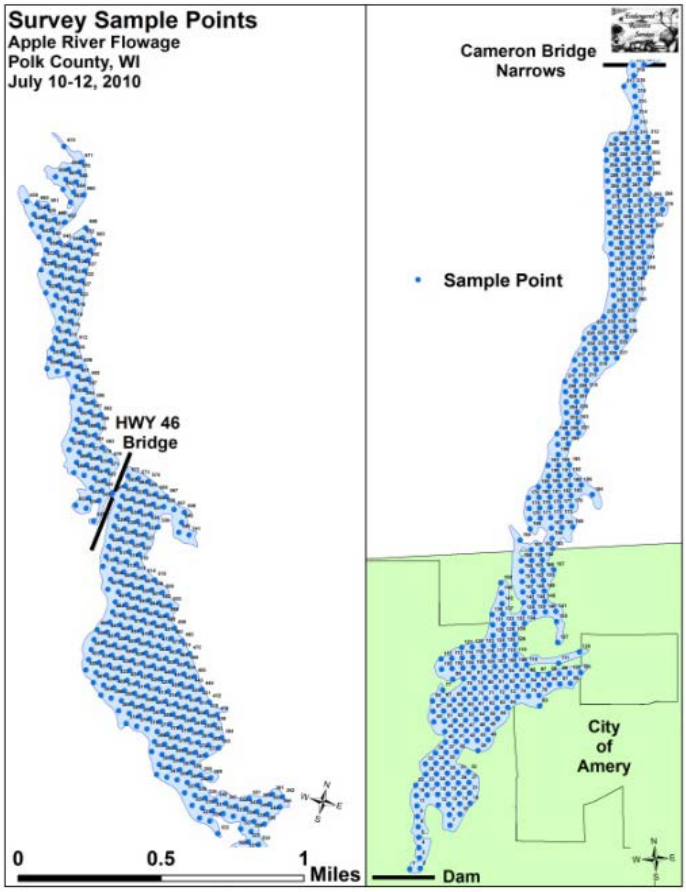



*Figure 10. Sampling Point Grid*

There was little change seen in the plant community when 2016 results are compared to those from 2010 and 2011. In July 2016, plants were found growing on approximately 89% of the lake bottom (597 out of 672 sampling points) with nearly all of the points at depths shallower than the 13.5 foot depths where plants were found. The lake area with depths at which plants can grow is called the littoral zone. Most of the flowage has a muck bottom (Figure 11). Most of the sand was found scattered along wave swept points and shoreline, while the majority of the gravel and cobble substrates occurred in scoured areas of the river channel.

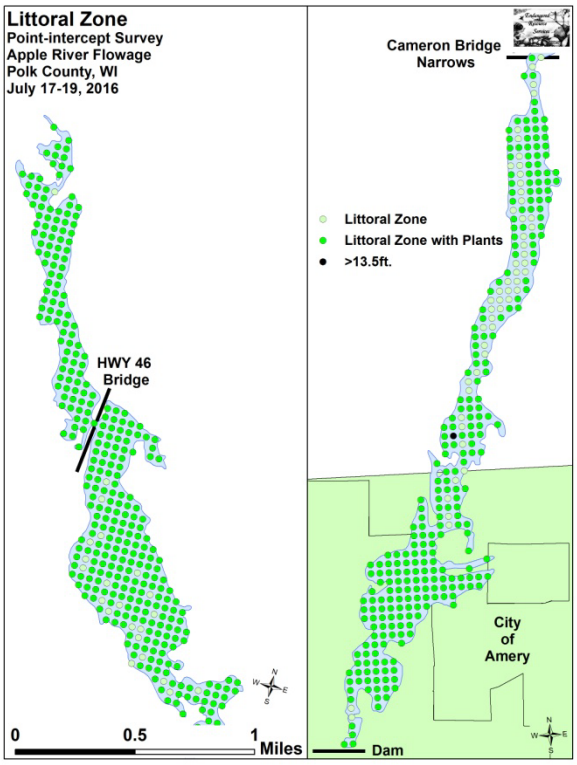



*Figure 11. Flowage Littoral Zone*

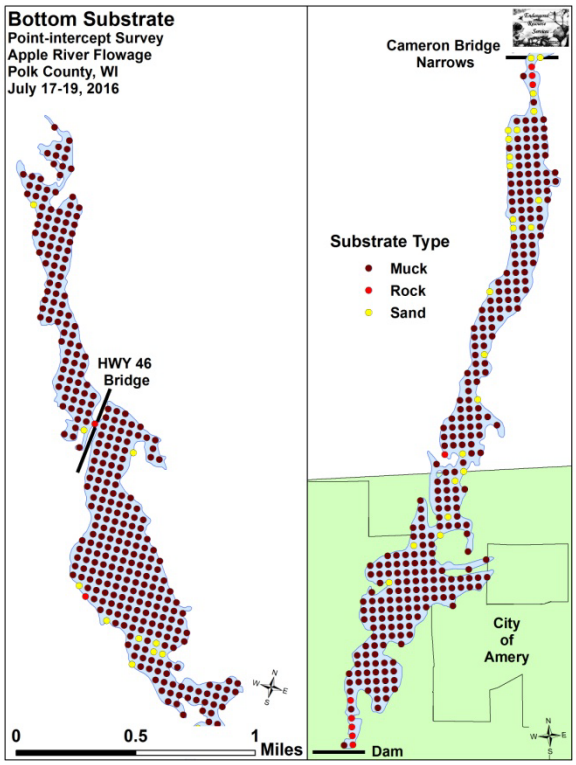



*Figure 12. Bottom Sediment Type*

Plant diversity was high in the flowage in 2016 with a Simpson Diversity Index of 0.86. The Simpson Diversity Index is a measure of the likelihood that a different species of plant would be found each time a grab sample is taken. The highest Simpson Diversity Index is 1.0. A total of 35 aquatic macrophyte species were sampled in and adjacent to the flowage during the 2016 study, up slightly from the 32 species sampled in 2010. The shallow, mucky bays supported the highest richness (numbers of different) native species and the greatest overall growth of plants. Rocky and sandy areas had species not found elsewhere. Species richness dropped rapidly with increasing depth. Summary statistics from the summer surveys in 2010 and 2016 are reported in Table 7. Statistics by species for 2016 are reported in Table 8. Results are quite similar in 2010 and 2016. A comparison of survey results is presented in detail in the plant survey report.

In 2016, coontail, common watermeal, small duckweed, and large duckweed were the most common species. They were found at 91%, 64%, 64%, and 62% of sites with vegetation (Table 4), and they accounted for 71% of the total relative frequency.

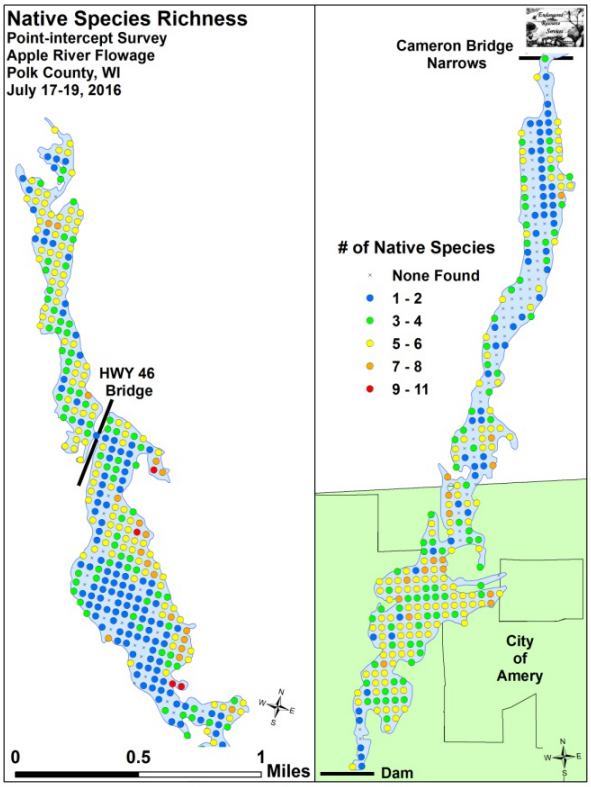



*Figure 13. Native Species Richness*

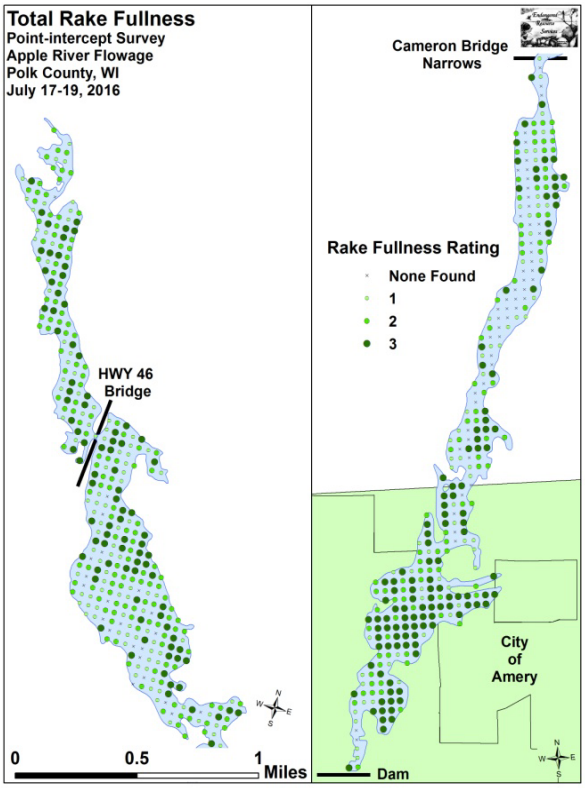



*Figure 14. Total Rake Fullness*

*Table 7. Aquatic Plant Summary Statistics*

| | 2010 | 2016 |
|---|---|---|
| Total number of points sampled | 671 | 672 |
| Total number of sites with vegetation | 588 | 597 |
| Total number of sites shallower than the maximum depth of plants | 669 | 671 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 87.89 | 88.97 |
| Simpson Diversity Index | 0.87 | 0.86 |
| Maximum depth of plants (ft) | 14.0 | 13.5 |
| Mean depth of plants (ft) | 5.3 | 5.1 |
| Median depth of plants (ft) | 4.5 | 5.0 |
| Average number of all species per site (shallower than max depth) | 3.55 | 3.56 |
| Average number of all species per site (veg. sites only) | 4.04 | 4.00 |
| Average number of native species per site (shallower than max depth) | 3.51 | 3.51 |
| Average number of native species per site (sites with native veg. only) | 4.02 | 3.96 |
| Species richness | 30 | 33 |
| Species richness (including visuals) | 32 | 35 |
| Species richness (including visuals and boat survey) | 36 | 37 |
| Mean rake fullness (veg. sites only) | 2.27 | 2.08 |

**The Floristic Quality Index** (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community response to development and human influence on the lake. It takes into account the species of aquatic plants present and their tolerance for changing water quality and habitat characteristics. A plant's tolerance is expressed as a coefficient of conservatism (C). Native plants in Wisconsin are assigned a conservatism value between 0 and 10. A plant with a high conservatism value has more specialized habitat requirements and is less tolerant of disturbance and/or water quality changes. Those with lower values are more able to adapt to disturbance or changing conditions, and can therefore be found in a wider range of habitats. The FQI is calculated using the number of species present and these plants' species conservatism values. A higher FQI generally indicates a healthier aquatic plant community.

The 29 plants identified to species during the point intercept survey in 2010 produced a mean Coefficient of Conservatism of 5.9 and a Floristic Quality Index of 31.8. In 2016, a total of 31 native index species were identified in the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism of 5.7 and a Floristic Quality Index of 31.8. Nichols (1999) reported an average mean C for the Northern Central Hardwood Forests Region of 5.6 putting the Apple River Flowage just above average for this part of the state. The FQI mean for the Northern Central Hardwood Forests Region (Nichols 1999) was 20.9.

*Table 8. Species Frequency and Rake Fullness 2016*

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Ceratophyllum demersum* | Coontail | 545 | 22.90 | 91.29 | 81.22 | 1.94 | 7 |
| *Wolffia columbiana* | Common watermeal | 384 | 16.13 | 64.32 | 57.23 | 1.98 | 1 |
| *Lemna minor* | Small duckweed | 383 | 16.09 | 64.15 | 57.08 | 1.94 | 1 |
| *Spirodela polyrhiza* | Large duckweed | 373 | 15.67 | 62.48 | 55.59 | 1.45 | 1 |
| | Filamentous algae | 299 | * | 50.08 | 44.56 | 1.41 | 0 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 211 | 8.87 | 35.34 | 31.45 | 1.40 | 36 |
| *Elodea canadensis* | Common waterweed | 174 | 7.31 | 29.15 | 25.93 | 1.48 | 6 |
| *Nymphaea odorata* | White water lily | 55 | 2.31 | 9.21 | 8.20 | 1.76 | 27 |
| *Lemna trisulca* | Forked duckweed | 51 | 2.14 | 8.54 | 7.60 | 1.06 | 0 |
| *Potamogeton pusillus* | Small pondweed | 46 | 1.93 | 7.71 | 6.86 | 1.17 | 3 |
| *Zizania palustris* | Northern wild rice | 31 | 1.30 | 5.19 | 4.62 | 1.45 | 10 |
| *Potamogeton crispus* | Curly-leaf pondweed | 27 | 1.13 | 4.52 | 4.02 | 1.11 | 6 |
| *Potamogeton praelongus* | White-stem pondweed | 17 | 0.71 | 2.85 | 2.53 | 1.12 | 9 |
| *Ranunculus aquatilis* | White water crowfoot | 15 | 0.63 | 2.51 | 2.24 | 1.13 | 1 |
| *Nitella sp.* | Nitella | 13 | 0.55 | 2.18 | 1.94 | 1.85 | 0 |
| *Nuphar variegata* | Spatterdock | 12 | 0.50 | 2.01 | 1.79 | 1.67 | 6 |
| *Heteranthera dubia* | Water star-grass | 10 | 0.42 | 1.68 | 1.49 | 1.10 | 5 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 5 | 0.21 | 0.84 | 0.75 | 1.40 | 7 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 5 | 0.21 | 0.84 | 0.75 | 1.60 | 1 |
| *Sparganium eurycarpum* | Common bur-reed | 5 | 0.21 | 0.84 | 0.75 | 2.40 | 4 |
| *Vallisneria americana* | Wild celery | 3 | 0.13 | 0.50 | 0.45 | 1.67 | 0 |
| *Potamogeton nodosus* | Long-leaf pondweed | 2 | 0.08 | 0.34 | 0.30 | 1.50 | 2 |
| *Typha* X *glauca* | Hybrid cattail | 2 | 0.08 | 0.34 | 0.30 | 1.50 | 3 |

*Excluded from relative frequency analysis

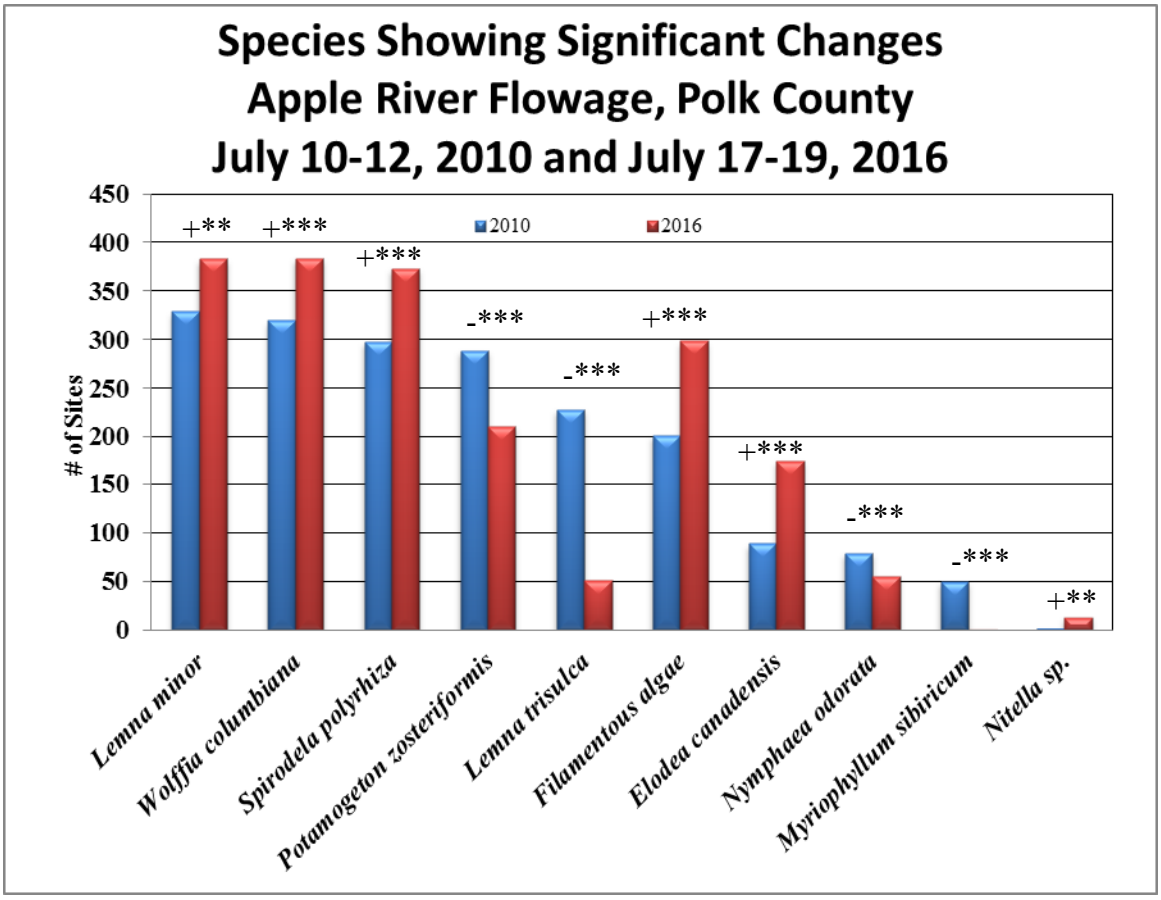
*Table 8. Species Frequency and Rake Fullness 2016 (continued)*

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Carex comosa* | Bottle brush sedge | 1 | 0.04 | 0.17 | 0.15 | 3.00 | 3 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 1 |
| *Najas flexilis* | Slender naiad | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 1 |
| *Phalaris arundinacea* | Reed canary grass | 1 | 0.04 | 0.17 | 0.15 | 3.00 | 1 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 0 |
| *Potamogeton robbinsii* | Fern pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 2 |
| *Potamogeton strictifolius* | Stiff pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 0 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 4 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 1 | 0.04 | 0.17 | 0.15 | 1.00 | 0 |
| *Stuckenia pectinata* | Sago pondweed | 1 | 0.04 | 0.17 | 0.15 | 2.00 | 0 |
| *Typha latifolia* | Broad-leaved cattail | 1 | 0.04 | 0.17 | 0.15 | 2.00 | 0 |
| *Eleocharis erythropoda* | Bald spikerush | ** | ** | ** | ** | ** | 1 |
| *Lythrum salicaria* | Purple loosestrife | ** | ** | ** | ** | ** | 1 |
| *Juncus effusus* | Common rush | *** | *** | *** | *** | *** | *** |
| *Utricularia vulgaris* | Common bladderwort | *** | *** | *** | *** | *** | *** |

** Visual Only *** Boat Survey Only

## Significant Changes in Aquatic Plants (2010 and 2016)

Ten species showed significant changes in distribution from 2010 to 2016 (Figure 14). common watermeal, large duckweed, filamentous algae, and common waterweed all experienced highly significant increases; and small duckweed and nitella demonstrated moderately significant increases. Conversely, flat-stem pondweed, forked duckweed, and northern water-milfoil suffered highly significant declines; and white water lily showed a significant decline.




**Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$**

*Figure 14. Macrophytes Showing Significant Changes from 2010-2016 (Berg 2016)*

Most the dense beds of flat-stem pondweed (*Potamogeton zosteriformis*) occurred above and just below the Cameron Bridge in 2010. The 2016 survey showed little change for this species in shallow water beds, but areas occurring in 4.5 feet or more were often noticeably reduced or absent. Because it is a shallow-rooting species that sprouts from overwintering turions and does not readily regenerate, it's possible and perhaps likely that these significant declines are the result of harvesting.

Most of the expansion of common waterweed species (*Elodea Canadensis)* occurred in shallow water areas where no harvesting occurred suggesting these differences were in response to localized habitat changes rather than to management activities.

White water lily (*Nymphaea odorata*) is a species of shallow bays that was most common in stump fields along the flowage's eastern shoreline, it seems unlikely the reduction in distribution was tied to harvesting.

Small pondweed (*Potamogeton pusillus)* density declined with the loss of several large beds that occurred south of the Cameron Bridge in 2010 but not in 2016. Because this area is harvested, it is possible management has been at least partially responsible for the decline in density in that area.

Northern water-milfoil (*Myriophyllum sibiricum)* was difficult to find in 2016 while it was the ninth most common species in 2010. A species known for "boom to bust" population cycles, this may be the best explanation for this highly significant decline in distribution as most of the population in 2010 was found in areas of the flowage that have never been harvested.

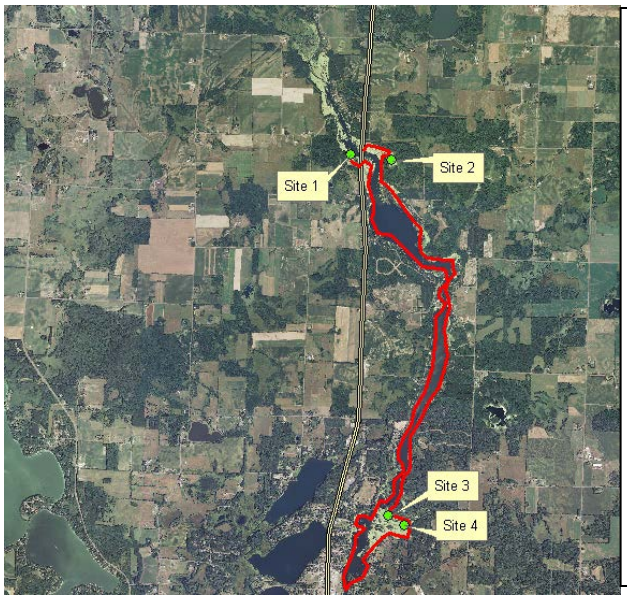
**Northern Wild Rice (*Zizania palustris*)**

Wild rice is an aquatic plant with special significance to Native American Tribes. Wild rice is both ecologically and culturally important on the landscape. Rice beds provide diverse habitat for wildlife and fish, acting as brood rearing and nursery areas. Waterfowl also use rice beds as a food source for both the abundant seeds and the diverse invertebrate community found attached to stalks. An annual grass dependent on flowing water, rice can exhibit a fair amount of variation in abundance from year to year in the same bed. Densities can fluctuate from bumper crops to poor production years. Wild rice grows in shallow water. Beds will not expand out further than 4 feet deep, and most rice grows in water depths from 6 inches to 3 feet. Culturally rice has played a prized role in the lives of the Ojibwe and others who have realized the nutritional value of this important resource.

The St. Croix Tribal Environmental Department surveyed wild rice in August of 2010.[19] Including some areas just upstream of the flowage, 38 acres of wild rice were mapped in 2010 and 41 acres were mapped in 2011. Very dense beds were located on the north end where the river enters the flowage (Figure 17). Wild rice was also found in these areas during the July survey (Figure 19). Impacts to wild rice must be considered with any aquatic plant management method.

Wild rice was confined to two areas on the flowage in 2016 neither of which was deep enough to allow for mechanical harvesting. Around the Beaver Brook Inlet, rice occurred in generally low density, and the plants that were present had been heavily cropped by geese. On the upstream end of the flowage in the Apple River Inlet, a more or less continuous rice bed of moderate density covered at least 20 acres.

[19] Havranek. 2010.




**Site Survey Information 2010**

**Site 1:** West of HWY 46 Bridge. This is a remnant site with less than 20 plants.

**Site 2:** Small, shallow bay east of bridge. This site has about 500 scattered plants.

**Site 3:** Delta where Beaver Brook enters. About 50 plants present.

**Site 4:** Along Beaver Brook in emergent vegetation. About 20 plants scattered 100 feet or more apart.

Figure 15. *Sites of Wild Rice Growth*

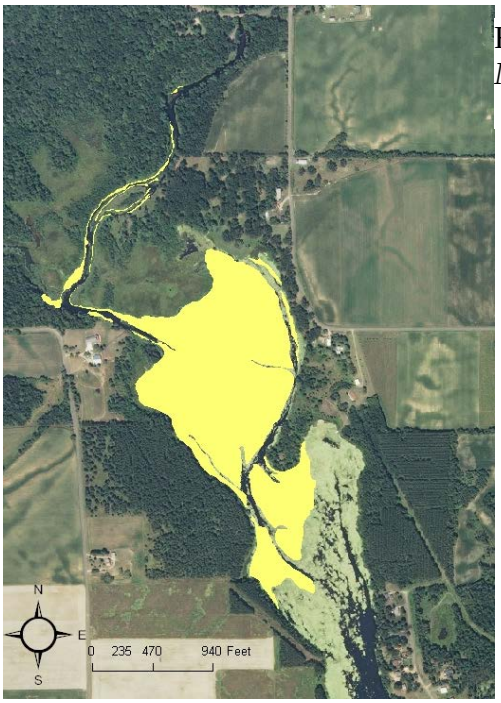



Figure 16. *Wild Rice Locations 2011 North End of the Flowage (in yellow)*

Figure 17. *Dense Wild Rice Growth Looking Southeast toward the Flowage*

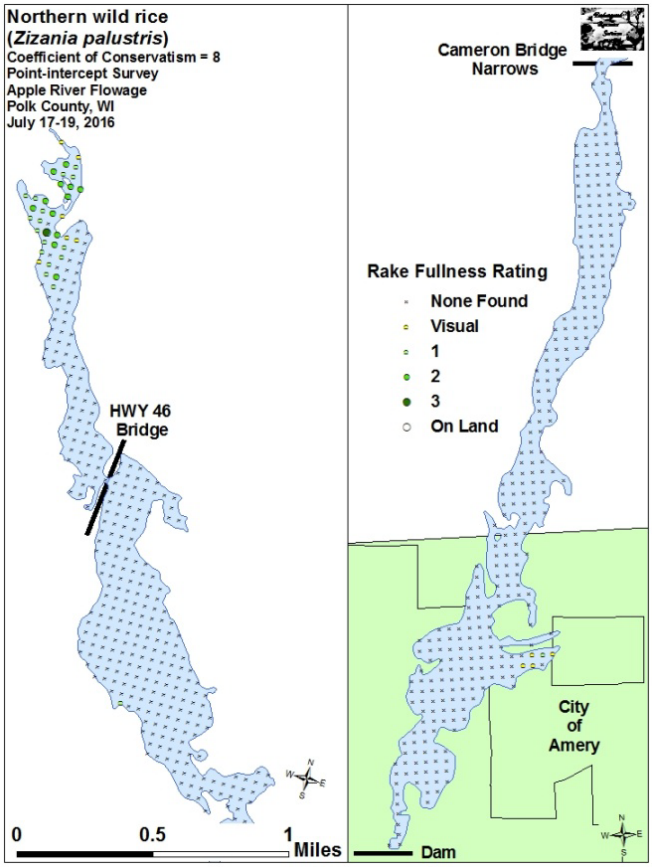



*Figure 18. Northern Wild Rice Point Intercept Distribution (2016)*

## 2003 Aquatic Plant Survey

The Polk County Land and Water Resources Department and the Department of Natural Resources conducted an aquatic plant survey the first two weeks of June 2003 to assess the distribution and density of curly leaf pondweed. A second survey to assess the native aquatic plant species density and distribution was conducted the last week of July and first week of August 2003. Sampling occurred along twenty-two randomly selected transects. This was an accepted plant sampling method at the time. Aquatic plant coverage was reported to be 65% at the time of the survey in 2003 compared to 88% in 2010.

## Aquatic Plant Nuisances

The 2003 report mentions nuisance problems association with coontail, duckweed, and other native species. Coontail was reported to be dominant. It was present at over 90 percent of sample sites – equivalent to the 2010 and 2016 results. The report stresses that coontail can grow as a free-floating plant and take nutrients from the water column.

Growth was reported to be extremely thick in the July 2010 survey. The survey report states: "clouds of algae/duckweed and mats of coontail dominated the plant community." The report goes on to state:

> *Most of the Apple River Flowage is a shallow "salad bowl" that is dominated by coontail and curly-leaf pondweed interspersed with abundant populations of duckweeds, watermeal, and various green and blue-green algae – all species that tend to proliferate in nutrient rich conditions. During the plant survey in July, it was very difficult to navigate east/west in the majority of the flowage due to this excessive plant growth which stretched from shore to shore with the exception of the main river channel. Prop cut trails from the main channel to private residences were present throughout, and we noted that, especially in areas where the water was <5ft such as north of the HWY 46 Bridge, navigation often required continuous cleaning of the motor.*

However, by August 23, 2010 when a boat tour was conducted, there was little floating vegetation and no navigation impairment evident in much of the flowage.

> *A specific example of this was the area below the Cameron Narrows Bridge which had been solid canopied coontail and small pondweed (Potamogeton pusillus) in 10ft+ water during the July survey, but was now completely devoid of plants.*

## Invasive Species

Four invasive species were located in the aquatic plant surveys. They include purple loosestrife, reed canary grass, hybrid cattail, and curly leaf pondweed. More information about these species is included in Appendix B.

### Purple Loosestrife

Purple loosestrife was found at a single location just south of the Highway 46 Bridge in 2010. It was also noted in the 2016 survey on the eastern shoreline below the bridge.

### Reed Canary Grass

Reed canary grass is well established around the perimeter of the flowage.

### Hybrid Cattail

Native to southern but not northern Wisconsin, narrow-leaved cattail (*Typha angustifolia*) and its hybrids with broad-leaved cattail are becoming increasingly common in northern Wisconsin where they tend to be invasive. There were several stands of these hybrids scattered throughout the flowage in 2016, and they appear to be expanding and crowding out other emergent species.

### Curly Leaf Pondweed

Curly leaf pondweed was listed as common or abundant in 1993, 1994, and 1995 plant survey reports. Plant surveys completed in late June and August of 1977 or 1978 (date is not clear in the report) do not mention the presence of curly leaf pondweed. However, the plant may have not been obviously present at these survey times. Curly leaf pondweed was found at 64 percent of sample sites during the 2003 survey. (Although the 2003 Polk County/DNR report states that CLP was found in 1977, no mention of the plant was found in the 1977 OILR report.)

Endangered Resource Services completed curly leaf pondweed bed mapping surveys in June 2011 and May 2016. CLP growth dominates the flowage in early summer according to the survey report. Both a rake survey and bed mapping were completed. Survey results suggest the 2016 CLP distribution in the flowage was almost identical to results from 2011. These results suggest the current management program has resulted in little change to CLP's overall population structure in the flowage.

For the mapping, CLP beds met two criteria: CLP plants made up greater than 50 percent of all aquatic plants in the area, and the CLP had canopied at the surface or was close enough to the surface that it would likely interfere with normal boat traffic. Areas that had a high amount of CLP, but were not canopied or were not dense enough to meet the "bed" criteria, were also mapped and identified as "high density CLP areas". These areas have the potential to form beds in the future.

In May 2016 CLP was present at 463 of 672 sample points which approximated to 69% of the entire flowage having coverage. This is the same coverage as in 2011.

From the 2011 report:

*Although found throughout the littoral zone, CLP achieved its greatest densities in sheltered bays with muck bottoms in water 3-7 feet deep. In general, the only place CLP wasn't found was in the deepest parts of the river channel, in water <1 foot deep where coontail filled the entire water column, and in most of the shallow northern wild rice (Zizania palustris) areas surrounding the Apple River Inlet.*

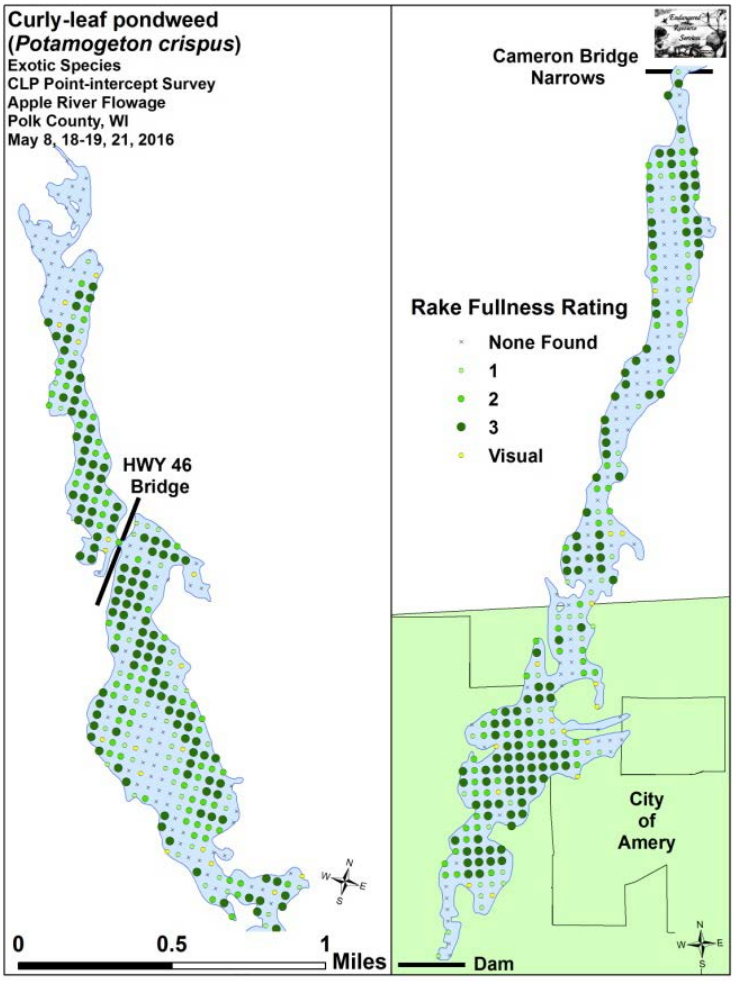



*Figure 19. Curly Leaf Pondweed Rake Density 2016*

In 2016, 13 curly-leaf pondweed beds that covered 382 acres or 63% of the flowage's 604 total acres were mapped. Beds ranged in size from 0.3 acre to 93.5 acres. This represented an 11.20 acre (3%) increase from the CLP that covered 371 acres (61% of the flowage's surface area) during the original 2011 survey.

Maps and tables below summarize the bed mapping results from the 2016 CLP survey. A detailed description of each of the beds and high density areas is included in the Endangered Resource Services Report.

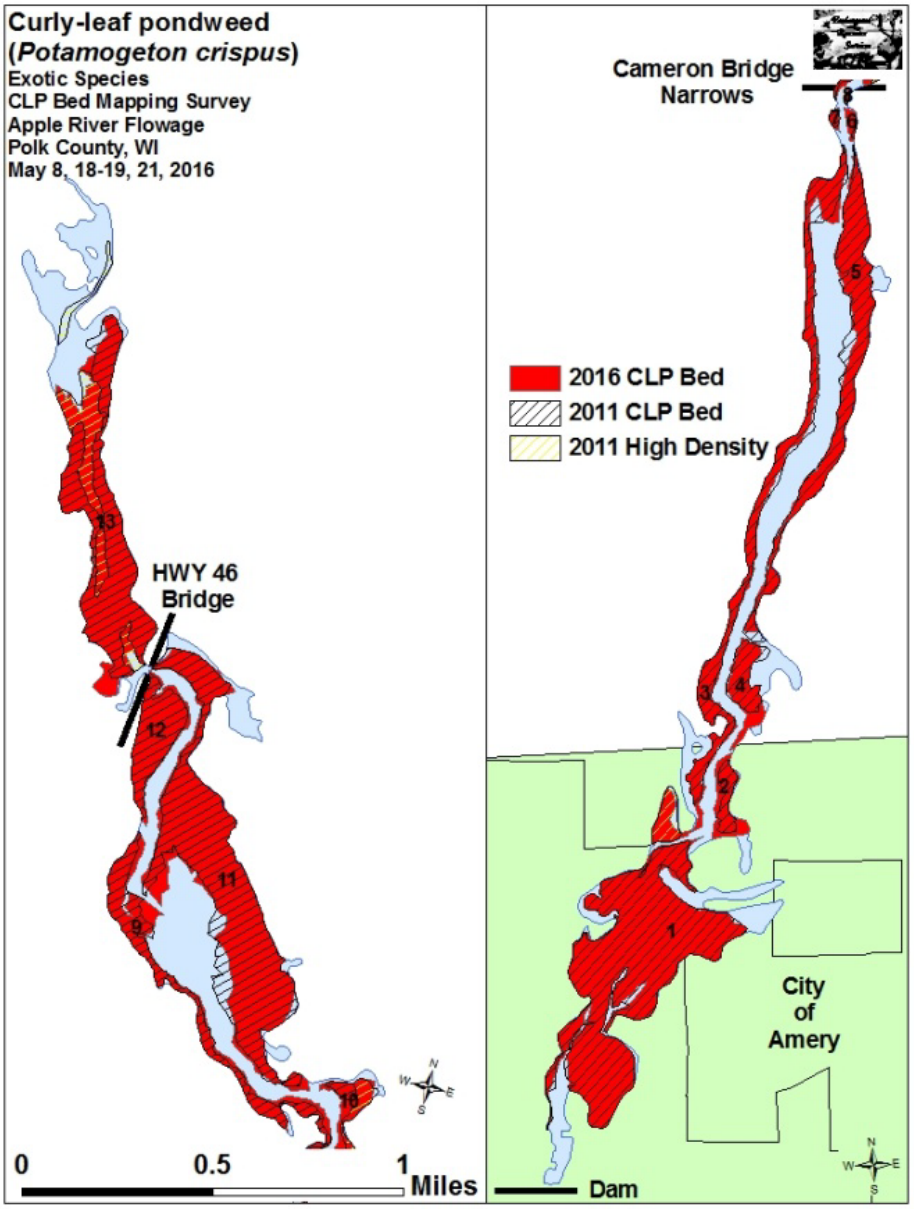



*Figure 20. Curly Leaf Pondweed Beds and High Density Areas 2016*

*Table 9. CLP Bed and High Density Area Summary June 2011 and May 2016*

| Bed and HDA Number | 2016 Acreage | 2011 Acreage | 2016 Acreage Change | 2016 Rake Range | 2016 Mean Rake Fullness | 2016 Max Depth of CLP | 2016 Canopied | 2016 Potential Navigation Impairment Level |
|---|---|---|---|---|---|---|---|---|
| 1 | 93.53 | 93.62 | -0.09 | <1-3 | 3 | 8 | Yes | Severe |
| 2 | 7.13 | 3.97 | 3.16 | <<1-3 | 2 | 9 | Yes | Moderate |
| 3 (and HDA 1) | 36.71 | 37.78 | -1.07 | <<1-3 | 3 | 9 | Yes | Moderate |
| 4 | 9.12 | 7.71 | 1.41 | <1-3 | 2 | 11.5 | Yes | Moderate |
| 5 | 32.45 | 33.90 | -1.45 | <1-3 | 3 | 10 | Yes | Severe |
| 6 | 1.19 | 0.15 | 1.04 | <1-3 | 2 | 8 | Yes | Moderate |
| 7 | 0.75 | 0.60 | 0.15 | <1-3 | 2 | 8 | Yes | Moderate |
| 8 | 0.28 | 0.22 | 0.06 | <1-2 | 2 | 8.5 | Yes | Minor |
| 9 | 26.63 | 21.31 | 5.32 | <1-3 | 3 | 9 | Yes | Severe |
| 10 (and HDA 2) | 7.32 | 5.15 | 2.17 | <<1-3 | 2 | 10.5 | Yes | Moderate |
| 11 | 85.91 | 84.89 | 1.02 | <1-3 | 3 | 10.5 | Yes | Severe |
| 12 | 17.97 | 16.30 | 1.67 | <1-3 | 3 | 9 | Yes | Severe |
| 13 (and HDA 3 and 4) | 63.37 | 63.24 | 0.13 | <1-3 | 3 | 8 | Yes | Severe |
| HDA 5 | 0.00 | 2.32 | -2.32 | - | - | - | - | - |
| **Total Acres** | **382.35** | **371.15** | **11.20** | | | | | |

## Aquatic Plant Management

This section reviews the potential management methods available and reports past management activities on the flowage.

### Permitting Requirements

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107 – Aquatic Plant Management. A permit is required for any aquatic chemical application in Wisconsin. Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) due, in the case of the Apple River Flowage, to the presence of a special concern species.

The requirements for manual and mechanical plant removal are described in *NR 109 – Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations.* A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, (with the exception of wild rice) from his/her shoreline up to a 30-foot corridor. A riparian landowner may also manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[21]

The *Department of Natural Resources Northern Region Aquatic Plant Management Strategy* (May 2007) requires documentation of impaired navigation or nuisance conditions before native plants may be managed with herbicides. Severe impairment or nuisance will generally mean that vegetation grows thickly and forms mats on the water surface.

[21] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR web site: www.dnr.state.wi.us.

## Past Aquatic Plant Management

The 1979 Office of Inland Lake Renewal study provided some general recommendations including consideration of harvesting or herbicide use to allow navigation. This study mentions that attempts at controlling nuisance vegetation with herbicides began in 1967 and continued since through 1978. However, the flowage district was not formed until 1975, and treatment records from that time period are not available.

**Navigation Channels**

Navigation channels have been maintained by the ARPRD for many years. District records were found for harvesting aquatic vegetation from channels in 1985, 1986, and 1990 and from 1992 through 1997, although harvesting may have occurred in additional years. The harvesting contractor in each year reported was Aquatic Nuisance Control. It appears that herbicides were used to maintain navigation channels from 1993 through 2009. This use is summarized in Table 12.

*Table 10. Apple River Flowage Harvesting (1985-1997)*

| **Year** | **Area Harvested/ Pounds Removed** | **Private Harvesting Offered (pounds removed)** |
|---|---|---|
| 1985 | Main channels | Yes |
| 1986 | Main channels | Yes |
| 1992 | 281,000 lbs. | 52,000 lbs. |
| 1993 | North Park Area: 82,000 lbs.<br>North of 46 Bridge: 71,000 lbs. | Yes<br>187,000 lbs. |
| 1994 | North of HWY 46 and "Byron Burmans into town" | Yes |
| 1995 | City of Amery: 197,000 lbs.<br>Upper Apple: 163,500 lbs. | Yes<br>53,000 lbs. |
| 1996 | | Yes |
| 1997 | Budget notes $4,640 for weed harvesting | |

*Table 11. Apple River Flowage Navigation Channel Herbicide Treatments (1993-2009)*

| Year | Contractor/ Budget | Area Treated | Chemicals Used/Plants Targeted | Comments |
|---|---|---|---|---|
| 1993 | Aquatic Nuisance Control | **North Park** (225'X125') Unknown Additional Channel (100'X80') **Town of Lincoln Landing** (50' X 100') | | |
| 1994 | Aquatic Nuisance Control | **North Park** (150'X100' in June) **Town of Lincoln Landing** (50'X100' in July and Aug) | Diquat Copper Sulfate Aquathol | |
| 1995 | Aquatic Nuisance Control | **North Park** (150'X100') **Town of Lincoln Landing** (50'X100') | Diquat Copper Sulfate | |
| 1996 | Aquatic Nuisance Control | **North Park** **Town of Lincoln Landing** | | No channel size indicated on permit |
| 1997 | Aquatic Nuisance Control | **North Park** **Town of Lincoln Landing** | | No channel size indicated on permit |
| 1998 | Lake Management, Inc. | **Birch Street to beyond North Park** (25' wide, 2.27 acres) **Vijobi Area** (25' wide, .91 acres) | | DNR required buoys to mark channels |
| 1999 | Lake Management, Inc. | **Birch Street to beyond North Park** (25' wide, 2.27 acres) **Vijobi Area** (25' wide, .91 acres) | | Treatment only where access is hindered. Area to be well marked to encourage boating use. |
| 2000 | Lake Management, Inc. | **Birch Street to beyond North Park** **North Park; WI Lane** Total up to 2.72 acres | Reward (Diquat) Copper Sulfate | Areas to be clearly marked for their intended use |
| 2001 | Lake Management, Inc. | **Birch Street to beyond North Park** (25' wide, 2.27 acres) **North Park** **Town of Lincoln Landing** | Reward Aquathol K Copper Sulfate | |
| 2002 | Lake Management, Inc./ $6,225 | **Birch Street to beyond North Park** (25' wide, 2.27 acres) **HWY 46 to north** (25' wide, 2.53 acres) | Reward Copper Sulfate | Encourage travel Clearly mark |

| Year | Contractor/ Budget | Area Treated | Chemicals Used/Plants Targeted | Comments |
|---|---|---|---|---|
| 2003 | Aquatic Engineering/ $8,219 | **3 Channels** cover up to 6.22 acres:<br>**Birch Street to beyond North Park**<br>**HWY 46 to north**<br>**Hwy 46 to south**<br>**North Park and Birch Street**<br>Boat Landing Sites (.22 acres) | Diquat and others in late June. | Authorized for CLP treatment, but public landing (at least) completed near CLP die-off. No report for navigation channels. |
| 2004 | Aquatic Engineering/ $10,544 | **4 Channels** (12.05 acres) + 2 Boat Launches (.22 acres) Similar locations to 2007 map (Figure 26) | Treated with "efficacy mix"[22] in June and August (no early season treatment) | Boat launches surveyed (3X) and treated (2X) with "efficacy mix" on 0.2 acres |
| 2005 | Lake Restoration, Inc./ $6,823 | **4 Channels** (12.05 acres) + 2 Boat Launches (.22 acres) Similar locations to 2007 map (Figure 26) | Reward in late May and mid July | Inspection for EWM encouraged but treatment as preventative not a valid strategy |
| 2006 | Lake Restoration, Inc./ $11,017 | **4 Channels** (12.05 acres) + 2 Boat Launches (.22 acres) Similar locations to 2007 map (Figure 26) | Reward<br>Cutrine Plus in late June and early August | Channels to be clearly marked to encourage use |
| 2007 | Lake Restoration, Inc./ $11,095 | **4 Channels** (13.53 acres) + 2 Boat Launches (.22 acres) Similar locations to 2007 map (Figure 26) | Reward<br>Cutrine Plus | Disturbance of Wild Rice Prohibited. Submit GPS cords. with treatment record |
| 2008 | Lake Restoration, Inc./$11,618 | **4 Channels** (13.53 acres) + 2 Boat Launches (.22 acres) Similar locations to 2007 map (Figure 26) | Reward<br>Cutrine Plus in late July.<br>No early season treatment completed. | Permit for early season CLP treatment and natives with inspection |
| 2009 | Lake Restoration, Inc./$9,717 | **4 Channels** and 2 Launches Similar locations to 2007 map (Figure 26) | Diquat in mid June and late July. | Permit for early season CLP treatment and natives with inspection |

[22] Efficacy mix is described as 12.5 gallons each of Reward, Aquathol-K and Cutrine Plus mixed with 25 gallons of water.

Navigation channel locations in 2007 are indicated in Figure 22. Navigation channels have remained in approximately the same location from 2004 through 2009. The first channel to be permitted for herbicide treatment began at Birch Street in the city of Amery and extended to beyond North Park. This channel appears to have been established in 1998, but may have been similar to the area that was harvested for navigation in past years.

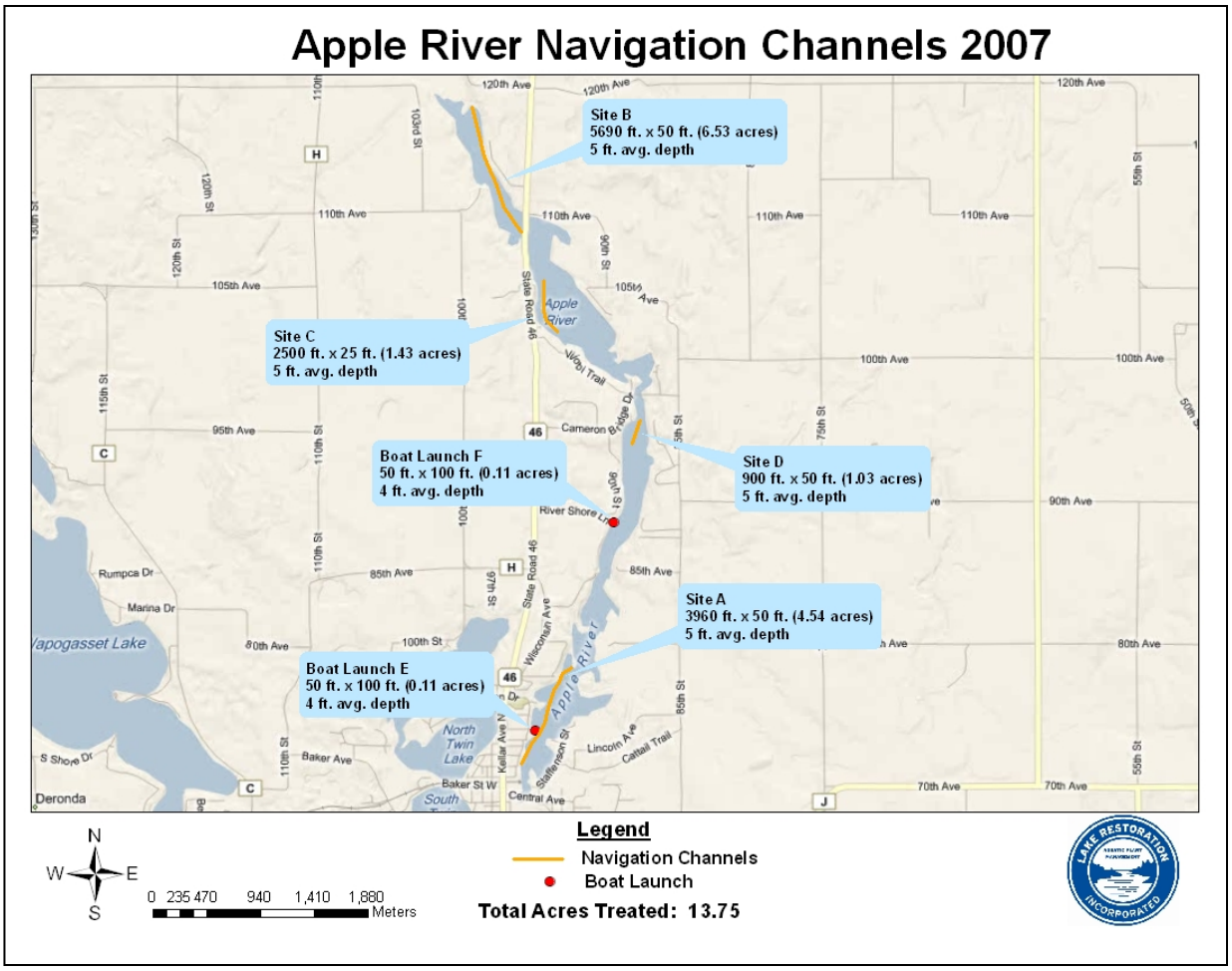



Figure 21. *Navigation Channel Locations 2007*

## Flowage Harvesting 2012-2016

The Wisconsin Department of Natural Resources approved the Apple River Flowage Aquatic Plant Management Plan (September 2011) in December 2011. The plan outlined ARPRD purchase and operation of a harvester to maintain navigation channels on the flowage.

The ARPRD purchased and began operating an aquatic plant harvester in August 2012. Key considerations identified in the 2011 plan for harvesting on the flowage were 1) access for a harvester north and west of the Highway 46 Bridge, 2) availability of disposal/beneficial use sites for harvested plant materials, 3) cost of harvester purchase, 4) operation and maintenance, and 5) timing of harvesting. All of these issues have been addressed in plan implementation.

Dale Richardson, volunteer Operations Manager oversees the harvesting operation on behalf of the ARPRD board. Dave Schleusner maintains equipment and operates the harvester. There are also two additional paid operators.

### Access for harvester

Access points are shown in harvesting maps in Appendix G. Access for a harvester is available at public landing points south and east of the Highway 46 Bridge north of Amery. However, this bridge has a box culvert which provides only about 5.5 feet of clearance at normal water levels. This is not enough clearance for the current harvester. Small harvesters are available for access through areas with low clearance.

The ARPRD developed an access site north of Highway 46 Bridge at the Boles Farm. The site is privately owned and there are no long term agreements for its use.

### Availability of disposal/beneficial use sites

Harvested aquatic plants can be land applied and/or composted as a soil amendment. County and state “do not transport” regulations restrict moving aquatic plants on roadways, but transport is allowed for disposal as part of a harvest or control activity conducted under an aquatic plant management permit issued under Ch. NR 109.

The ARPRD owns a truck for hauling and disposing of harvested aquatic plants. Harvested plants have been in demand and are used as soil amendment for farm fields, gardens, and site reclamation. The 2017 aquatic plant management permit application lists a total of 15 potential disposal sites. In 2016 two primary dump site were used, the Fougner farm and the Town of Lincoln gravel pit.

### Cost of harvester purchase

The ARPRD purchased a harvester, conveyor, and trailer in 2012 for $153,580. They received a $67,690 grant from the Wisconsin Waterways Commission for the purchase. The harvester loan will be paid off by August 2017($14,585 is budgeted for this).

Cost Estimates from Grant:

| | |
|---|---|
| 7-8 foot harvester | $115,000 |
| Conveyor | $26,000 |
| Trailer | $13,000 |

Additional harvesting capacity is needed, especially early in the season when curly leaf pondweed is prevalent.

Operation and maintenance

The City of Amery provides payroll service for ARPRD employees who operate and maintain harvesting equipment. Employment is seasonal. Volunteers also operate, maintain, and supervise harvesting operations. The ARPRD budgeted $35,135 in 2017 for harvesting operation based on recent past annual expenses.

Harvesting schedule

Harvesting begins on the flowage in mid to late May and continues through late August to early September. This schedule depends upon ice-out time, weather, and resulting plant growth. The annual harvester permit application includes curly leaf pondweed and coontail harvesting plans. Permit conditions limit harvesting depth to three feet and greater. Where wild rice is nearby, the minimum harvesting depth is five feet.

Curly leaf pondweed is harvested between mid-May and the end of June. Once the curly leaf has been harvested the crew begins on other species - primarily coontail which is in abundance throughout the flowage. This weed tends to float, so it is a challenge for the harvesting team to stay ahead.

Harvesting has resulted in improved navigation in the flowage. A single 50 foot navigation channel is maintained along most of the length of the flowage. Additional 25 foot channels provide access to waterfront properties. Some areas of heavy use such as North Park and the Lincoln Boat Landing are also harvested. Maps of these areas are included in Appendix G.

Daily records of all harvesting activities are recorded and the Operations Manager periodically submits records to the Wisconsin DNR. A compilation of these records is included in Table 12 below.

*Table 12. Apple River Flowage Harvesting 2012-2016*

| Year | Began | Ended | Days | Loads[23] | Volume ($ft^3$) | Weight (lbs.) |
|---|---|---|---|---|---|---|
| 2012 | August 10 | Sept. 14 | 22 | 112 | 30,800 | 501,760 |
| 2013 | May 28 | August 29 | | 566 | 155,650 | 2,535,680 |
| 2014 | May 28 | Sept. 5 | 63 | 513 | 141,075 | 2,302,857 |
| 2015 | May 8 | Sept. 9 | 68 | 500 | 137,500 | 2,244,500 |
| 2016 | May 11 | Sept. 9 | 75 | 564 | 155,100 | 2,531,796 |

[23] Each load is approximately 275 $ft^3$ and 4489 pounds

## Individual Corridors

In 1979 Aquatic Nuisance Control offered herbicide control to residents. There was no district funding involved. According to district records, some individual property owners contracted to have plants harvested in front of their properties at least in 1985, 1986, and 1990 and from 1992 to 1996. Table 13 reports permitted herbicide treatments in front of individual properties from 1986 through 2009. Records are incomplete so accuracy is not absolute. The number of properties treated has ranged from 2 to 26 sites and the acreage ranged from .20 acres to 3.57 acres. An application for herbicide treatment at four private sites was denied in 2010.

*Table 13. Waterfront Herbicide Treatments on the Apple River Flowage*[24]

| Year | Individual Properties (#) | Acres Treated w/ Herbicide |
|---|---|---|
| 1986 | 2 | .30 |
| 1991 | 2 | .83 |
| 1992 | 2 | .83 |
| 1993 | 2 | .20 |
| 1994 | 2 | .28 |
| 1995 | 3 | .39 |
| 1996 | 5 | .57 |
| 1997 | 6 | .64 |
| 1998 | 9 | 1.09 |
| 1999 | 10 | 1.20 |
| 2000 | 4 | .46 |
| 2001 | 25 | 3.29 |
| 2002 | 26 | 3.04 |
| 2003 | 11 | 1.89 |
| 2004 | 21 | 3.57 |
| 2005 | 14 | 2.41 |
| 2006 | 23 | 3.88 |
| 2007 | 21 | 3.01 |
| 2008 | 4 | .51 |
| 2009 | 4 | .69 |

[24] Information from Department of Natural Resources Aquatic Plant Management permit applications, permits, and treatment records.

The DNR Northern Region released an Aquatic Plant Management Strategy (Appendix C) in the summer of 2007 to protect the important functions of aquatic plants in lakes. As part of this strategy, the DNR prohibited management of native aquatic plants in front of individual lake properties after 2008 unless management is designated in an approved aquatic plant management plan.[25] Because of the importance of the native plant population for habitat, protection against erosion, and as a guard against invasive species infestation, plant removal with herbicides as an option for individual property owners must be carefully reviewed before permits are issued. The DNR will not allow removal after January 1, 2009 unless the "impairment of navigation" and/or "nuisance" conditions are clearly documented.

**Curly Leaf Pondweed Treatment**

Aquatic Plant Management Permit applications and permits refer to requests and authorization for early season curly leaf pondweed (CLP) treatment and provide navigation channel treatment locations as shown in Figure 22. However, there is no record of treatment in any year that could have targeted curly leaf pondweed. Curly leaf pondweed grows in the fall and spring, then dies back by late June. As described previously, effective treatment measures to target curly leaf pondweed growth must be completed early in the season. Water temperatures between 50 and 60 degrees Fahrenheit are generally targeted. These temperatures generally occur sometime in May in the Amery area. This timing is intended to kill CLP before its reproductive structures are formed. At the very least, herbicides treatments that supposedly target CLP in mid-June have no real effect when the plants die back in late June to early July anyway. There are no records of aquatic herbicide treatment of navigation channels that occurred prior to mid-June. Unless treatment records are missing, there has been no herbicide treatment effectively targeting CLP to date on the Apple River Flowage.

**Monitoring for Invasive Species**

The harvesting contractor checked the boat landings during summer months for the presence of Eurasian water milfoil and other invasive plants at least from 1994 to 1997. The 2003 report recommends volunteer monitoring of boat launches, beaches, and other access points at least every few weeks throughout the summer growing season.

A committee of volunteers lead by Derrick Carlson made periodic checks for invasive species at areas of high public use such as the boat landings beginning in 2012.

**Clean Boats, Clean Waters Program**

The ARPRD implemented the Clean Boats, Clean Waters Program watercraft inspections and education for users at the Lincoln Landing beginning in 2012. Student staff were hired and trained in cooperation with the Amery Lakes District and payroll services were provided by the City of Amery. Student staff entered monitoring data into SWIMS.

WDNR grant funding supported the CBCW program from 2012 – 2016 with 75% state funding.

[25] Aquatic Plant Management Strategy. DNR Northern Region. Summer 2007.

**Educational Activities**
Public information was distributed at the annual meetings.

A map of the Apple River Flowage with AIS information was developed in cooperation with the Polk County Association of Lakes and Rivers. A sign was created and posted at the Lincoln Landing. The sign contains a mailbox in which AIS maps of the flowage were placed. About 200 maps are distributed each season.

The ARPRD distributes an annual newsletter to report district activities and provide water quality recommendations for residents.

**Polk County Land and Water Resources Department (LWRD)**
The ARPRD has the opportunity to coordinate training and educational activities with the Polk County Land and Water Resources Department and the Polk County Association of Lakes and Rivers. Volunteers can be trained through Clean Boats, Clean Waters workshops in cooperation with the Polk County LWRD. County staff is also willing to provide plant identification assistance.

## Selection of Management Strategies

The aquatic plant management plan advisory committee carefully considered and evaluated the goals, objectives, and actions for aquatic plant management. Some of the crucial decisions (from 2012) are outlined below.

The goals are listed in priority order with water quality improvement as the top goal for the committee. Water quality is especially critical to plant management in the flowage because the most abundant species are coontail and duckweeds which obtain nutrients from the water column. Detailed recommendations for water quality improvements are beyond the scope of this aquatic plant management plan. The plan does establish steps to learn more about the water quality of the flowage, so water quality improvements can be made in the future. The next two goals: prevention of invasive species and allowing navigation had nearly equal priority. The management methods chosen are commonly used in similar situations and not known to cause adverse impacts. Permits will be sought from the Department of Natural Resources when required.

There was extensive committee input regarding what management method was most appropriate following a review of the advantages and disadvantages of each method. A written survey was distributed and compiled prior to the third committee meeting where members discussed then voted on selection of navigation management methods. These records of committee deliberations are included as Appendix G.

Navigation access will be provided primarily through the use of an aquatic plant harvester. The harvester will also be able to pick up floating nuisance plants such as duckweed and coontail – although picking up duckweed has proven difficult in implementation.

Because of a high concern for invasion of Eurasian water milfoil and other aquatic invasive species, several activities were chosen to monitor for and prevent the introduction of invasives. There was universal support for these activities.

Initially curly leaf pondweed management will involve harvesting to allow early summer access through navigation channels. As the District gains experience with harvesting methods and more is known about the CLP in the flowage, curly leaf may be managed more aggressively to remove nutrients and allow native plant growth.

## Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for the Apple River Flowage. It also presents a strategy of actions that will be used to reach aquatic plant management plan goals.

**Goals** are broad statements of direction.

**Objectives** are steps (preferably measurable) toward the goal.

**Actions** are actions to take to accomplish objectives.

The **Implementation Plan** outlines a timeline, resources needed, funding sources, responsible parties and partners for each action item. The implementation plan will be updated as needed to reflect changing budgets, partners, and new information.

### Funding Plan Implementation

Most of the cost of plan implementation is for harvesting equipment, acquisition, operation and maintenance. The cost of ARPRD harvesting operation is kept relatively low because of extensive volunteer time spent managing the program, maintaining equipment, and operating the harvester. There are paid harvester operators as well. Contracted harvesting would be considerably more expensive.

The ARPRD Board will carefully consider costs and seek to maintain current (2017) assessment rates. Grants will be sought when available.

### Adaptive Management Approach

The plant management control methods and procedures will be reviewed each year to see if they are effective and cost efficient at meeting plan goals and objectives. Changes may be made to the management approach based upon project results, the experience of other lake and river groups, and/or recommendations from the Department of Natural Resources. These changes will be reflected in updated implementation plans. Significant changes (especially those which change management objectives) will be documented as brief addendums to the aquatic plant management plan to be reviewed by the Apple River Protection and Rehabilitation District Board, the Aquatic Plant Management Committee, and the Department of Natural Resources.

## Plan Goals

1. Improve water quality on the Apple River Flowage and downstream on the Apple River.[26]

2. Prevent the introduction of aquatic invasive species.

3. Maintain navigation for fishing, boating, and access to lake residences.

4. Maintain native aquatic plant functions.

5. Minimize environmental impacts of aquatic plant management.

1. Improve water quality on the Apple River Flowage and downstream on the Apple River.

***Objectives***

A. Manage curly leaf pondweed (CLP) to remove nutrients from the flowage and from the Apple River downstream of the flowage.

***Actions***[27]

1. Harvest CLP in navigation channels and areas of concentrated growth (CLP beds) when harvester is available.

***Evaluation***

- Record amounts of CLP harvested in daily records
- Note where CLP beds are harvested each year to assess impact on CLP and native plant growth when point intercept survey occurs.

[26] Goal 1 is addressed primarily through the Apple River Flowage Lake Management Plan 2013.

2. Prevent the introduction of aquatic invasive species.

***Objectives***

A. Boaters inspect, clean, and drain boats, trailers, and equipment.

B. Identify new aquatic invasive species as soon as possible after introduction to the flowage.

C. Rapidly and aggressively respond to new introductions of invasive species such as Eurasian water milfoil.

D. Eradicate purple loosestrife and other invasive species if found in and around the flowage.

***Actions***[28]

1. Implement a Clean Boats, Clean Waters program. (Objective A)
2. Monitor regularly for invasive species introduction at areas of high public use such as the boat landings using volunteers, divers, and/or other comprehensive, reliable methods. (Objective B)
3. Follow the Aquatic Invasive Species Rapid Response plan (Appendix E). (Objective C)
4. Encourage owners to control small areas of purple loosestrife. Consider biological control if larger infestations are discovered. (Objective D).
5. Investigate and pursue available monitoring and control measures for priority invasive species such as Eurasian water milfoil and zebra mussels. (Objective B, C)

[28] Actions in bold will be implemented in the first implementation period. Others will be considered for implementation in the future.

3. Maintain navigation for fishing, boating, and access to lake residences.

***Objectives***

A. Allow access along designated common navigation channels when dense aquatic plants impair navigation.

B. Collect free-floating plant fragments which create nuisance conditions.

C. Allow access through individual waterfront corridors when navigation becomes impaired (as determined by DNR).

4. Maintain native aquatic plant functions.

***Objectives***

A. Minimize removal of rooted aquatic plants to stabilize bottom sediments, provide fish and wildlife habitat, minimize algae growth, and protect against establishment of invasive species.

B. Avoid herbicide use near wild rice, especially when in early stages of growth (June and early July).

C. Avoid cutting and uprooting wild rice seedlings.

D. Manage curly leaf pondweed to encourage the growth of native plants in specific areas of the flowage.

5. Minimize environmental impacts of aquatic plant management.

***Objective***

A. Use manual or mechanical methods over chemical methods to maintain navigation where effective, economically feasible, and uprooting of native plants and stirring of sediments can be minimized.

***Actions***

**Common Navigation Channels**

Harvesting is selected as the preferred method for both native plant and curly leaf pondweed navigation management.

Obtaining harvesting equipment

1. Purchase second harvester and related equipment to handle harvesting demand. Timing will depend upon costs and funding availability.
   - Investigate borrowing costs
   - Pursue grant
   - Second harvester will extend lifespan of 2012 harvester

2. Maintain existing equipment (harvester, truck, etc.) purchased in 2012.

3. Refurbish/replace existing equipment – expected in 2022.

Harvester access and offload sites

4. Secure permanent harvester landing at the north end of the flowage.

Obtaining permits

5. Apply for a harvesting permit. The Apple River Protection and Rehabilitation District will secure a Wisconsin Department of Natural Resources Aquatic Plant Management Permit for harvester operations each year in February or March.

Disposal sites

Disposal sites are identified in harvesting permit applications. They include farm fields, city yard waste areas, and local nursery operations. There is high demand for the material collected.

Harvesting operating standards

6. Operate harvester – approximately from May to September.

   Cutting will occur only at depths greater than 3 feet (or with experience a depth at which disturbance of plant roots and suspension of sediment is avoided).

   Cutting and harvesting (skimming) will be avoided near areas of wild rice growth, especially early in the summer (June and early July). If wild rice is nearby, harvesting depths will be greater than 5 feet.

   Harvesters will be used to gather plant fragments (skimming) both along common navigation channels and in other nuisance areas. Coontail and duckweed are the target species along with fragments that may be created by harvester cutting. Nuisance areas will include deep waters where plant fragments limit navigation and other areas

where fragments accumulate. Cutters will not be used when plant fragments are gathered. Harvesting collected plant fragments (skimming) will only extend to 3 feet of water depth (not shallower). Harvesters may be used in the future to gather plant fragments for the purpose of flowage and downstream nutrient control.

Common channel locations are mapped in Appendix G. Current (2017) harvesting channels total about 72 acres. Channels width may be increased to up to 100 feet wide in the area directly south of the Highway 46 Bridge to the narrows above the Cameron Bridge. The channel north of the Highway 46 Bridge is 25 feet wide north of the end of the Birchwood Road. Channels may be modified to better accommodate harvester use.

Proposed sensitive areas will be taken into account when considering areas for harvesting channel expansion or skimming to collect coontail and other plant fragments. Special care will be taken in these areas to limit disturbance to rooted aquatic plants.

Harvesting will not be provided for individual access. Instead, secondary navigation channels from the main common channels will be offered if harvester time is available. Harvesting will occur no less than 3 feet in depth and will be for multiple residences only.

Monitoring

Harvester operators or flowage district representatives will monitor vegetative growth in designated navigation channels at least weekly for navigation impairment and height of aquatic plants (depth below surface) within each channel. This will serve to identify when harvesting is needed and how long the effects of harvesting last.

Nuisance reporting

A telephone contact is established for lake residents to report problems related to floating plant fragments. These complaints will be investigated by harvester operators and/or flowage district representatives. Plant fragments will be collected as time and budget allows.

If a nuisance related to aquatic plants near a resident's access is reported, it will be clarified that the flowage district will pick up plant fragments if time allows, but not harvest for resident access. Options for resident access corridors will be provided.

***Evaluation***

A written log will record where cutting and harvesting and harvesting only (skimming) occurred and the acreage and species collected for each. Additional information to be recorded each day of harvesting: hours of operation, number of truckloads hauled, estimated tons of material hauled.

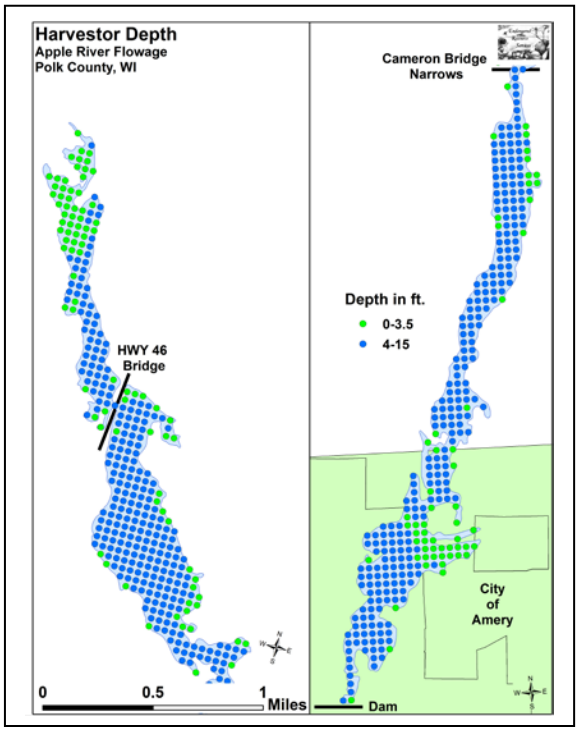



*Figure 27. Approximate Flowage Depth*

## Individual Access Corridors

Property owners are responsible for paying the cost of individual access corridor maintenance. Secondary harvesting channels lessen the need for management for individual access.

**Manual Removal**
If residents wish to remove nuisance aquatic plants that limit access along their docks, they will be encouraged to do so with hand removal methods. No permit is required as long as corridors are cleared no more than 30 feet in width and no mechanized or chemical controls are used. These corridors must remain in the same location from year to year. No clearing may occur without a permit when wild rice is present. Homeowners or contractors may complete hand removal.[29]

**Mechanical Removal**
**A Wisconsin Department of Natural Resources permit (NR109) is required for mechanical devices which remove or prevent the growth of aquatic plants.** Such devices include weed rollers, aerators, lake groomers, mechanized mowers, and water circulators.

**Weed Barriers**
**A Wisconsin Department of Natural Resources permit (Chapter 30/31) for placement of materials such as weed blankets on the lake bottom.**

**Chemical Removal**
**A Wisconsin Department of Natural Resources permit (NR 107) is required for any use of herbicides in the water.** This includes those available through retail and on-line sources. Only a licensed applicator may apply liquid aquatic herbicides. The procedure for aquatic plant chemical permits for individual access corridors is shown on the following page.

***Action***

1. Establish an ARPRD Design Team to respond to property owner requests for permits for aquatic plant management in individual access corridors. The ARPRD Design team will work with DNR to evaluate navigational conditions prior to management.

[29] These are requirements in regulation NR 109.

**Procedure for Individual Corridor Permitting and Monitoring**

**A Wisconsin Department of Natural Resources Permit is required for application of chemicals in the water. http://dnr.wi.gov/lakes/plants/forms/**

Document nuisance conditions (landowner/ herbicide contractor will provide in permit application in February/March)

- Indicate when plants cause problems and how long problems persist.
- Include dated photos of nuisance conditions from previous season (or location relative to curly leaf pondweed bed map).
- List depth at end of dock.
- Provide examples of specific activities that are limited because of presence of nuisance aquatic plants.
- Describe practical alternatives to herbicide use or harvesting that were considered. These might include:
  - Hand removal/hand raking of aquatic plants
  - Extending dock to greater depth
  - Altering the route to and from the dock
  - Use of another type of watercraft or motor, i.e., is the type of watercraft used common to other sites with similar conditions on this lake?
- Herbicide use for curly leaf pondweed may occur along the entire length of a waterfront property owner's shoreline. Herbicide use in areas with wild rice will not be permitted. Note that aquatic herbicides tend to not be effective in areas with flowing water.
- Aquatic Herbicide/Harvesting Contractor to provide this information in permit application based on information from the landowner.

Verify/refute nuisance conditions and/or navigation impairment

- Landowners will document conditions with photographs and submit request for review by the ARPRD DESIGN TEAM. The design team will consist of trained lake volunteers who are familiar with options for individual corridor management.
- Landowner requests ARPRD DESIGN TEAM review of their property prior to submitting a permit application to DNR.
- The ARPRD DESIGN TEAM representative visits site, reviews documentation and provides a written opinion of navigation impairment i.e., is herbicide treatment or harvesting warranted? The design team will also provide other options for the owner to consider.
- Landowner decides which method to use.
- If herbicides are to be used, landowner/applicator applies for permit to WDNR including photographic documentation, identification of plants causing navigation problems, and ARPRD DESIGN TEAM evaluation. http://dnr.wi.gov/files/pdf/forms/3200/3200-004.pdf
- For curly leaf pondweed treatment, verification must occur the year before treatment in May or June. Once CLP nuisance is verified and a permit is approved, additional verification is not needed for three subsequent years (although permit applications must be completed each year). Treatment for CLP must occur with water temperatures from 50 - 58 degrees F.
- WDNR will contact herbicide contractor and owner with a notice to proceed with treatment or denial of permit application.

## Public Education and Outreach

***Audience***
Lake residents (full time and part time)
Lake users/visitors

***Messages***
Aquatic plant management plan
Why we are implementing the plan; who is doing it; when it will be completed.
Report progress toward plan goals and objectives
Inform landowners of the process for applying for individual corridor permits.
It is against the law to apply herbicide in the lake without a permit.
Homeowners may use hand removal methods such as raking to open access to docks and shoreline in a designated area up to thirty feet wide on their waterfront.

Invasive species prevention
Identify Curly Leaf Pondweed, Purple Loosestrife and Eurasian Water Milfoil with photos and descriptions.
List contacts to confirm invasive species identification
Explain methods to avoid spread of invasive species.
Show maps of Curly Leaf Pondweed and Purple Loosestrife on the flowage.
Clean aquatic vegetation from boats and trailers.
Polk County and the state of Wisconsin prohibit transporting aquatic plants on boats and trailers. Fines may result if you don't obey the law.

Native plant values
Rooted aquatic plants are critical for holding sediments in place and preventing algae blooms.
Shallow lakes without aquatic plants are generally murky and algae-dominated.
Native plants prevent invasive species from getting established.
Residents should understand the need for a balance and not attempt to eliminate all aquatic plants.

Reducing runoff
Use of fertilizer with phosphorus on fields and lawns can cause algae growth in lakes.
Shorelines can be managed/landscaped to reduce runoff.

***Methods***
- Website (include pictures)
- Newsletter, newspaper articles
- Signs
- Clean Boats, Clean Waters inspectors
- Lake District meetings: annual meeting, special meetings
- Plant identification workshops
- Neighborhood/smaller group meetings

- Mailing: information/reports to all lake property owners. Will also consider door to door contact
- Personal visits to lake residents
- Flyers at local businesses, pictures, handouts
- Displays and presentations
- Town of Lincoln and Amery City Council meetings

## Monitoring and Assessment

**Aquatic Plant Surveys**
Aquatic plant (macrophyte) surveys are the primary means for tracking achievement toward plan goals.

*Action.* Conduct whole lake aquatic plant surveys approximately once every five years to track plant species composition and distribution. The next survey is scheduled for 2021.

The whole lake surveys will be conducted in accordance with the guidelines established by the Wisconsin DNR. Any new species sampled will be saved, pressed, and mounted for voucher specimens.

## Grants

**Aquatic Invasive Species Grants**
Department of Natural Resources Aquatic Invasive Species (AIS) grants are available to assist in funding some of the action items in the implementation plan. Grants provide up to 75 percent funding.Native plant and filamentous algae management and navigation are not eligible grant activities. AIS Education, Prevention (AEPP), and Planning and Clean, Boats Clean Waters (CBCW) grants are due December 10 of each year. AIS Control (ACEI) grants are due February 1 of each year.

**Recreational Boating Grants**
Recreational Boating Grants are available from the Wisconsin Waterways Commission through the Wisconsin Department of Natural Resources. Eligible expenses include "capital equipment to cut and remove aquatic plants that are nuisances." Equipment may include cutting devices, barges with propelling motors, conveyors, and trailering devices. A DNR-approved aquatic plant management plan establishes eligibility for the grant program. The minimal harvestable area to qualify for the grants is 30 acres, and the ARPRD well exceeds this minimum. Cities, towns, and lake protection districts are all eligible applications for the program. The grant provides up to 50% of the cost of a harvester and related equipment. Grants can also be used to establish or improve public access points. Projects are evaluated by the Waterways Commission quarterly. Ed Slaminski is the regional DNR contact for the program (715-635-4130).

*Table 14. Implementation Plan*

| **1. Improve water quality on the Apple River Flowage and downstream on the Apple River.** | | | | | | |
|---|---|---|---|---|---|---|
| **Actions** | **Timeline** | **Cost** | **Volunteer Hours** | | **Funding Source** | **Responsible Party / Partners** |
| 1. Harvest CLP when harvester is available | May/June<br>Ongoing | Included in harvesting program | | | | |

| **2. Prevent introduction of aquatic invasive species.** | | | | | | |
|---|---|---|---|---|---|---|
| **Actions** | **Timeline** | **Cost** | **Volunteer Hours** | | **Funding Source** | **Responsible Party / Partners** |
| 1. Clean Boats, Clean Waters | Memorial Day through Labor Day | $3,200<br>(? Increase) | 10 | | CBCW grant (75%) | Board<br>Amery Lakes District<br>City of Amery |
| 2a. Monitor areas of high public use | July/August | $0 | 40 | | | Volunteers<br>Amery High School (Schieffer) |
| 2b. Train volunteers to identify AIS and monitor. | As scheduled | $0 | 20 | | | Polk County LWRD |
| 3. Follow Rapid Response Plan/Set up a Eurasian Water Milfoil Contingency Fund | | $2,500 | 5 | | ARPRD | Treasurer |
| 4. Control purple loosestrife | July/August | $0 | 10 | | Homeowners | Flowage Residents |

**3. Maintain navigation for fishing, boating, and access to lake residences.**
**4. Maintain native aquatic plant functions.**
**5. Minimize environmental impacts of aquatic plant management.**

| Actions | Timeline | Cost | Volunteer Hours | | Funding Source | Responsible Party / Partners |
|---|---|---|---|---|---|---|
| 1. Purchase second harvester and related equipment to handle harvesting demand. | 2018/19 | Harvester/Trailer: $170,000 | | | ARPRD<br>Bank Loan<br>Waterways Commission | Board<br>Harvester Operations Committee |
| 2. Maintain existing equipment (2012 Purchase)<br>Maintain 2nd harvester | Ongoing | $7,000<br>? | | | ARPRD | Harvester Operations Committee |
| 3. Replace/refurbish existing equipment (2012 Purchase)<br>Truck<br>Harvester and Trailer | 2022 | <br>$10,000<br>$80-$200,000 | | | Establish Capital Savings<br>Bank Loan<br>Waterways Commission | Harvester Operations Committee<br>Board |
| 4. Secure permanent North Side harvester landing | 2017/18 | $? | | | ARPRD | Harvester Operations Committee<br>Board |
| 5. Apply for permits for harvester operation<br>(Indicate disposal sites) | February | $300 | | | ARPRD | Harvester Operations Committee<br>WDNR |
| 6. Operate harvester 1<br>(Maintain harvesting records)<br>Operate harvester 2 | May to September | $28,000<br>? | | | ARPRD | Harvester Operations Committee<br>City of Amery (payroll?) |
| 7. Establish a Design Team for Individual Corridor Review | 2017, Ongoing | | | | | Board |
| Apply for Waterways Commission grant for harvester purchase | 2018 (July = new budget) | $1,000 (grant application) | | | ARPRD | Board<br>Consultant |

| Public Education and Outreach | | | | | | |
|---|---|---|---|---|---|---|
| **Actions** | **Timeline** | **Cost** | **Volunteer Hours** | | **Funding Source** | **Responsible Party / Partners** |
| Website updates | Monthly | $100 | | | | ARPRD Board and Education Committee |
| Meetings | Annually | $50 | | | | ARPRD Board and Education Committee |
| Mailings and brochures | Ongoing | $500 | | | | ARPRD Board and Education Committee |
| Newsletter | Annually | $50 | | | | ARPRD Board and Education Committee |
| Special training | Annually | $0 | | | | ARPRD Board and Education Committee |
| **SUBTOTAL EDUCATION** | | **$600** | | | | |

**Action.** Conduct point intercept aquatic plant survey in 2021. Seek grant funding to support plant survey.

# Appendix A. Apple River Flowage Sensitive Area Recommendations

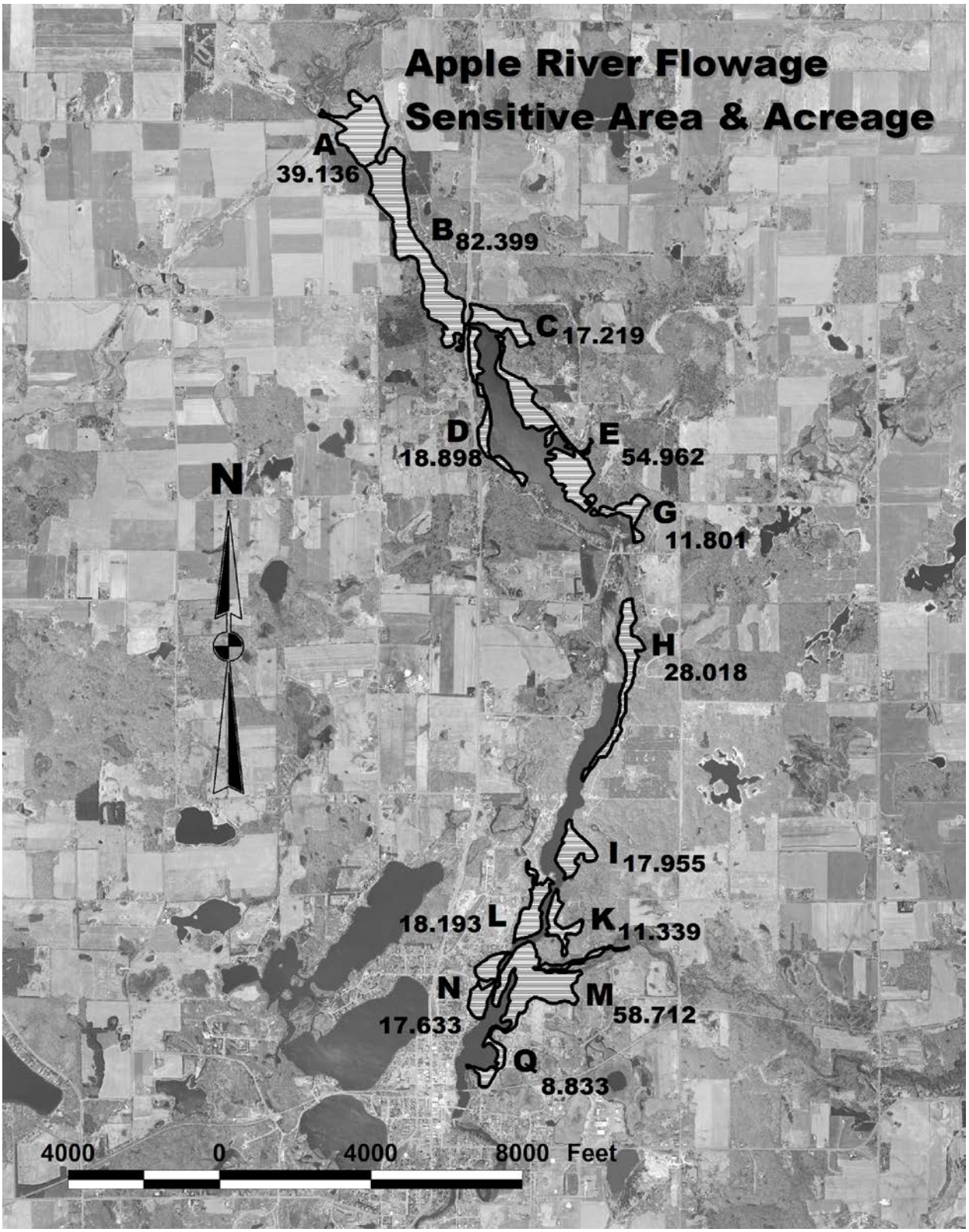



*Figure A. Recommended Sensitive Areas (with acreage) Designated on the Apple River Flowage*

**Sensitive Area - A (Transect 1w)**
Site A is located at the most upstream portion of the flowage west of Hwy 46. A large wild rice bed exists at the very upper end of the flowage covering approximately a quarter mile stretch of impounded river bed where the Apple River and Marquee Creek first enters the flowage until reaching a narrow finger of land that extends southwestward from the northeast shore restricting flows and enhancing sediment deposition above this point (Figure 4). Most of this area is only 1.0' to 2.0' in depth and has almost no open water habitat by mid July (virtually 100% coverage of emergent aquatic plants). The bottom substrate is dominated by silt and organics. Wildlife and fishery values make this a unique yet critical habitat found within the Apple River Flowage. This area covers approximately 39 acres.

Rice was the dominant emergent aquatic plant with some burr reeds and arrowheads occupying the near shore areas. Submergent species included coontail and flat-stemmed pondweed with scattered water crowfoot or buttercup. Curly leaf pondweed was present during the June sampling, but did not dominate any of this area and did not appear to be displacing native species.

Other species encountered within this area included: the major duckweeds including *Lemna minor, Spirodela polyrhiza, Wolffia columbiana, and Lemna trisulca*. Some filamentous algae were also common and readily identifiable to genus with the naked eye which included *Hydrodiction* or water-net which forms unique nets which resemble a spider web.

The lack of developed shorelines with established residences and the overall character of bottom substrate and water depth favor wild rice and preclude the need for herbicide or mechanical manipulation of the aquatic plant community within this area. Chemical treatments on lakes and impoundments are limited to waters along developed shorelines by NR 107.08(3) unless the Department approves the project for reasons of greater public benefit.

This area should be considered a higher quality wildlife habitat for waterfowl, furbearers, amphibians, reptiles, and other sensitive nongame species. Aquatic plants in this area also perform a critical role in stabilizing nutrient rich soft lakebed sediments and sensitive shoreline areas.

**Sensitive Area - B (Transects 2E, 3w, and 4E)**
Site B is a large shallow flat with some open water areas extending downstream from area A to the Highway 46 Bridge. This area is prime spawning and nursery area habitat. The existence of developed shorelines with established residences within this area of the flowage create a challenge to balance recreational access with habitat protection. Currently the P&R District has been paying to treat a 4400' long 50' wide priority navigational access channel within this area with broad-spectrum herbicides. It appears

as though this strategy has been providing navigational access while still protecting the remaining high quality habitat within site B.

Curly-leaf pondweed occurred in much of the site, but dominated none of it. Coontail was the most abundant species found within this area. Since coontail doesn't need to be rooted to grow and easily drifts around with prevailing winds or flood events treated channels will likely become compromised with drifting coontail making it difficult to maintain larger open water priority navigational access channels completely free of aquatic vegetation.

Since coontail freely drifts around additional costly herbicide treatments directed at coontail within priority navigational access channels should be avoided. The Department receives numerous complaints from people who thought a herbicide treatment would provide some form of long-term control in a specific area only to be continuously compromised by free floating coontail.

Mechanical removal of free floating coontail within priority navigational access channels using conventional aquatic plant harvesting equipment should bridge the gap between herbicide treatments. The size of the harvesting equipment can limit the depths to which equipment can operate without disturbing bottom sediments. These shallow areas North of Hwy 46 may not be suitable for larger harvesters which require at least 2' of water to operate without disturbing bottom sediments. Harvesting for free floating coontail will be limited to the top half of the water column and restricted to areas with water depths greater than 2'.

This area should be considered one of the higher quality Musky and Northern Pike spawning and nursery areas. Aquatic plants in this area also perform a critical role in stabilizing soft lakebed sediments and sensitive shoreline areas.

**Sensitive Area - C (Transect 5E)**
Site C includes the north shore east of the Highway 46 Bridge into and around the small bay where Burns creek enters the flowage.

The majority of the shoreline around this bay functions as a deposition area where organic plant matter is broken down and the energy within recycled into the aquatic food chain/web. Depositional shorelines are often dominated by rich aquatic plant growth with a wetland transitional zone. Aquatic plants provide important stabilization for these loose flocculent sediments through direct root structures, but also help reduce the overall erosive force of waves in these delicate shorelines areas.

Site C provides high quality spawning and nursery area habitat. It also provides high quality wildlife habitat for waterfowl, reptiles, amphibians, and furbearers. Aquatic plants in this area also perform a critical role in stabilizing soft lakebed sediments and sensitive shoreline areas.

Curly leaf pondweed dominated the aquatic plant community within the 4-7' depth zone in June with coontail prevalent in the other depth zones and dominating all depth zones in August. Minimal navigational access needs exist within this bay.

Larger flats dominated by curly leaf pondweed with greater potential for exotics control and required treatment monitoring to document long-term effectiveness and effects of treatments exist at the south end of the flowage near transects 17E, 20E, and 22E. These larger flats also have legitimate navigational access issues which make them higher priorities for limited control dollars and required monitoring costs.

This area covers approximately 17 acres. This area, though relatively small in size, should still be considered a higher quality Musky and Northern Pike spawning and nursery area. Aquatic plants in this area also perform a critical role in stabilizing soft lakebed sediments and sensitive shoreline areas.

**Senstive Area - D (Transect 6w)**
Site D covers a small point bar on the southeast side of the Highway 46 Bridge. This point bar provides high quality habitat in the form of large leaf pondweeds adjacent to deeper open water which create excellent ambush habitat for large predators including Musky, Northern Pike, and Largemouth Bass.

**Sensitive Area - E (Transect 7E)**
Site E is a large long flat on the east shore with dense aquatic plant habitat extending westward from the east shore several hundred feet from shore.

This area provides important lush aquatic plant growth rich in aquatic insects which attract large numbers of baitfish and panfish. These in turn attract the larger predators. Pockets and open water areas are interspersed along the deeper water edges providing good predator ambush points. Aquatic plants in this area also perform a critical role in stabilizing soft lake bed sediments and sensitive shoreline areas while providing good travel corridors for fish moving up and down the shoreline.

**Transect 8w**
This area is a good example of a narrower littoral area along the west shoreline. While the area does not have the wider lush growth of other areas in the flowage the available aquatic plant habitat does provide important travel corridors for small panfish and younger predators to move up and down the shoreline with at least some protective cover. This vegetation also reduces the erosive energy in wind or boat driven waves reducing shoreline erosion potential.

These areas with less dense aquatic plant growth are often associated with firmer substrates which are desirable for nest builders such as Bass and panfish.

**Sensitive Area G - Transect 9E**
Site G is another backwater bay.

**Sensitive Area H - Transects 10w, 11E, 12w**
Site H covers a large portion of the mid section of the flowage. Aquatic plant community structure is not all that dense and coverage is not over larger broader areas. The existing aquatic plant cover does provide important travel corridors with panfish spawning also occurring throughout selected areas of the shoreline. This vegetation also reduces the erosive energy in wind or boat driven waves reducing shoreline erosion potential.

**Sensitive Area - I (Transect 13E)**
Site I is another backwater bay with lush aquatic plant growth.

**Transect 14W**
This area is relatively small with quickly sloping bottom which limits available light to support aquatic plant growth. Developed residences appear to be managing some aquatic plant removal by hand pulling and raking.

**Sensitive Area - K (Transect 15E)**
Site K is a small backwater bay with high quality aquatic plant habitat.

**Sensitive Area - L (Transect 16W)**
Site L is a deposition bar with lush aquatic plant growth.

**Sensitive Area - M (Transect 17 E and 20 E)**
Site M is one of the largest shallow water flats found within the southern half of the flowage. It is a large depositional area receiving nutrients and sediments from Beaver Brook. It also provides some of the most important habitat for a broad array of fish species during different stages of their life cycle.

**Sensitive Area - N (Transect 18W and 19W)**
Site N includes two small bays on the northeast side and southeast side of Northwood Park in the City of Amery. Dense lush aquatic plant growth provides critical habitat for bass and panfish.

**Transect 21W**
Transect 21 is located at the bottom end of the flowage. It appears sediment deposition is compromising the ability to navigate larger boats through these lower reaches. Aquatic plants are abundant and maintaining defined open water navigational channels by late summer difficult.

**Sensitive Area - Q (Transect 22E)**
Site Q is the last bay within the flowage. Dense lush aquatic plant growth provides critical habitat for bass and panfish.

# Appendix B. Invasive Species Information

## Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c)."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[30]

The state of Minnesota DNR web site explains that curly leaf pondweed often causes problems due to excessive growth. At the same time, the plant provides some cover for fish, and some waterfowl species feed on the seeds and winter buds.[31]

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[30] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species.* Prepared by Wisconsin DNR. September 2003.

[31] Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants).

The following description is taken from a Great Lakes Indian Fish and Wildlife Commission handout.

## Curly Leaf Pondweed (Potamogeton crispus)[32]

**Identification**


Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters one to three meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as two meters. The stems are dark reddish-green to reddish-brown, with the mid-vein typically tinged with red. Curly leaf pondweed is native to Eurasia, Africa, and Australia and is now spread throughout most of the United States and southern Canada.

**Characteristics**

New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter form can grow beneath the ice and is highly shade-tolerant. Rapid growth begins with warming water temperatures in early spring – well ahead of native aquatic plants.

**Reproduction and Dispersal**

Curly leaf pondweed reproduces primarily vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions are typically 1.0 – 1.7 cm long and 0.8 to 1.4 cm in diameter. Turions separate from the plant by midsummer, and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, turions germinate in the fall, over-wintering as a small plant. The next summer plants mature, producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

**Ecological Impacts**

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely

[32] Information from GLIFWC Plant Information Center (http://www.glifwc.org/epicenter).

affect fish populations. The foliage of curly leaf pondweed is relatively high in alkaloid compounds possibly making it unpalatable to insects and other herbivores.

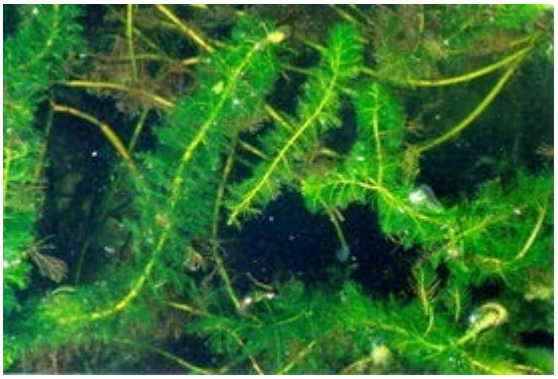
**Control**

Small populations of curly leaf pondweed in otherwise un-infested water bodies should be attacked aggressively. Hand pulling, suction dredging, or spot treatments with contact herbicides are recommended. Cutting should be avoided because fragmentation of plants may encourage their re-establishment. In all cases, care should be taken to remove all roots and plant fragments, to keep them from re-establishing.

Control of large populations requires a long-term commitment that may not be successful. A prudent strategy includes a multi-year effort aimed at killing the plant before it produces turions, thereby depleting the seed bank over time. It is also important to maintain, and perhaps augment, native populations to retard the spread of curly leaf and other invasive plants. Invasive plants may aggressively infest disturbed areas of the lake, such as those where native plant nuisances have been controlled through chemical applications.

## Eurasian Water Milfoil (Myriophyllum spicatum)

**Introduction**



Eurasian water milfoil 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, Eurasian water milfoil is nearly impossible to distinguish from Northern water milfoil. Eurasian water milfoil 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.

**Distribution and Habitat**
Eurasian milfoil first arrived in Wisconsin in the 1960's. During the 1980's, it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. As of 1993, Eurasian milfoil was common in 39 Wisconsin counties (54%) and at least 75 of its lakes, including shallow bays in Lakes Michigan and Superior and Mississippi River pools.

Eurasian water milfoil 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.

**Life History and Effects of Invasion**
Unlike many other plants, Eurasian water milfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively 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. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or 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, Eurasian water milfoil 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 Eurasian milfoil 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 Eurasian water milfoil 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 Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. [33]

[33] Taken in its entirety from WDNR, 2008 (http://www.dnr.state.wi.us/invasives/fact/milfoil.htm)

## Reed Canary Grass (*Phalaris arundinacea*)


**Description**

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

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

Reed canary grass also resembles non-native orchard grass (*Dactylis glomerata*), but can be distinguished by its wider blades, narrower, more pointed inflorescence, and the lack of hairs on glumes and lemmas (the spikelet scales). Additionally, bluejoint grass (*Calamagrostis canadensis*) may be mistaken for reed canary in areas where orchard grass is rare, especially in the spring. The highly transparent ligule on reed canary grass is helpful in distinguishing it from the others. Ensure positive identification before attempting control. The ligule is a transparent membrane found at the intersection of the leaf stem and leaf.

**Distribution and Habitat**

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

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

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

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.[34]

## Purple Loosestrife (Lythrum salicaria)[35]

**Description**
Purple loosestrife is a non-native plant common in Wisconsin. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a 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 vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes (underground stems) that form a dense mat.

**Characteristics**
Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, about 24 states have laws prohibiting its importation or distribution because of its aggressively

[34] Taken from WDNR, 2008. (http://www.dnr.state.wi.us/invasives/fact/reed canary.htm).
[35] Wisconsin DNR invasive species factsheets.(http:/dnr.wi.gov/invasives).

invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. This plant's optimal habitat includes marshes, stream margins, river flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

**Reproduction and Dispersal**
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. 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 disturbance is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. 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. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland.

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

**Mechanical Control**
Purple loosestrife (PL) can be controlled by cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seed may have already fallen. Since lower pods can drop seed while upper flowers are still blooming, check for seed. If none, simply bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding it upright, then bend it over into a bag to catch any dropping seeds. Dispose of plants/seeds in a capped landfill, or dry and burn them. Composting

will not kill the seeds. Keep clothing and equipment seed-free to prevent its spread. Rinse all equipment used in infested areas before moving into uninfested areas, including boats, trailers, clothing, and footwear.

Pulling and digging can be effective, but can also create disturbed bare spots, which are good sites for PL seeds to germinate, or leave behind root fragments that grow into new plants. Use these methods primarily with small plants in loose soils, since they do not usually leave behind large gaps nor root tips, while large plants with multiple stems and brittle roots often do. Dispose of plants as described above.

Mowing has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full twelve months. Burning has also proven largely ineffective. Mowing and flooding are not encouraged because they can contribute to further dispersal of the species by disseminating seeds and stems.

Follow-up treatments are recommended for at least three years after removal.

**Chemical Control**

This is usually the best way to eliminate PL quickly, especially with mature plants. The chemicals used have a short soil life. Timing is important. Treat in late July or August, but before flowering to prevent seed set. Always back away from sprayed areas as you go, to prevent getting herbicide on your clothes. The best method is to cut stems and paint the stump tops with herbicide. The herbicide can be applied with a small drip bottle or spray bottle, which can be adjusted to release only a small amount. Try to cover the entire cut portion of the stem, but not let the herbicide drip onto other plants since it is non-selective and can kill any plant it touches.

Glyphosate herbicides: Currently, glyphosate is the most commonly used chemical for killing loosestrife. Roundup and Glyfos are typically used, but if there is any open water in the area use Rodeo, a glyphosate formulated and listed for use over water. Glyphosate must be applied in late July or August to be most effective. Since you must treat at least some stems of each plant and they often grow together in a clump, all stems in the clump should be treated to be sure all plants are treated.

Another method is using very carefully targeted foliar applications of herbicide (NOT broadcast spraying). This may reduce costs for sites with very high densities of PL, since the work should be easier and there will be few other plant species to hit accidentally. Use a glyphosate formulated for use over water. A weak solution of around 1% active ingredient can be used and it is generally necessary to wet only 25% of the foliage to kill the plant.

You must obtain a permit from WDNR before applying any herbicide over water. The process has been streamlined for control of purple loosestrife and there is no cost. Contact your regional Aquatic Plant Management Coordinator for permit information.

**Biological Control**
Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective in controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations. The WDNR, in cooperation with the U.S. Fish and Wildlife Service, is introducing several natural insect enemies of purple loosestrife from Europe. A species of weevil (*Hylobius transversovittatus*) has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue. In addition, two species of leaf eating beetles (*Galerucella calmariensis* and *G. pusilla*) are being raised and released in the state, and another weevil that feeds on flowers (*Nanophyes marmoratu*s) is being used to stress the plant in multiple ways. Research has shown that most of these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants, although one species showed some cross-over to native loosestrife. These insects will not eradicate loosestrife, but may significantly reduce the population so cohabitation with native species becomes a possibility.

## Japanese Knotweed

(*Polygonum cuspidatum.; syn. Polygonum zuccarini, Fallopia japonica, or Reynoutria japonica.*)

*Also known as Japanese bamboo, Japanese fleece-flower, and Mexican bamboo*

**Description**
Japanese knotweed, in the buckwheat family, is a perennial that grows to heights of 5-10 feet in large clones up to several acres in size. The arching stems are hollow and bamboo-like, a reddish-brown to tan color Stems die, but remain upright through the winter. Mature leaves are 3-5” wide and 4-9” long, lighter on the lower surface, and egg to spade shaped. Young leaves are heart-shaped. Lacy 2 inch long clusters of tiny greenish-white flowers are produced in late summer and held upright at the leaf base. Japanese knotweed reproduces occasionally by seed, but spreads primarily by extensive networks of underground rhizomes, which can reach 6 feet deep, 60 feet long, and become strong enough to damage pavement and penetrate building foundations.

**Look-alikes**
Another much less widespread invasive species, giant knotweed (*Polygonum sachalinense*), is similar, but can grow taller and has much larger leaves (up to 12" long). The upper surface of Japanese knotweed has an extremely fine-sandpaper feel in contrast to the fine-leather feel of giant knotweed.

**Impacts & Habitat**
Introduced in the late 1800s, Japanese knotweed is now found throughout much of North America. It is especially widespread in the coastal Pacific Northwest, in the East from Newfoundland to North Carolina, and in the Midwest. It is often considered to be the most troublesome weed in Great Britain. It grows in a variety of habitats, in many soil types, and a range of moisture conditions. Of particular concern is its tendency to invade valuable wetland habitat and line the banks of creeks and rivers where it often forms an impenetrable wall of stems, crowding out native vegetation and leaving banks vulnerable to erosion when it dies in winter. It is also found along roads, railroads, utility pathways, and strip-mining areas. In addition to spreading by rhizomes and seed, it is often spread by streams, by transportation of fill dirt, or through roadside plowing.

**Control**
Attempting to remove Japanese knotweed by pulling or digging is generally ineffective due to its extensive underground rhizome network; it may even promote further spreading if pieces of the plant are not disposed of properly. Herbicide application has been effective, when the entire clone is treated repeatedly. Applications of herbicides containing glyphosate are typically used after spring leaf out and on sprouts emerging after cutting.

# Appendix C. Aquatic Plant Management Strategy WDNR

# AQUATIC PLANT MANAGEMENT STRATEGY

## Northern Region WDNR
## Summer, 2007

# AQUATIC PLANT MANAGEMENT STRATEGY
# Northern Region WDNR

## ISSUES

- Protect desirable native aquatic plants.
- Reduce the risk that invasive species replace desirable native aquatic plants.
- Promote "whole lake" management plans
- Limit the number of permits to control native aquatic plants.

## BACKGROUND

As a general rule, the Northern Region has historically taken a protective approach to allow removal of native aquatic plants by harvesting or by chemical herbicide treatment. This approach has prevented lakes in the Northern Wisconsin from large-scale loss of native aquatic plants that represent naturally occurring high quality vegetation. Naturally occurring native plants provide a *diversity of habitat* that *helps maintain water quality*, helps *sustain the fishing* quality known for Northern Wisconsin, supports common lakeshore wildlife from loons to frogs, and helps to provide the *aesthetics* that collectively create the "up-north" appeal of the northwoods lake resources.

In Northern Wisconsin lakes, an inventory of aquatic plants may often find 30 different species or more, whereas a similar survey of a Southern Wisconsin lake may often discover less than half that many species. Historically, similar species diversity was present in Southern Wisconsin, but has been lost gradually over time from stresses brought on by cultural land use changes (such as increased development, and intensive agriculture). Another point to note is that while there may be a greater variety of aquatic vegetation in Northern Wisconsin lakes, the vegetation itself is often *less dense*. This is because northern lakes have not suffered as greatly from nutrients and runoff as have many waters in Southern Wisconsin.

The newest threat to native plants in Northern Wisconsin is from invasive species of aquatic plants. The most common include Eurasian Water Milfoil (EWM) and CurlyLeaf Pondweed (CLP). These species are described as *opportunistic invaders*. This means that these "invaders" benefit where an opening occurs from removal of plants, and without competition from other plants may successfully become established in a lake. Removal of native vegetation not only diminishes the natural qualities of a lake, it *may increase the risk that an invasive species can successfully invade onto the site where native plants have been removed*. There it may more easily establish itself without the native plants to compete against. This concept is easily observed on land where bared soil is quickly taken over by replacement species (often weeds) that crowd in and establish themselves as new occupants of the site. While not a providing a certain guarantee against invasive plants, protecting and allowing the native plants to remain may reduce the success of an invasive species becoming established on a lake. Once established, the invasive species cause far more inconvenience for all lake users, riparian and others included; can change many of the natural features of a lake; and often lead to *expensive annual control plans*. Native vegetation may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.

To the extent we can maintain the normal growth of native vegetation, Northern Wisconsin lakes can continue to offer the water resource appeal and benefits they've historically provided. A regional position on removal of aquatic plants that carefully recognizes how native aquatic plants benefit lakes in Northern Region can help prevent a gradual decline in the overall quality and recreational benefits that make these lakes attractive to people and still provide abundant fish, wildlife, and northwoods appeal.

## GOALS OF STRATEGY:

1. Preserve native species diversity which, in turn, fosters natural habitat for fish and other aquatic species, from frogs to birds.
2. Prevent openings for invasive species to become established in the absence of the native species.
3. Concentrate on a" whole-lake approach" for control of aquatic plants, thereby fostering systematic documentation of conditions and specific targeting of invasive species as they exist.
4. Prohibit removal of wild rice. WDNR – Northern Region will not issue permits to remove wild rice unless a request is subjected to the full consultation process via the Voigt Tribal Task Force. We intend to discourage applications for removal of this ecologically and culturally important native plant.
5. To be consistent with our WDNR Water Division Goals (work reduction/disinvestment), established in 2005, to "not issue permits for chemical or large scale mechanical control of native aquatic plants – develop general permits as appropriate or inform applicants of exempted activities." This process is similar to work done in other WDNR Regions, although not formalized as such.

## BASIS OF STRATEGY IN STATE STATUTE AND ADMINISTRATIVE CODE

**State Statute 23.24 (2)(c)** states:

"The requirements promulgated under par. (a) 4. may specify any of the following:

1. The **quantity** of aquatic plants that may be managed under an aquatic plant management permit.
2. The **species** of aquatic plants that may be managed under an aquatic plant management permit.
3. The **areas** in which aquatic plants may be managed under an aquatic plant management permit.
4. The **methods** that may be used to manage aquatic plants under an aquatic plant management permit.
5. The **times** during which aquatic plants may be managed under an aquatic plant management permit.
6. The **allowable methods** for disposing or using aquatic

plants that are removed or controlled under an aquatic plant management permit.

7. The requirements for plans that the department may require under sub. (3) (b). “

**State Statute 23.24(3)(b)** states:
“The department may require that an application for an aquatic plant management permit contain a plan for the department’s approval as to how the aquatic plants will be introduced, removed, or controlled.“

**Wisconsin Administrative Code NR 109.04(3)(a)** states:
“The department may require that an application for an aquatic plant management permit contain an aquatic plant management plan that describes how the aquatic plants will be introduced, controlled, removed or disposed. Requirements for an aquatic plant management plan shall be made in writing stating the reason for the plan requirement. In deciding whether to require a plan, the department shall consider the potential for effects on protection and development of diverse and stable communities of native aquatic plants, for conflict with goals of other written ecological or lake management plans, for cumulative impacts and effect on the ecological values in the body of water, and the long-term sustainability of beneficial water use activities.”

# AQUATIC PLANT MANAGEMENT STRATEGY
# Northern Region WDNR

## APPROACH

1. After January 1, 2009* no individual permits for control of native aquatic plants will be issued. Treatment of native species may be allowed under the auspices of an approved lake management plan, and only if the plan clearly documents "impairment of navigation" and/or "nuisance conditions". Until January 1, 2009, individual permits will be issued to previous permit holders, only with adequate documentation of "impairment of navigation" and/or "nuisance conditions". No new individual permits will be issued during the interim.

2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report.

3. Invasive species must be controlled under an approved lake management plan, with two exceptions (these exceptions are designed to allow sufficient time for lake associations to form and subsequently submit an approved lake management plan):
   a. Newly-discovered infestations. If found on a lake with an approved lake management plan, the invasive species can be controlled via an amendment to the approved plan. If found on a lake without an approved management plan, the invasive species can be controlled under the WDNR's Rapid Response protocol (see definition), and the lake owners will be encouraged to form a lake association and subsequently submit a lake management plan for WNDR review and approval.
   b. Individuals holding past permits for control of *invasive* aquatic plants and/or "mixed stands" of native and invasive species will be allowed to treat via individual permit until January 1, 2009 if "impairment of navigation" and/or "nuisance conditions" is adequately documented, unless there is an approved lake management plan for the lake in question.

4. Control of invasive species or "mixed stands" of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on Spring treatment. (typically, a water temperature of less than 60 degrees Fahrenheit, or approximately May 31st, annually).

5. Manual removal (see attached definition) is allowed (Admin. Code NR 109.06).

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* *Exceptions to the Jan. 1, 2009 deadline will be considered only on a very limited basis and will be intended to address unique situations that do not fall within the intent of this approach.*

# AQUATIC PLANT MANAGEMENT STRATEGY
# Northern Region WDNR

## DOCUMENTATION OF IMPAIRED NAVIGATION AND/OR NUISANCE CONDITIONS

Navigation channels can be of two types:

- Common use navigation channel. This is a common navigation route for the general lake user. It often is off shore and connects areas that boaters commonly would navigate to or across, and should be of public benefit.

- Individual riparian access lane. This is an access lane to shore that normally is used by an individual riparian shore owner.

Severe impairment or nuisance will generally mean vegetation grows thickly and forms mats on the water surface. Before issuance of a permit to use a regulated control method, a riparian will be asked to document the problem and show what efforts or adaptations have been made to use the site. (This is currently required in NR 107 and on the application form, but the following helps provide a specific description of what impairments exist from native plants).

**Documentation of *impairment of navigation*** by native plants must include:

a. Specific locations of navigation routes (preferably with GPS coordinates)
b. Specific dimensions in length, width, and depth
c. Specific times when plants cause the problem and how long the problem persists
d. Adaptations or alternatives that have been considered by the lake shore user to avoid or lessen the problem
e. The species of plant or plants creating the nuisance (documented with samples or a from a Site inspection)

**Documentation of the *nuisance*** must include:

a. Specific periods of time when plants cause the problem, e.g. when does the problem start and when does it go away.
b. Photos of the nuisance are encouraged to help show what uses are limited and to show the severity of the problem.
c. Examples of specific activities that would normally be done where native plants occur naturally on a site but can not occur because native plants have become a nuisance.

# AQUATIC PLANT MANAGEMENT STRATEGY
# Northern Region WDNR

## DEFINITIONS

| | |
|---|---|
| Manual removal: | Removal by hand or hand-held devices without the use or aid of external or auxiliary power. Manual removal cannot exceed 30 ft. in width and can only be done where the shore is being used for a dock or swim raft. The 30 ft. wide removal zone cannot be moved, relocated, or expanded with the intent to gradually increase the area of plants removed. Wild rice may not be removed under this waiver. |
| Native aquatic plants: | Aquatic plants that are indigenous to the waters of this state. |
| Invasive aquatic plants: | Non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health. |
| Sensitive area: | Defined under s. NR 107.05(3)(i) (sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water). |
| Rapid Response protocol: | This is an internal WDNR document designed to provide guidance for grants awarded under NR 198.30 (Early Detection and Rapid Response Projects). These projects are intended to control pioneer infestations of aquatic invasive species before they become established. |

# Appendix D. References

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# Appendix E. Rapid Response for Early Detection of Aquatic Invasive Species

*Definition: Aquatic Invasive Species (AIS) are non-native plant and animal species that can out-compete and overtake native species damaging native lake habitat and sometimes creating nuisance conditions. AIS currently in the Apple River Flowage include curly leaf pondweed (CLP), purple loosestrife, and Chinese mystery snail. Additional AIS threaten the lake and will be monitored throughout the lake by volunteers.*

1. Develop and maintain a contingency fund for rapid response to EWM or other invasive species (ARPRD Board).

2. Conduct volunteer (AIS Volunteer Monitor) at designated public boat landings and other likely areas of AIS introduction. If a suspected plant is found, contact the AIS ID Volunteer.

3. Direct lake residents and visitors to contact the AIS ID Volunteer if they see a plant in the lakes they suspect might be Eurasian water milfoil (EWM) or another aquatic invasive species. Signs at the public boat landings, web pages, handouts at annual meeting, and newsletter articles will provide plant photos and descriptions, contact information, and instructions.

4. If a volunteer locates a likely AIS, instructions will request that the volunteer record the location of suspected AIS using GPS, if available, or mark the location with a small float. *Provide instructions on marking with float.* Note that cell phone applications are available to identify GPS point.

   If a plant:

   a. Take a digital photo of the plant in the setting where it was found (if possible). Then collect 5 to 10 intact specimens. Try to get the root system, and all leaves as well as seed heads and flowers when present. Place in a zip lock bag with no water. Place on ice and transport to refrigerator.
   b. Inform AIS ID Volunteer or Board Contact.

   If an animal other than a fish:

   a. Take a digital photo of the animal in the setting where it was found (if possible). Then collect up to five specimens. Place in a jar with water; put on ice and transport to refrigerator. Transfer specimen to a jar filled with rubbing alcohol (except for Jellyfish – leave in water).

   b. Inform AIS ID Volunteer or Board Contact.

5. The AIS ID Volunteer or Board Contact will tentatively confirm identification of plant or animal AIS with Polk County LWRD or lake management consultant then,

   If a plant:

   a. Fill out plant incident form http://dnr.wi.gov/lakes/forms/3200-125-plantincident.pdf
   b. Contact WDNR staff, then deliver collected plants to the WDNR (810 W. Maple St., Spooner, WI 54801) as soon as possible (or to the location they specify).

   If an animal:

   a. Be sure the suspected invasive species has not been previously found on the waterbody
   b. If a zebra mussel report to WDNR and Polk County
   c. Fill out form 3200-126 – Aquatic Invasive Animal Incident Report

6. If identification is positive:
   a. Inform the person who reported the AIS and the board (EWM ID Volunteer), who will then inform Polk County LWRD, harvester operators, and lake management consultant. Harvesting will be suspended within 100 feet of where the AIS was found (if a plant).

   b. Mark the location of AIS with a more permanent marker. Special EWM buoys are available. (AIS ID Volunteers).

   c. Post a notice at the public landing (DNR has these signs available) and include a notice in the next newsletter. Notices will inform residents and visitors of the approximate location of AIS and provide appropriate means to avoid its spread (ARPRD Board).

7. Hire a consultant to determine the extent of the AIS introduction (ARPRD Board). A diver may be used. If small amounts of EWM or other invasive plants are found during this assessment, the consultant will be directed to identify locations with GPS points and hand pull plants found. All plant fragments will be removed from the lake when hand pulling.

8. Select a control plan in cooperation with the WDNR (ARPRD Board). The goal of the rapid response control plan will be eradication of the AIS. Additional guidance regarding EWM treatment is found in DNR's *Response for Early Detection of Eurasian Water Milfoil Field Protocol*.

   Control methods may include hand pulling, use of divers to manually or mechanically remove the EWM from the lake bottom, application of herbicides, and/or other effective and approved control methods.

9. Implement the selected control plan including applying for the necessary permits. Regardless of the control plan selected, it will be implemented by persons who are qualified and experienced in the technique(s) selected.

10. ARPRD funds may be used to pay for any reasonable expense incurred during the implementation of the selected control plan, and implementation will not be delayed by waiting for WDNR to approve or fund a grant application.

11. The ARPRD Board will work with the WDNR to confirm, as soon as possible, a start date for an Early Detection and Rapid Response AIS Control Grant. Thereafter, the ARPRD shall formally apply for the grant.

12. Frequently inspect the area of the AIS to determine the effectiveness of the treatment and whether additional treatment is necessary (ARPRD Board, APM Monitor).

13. Review the procedures and responsibilities of this rapid response plan on an annual basis. Changes may be made with approval of the ARPRD Board.

# EXHIBIT A[1]

## APPLE RIVER PROTECTION AND REHABILITATION DISTRICT

| | |
|---|---|
| AIS ID Volunteers | Derrick Carlson: 612-859-7672<br>dc@sigpubco.com |
| Board Contact | Roland (Pete) Peterson: (763) 571-4835<br>peter015@umn.edu |

## POLK COUNTY LAND AND WATER RESOURCES DEPARTMENT

| | |
|---|---|
| AIS Coordinator | Jeremy Williamson: 715-485-8639<br>jeremyw@co.polk.wi.us |
| Director | Tim Ritten: 715-485-8631<br>TIMR@co.polk.wi.us |

## WISCONSIN DEPARTMENT OF NATURAL RESOURCES

| | |
|---|---|
| Grants and EWM Notice | Alex Smith: 715-635-4124<br>Alex.Smith@wisconsin.gov |
| Permits | Mark Sundeen: 715-635-4074<br>sundem@dnr.state.wi.us |
| EWM Identification and Notice | Spooner Lakes Team: 715-635-4073 |

## APM MONITOR

| | |
|---|---|
| Endangered Resource Services | Matt Berg: 715-483-2847<br>saintcroixdfy@gmail.com |

## DIVERS

| | |
|---|---|
| Endangered Resource Services | Matt Berg: 715-483-2847<br>saintcroixdfy@gmail.com |
| Ecological Integrity Services | Steve Schieffer: 715-554-1168<br>ecointegservice@gmail.com |

[1] This list will be reviewed and updated each year.

ADDITIONAL REFERENCES

WDNR websites on AIS
http://dnr.wi.gov/lakes/invasives/GoalsNew.aspx?show=emerging
http://dnr.wi.gov/lakes/invasives/AISDiscoveryCommunicationProtocol.pdf

# Appendix F. Management Options for Aquatic Plants

Various management options for aquatic plants including manual, mechanical, biological, and chemical control are discussed in detail in following pages. The application, location, timing, and combination of techniques must be considered carefully.

## Manual Removal[1]

Manual removal—hand pulling, cutting, or raking—will effectively remove plants from small areas. It is likely that plant removal will need to be repeated more than once during the growing season. The best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants with rhizomatous (underground stem) growth, pulling roots is not generally recommended since it may stimulate new shoot production. Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil establishment and for private landowners who wish to remove small areas of curly leaf pondweed growth. Raking is recommended to clear nuisance growth in riparian area corridors up to thirty feet wide.

SCUBA divers may engage in manual removal for invasive species like Eurasian water milfoil. Care must be taken to ensure that all plant fragments are removed from the lake. Manual removal with divers is recommended for shallow areas where sporadic EWM growth occurs.

## Mechanical Control

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver-operated suction harvesting, and rotovating (tilling) are the most common forms of mechanical control available. WDNR permits under Chapter NR 109 are required for mechanical plant removal.

**Aquatic plant harvesters** are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cut to depths from one to six feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. A harvester can also be used to gather dislodged, free-floating plant fragments such as from coontail or wild celery. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

The size, and consequently the harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight).

In some cases, the plants are transported to shore by the harvester itself for disposal, while in other cases, a barge is used to store and transport the plants in order to increase

[1] Information from APIS (Aquatic Plant Information System). U.S. Army Corps of Engineers. 2005. and the *Wisconsin Aquatic Plant Management Guidelines.*

the efficiency of the cutting process. The plants are deposited on shore, where they can be transported to a local farm to be used as compost (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

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

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

While the results of harvesting aquatic plants may be short term, the negative consequences are not so short lived. Much like mowing a lawn, harvesting must be conducted numerous times throughout the growing season. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species to propagate and colonize in new, previously unaffected areas of the lake. Harvesting may also result in re-suspension of contaminated sediments and the excess nutrients they contain.

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

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For curly leaf pondweed, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting is conducted too early, the plants will not be close enough to the surface, and the cutting will not do much damage to

them. If too late, turions may have formed and may be spread, and there may be too much plant matter on the surface of the lake for the harvester to cut effectively.

If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since contracted machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines.

**Diver dredging** operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The dredge hoses are from 3 to 5 inches in diameter and are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver dredging is especially effective against the pioneering establishment of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology can be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can result from diver dredging, but fragmentation is not as great a problem when infestations are small. Diver dredging operations may need to be repeated more than once to be effective. When applied to a pioneering infestation, control can be complete. However, periodic inspections of the lake should be performed to ensure that all the plants have been found and collected.

Lake substrates play an important part in the effectiveness of a diver dredging operation. Soft substrates are very easy to work in. Divers can remove the plant and root crowns with little difficulty. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment. Diver dredging will be considered as a rapid response control measure for Eurasian water milfoil if discovered in the flowage.

**Rotovation** involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of 20 feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling contaminated sediments could possibly release toxins into the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine the potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

## Biological Control[2]

Biological control is the purposeful introduction of parasites, predators, and/or pathogenic microorganisms to reduce or suppress populations of plant or animal pests. Biological control counteracts the problems that occur when a species is introduced into a new region of the world without a complex or assemblage of organisms that feed directly upon it, attack its seeds or progeny through predation or parasitism, or cause severe or debilitating diseases. With the introduction of pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

The effectiveness of biocontrol efforts varies widely (Madsen, 2000). Beetles are commonly and successfully used to control purple loosestrife populations in Wisconsin. Weevils are used as an experimental control for Eurasian water milfoil once the plant is established. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, an herbivorous fish, is sometimes used to feed on pest plant populations, but grass carp introduction is not allowed in Wisconsin.

**Eurasian Water Milfoil Biocontrol**

A potential management method for EWM is the use of the native weevil *Euhrychiopsis lecontei*. This weevil has a larvae stage that feeds on both native milfoils and Eurasian water milfoil. The larvae tunnel into the stem causing the plant to presumably lose the ability to transport nutrients and gases. *E. lecontei* adults swim and climb from plant to plant, feeding on leaflets and stem material. After mating, the female lays an average of 1.9 eggs a day, usually 1 egg per watermilfoil apical meristem (growing tip). One female may lay hundreds of eggs in her lifetime. The eggs hatch, and the larvae first feed on the apical meristem and then mine down into the stem of the plant, consuming internal stem tissue. Weevils pupate inside the stem in the pupal chamber, a swelled cavity in the stem. Adults emerge from the pupal chamber to mate and lay eggs. In the autumn, adults travel to the shore where they over-winter on land. In the laboratory, *E. lecontei* take 20 to 30 days to complete 1 life cycle, depending on water temperatures. For complete development, weevils require about 310 degree-days with temperatures above 10 degrees C. Two to four generations per year are generally observed in the field.[3]

Since this weevil naturally occurs in many Wisconsin Lakes, its use involves the augmentation of the natural population of weevils present in the lake. This augmentation significantly increases the population of larvae per stem of milfoil. The premise is that this increase will lead to more destruction of the plants.

The Minocqua and Kawaguesaga Lakes Protection Association experimented with a weevil program for six areas infested with Eurasian Water Milfoil beginning in 2008. The weevils showed little effect on EWM growth when monitored in 2010. Herbicide treatment began in one of the six beds because of concern for EWM expansion. In 2011

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[2] Information from APIS (Aquatic Plant Information System). U.S. Army Corps of Engineers. 2005.

[3] *Euhrychiopsis lecontei* fact sheet. Cornell University Research Ponds Facility. < http://www.eeb.cornell.edu/ponds/weevil.htm>

the weevil augmentation results were showing some positive results with small decreases in both frequency and in density of EWM. However, a second bed was switched to herbicide treatment for 2012 because of expansion of EWM growth. Then in 2012, both frequency and density were back to levels seen in 2010 (density) and prior to 2010 (frequency). Beginning in 2012, any bed that met the criteria for herbicide treatment was treated and reliance on the weevil program was essentially discontinued. (Schieffer, 2012). The results report for Minocqua and Kawaguesaga Lakes are consistent with DNR research that indicates weevils are not an effective solution in Northern Wisconsin.[4]

Results for use of weevils for a St. Croix County lake, Perch Lake are more positive. Milfoil weevils were raised by Beaver Creek Reserve and stocked into Perch Lake in 2013 and 2014 as a biocontrol tool for EWM. During this time, volunteers raised over 20,000 weevils and put them into Perch Lake. 2014 records showed weevil damage evident in 22-42% of stem samples collected in EWM beds, depending on bed. Weevils were present at a rate of 0.24 N/stem. Control has been documented (Newman) at as low as 0.22 N/stem. EWM had decreased significantly in 2014.[5]

**Purple Loosestrife Biocontrol[6]**

Biocontrol may be the most viable long term control method for control of large stands of purple loosestrife. The WDNR and University of Wisconsin-Extension (UWEX), along with hundreds of citizen cooperators, have been introducing natural insect enemies of purple loosestrife, from its home in Europe to infested wetlands in the state since 1994. Careful research has shown that these insects are dependent on purple loosestrife and are not a threat to other plants. Insect releases monitored in Wisconsin and elsewhere have shown that these insects can effectively decrease purple loosestrife size and seed output, thus letting native plants reduce its numbers naturally through enhanced competition.

A suite of four different insect species has been released as biological control organisms for purple loosestrife in North America and Wisconsin. Two leaf beetle species called "Cella" beetles that feed primarily on shoots and leaves were the first control insects to be released in Wisconsin, and are the insects available from WDNR for citizens to propagate and release into their local wetlands. A root-mining weevil species and a type of flower-eating weevil have also been released and are slowly spreading naturally. The Purple Loosestrife Biocontrol Program offers cooperative support, including free equipment and starter beetles from WDNR and UWEX, to all state citizens who wish to use these insects to reduce their local purple loosestrife.

The length of time required for effective biological control of purple loosestrife in any particular wetland ranges from one to several years depending on such factors as site size and loosestrife densities. The process offers effective and environmentally sound control of the plant, not elimination, in most cases. It is also typically best done in some

[4] Susan Knight, Personal Communication with Noah Lottig.

[5] Thorstenson, Amy. Golden Sands Resource Conservation & Development Council, Inc. *Email communication.* November 2015.

[6] http://dnr.wi.gov/topic/Invasives/loosestrife.html

combination with occasional use of more traditional control methods such as digging and herbicide use. Biocontrol with beetles may be appropriate at some point in time should purple loosestrife become established around the flowage.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, and plant-specific control. On the other hand there are several disadvantages to consider, including very long control times (years instead of weeks), a lack of available agents for particular target species, and relatively specific environmental conditions necessary for success. Biological control is not without risks; new non-native species introduced to control a pest population may cause problems of its own.

**Re-vegetation with Native Plants**

Another aspect to biological control is native aquatic plant restoration. The rationale for re-vegetation is that restoring a native plant community should be the end goal of most aquatic plant management programs (Nichols 1991; Smart and Doyle 1995). However, in communities that have only recently been invaded by nonnative species, a propagule (seed) bank probably exists that will restore the community after nonnative plants are controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant removal is probably not necessary on the flowage because a healthy, diverse native plant population is present.

## Physical Control[7]

In physical management, the environment of the plants is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, drawdown, benthic (lake bottom) barriers, and shading or light attenuation. Because they involve placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 WDNR permit would be required.

**Dredging** removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson 1982). Lakes that are very shallow due to sedimentation tend to have excess plant growth. Dredging can form an area of the lake too deep for plants to grow, thus creating an area for open water use (Nichols 1984). By opening more diverse habitats and creating depth gradients, dredging may also create more diversity in the plant community (Nichols 1984). Results of dredging can be very long term. However, due to the cost, environmental impacts, and the problem of disposal, dredging should not be performed for aquatic plant management alone. It is best used as a lake remediation technique. Dredging is not suggested for the flowage as part of the current aquatic plant management plan. However, depending upon the success of the management measures of this plan and water quality recommendations, it may be considered in the future.

[7] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

**Drawdown,** or significantly decreasing lake water levels can be used to control nuisance plant populations. With drawdown, the water body has water removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns need to be at least one month long to ensure thorough drying and effective removal of target plants (Cooke 1980a). In northern areas, a drawdown in the winter that will ensure freezing of sediments is also effective. Although drawdown may be effective for control of hydrilla for one to two years (Ludlow 1995), it is most commonly applied to Eurasian water milfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980).

Although drawdown can be inexpensive and have long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function (e.g., power generation or drinking water supply) of the water body during the drawdown period. Lastly, species respond in very different manners to drawdown, and individual species responses can be inconsistent (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals.

The Amery dam does allow for drawdown. However, there are several reasons that drawdown for aquatic plant control is not a viable option for the flowage. Curly leaf pondweed is found in much of the littoral zone area. A drawdown intended to decrease curly leaf pondweed growth would have an unknown impact on native aquatic plants and other aquatic organisms. Drawdown would dramatically change the use and appearance of the flowage and may have additional unintended consequences.

**Benthic barriers** or other bottom-covering approaches are another physical management technique. The basic idea is to cover the plants with a layer of a growth-inhibiting substance. Many materials have been used, including sheets or screens of organic, inorganic, and synthetic materials; sediments such as dredge sediment, sand, silt or clay; fly ash; and various combinations of the above materials (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with synthetic sheeting is that the gases evolved from plant and sediment decomposition collect underneath and lift the barrier (Gunnison and Barko 1992). The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984).

Benthic barriers will typically kill the plants under them within 1 to 2 months, after which time they may be removed (Engel 1984). Sheet color is relatively unimportant; opaque (particularly black) barriers work best, but even clear plastic barriers will work effectively (Carter et al. 1994). Sites from which barriers are removed will be rapidly re-colonized (Eichler et al. 1995). Synthetic barriers, if left in place for multi-year control, will eventually become sediment-covered and will allow colonization by plants. Benthic barriers may be best suited to small, high-intensity use areas such as docks, boat launch areas, and swimming areas. However, they are too expensive to use over widespread areas, and heavily affect benthic communities by removing fish and invertebrate habitat. A WDNR permit would be required for a benthic barrier, and these barriers are not recommended.

**Shading or light attenuation** reduces the amount of light plants have available for growth. Shading has been achieved by fertilization to produce algal growth, application of natural or synthetic dyes, shading fabric, or covers, and establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general these techniques are only of limited applicability. Physical control is not currently proposed for management of aquatic plants in the flowage.

## Herbicide and Algaecide Treatments

Herbicides are chemicals used to kill plant tissue. Currently, no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability, or persistence in the environment (Joyce, 1991). Thus, there are a limited number of active ingredients that are assured to be safe for aquatic use (Madsen, 2000).

An important caveat is that these products are considered safe when used according to the label. The U.S. Environmental Protection Agency (EPA)-approved label gives guidelines protecting the health of the environment, the humans using that environment, and the applicators of the herbicide. WDNR permits under Chapter NR 107 are required for herbicide application.

General descriptions of herbicide classes are included below.[8]

**Contact herbicides**

Contact herbicides act quickly and are generally lethal to all plant cells they contact. Because of this rapid action, or other physiological reasons, they do not move extensively within the plant and are effective only where they contact plants directly. They are generally more effective on annuals (plants that complete their life cycle in a single year). Perennial plants (plants that persist from year to year) can be defoliated by contact herbicides, but they quickly resprout from unaffected plant parts. Submersed aquatic plants that are in contact with sufficient concentrations of the herbicide in the water for long enough periods of time are affected, but regrowth occurs from unaffected plant parts, especially plant parts that are protected beneath the sediment. Because the entire plant is not killed by contact herbicides, retreatment is necessary, sometimes two or three times per year. **Endothall, diquat,** and **copper** are contact aquatic herbicides.

**Systemic herbicides**

Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as soil active

[8] This discussion is taken from: *Managing Lakes and Reservoirs.* North American Lake Management Society.

herbicides and those that are absorbed by leaves are referred to as foliar active herbicides. **2,4-D, dichlobenil, fluridone, and glyphosate** are systemic aquatic herbicides. When applied correctly, systemic herbicides act slowly in comparison to contact herbicides. They must move to the part of the plant where their site of action is. Systemic herbicides are generally more effective for controlling perennial and woody plants than contact herbicides. Systemic herbicides also generally have more selectivity than contact herbicides.

**Broad spectrum herbicides**

Broad spectrum (sometimes referred to as nonselective) herbicides are those that are used to control all or most species of vegetation. This type of herbicide is often used for total vegetation control in areas such as equipment yards and substations where bare ground is preferred. **Glyphosate** is an example of a broad spectrum aquatic herbicide. **Diquat, endothall, and fluridone** are used as broad spectrum aquatic herbicides, but can also be used selectively under certain circumstances.

**Selective herbicides**

Selective herbicides are those that are used to control certain plants but not others. Herbicide selectivity is based upon the relative susceptibility or response of a plant to an herbicide. Many related physical and biological factors can contribute to a plant's susceptibility to an herbicide. Physical factors that contribute to selectivity include herbicide placement, formulation, timing, and rate of application. Biological factors that affect herbicide selectivity include physiological factors, morphological factors, and stage of plant growth.

**Environmental considerations**

Aquatic communities consist of aquatic plants including macrophytes (large plants) and phytoplankton (free floating algae), invertebrate animals (such as insects and clams), fish, birds, and mammals (such as muskrats and otters). All of these organisms are interrelated in the community. Organisms in the community require a certain set of physical and chemical conditions to exist such as nutrient requirements, oxygen, light, and space. Aquatic weed control operations can affect one or more of the organisms in the community, and in turn affect other organisms or weed control operations. These operations can also impact water chemistry which may result in further implications for aquatic organisms.

**Aquatic Herbicides Licensed in Wisconsin**

There are six classes of aquatic herbicides licensed for use in Wisconsin. Information about these chemicals as presented on the DNR web site and is summarized in Table 15.

*Table 1. Aquatic Herbicides Licensed for use in Wisconsin*

| Chemical (Trade Names) | Management Summary | Management Implications |
|---|---|---|
| Copper Compounds | Broad spectrum algaecides used to control algae. No carryover control. | Non-selective. Will kill algae within 72 hours, but algae can return within 10 days. Some algae are resistant. |
| Diquat Dibromide (Reward, Redwing, Diquat) | Broad spectrum, contact herbicides effective on submersed plants. No carryover control. | Non-selective. Will kill plants within 10-14 days. Not effective in turbid waters. Consumption restrictions apply. |
| Endothall Acid (Aquathol, Hydrothol) | Broad spectrum, contact herbicide. No carryover control. | Non-selective. Will kill plants within 10-14 days. Drinking and irrigation restrictions apply. |
| Glyphosate (Rodeo) | Broad spectrum and systemic. Includes a surfactant for aquatic use to control emergent and floating plants. | Non-selective. Requires surfactant for aquatic use. Most commonly used for purple loosestrife. |
| 2,4-D (Aquakleen, Navigate and others) | Controls dicots (broad leaf plants such as water lilies, watershield, and water milfoil)[9] Potential for multiple year control. | Used for control of Eurasian water milfoil. Drinking and irrigation restrictions apply. |
| Fluridone (Sonar) | Broad spectrum herbicide. May have multiple year control. | Generally used for whole-lake or pond treatments. Kills plants slowly (30-90 days). Most useful for duckweed control. Irrigation restrictions apply. |

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[10]

**Copper**

Copper is a naturally occurring element that is essential at low concentrations for plant growth. It does not break down in the environment, but it forms insoluble compounds with other elements and is bound to charged particles in the water. It rapidly disappears from water after application as an herbicide. Because it is not broken down, it can accumulate in bottom sediments after repeated or high rates of application. Accumulation rarely reaches levels that are toxic to organisms or significantly above background concentrations in the sediment.

[9] Although DNR and Army Corps of Engineer Studies (2010) have shown impacts on monocots such as pondweeds.

10 These descriptions are taken from Hoyer/Canfield: *Aquatic Plant Management*. North American Lake Management Society. 1997.

The Polk County Land and Water Resources Department sampled flowage sediments and tested them for copper in 2012. Sediment copper concentrations were 21.12 mg/kg at site one and 21.78 mg/kg at site two. These concentrations are well below the consensus based threshold effect concentrations for copper, or the concentration below which harmful effects are unlikely to be observed.[11]

**Copper Compounds**
Copper-based compounds are generally used to treat filamentous algae. Common chemicals used are copper sulfate and Cutrine Plus, a chelated copper algaecide.

**Diquat**
When applied to enclosed ponds for submersed weed control, diquat is rarely found longer than 10 days after application and is often below detection levels 3 days after application. The most important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by aquatic vegetation and bound tightly to particles in the water and bottom sediments. When bound to certain types of clay particles, diquat is not biologically available. When diquat is bound to organic matter, it can be slowly degraded by microorganisms. When diquat is applied foliarly, it is degraded to some extent on the leaf surfaces by photodegradation. Because it is bound in the plant tissue, a proportion is probably degraded by microorganisms as the plant tissue decays.

**Endothall**
Endothall is rapidly and completely broken down into naturally occurring compounds by microorganisms. The by-products of endothall dissipation are carbon dioxide and water. Complete breakdown usually occurs in about 2 weeks in water and 1 week in bottom sediments.

**Glyphosate**
Glyphosate is not applied directly to water for weed control, but when it does enter the water it is bound tightly to dissolved and suspended particles and to bottom sediments and becomes inactive. Glyphosate is broken down into carbon dioxide, water, nitrogen, and phosphorus over a period of several months.

**2,4-D**
2,4-D photodegrades on leaf surfaces after being applied to leaves, and is broken down by microbial degradation in water and in sediments. Complete decomposition usually takes about 3 weeks in water but can be as short as 1 week. 2,4-D breaks down into naturally occurring compounds.

[11] Polk County Land and Water Resources Department. 2013.

Recent WDNR studies contradict the above information. Under certain conditions, residual concentrations of 2,4-D above 100 *u*g/L may be present well past label irrigation restriction guidelines of 21 days. Degradation takes longer in some lakes:

- Oligotrophic (low-nutrient) lakes
- Low alkalinity lakes
- Lakes with no history of herbicide usage
- When water temperatures are cool. (WDNR 2011)

Granular formulations of 2,4-D and other herbicides dissipate at about the same rate as liquid formulations of herbicides (WDNR 2011)

Some recent studies indicate a need to consider the long-term effects of 2,4-D use. One is the effect on the endocrine system and reproduction of fat head minnows (DeQuattro, 2015). There is also some evidence that hybrid EWM can acquire resistance to 2,4-D (LaRue et al, 2013).

**Fluridone**

Dissipation of fluridone from water occurs mainly by photodegradation. Metabolism by tolerant organisms and microbial breakdown also occurs, and microbial breakdown is probably the most important method of breakdown in bottom sediments. The rate of breakdown of fluridone is variable and may be related to time of application.

Applications made in the fall or winter, when the sun's rays are less direct and days are shorter, result in longer half-lives. Fluridone usually disappears from pondwater after about 3 months but can remain up to 9 months. It may remain in bottom sediment between 4 months and 1 year.

*Table 2. Herbicides Used to Manage Aquatic Plants on the Apple River Flowage (1985-2009)*

| **Brand Name(s)** | **Chemical** | **Target Plants** |
|---|---|---|
| Cutrine Plus, $CuSO_4$, Copper Sulfate, Other Copper Products | Copper compounds | Filamentous algae, coontail, wild celery, elodea, and pondweeds |
| Reward, Redwing | Diquat | Coontail, duckweed, elodea, water milfoil, and pondweeds |
| Aquathol, Aquathol K, | Endothall | Coontail, water milfoil, pondweeds, and wild celery as well as other submersed weeds and algae |
| Rodeo | Glyphosate | Cattails, grasses, bulrushes, purple loosestrife, and water lilies |
| Navigate, Aqua-Kleen | 2, 4-D | Water milfoils, water lilies, and bladderwort |

**Effects of Herbicides on Wild Rice**

Any herbicide use in the flowage should consider potential impacts to wild rice. A US Army Corps of Engineers Study used tank studies to examine the effects of several aquatic herbicides on the growth and survival of wild rice. The study tested aquatic formulations of diquat, endothall, fluridone, and 2,4-D applied at varying rates and contact times to three growth stages of wild rice. **The results of this study suggest that wild rice is most resistant to herbicides applied to the water column when plants are mature or in the late flowering stages of development.** Of the herbicides evaluated, wild rice was most sensitive to 2,4-D. Rates as low as 1 mg 2,4-D significantly inhibited biomass production in young wild rice.[12] However, in-lake 2,4-D treatments for Eurasian water milfoil control near wild rice did not show significant impacts to the rice in Spring Lake.[13]

The life cycle of wild rice may influence control options for other plants. The seed drops in August or September and remains dormant until spring. By late May to early June the plant is in the submerged leaf stage with a cluster of 1-4 underwater basal leaves. The floating leaf stage occurs by mid-June. At this stage high winds or rapid increase in water levels can uproot or drown wild rice. By the end of June one or more aerial shoots begin to develop. These shoots continue to grow to 2-8 feet through the end of August. **Flowering begins in late July, and seeds mature in August and September.**

**Coontail Control with Herbicides**

The US Army Corps of Engineers Plant Information System lists diquat, endothall, and floridone as appropriate for coontail control. Floridone requires chemical residence times of over 60 days to be effective. Diquat and endothall require an exposure time of 4-24 hours. Flowing water will make floridone use not feasible, and would make diquat and endothall less effective. Low concentration applications of endothall require exposure times of 8 to 48 hours.[14]

**Duckweed Control with Herbicides**

According to the US Army Corps of Engineers Plant Information System, diquat and floridone are the only chemicals licensed for use in Wisconsin that are appropriate for duckweed treatment. Floridone requires chemical residence times of over 60 days to be effective. Diquat requires an exposure time of 4-24 hours and will kill plants in 10-14 days. Flowing water will make floridone use not feasible, and would make diquat less effective.[15]

[12] USACE 2003.
[13] Personal communication with Anthony Havranek. February 9, 2010
[14] APIS.
[15] APIS.

## Herbicide Used to Manage Invasive Species

**Eurasian Water Milfoil**

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian water milfoil: complexed copper, 2,4-D, diquat, endothall, fluridone, and triclopyr. Early season treatment of Eurasian water milfoil is recommended by the Department of Natural Resources to limit the impact on native aquatic plant populations when chemical treatments are used. 2,4-D is frequently used to target EWM (a dicot) over many other native plants (monocots).

However, large-scale treatments can result in significant damage to both monocots and dicots.

- Dicots susceptible to both 2,4-D and fluridone include native watermilfoils (particularly northern), bladderworts, water lilies and coontail.
- Monocot species such as elodea, several narrow leaf pondweeds, and naiads are also impacted by fluridone and some 2,4-D use.
- Fewer natives are affected at lower dosages. (WDNR 2011)

Wisconsin DNR research indicates that larger scale treatments seem to have more consistent reduction from herbicide use than smaller treatments. These results are based upon data collection in many Wisconsin lakes where herbicides were used for EWM control. (Nault et al, 2015)

Herbicides can dissipate off of a small treatment site very rapidly. 2,4-D dissipated rapidly after treatment after it was applied to 98 small (0.1-10 acre) treatment areas across 22 study lakes with application rates of 2-4 ppm. The following results were found:

- Initial 2,4-D concentrations detected in the water column were well below application targets.
- Herbicide moved quickly away from treatment sites within a few hours after treatment.
- The rapid dissipation of herbicide indicates that the concentrations in target areas may be lower than what is needed for effective EWM control. (Nault 2012)

**Curly Leaf Pondweed**

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies three herbicides for control of curly leaf pondweed: diquat, endothall, and fluridone. Fluridone requires exposure of 30 to 60 days making it infeasible to target a discreet area in a lake system. The other herbicides act more rapidly. Herbicide labels provide water use restriction following treatment. Diquat (Reward) has the following use restrictions: drinking water 1-3 days, swimming and fish consumption 0 days. Endothall (Aquathol K) has the following use restrictions: drinking water 7 – 25 days, swimming 0 days, fish consumption 3 days.

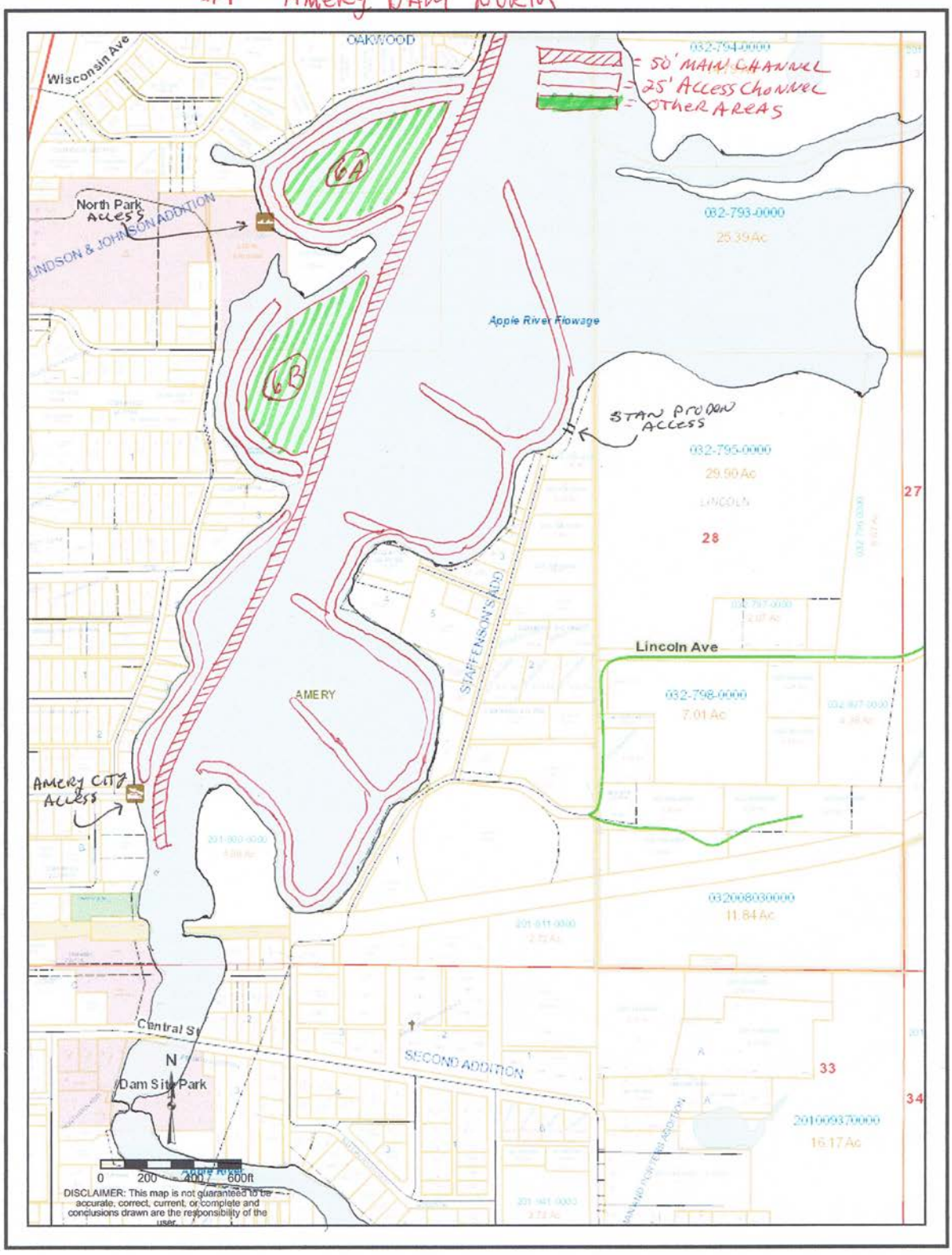
Early season herbicide treatment:[16]
Studies have demonstrated that curly leaf can be controlled with Aquathol K (a formulation of endothall) in 50 - 60 degree F water, and treatments of curly leaf this early in its life cycle can prevent turion formation. Since curly leaf pondweed is actively growing at these low water temperatures and many native aquatic plants are yet dormant, this early season treatment selectively targets curly leaf pondweed.

Because the dosage is at lower rates than dosage recommended on the label, a greater herbicide residence time is necessary. To prevent drift of herbicide and allow greater contact time, application in shallow bays where there is little or no flowing water is likely to be most effective. Herbicide applied to a narrow band of vegetation along the shoreline is likely to drift, rapidly decrease in concentration, and be rendered ineffective.[17] Steep drop-off, high winds, flowing water, and other factors that increase herbicide dilution and contact time can decrease treatment effectiveness. Early season treatment similar to that described above can be used to treat corridors for navigation purposes. Because of potential for drift, a higher concentration of endothall is generally used.

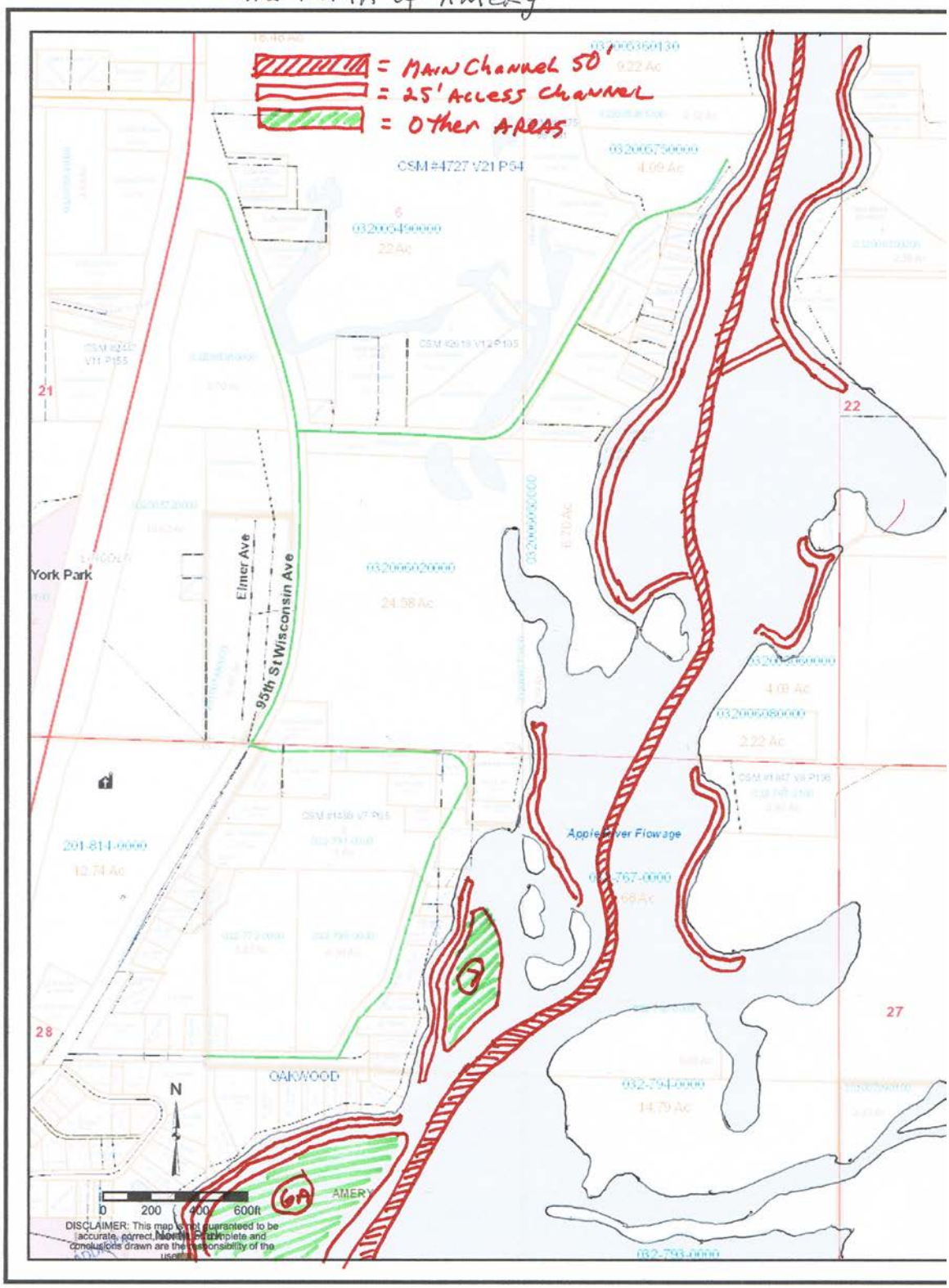
[16] Research in Minnesota on Control of Curly Leaf Pondweed. Minnesota Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[17] Personal communication, Frank Koshere. March 2005.

# Appendix G. Harvesting Lanes

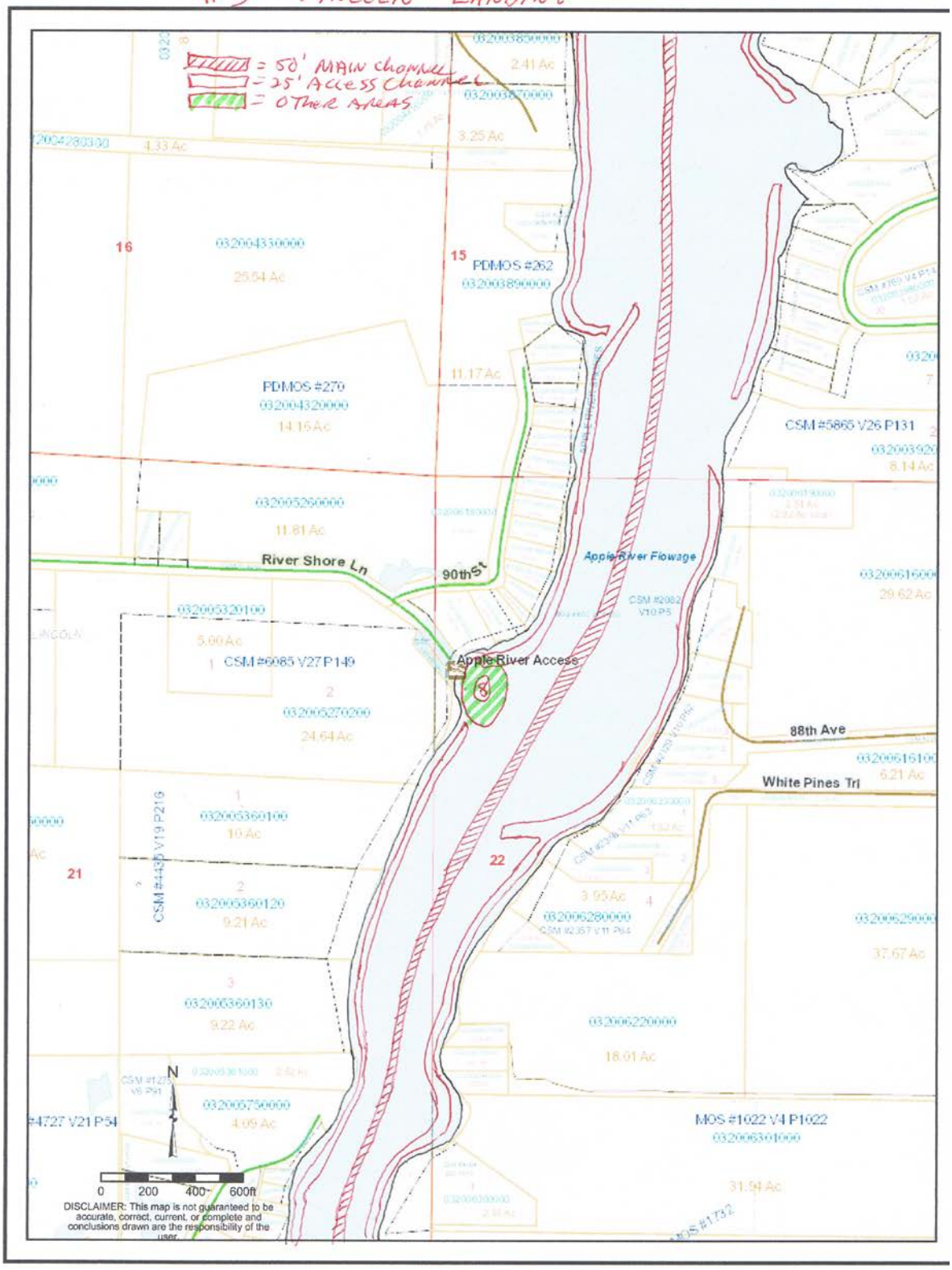
#1 AMERY DAM NORTH

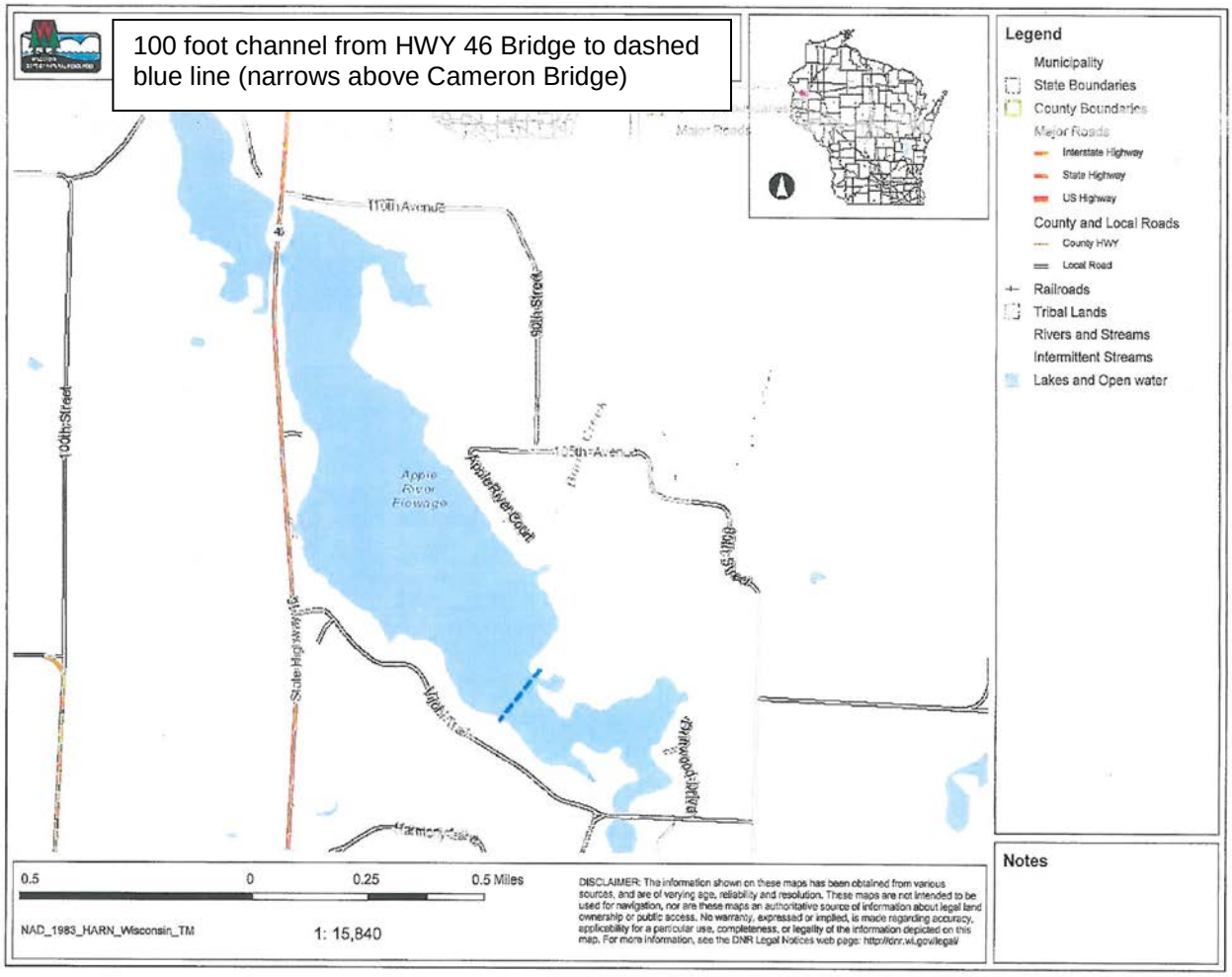


#2 NORTH of AMERY



#3 LINCOLN LANDING




100 foot channel from HWY 46 Bridge to dashed blue line (narrows above Cameron Bridge)
110th Avenue
90th Street
100th Street
105th Avenue
Apple River Frontage
Apple River Court
State Highway 46
Legend
Municipality
State Boundaries
County Boundaries
Major Roads
Interstate Highway
State Highway
US Highway
County and Local Roads
County HWY
Local Road
Railroads
Tribal Lands
Rivers and Streams
Intermittent Streams
Lakes and Open water
Notes
0.5
0
0.25
0.5 Miles
NAD_1983_HARN_Wisconsin_TM
1: 15,840
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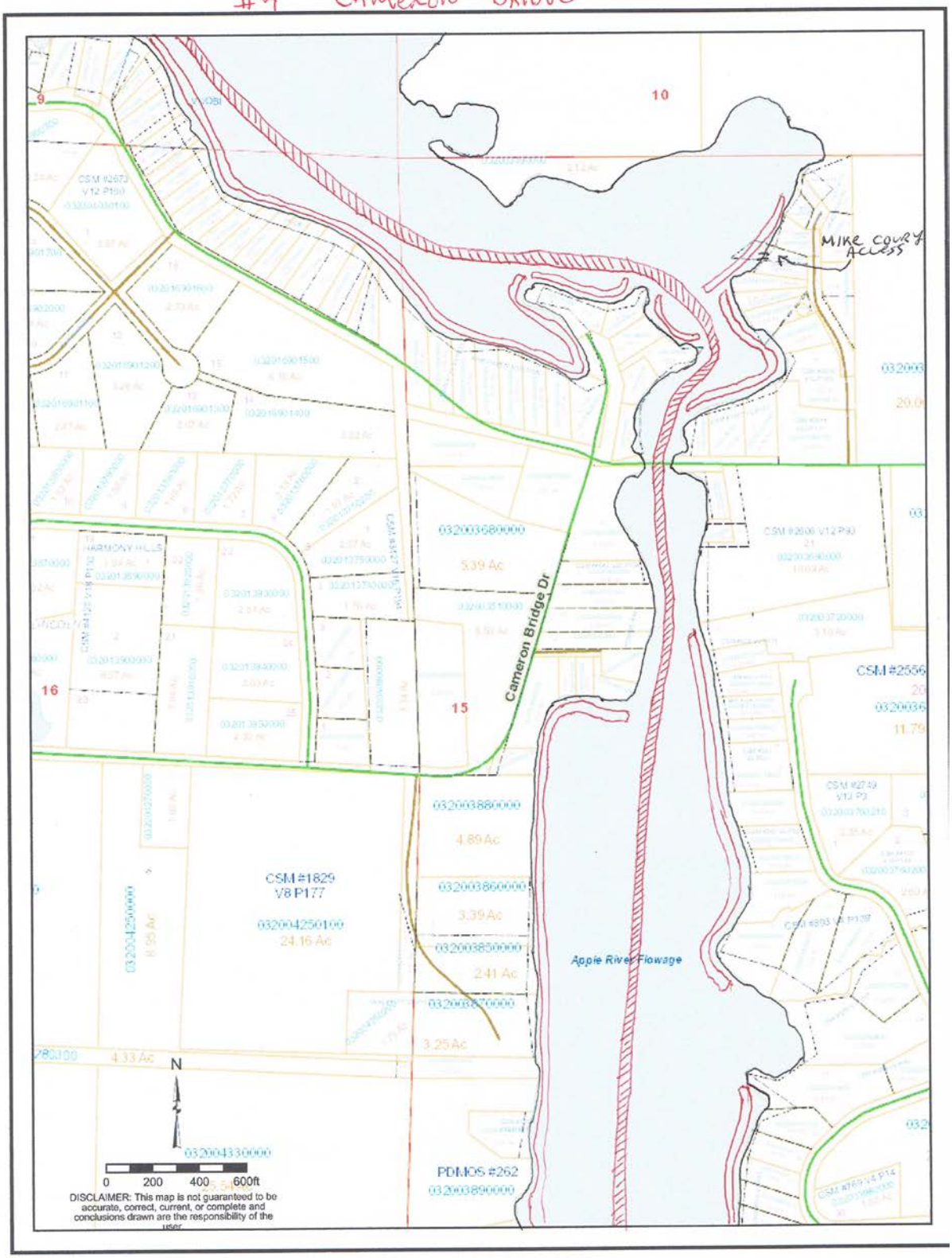
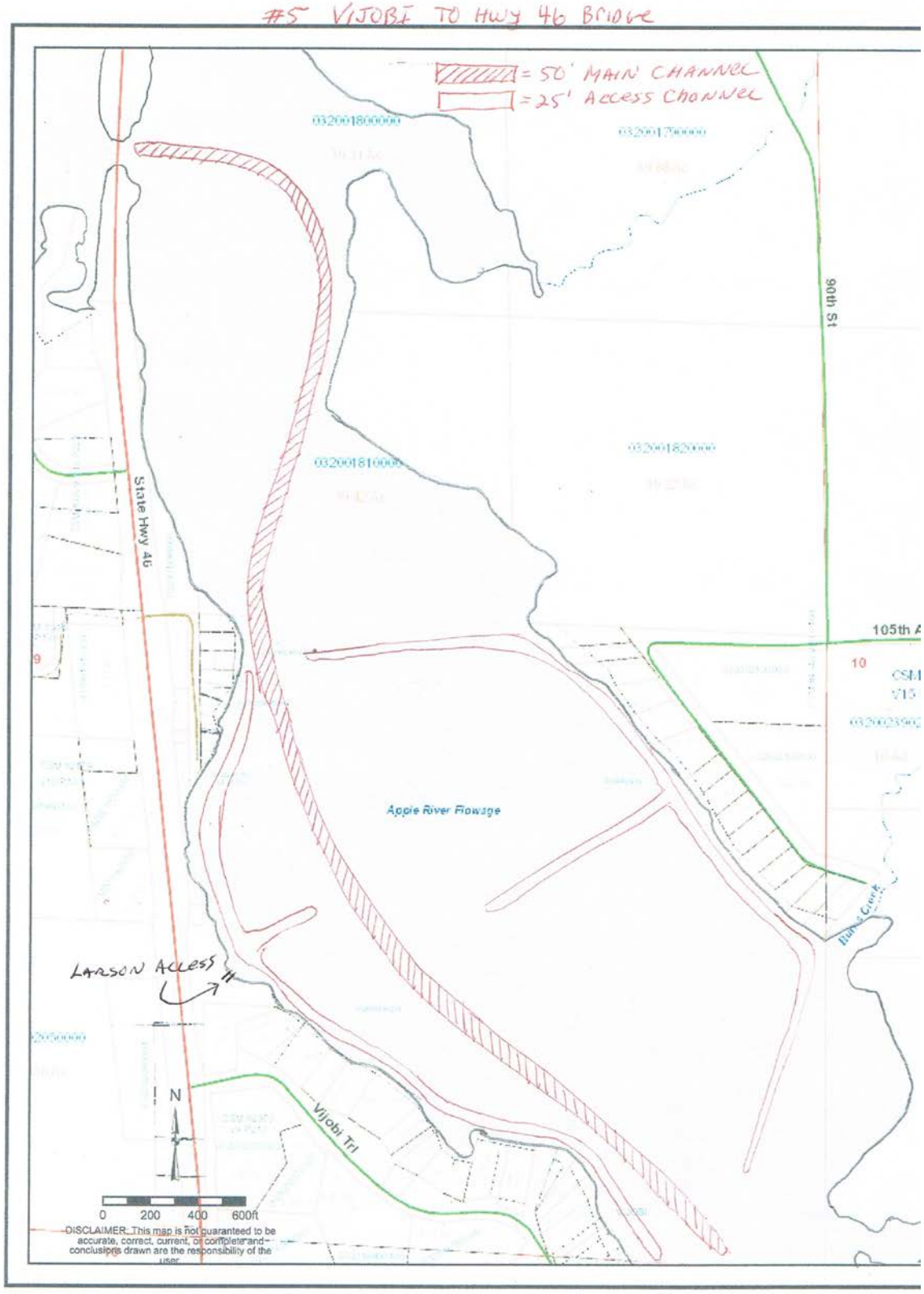
#4 CAMERON BRIDGE



#5 VIJOBI TO HWY 46 BRIDGE



#6 North of 46 Bridge