# Aquatic Plant Management Plan

# Apple River Flowage

Polk County, Wisconsin

September 2011

Sponsored By

Apple River Flowage Protection and Rehabilitation District

Prepared By

Aquatic Plant Advisory Committee

| | |
|---|---|
| Harmony Environmental | Plan Writing and Facilitation |
| Endangered Resource Services, LLC | Aquatic Plant Survey and Mapping |

Harmony Environmental
Finding a balance
People Land Water

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## Aquatic Plant Advisory Committee

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Harmony Environmental — Plan Writing and Facilitation
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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 2016. 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. The aquatic plant survey found that 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. Locations and density of this plant will be surveyed in June 2011 when it is at peak growth. Eurasian water milfoil, an invasive plant of concern, was not found in the 2010 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 choose 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 approved both the plan and the budget at the meeting held August 27, 2011.

### 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 2016. 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 2011 through 2016).

### Public Input for Plan Development

The ARPRD Aquatic Plant Management (APM) Advisory Committee provided input for the development of this plan. The APM Advisory Committee met five times. At the first meeting on February 16, 2011, the committee reviewed aquatic plant management planning requirements, plant survey results, and discussed aquatic plant management concerns. At a second meeting on March 9, 2011, and a third meeting on March 30, 2011, the committee reviewed aquatic plant management efforts to date, and management options available. At the fourth and fifth meeting (April 20 and May 18) the committee developed 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 4 and 11, 2011. 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 27, 2011 including at the ARPRD annual meeting on that date.

Sixty three people registered at the annual meeting, and more were in attendance who did not sign an attendance sheet. The membership approved both the plan and the budget at the meeting. Three ARPRD committees for plan implementation were also established including: Harvester Purchase (5 volunteers), Harvester Operations (6 volunteers), Water Quality Planning (7 volunteers).

**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. Staff of the St. Croix Tribe Environmental Department and the Great Lakes Indian Fish and Wildlife Commission participated in the planning process. Draft and final copies will be distributed to these entities as well.

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 improving water quality (including downstream water quality), maintaining navigation, managing curly leaf pondweed, and maintaining overall ecosystem health.

A property owner survey was not completed as part of this planning process. A 2001 survey of Apple River residents was completed as part of a DNR River Protection Project in 2002. Although responses were not differentiated by the portion of the Apple River where people lived, people along the river in general had a high level of concern regarding aquatic plants. Of the 181 river residents who responded to the survey, just over 50 stated that aquatic plants was the top ranked concern that threatens the quality of the Apple River. Pollution was the overall top ranked concern (54 responses) and development was the third (39 responses).

## 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 shallow waters of the flowage, these mucky sediments promote heavy aquatic plant growth. In fact, aquatic plants cover nearly the entire surface of the lake bottom with plants growing to a depth of 14 feet.[2] The Apple River Flowage is a very nutrient rich water body with summer Secchi depths averaging only 3.5 feet in 2010.

The flowage is created by a dam within the city limits of Amery. The flowage extends about 7 miles upstream almost to U.S. Highway 8. 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 1. 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.

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[2] Berg, Matthew S., Endangered Resources Services, LLC. *Warm Water Point/Intercept Macrophyte Survey Balsam Lake Polk County, Wisconsin. July 2009.*

[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.

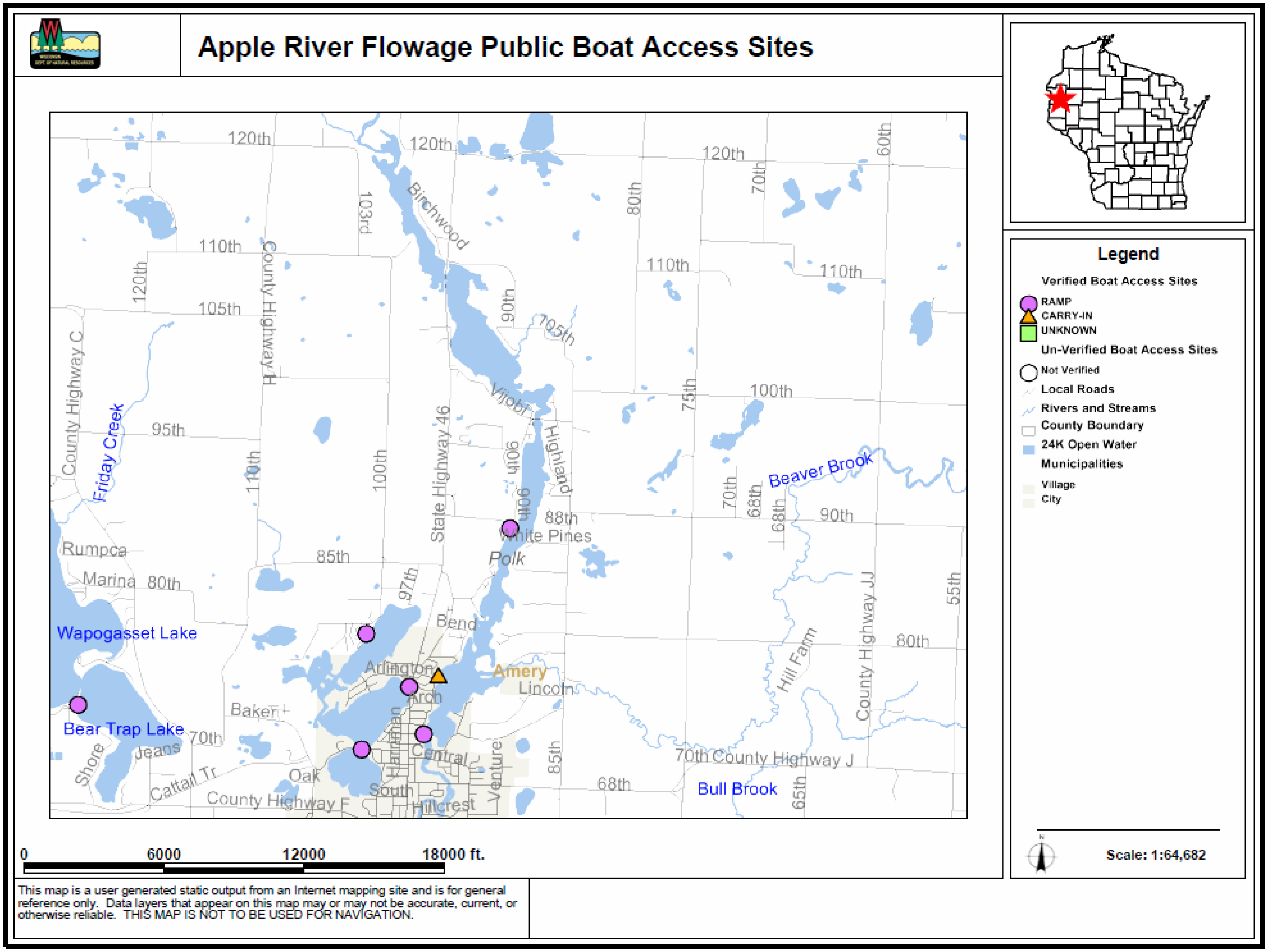


*Figure 1. Apple River Flowage Public Access Sites*

## 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 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 2. Citizen Lake Monitoring Results, 2010[5]

| | **2010** |
|---|---|
| **Secchi Depth** (ft) | 3.5 |
| **Total Phosphorus** (µg/l) | 94.5 |
| **Chlorphyll** (µg/l) | 57.5 |
| **Trophic State Index** (TSI) | 65 |
| **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 2011. <http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/>
[5] *Reports and Data: Polk County*. WDNR website. February 2011. http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/

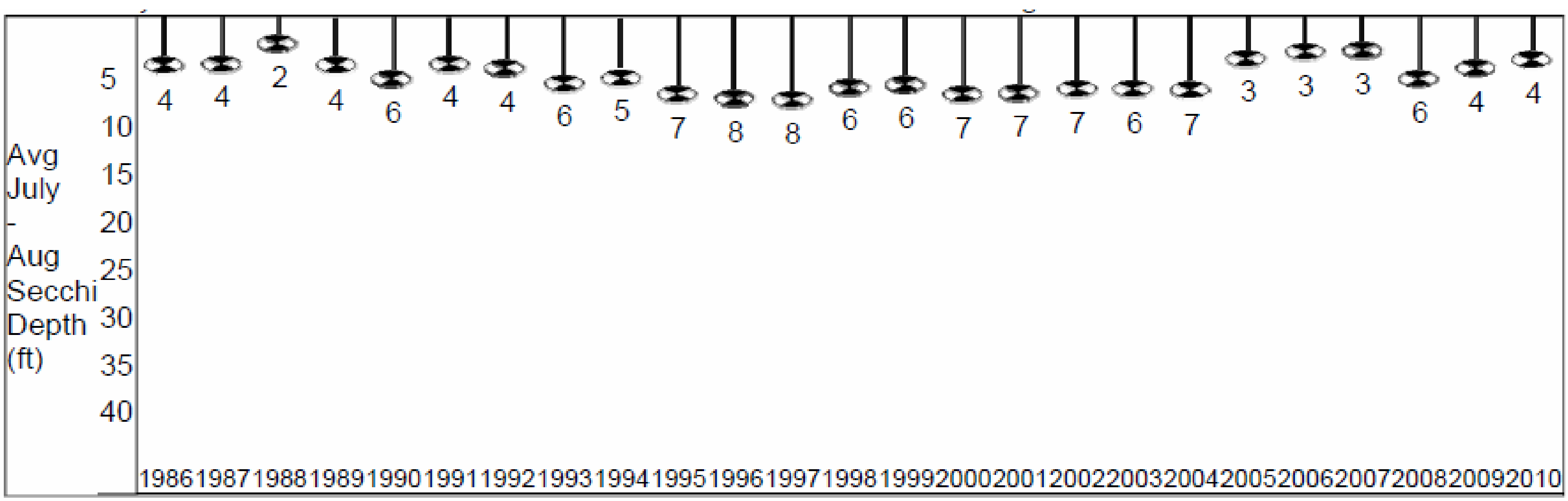


*Figure 2. Deep Hole Basin Summer Average Secchi Depths 1986-2010*

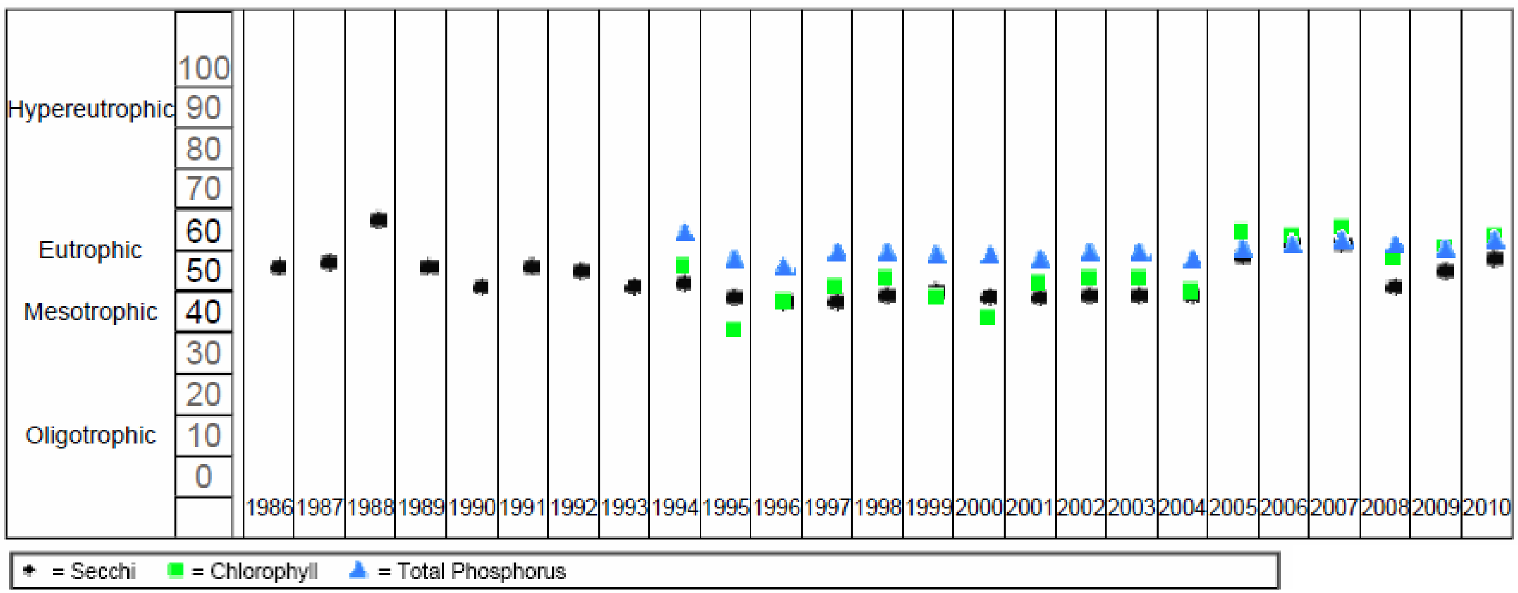


*Figure 3. Deep Hole Trophic State Index 1986-2010*

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 111,943 acres, a 175:1 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.

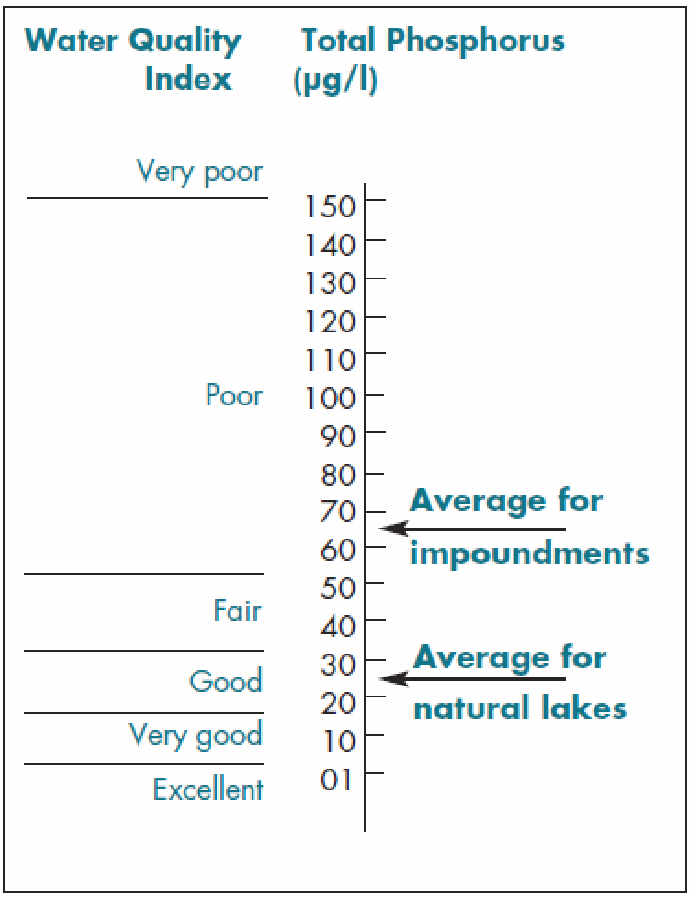


**FIGURE 4.** Total phosphorus concentrations for Wisconsin's natural lakes and impoundments. (*Adapted from Lillie and Mason, 1983.*)

*Figure 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 12 days.[6] Its characteristics mimic lakes with short retention times described in the table below.

Table 3. 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.

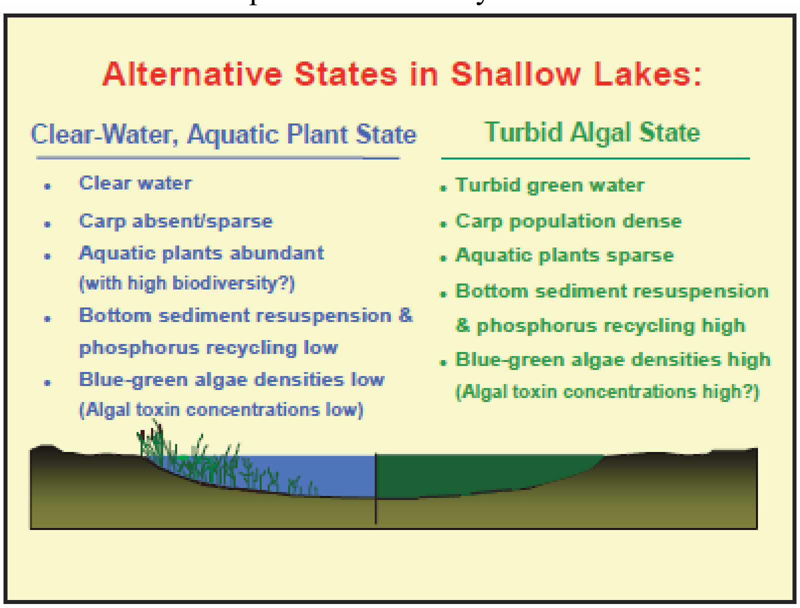


*Figure 5. Alternative States in Shallow Lakes*
*From Lake Wingra presentation adopted from Sheffer 1990.*

[6] At 200 cfs (used as an example in a previous plan, this does not appear to be a measured value) and a lake volume of 209,000,000 cubic feet or 4,800 acre feet. This volume is from DNR dam safety information.

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 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. The North Lake has excessive native plant growth throughout the season along with higher water clarity. The South 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).

Aquatic plant growth and light levels influence the 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 Apple River watershed is part of the larger St. Croix River Basin. The 111,943-acre Upper Apple River watershed consisted of 13.5 percent agricultural land and 0.2 percent urban land when measured from satellite photos in 1992.[7] These land uses are generally of most concern for phosphorus loading to water resources. Remaining land cover is mostly forest and wetland.

### 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.

A 2002 State of the St. Croix River Basin identified three key priorities for the basin that apply to the Upper Apple River Watershed, all of which are associated with water quality:[8]

1. Protection and restoration of shoreland habitat
2. Control of nonpoint source runoff contamination of surface waters
3. Restoration of grasslands, prairies, and wetlands to protect soil and water quality and to enhance wildlife habitat

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

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[7] Polk County LCC. 2009.

[8] *The State of the St. Croix River Basin.* Wisconsin Department of Natural Resources. 2002.

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

Transect surveys, used by the Polk County Land and Water Resources Department to monitor soil erosion, found that erosion increased in the Upper and Lower Apple River watershed from 1999 to 2009. There are more sample sites above T, the tolerable soil loss rate. Recent changes have slowed the increased erosion somewhat. A shift to row crops has led to high soil loss. The shift in crops was due to a more favorable commodity price for corn and wheat compared to soybeans. Forage and idle ground, such as that in the Conservation Reserve Program (CRP), have also been on a steady decline. The graph below illustrates the percentage of crop fields sampled with various multiples of T, which is generally a loss of 4 to 5 tons of soil per acre per year in Polk County.

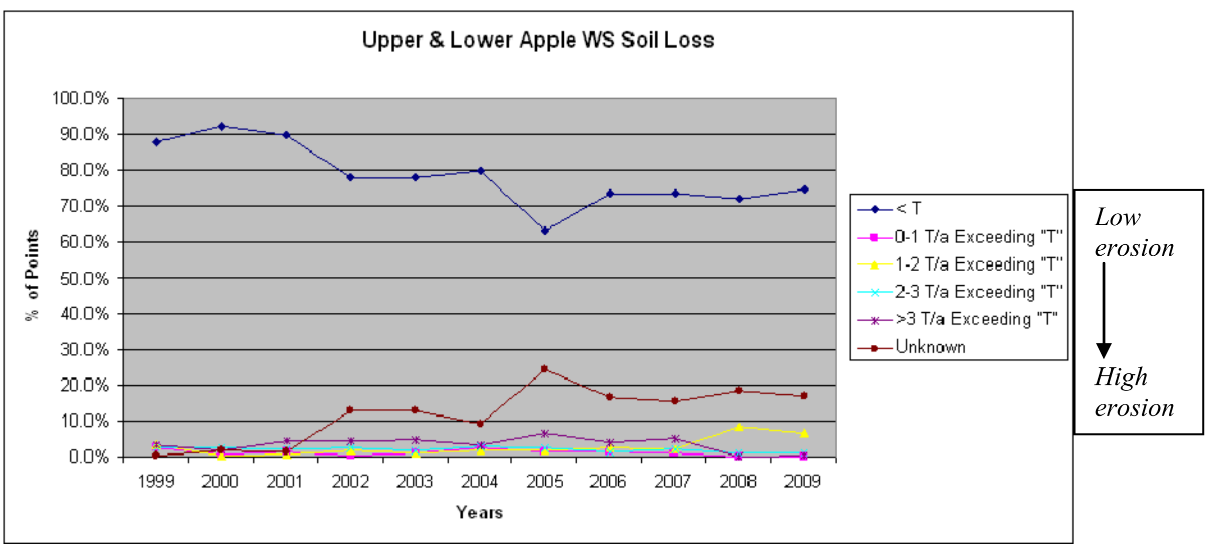


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*Figure 6. Soil Loss in the Upper and Lower Apple River Watershed*

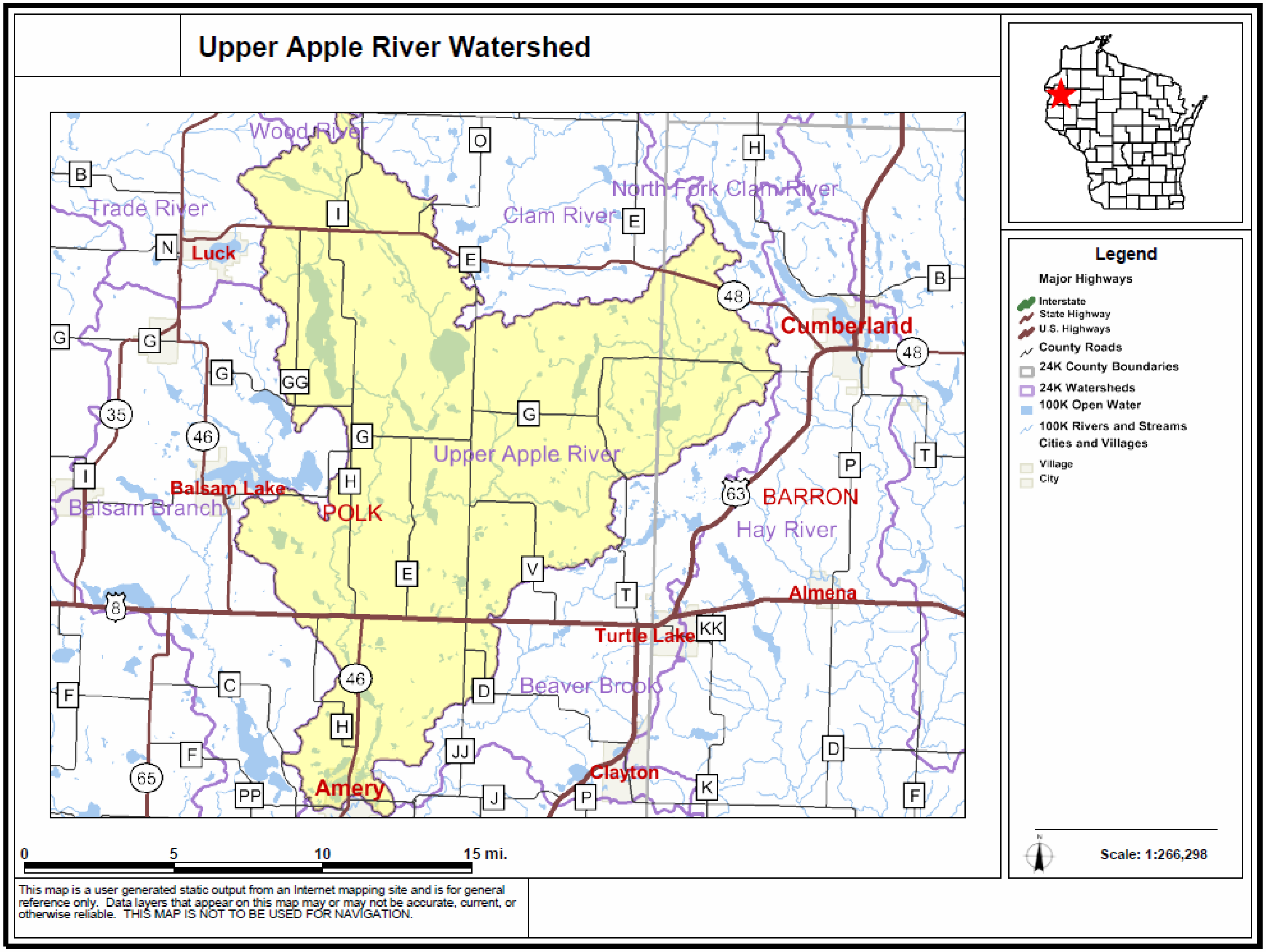


*Figure 7. Upper Apple River Watershed*

## Flowage Feasibility Study

Aside from ongoing citizen monitoring, there is little recent information about the water quality and sediment build-up in the Apple River Flowage. A study completed in 1979 provides the most comprehensive information about the flowage. The report documents erosion and feedlots 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 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 of the plant sampling times. 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 explains 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[9]

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

[9] Office of Inland Lake Renewal 1979.

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 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.

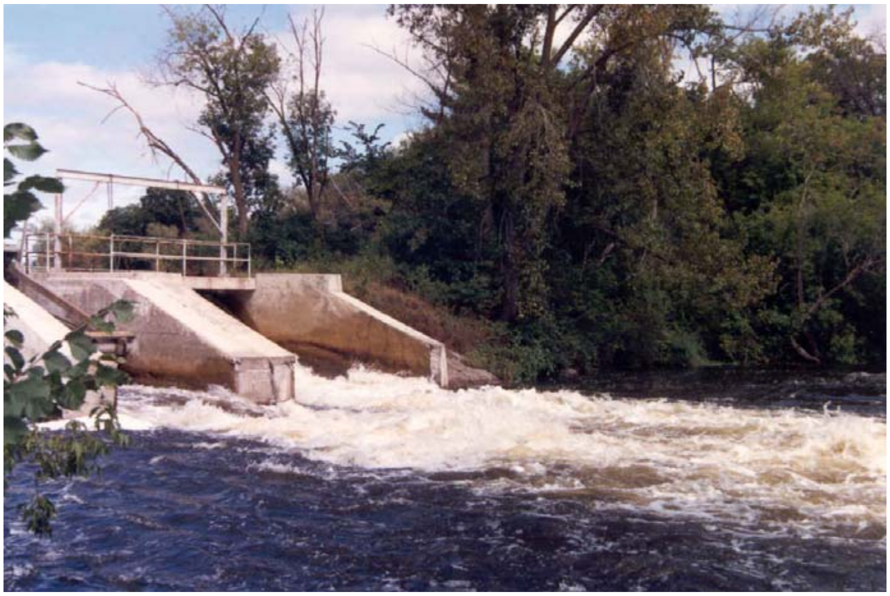

*Figure 8. The Amery Dam*

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.[10]

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.[11] 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 report increased floating vegetation and organic muck in 2011 which they believe was caused by the dam removal.

[10] Personal communication. John Frisco, former city of Amery Public Works Supervisor, February 2011.
[11] 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."

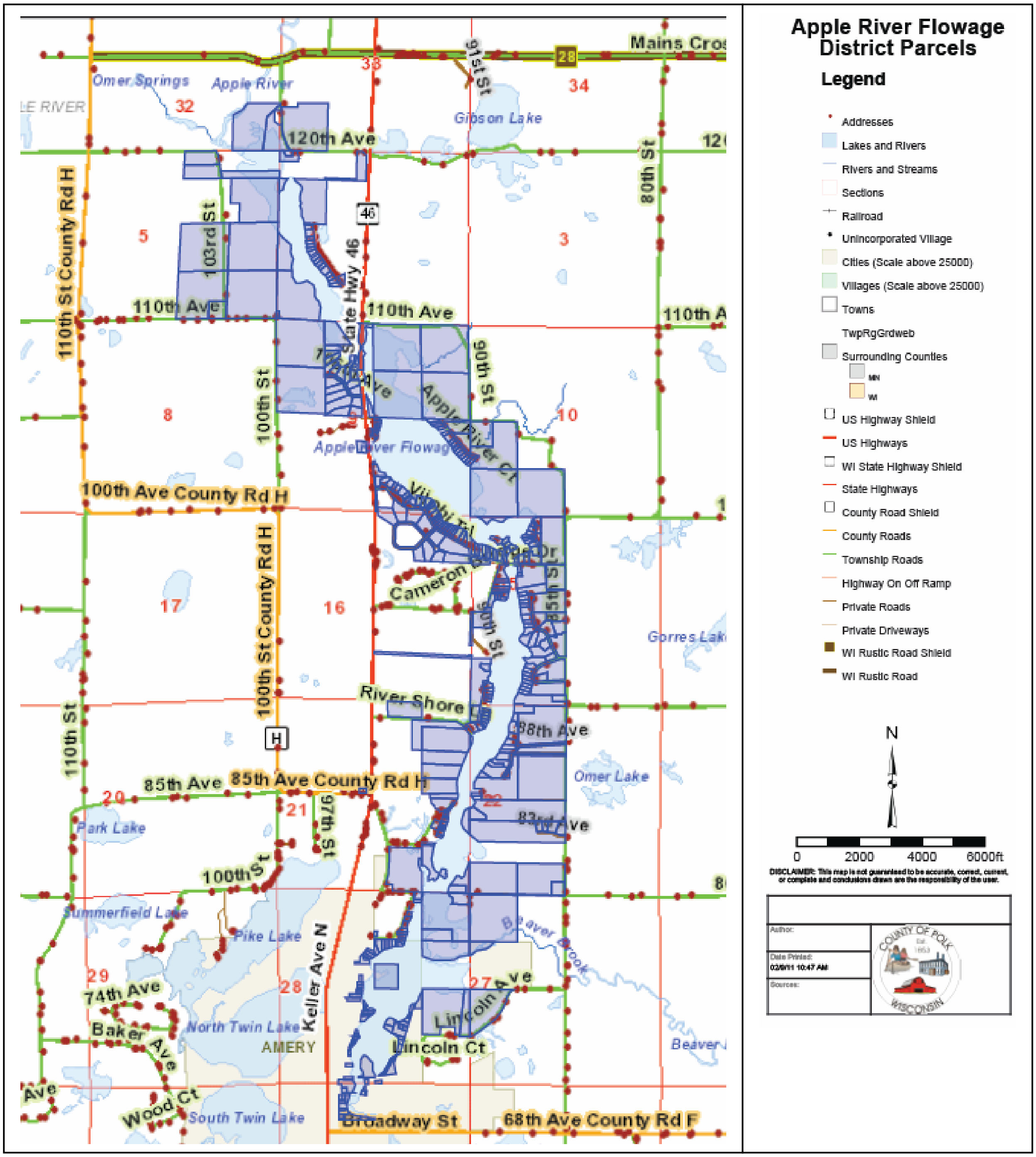


*Figure 9. Apple River Protection and Rehabilitation District Parcels*

**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.

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

### 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.[12]

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.[13]

*Figure 10. The Black Brook Dam*

[12] DNR Web View On-Line Mapping http://dnrmaps/wisconsin.gov
[13] 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 State 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.[14]

**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

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[14] 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.[15]

### Aquatic Invasive Species Status

Purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), and curly leaf pondweed (*Potamogeton crispus*) were observed on the Apple River Flowage in the 2010 plant survey. Purple loosestrife was found at a single location 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.[16]

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. According to the Minnesota Sea Grant Office:

> *Eurasian water milfoil can form dense mats of vegetation and crowd out native aquatic plants, clog boat propellers and make water recreation difficult. Eurasian water milfoil has spread to over 150 lakes [in Minnesota], primarily in the Twin Cities area.*

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). In Polk County, EWM is found in Long Trade, Horseshoe and Pike Lakes.

### 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

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[15] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.
[16] Berg. 2010 and Berg. 2011.

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* 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. They 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 4. Natural Heritage Species in the Town of Lincoln

| Scientific Name | Common Name | Status |
|---|---|---|
| *Fundulus diaphanus* | Banded killifish | SC/N |
| *Haliaeetus leucocephalus* | Bald eagle | SC/P |

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 Apple River Flowage fishery is comprised of muskie, northern pike, largemouth and smallmouth bass, and pan fish.[17] Pan fish include blue gills, crappies, pumpkin seeds, and yellow perch. Muskies are in small numbers, but good sized muskies are harvested from the flowage. The flowage is an excellent largemouth bass fishery with quality fish harvested in good numbers.

A fish survey is scheduled for the flowage in the spring of 2011. Additional information will be available if this survey is completed (the DNR is currently short a fish biologist in the region).

When considering fish in flowage aquatic plant management, the following should be considered[18]:

1. Black crappie spawn when the water temperature is the same as that recommended for CLP treatment. This 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 5. Spawning Temperatures and Substrate Needs

| **Fish species[19]** | **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 |

[17] *Wisconsin Lakes Book*. 2009 and personal communication Brian Spangler DNR Fisheries Technical February 10, 2011.
[18] From *Draft Aquatic Plant Management Plan Lake Wapogasset and Bear Trap Lake*. Ecological Integrity Services. August 2009.
[19] Information from Heath Benike. Wisconsin DNR Fisheries Biologist. 2006

# Plant Community

## Aquatic Plant Survey Results

An aquatic plant inventory was completed for the Apple River Flowage in July of 2010, according to the WDNR-specified point intercept method. The results discussed below, are summarized or taken directly from the aquatic plant survey.

The survey and data analysis methods for the aquatic macrophyte survey are found in the following report: *Warm Water Point/Intercept Macrophyte 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 671 points. Figure 11 below shows the distribution of these sampling points.

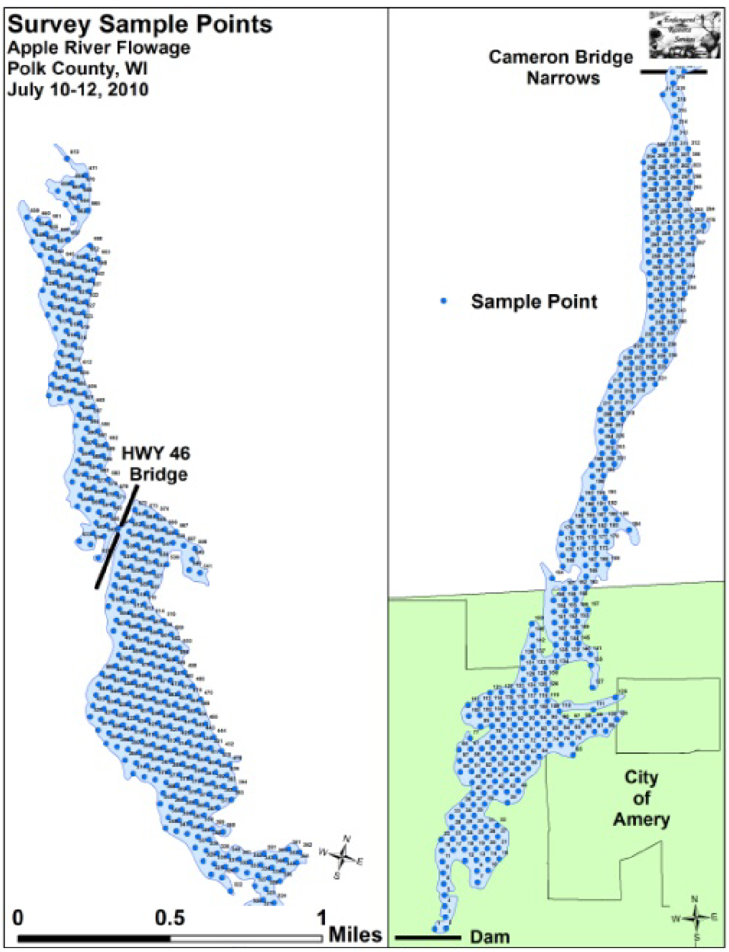



*Figure 11. Sampling Point Grid*

In July 2010, plants were found growing on approximately 88% of the lake bottom (588 out of 671 sampling points) with nearly all of the points at depths shallower than the 14 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 bottom consists of thick organic muck with some rock in the former river channel and sand near the Beaver Brook inlet.

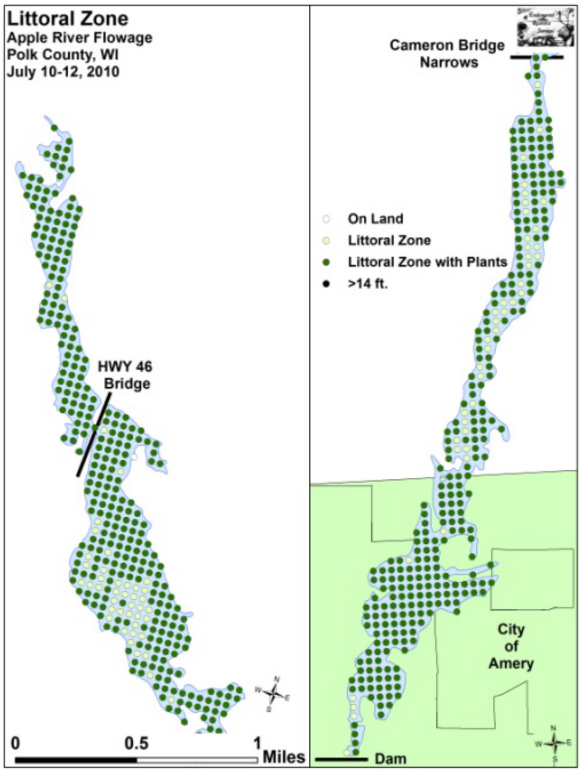



*Figure 12. Flowage Littoral Zone*

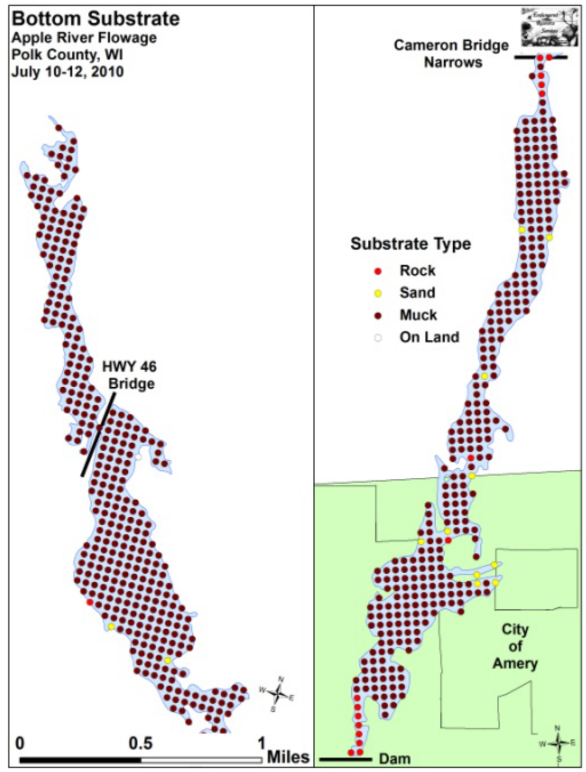



*Figure 13.  Bottom Sediment Type*

Plant diversity was high in the flowage with a Simpson Diversity Index of 0.87. 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 32 aquatic macrophyte species were sampled in and adjacent to the flowage during the study. 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. Plants found in the flowage area are summarized in Table 7.

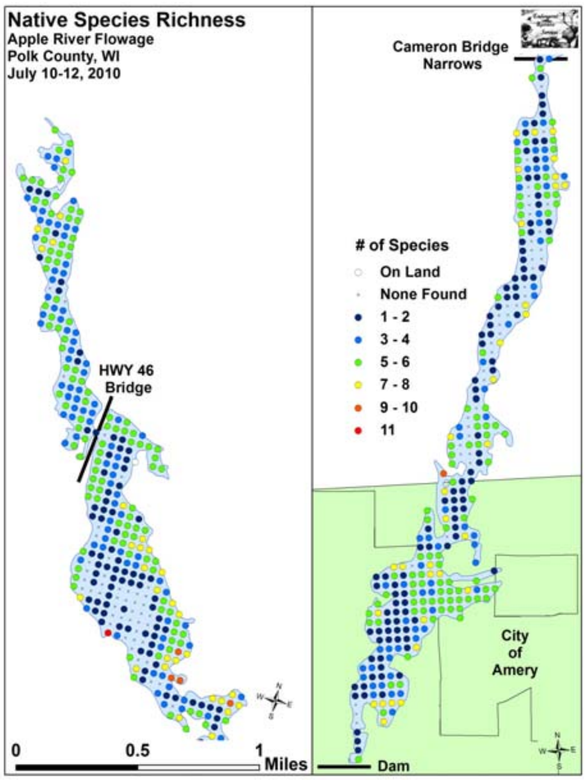



*Figure 14. Native Species Richness*

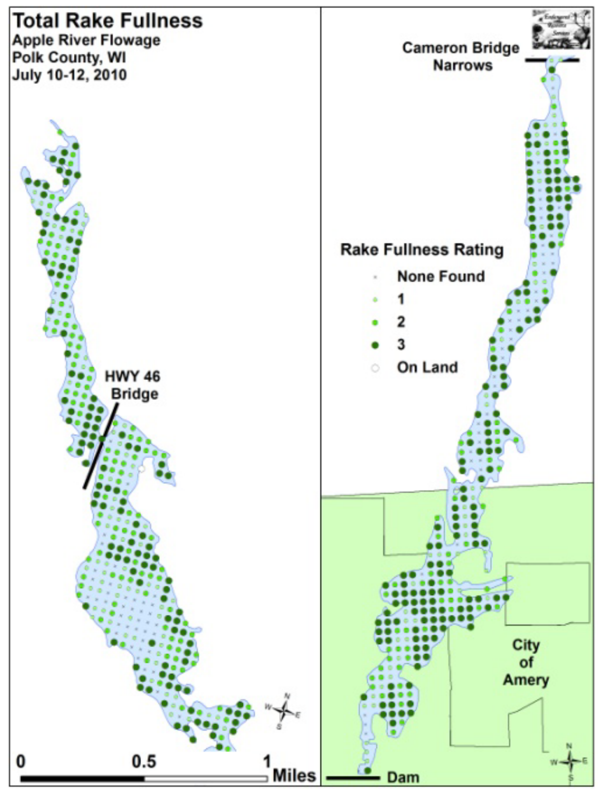



*Figure 15. Total Rake Fullness*

Table 6. Aquatic Macrophyte Survey Summary Statistics

| | |
|---|---|
| Total number of points sampled | 671 |
| Total number of sites with vegetation | 588 |
| Total number of sites shallower than the maximum depth of plants | 669 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 87.9 |
| Simpson Diversity Index | 0.87 |
| Maximum depth of plants (ft) | 14 |
| Number of sites sampled using rope rake (R) | 0 |
| Number of sites sampled using pole rake (P) | 671 |
| Average number of all species per site (shallower than max depth) | 3.55 |
| Average number of all species per site (veg. sites only) | 4.04 |
| Average number of native species per site (shallower than max depth) | 3.51 |
| Average number of native species per site (veg. sites only) | 4.02 |
| Species richness | 30 |
| Species richness (including visuals) | 32 |
| Species richness (including visuals and boat survey) | 36 |
| Mean depth of plants (ft) | 5.3 |
| Median depth of plants (ft) | 4.5 |

Table 7. Apple River Flowage Frequency and Mean Rake Fullness

| Species | Common Name | Total Sites | Relative Frequency | Freq. in Vegetation | Freq. in Littoral Zone | Mean Rake |
|---|---|---|---|---|---|---|
| *Ceratophyllum demersum* | Coontail | 529 | 22.33 | 89.97 | 79.07 | 1.99 |
| *Lemna minor* | Small duckweed | 329 | 13.89 | 55.95 | 49.18 | 2.22 |
| *Wolffia columbiana* | Common watermeal | 320 | 13.51 | 54.42 | 47.83 | 2.18 |
| *Spirodela polyrhiza* | Large duckweed | 298 | 12.58 | 50.68 | 44.54 | 1.27 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 289 | 12.20 | 49.15 | 43.20 | 1.67 |
| *Lemna trisulca* | Forked duckweed | 228 | 9.62 | 38.78 | 34.08 | 1.19 |
| | Filamentous algae | 202 | | 34.35 | 30.19 | 1.71 |
| *Elodea canadensis* | Common waterweed | 89 | 3.76 | 15.14 | 13.30 | 1.52 |
| *Nymphaea odorata* | White water lily | 79 | 3.33 | 13.44 | 11.81 | 1.58 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 50 | 2.11 | 8.50 | 7.47 | 1.22 |
| *Potamogeton pusillus* | Small pondweed | 36 | 1.52 | 6.12 | 5.38 | 1.56 |
| *Potamogeton crispus* | Curly-leaf pondweed | 27 | 1.14 | 4.59 | 4.04 | 1.04 |
| *Zizania palustris* | Northern wild rice | 19 | 0.80 | 3.23 | 2.84 | 2.11 |
| *Potamogeton praelongus* | White-stem pondweed | 17 | 0.72 | 2.89 | 2.54 | 1.29 |
| *Nuphar variegata* | Spatterdock | 13 | 0.55 | 2.21 | 1.94 | 2.31 |
| *Ranunculus aquatilis* | White water crowfoot | 6 | 0.25 | 1.02 | 0.90 | 1.17 |
| *Sparganium eurycarpum* | Common bur-reed | 6 | 0.25 | 1.02 | 0.90 | 2.83 |
| *Vallisneria americana* | Wild celery | 5 | 0.21 | 0.85 | 0.75 | 1.60 |
| *Heteranthera dubia* | Water star-grass | 4 | 0.17 | 0.68 | 0.60 | 1.25 |
| *Potamogeton nodosus* | Long-leaf pondweed | 4 | 0.17 | 0.68 | 0.60 | 1.25 |
| *Najas flexilis* | Slender naiad | 3 | 0.13 | 0.51 | 0.45 | 2.00 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 3 | 0.13 | 0.51 | 0.45 | 1.33 |
| *Stuckenia pectinata* | Sago pondweed | 3 | 0.13 | 0.51 | 0.45 | 1.33 |
| *Typha glauca* | Hybrid cattail | 3 | 0.13 | 0.51 | 0.45 | 2.00 |

Table 7. Apple River Flowage Frequency and Mean Rake Fullness (continued)

| Species | Common Name | Total Sites | Relative Frequency | Freq. in Vegetation | Freq. in Littoral Zone | Mean Rake |
|---|---|---|---|---|---|---|
| *Nitella* sp. | Nitella | 2 | 0.08 | 0.34 | 0.30 | 1.00 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 2 | 0.08 | 0.34 | 0.30 | 1.50 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 |
| *Potamogeton natans* | Floating-leaf pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 |
| *Potamogeton strictifolius* | Stiff pondweed | 1 | 0.04 | 0.17 | 0.15 | 1.00 |
| *Utricularia vulgaris* | Common bladderwort | 1 | 0.04 | 0.17 | 0.15 | 1.00 |
| *Phalaris arundinacea* | Reed canary grass | ** | ** | ** | ** | ** |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | ** | ** | ** | ** | ** |
| *Carex comosa* | Bottle-brush sedge | *** | *** | *** | *** | *** |
| *Carex crinita* | Fringed sedge | *** | *** | *** | *** | *** |
| *Carex hystericina* | Porcupine sedge | *** | *** | *** | *** | *** |
| *Lythrum salicaria* | Purple loosestrife | *** | *** | *** | *** | *** |

** Visual Only
*** Boat Survey Only

Coontail, small duckweed (*Lemna minor*), common watermeal (*Wolffia columbiana*), and large duckweed (*Spirodela polyrhiza*) were the most common species (Figure 16) (Table 7). They were found at 90%, 56%, 54% and 51% of survey points with vegetation respectively. All four were widely distributed and abundant throughout the flowage over muck bottoms. Flat-stem pondweed (*Potamogeton zosteriformis*) (49%), forked duckweed (*Lemna trisulca*) (39%), common waterweed (*Elodea canadensis*) (15%), and white water lily (*Nymphaea odorata*) (13%) were the only other species found at more than 10% of sites with vegetation.

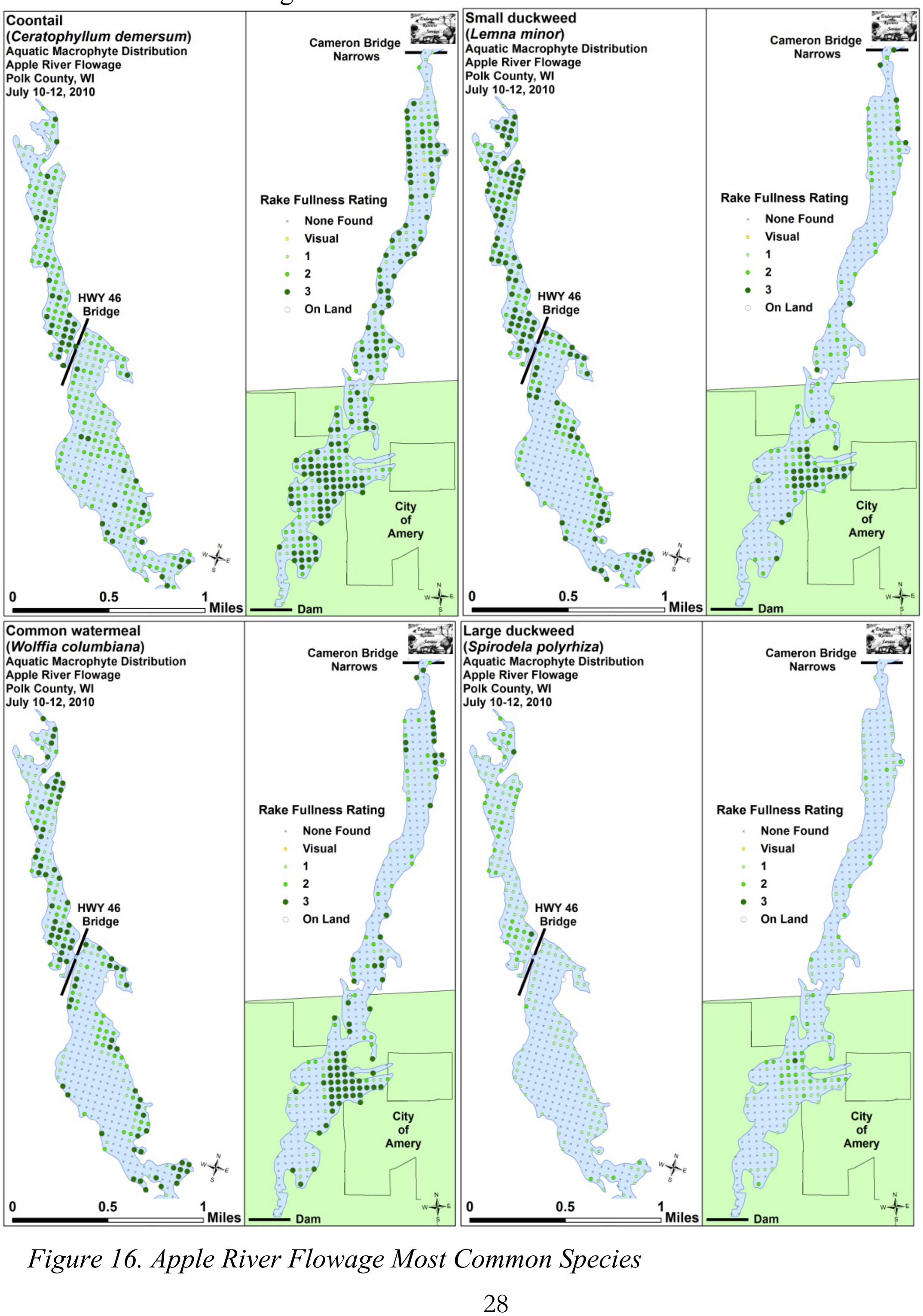



*Figure 16. Apple River Flowage Most Common Species*

**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.

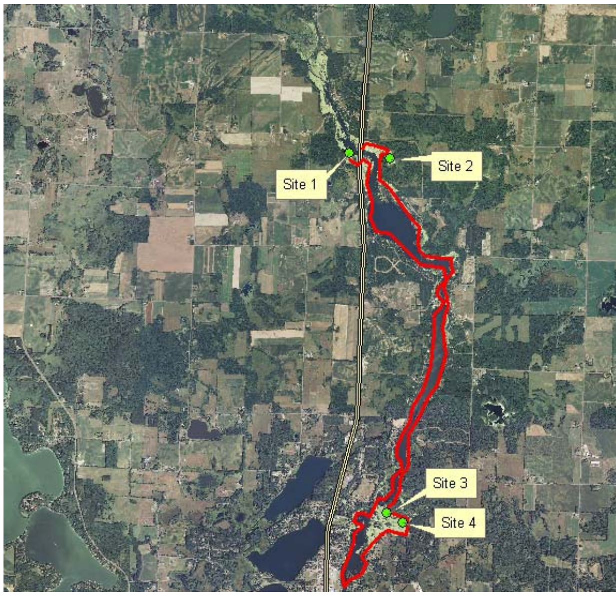
The 29 plants identified to species during the point intercept survey produced a mean Coefficient of Conservatism of 5.92 and a Floristic Quality Index of 31.8. Nichols (1999) reported an average mean C for the Northern Central Hardwood Forests Region of 5.6 putting the Apple River Flowage just above average for this part of the state. The FQI mean for the Northern Central Hardwood Forests Region (Nichols 1999) was 20.9

**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. Being a plant of shallow water means that beds will not expand out further than 4 feet deep, preferring 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.[20] 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 are located on the north end where the river enters the flowage (Figure 18). Wild rice was also found in these areas during the July survey (Figure 20). Impacts to wild rice must be considered with any aquatic plant management method. One wild rice bed on the upper end of the flowage is located close to where a navigation channel was proposed, but not treated in 2010 or 2011.

[20] 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 17. Sites of Wild Rice Growth*

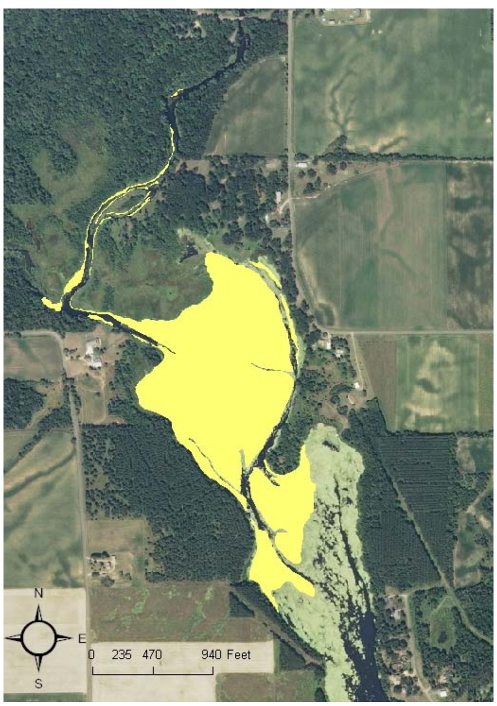



*Figure 18. Wild Rice Locations 2011 North End of the Flowage*

*Figure 19. Dense Wild Rice Growth Looking Southeast toward the Flowage*

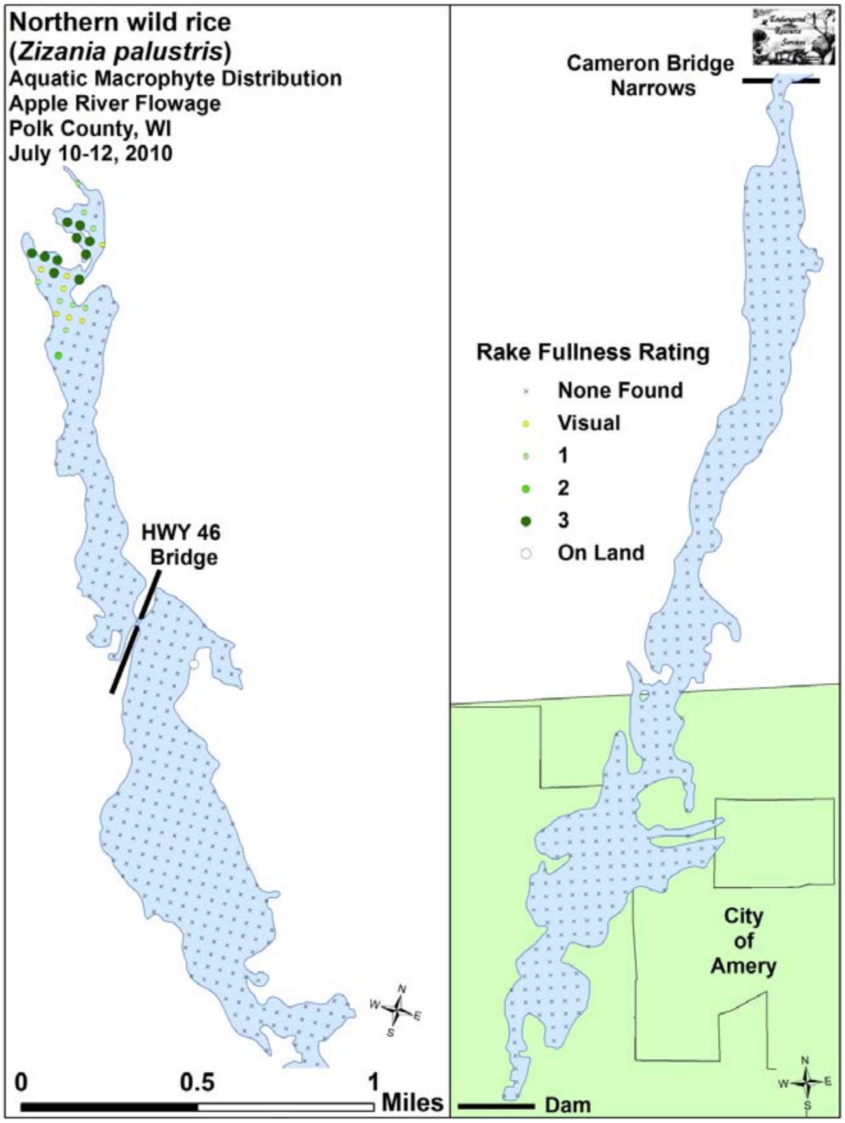



*Figure 20. Northern Wild Rice Point Intercept Distribution*

## Previous 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 their sample sites – equivalent to the 2010 result. 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

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

### Purple Loosestrife and Reed Canary Grass

Purple loosestrife was found at a single location just south of the Highway 46 bridge. Reed canary grass is well established around the perimeter of the flowage.

### Curly Leaf Pondweed

Curly leaf pondweed is found in many locations around the lake.[21] However, both the point intercept and the wild rice surveys were completed in mid to late summer when most curly leaf pondweed has died back. During visits in August 2010, curly leaf pondweed exhibited dramatic re-growth.

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 is found in the 1977 OILR report.)

Endangered Resource Services completed a curly leaf pondweed bed mapping survey in June 2011. CLP growth dominates the flowage in early summer according to the survey report. Both a rake survey and bed mapping were completed.

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". Although not beds in 2011, these areas have the potential to form beds in the future.

Curly leaf was found at 465 of 671 rake sample points. Therefore, CLP was present in 69% of the sample locations. From the 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.*

[21] Berg. 2010.

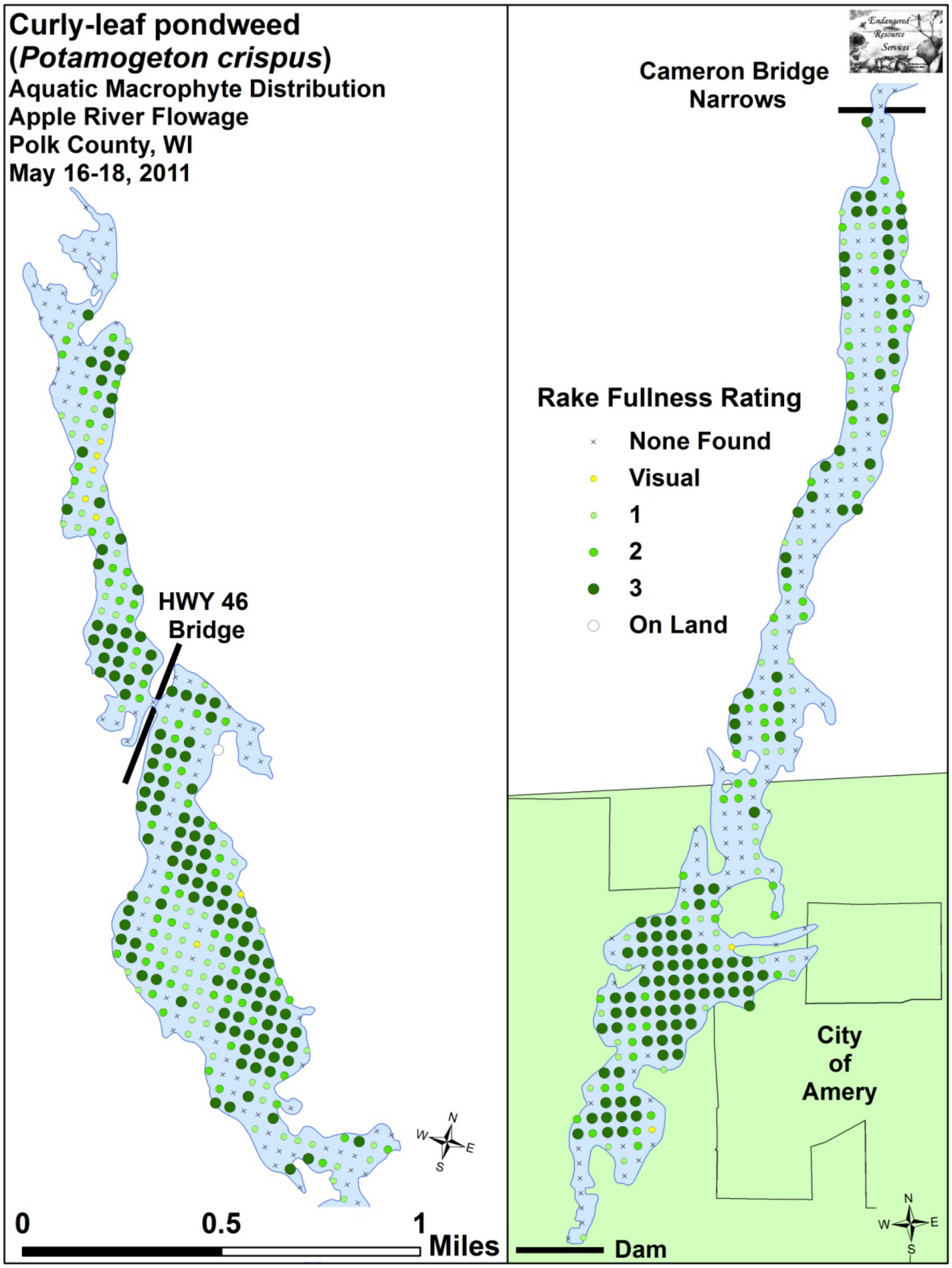



*Figure 21. Curly Leaf Pondweed Distribution and Density 2011*

Thirteen beds totally 345 acres were mapped on the flowage in June 2011. An additional 27 acres were mapped as areas of high density. Maps and tables below summarize the bed mapping results from the 2011 CLP survey. A detailed description of each of the beds and high density areas is included in the Endangered Resource Services Report.

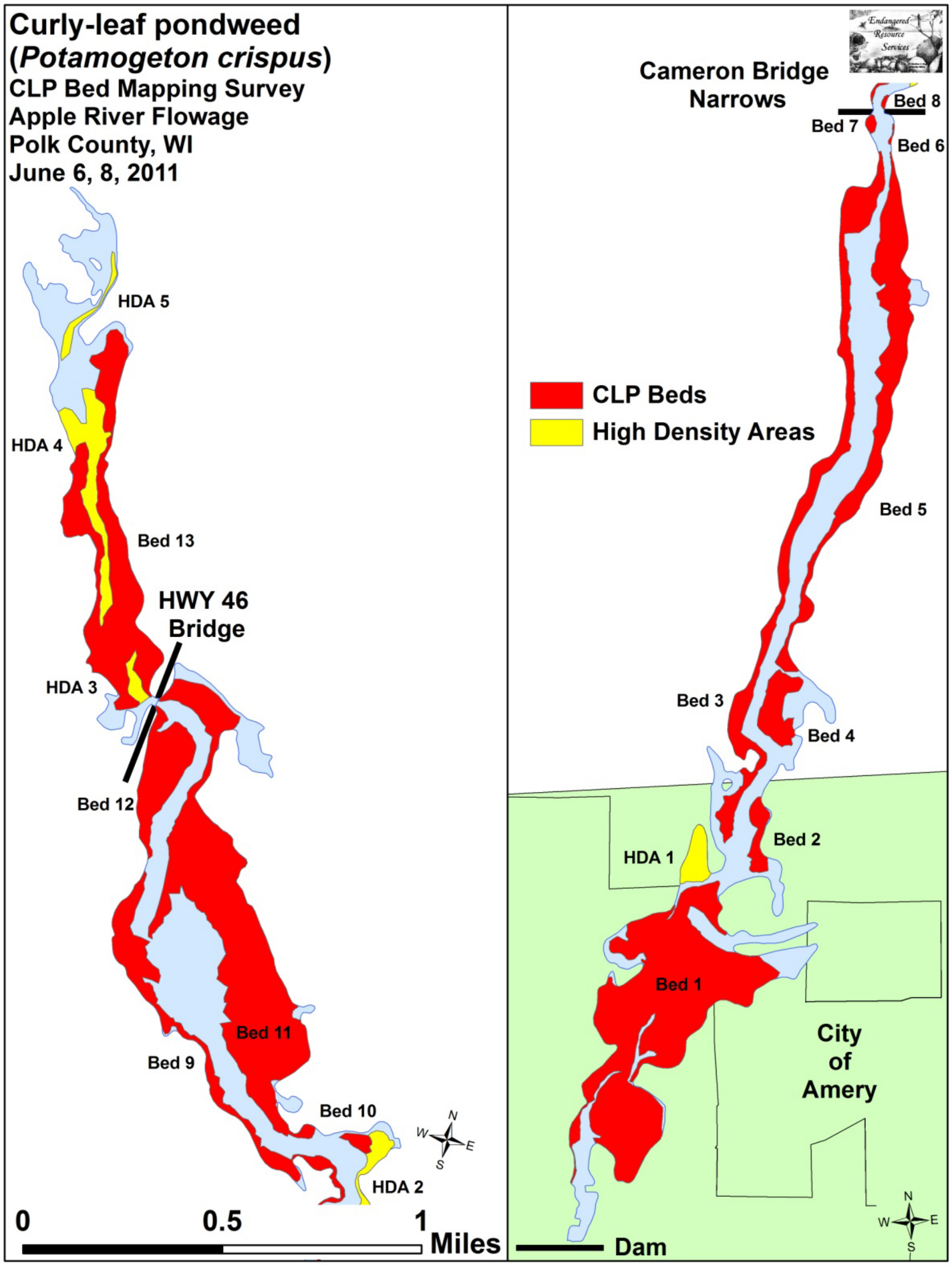



*Figure 22. Curly Leaf Pondweed Beds and High Density Areas 2011*

Table 8. CLP Bed and High Density Area Summary June 2011

| Bed Number | Acres |
|---|---|
| 1 | 93.62 |
| 2 | 3.97 |
| 3 | 33.14 |
| 4 | 7.71 |
| 5 | 33.9 |
| 6 | 0.15 |
| 7 | 0.60 |
| 8 | 0.22 |
| 9 | 21.31 |
| 10 | 1.53 |
| 11 | 84.89 |
| 12 | 16.3 |
| 13 | 47.31 |
| **Total Acres** | **344.65** |
| | |
| **HDA Number** | **Acres** |
| 1 | 4.64 |
| 2 | 3.62 |
| 3 | 2.04 |
| 4 | 13.89 |
| 5 | 2.32 |
| **Total Acres** | **26.51** |

## Historic Aerial Photos

Aerial photos can provide evidence of historic plant growth and sediment accumulation. The photos taken in August 18, 1938 show little plant growth in the flowage. However, this late in August aquatic plants may have died back and been flushed from the system. Aerial photos of Polk County are also available for 1951, 1958 and 1965. The 2006 photo shown at right was taken during leaf-off conditions in the spring or fall. Therefore, aquatic plant growth would not be evident from the air.

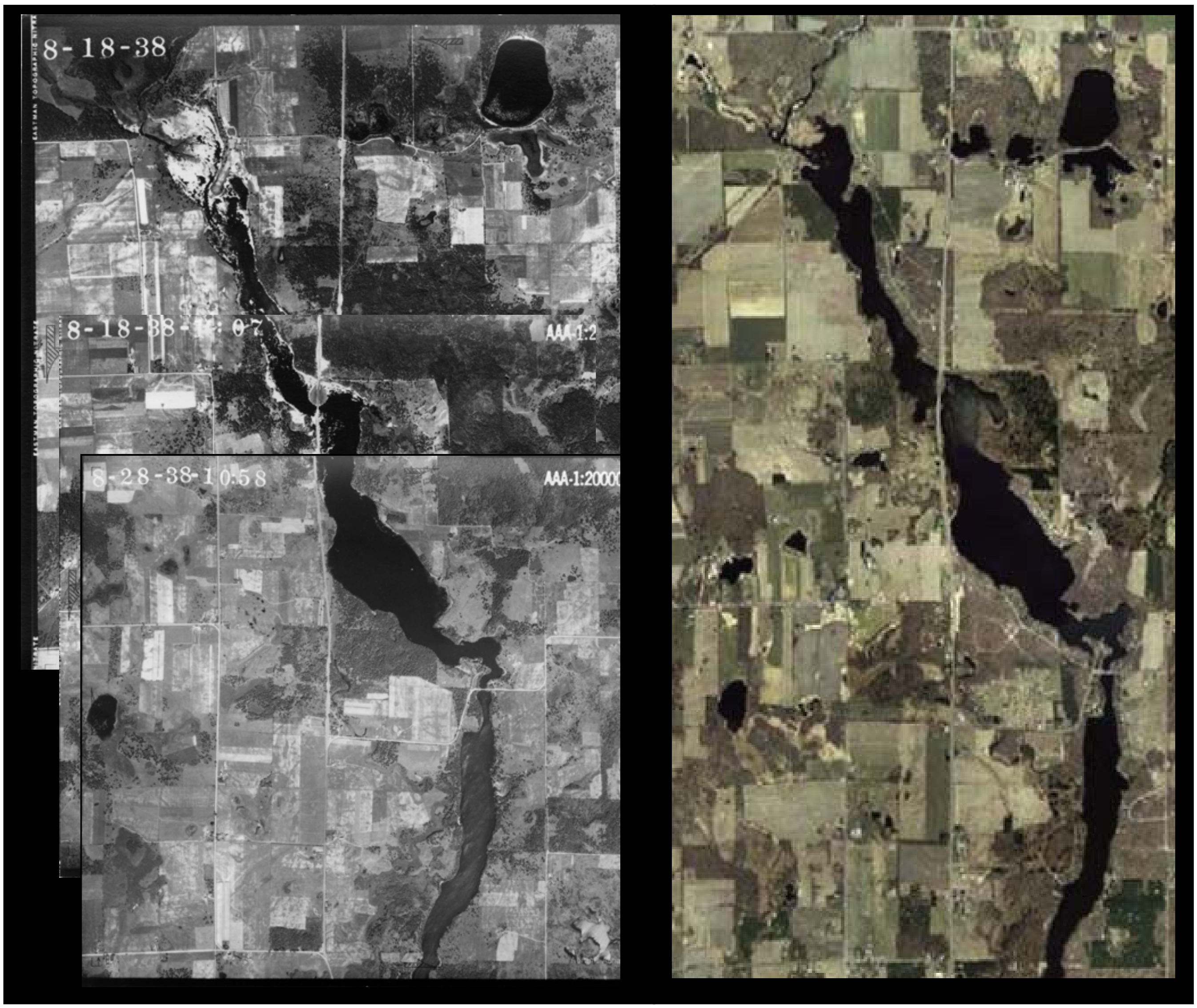



*Figure 23. Composite August 1938 (left) and 2006 Spring or Fall (right) Aerial Photos of the Northern Apple River Flowage*

*Figure 24. Lower Apple River Flowage August 1938 (left) and Spring or Fall 2006 (right)*

*Figure 25. A Summer 2010 View of the Lower Apple River Flowage*

## 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.[22]

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.

Techniques to control the growth and distribution of aquatic plants are discussed in the following text. The application, location, timing, and combination of techniques must be considered carefully. A summary table of Management Options for Aquatic Plants from the WDNR is found in Appendix F.

### Manual Removal[23]

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

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

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

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 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.

Because of the dense growth of aquatic plants along with flowing water - which may limit the effectiveness of herbicides - harvesting is an option that should be considered for the flowage. Key considerations for harvesting on the flowage are 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.

Access for harvester

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 beneath which provides only about 5.5 feet of clearance at normal water levels. Small harvesters are available for access through areas with low clearance. An alternative would be to develop a public access or obtain permission for private access for a harvester. Such access would be beneficial for off loading collected plant material even with a small harvester. Such a site does exist in the recently developed River Ridge area.

Availability of disposal/beneficial use sites

Harvested aquatic plants can be land applied and/or composted as a soil amendment. It is possible to find sites where plant material is accepted at no charge, but there are generally costs for hauling. 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. An ARPRD newsletter from 1996 mentions that Norm Fouger accepted harvested plants in 1996.

Cost of harvester purchase

Because contracted aquatic plant harvesting is not readily available, a harvester would likely need to be purchased. The cost of a harvester with an 8 foot blade along with related equipment (conveyor and trailer) is estimated to range from $130,000[24] to $180,000[25]. A small harvester with a 4 foot blade cost $75,000. Costs for additional equipment with the 4 foot unit are estimated to be $35,000.[26] Nearby lakes including White Ash and Big Blake Lakes have harvesting operations, but their harvesters are used throughout the summer. There may be an opportunity to rent a harvester from Clam Lake in Burnett County where three harvesters are currently not in use.

Operation and maintenance

Employees are needed to operate and maintain harvesting equipment. Employment would be seasonal and would depend upon the management strategy selected. The ARPRD currently does not have employees. It might be possible to contract with the city of Amery to provide such a service, although the city currently has no harvesting operations.

Timing of harvesting

Selecting the timing and depth of harvesting would be critical and would vary depending upon aquatic plant management objectives.

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[24] Spooner Machine. May 2011.
[25] Aquarius Systems. March 2011.
[26] Aquarius Systems. March 2011.

**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[27]

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.

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

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.

**Weevils**[28] have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations with weevil use. In these cases, EWM was not eliminated but its abundance was reduced enough so that it did not achieve dominance. These declines are attributed to an ample population of native milfoil weevils (*Euhrychiopsis lecontei*). Weevils feed on native milfoils but will shift preference over to EWM when it is present. Lakes where weevils can become an effective control have an abundance of native northern water milfoil and fairly extensive natural shoreline where the weevils can over-winter. Any control strategy for EWM that would also harm native milfoil may hinder the ability of this natural bio-control agent. Lakes with large bluegill populations are not good candidates for weevils because bluegills feed on the weevils. The presence and efficacy of stocking weevils in EWM lakes is being evaluated in Wisconsin lakes. So far, stocking does not appear to be effective.

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.

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[28] *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use*. Wisconsin Department of Natural Resources. July 2006.

## Physical Control[29]

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.

**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.

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

**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.[30]

**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 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.

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

**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 9.

Table 9. 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)[31] 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. |

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

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[32]

**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.

**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

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

takes about 3 weeks in water but can be as short as 1 week. 2,4-D breaks down into naturally occurring compounds.

**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 10. 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.[33] 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.[34]

[33] USACE 2003.

[34] Personal communication with Anthony Havranek. February 9, 2010

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.[35]

**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.[36]

## 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: 2,4-D, diquat, endothall, fluridone, and triclopyr.[37] All of these herbicides with the exception of diquat are available in both granular and liquid formulations. It is possible to target invasive species by using the appropriate herbicide and timing. Diquat is used infrequently in Wisconsin because it is nonspecific.[38] The herbicide 2,4-D is most commonly used to treat EWM in Wisconsin. This herbicide kills dicots including native aquatic species such as northern water milfoil, coontail, water lilies, spatterdock, and watershield. Early season (April to May) treatment of Eurasian water milfoil is recommended to limit the impact on native aquatic plant populations because EWM tends to grow before native aquatic plants.

Granular herbicide formulations are more expensive than liquid formulations (per active ingredient). However, granular formulations are generally thought to release the active ingredient over a longer period of time. Granular formulations, therefore, may be more

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35 APIS.
36 APIS.
37 Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.
38 Frank Koshere. Wisconsin DNR. email communication. 3/03/10.

suited to situations where herbicide exposure time will likely be limited, as is the case of treatment areas in small bands or blocks. In large, shallow lakes with widespread EWM, a whole lake treatment with a low rate of liquid herbicide may be most cost effective because exposure time is greater. Factors that affect exposure time are size and configuration of treatment area, water flow, and wind.

Application rates for liquid and granular formulations are not interchangeable. A rate of 1 to 1.5 mg/L 2,4-D applied as a liquid is a moderate rate that will require a contact time of 36 to 48 hours. Application rates recommended for Navigate (granular 2,4-D) are 100 pounds per acre for depths of 0 to 5 feet, 150 pounds per acre for 5 to 10 feet, and 200 pounds per acre for depths greater than 10 feet. Allowed and recommended application rates are found on herbicide labels.

**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 0 days.

Studies have demonstrated that curly leaf pondweed can be controlled with Aquathol K (a formulation of endothall) in 50 to 60 degree F water, and that treatments of CLP this early in its life cycle can prevent turion formation.[39] Since curly leaf pondweed is actively growing at these low water temperatures and many native aquatic plants are still dormant, early season treatment selectively targets curly leaf pondweed. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center conducted trials of this method. This treatment method is accepted as standard operating procedures being approved in Wisconsin for aquatic invasive species control projects.[40]

Because the dosage is at lower rates than the 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 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.[41] 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.

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[39] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[40] Plan comments, Frank Koshere, September 16, 2010.
[41] Personal communication, Frank Koshere. March 2005.

## Current and Past Aquatic Plant Management

No previous aquatic plant management plan has been prepared for the Apple River Flowage, although 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 have continued since that date (through 1978). However, the flowage district was not formed until 1975, and treatment records from that time period are not available. Recommendations for aquatic plant management are included in a DNR/Polk County *Apple River Flowage Aquatic Plant Survey Report* prepared in 2003.

### 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 11. Apple River Flowage Harvesting

| 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. North of 46 Bridge: 71,000 lbs. | Yes 187,000 lbs. |
| 1994 | North of HWY 46 and "Byron Burmans into town" | Yes |
| 1995 | City of Amery: 197,000 lbs. Upper Apple: 163,500 lbs. | Yes 53,000 lbs. |
| 1996 | | Yes |
| 1997 | Budget notes $4,640 for weed harvesting | |

Table 12. Apple River Flowage Navigation Channel Herbicide Treatments

| Year | Contractor/ Budget | Area Treated | Chemicals Used/Plants Targeted | Comments |
|---|---|---|---|---|
| 1993 | Aquatic Nuisance Control | **North Park** (225'X125')<br>Unknown Additional Channel (100'X80')<br>**Town of Lincoln Landing** (50' X 100') | | |
| 1994 | Aquatic Nuisance Control | **North Park** (150'X100' in June)<br>**Town of Lincoln Landing** (50'X100' in July and Aug) | Diquat<br>CuSO4<br>Aquathol | |
| 1995 | Aquatic Nuisance Control | **North Park** (150'X100')<br>**Town of Lincoln Landing** (50'X100') | Diquat<br>CuSO4 | |
| 1996 | Aquatic Nuisance Control | **North Park**<br>**Town of Lincoln Landing** | | No channel size indicated on permit |
| 1997 | Aquatic Nuisance Control | **North Park**<br>**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)<br>**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)<br>**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**<br>**North Park; WI Lane**<br>Total up to 2.72 acres | Reward (Diquat)<br>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)<br>**North Park**<br>**Town of Lincoln Landing** | Reward<br>Aquathol K<br>Copper Sulfate | |
| 2002 | Lake Management, Inc./ $6,225 | **Birch Street to beyond North Park** (25' wide, 2.27 acres)<br>**HWY 46 to north** (25' wide, 2.53 acres) | Reward<br>Copper Sulfate | Encourage travel<br>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: **Birch Street to beyond North Park** **HWY 46 to north** **Hwy 46 to south** **North Park and Birch Street** 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"[43] 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 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 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 Cutrine Plus in late July. 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 |

[43] 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 26. 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.

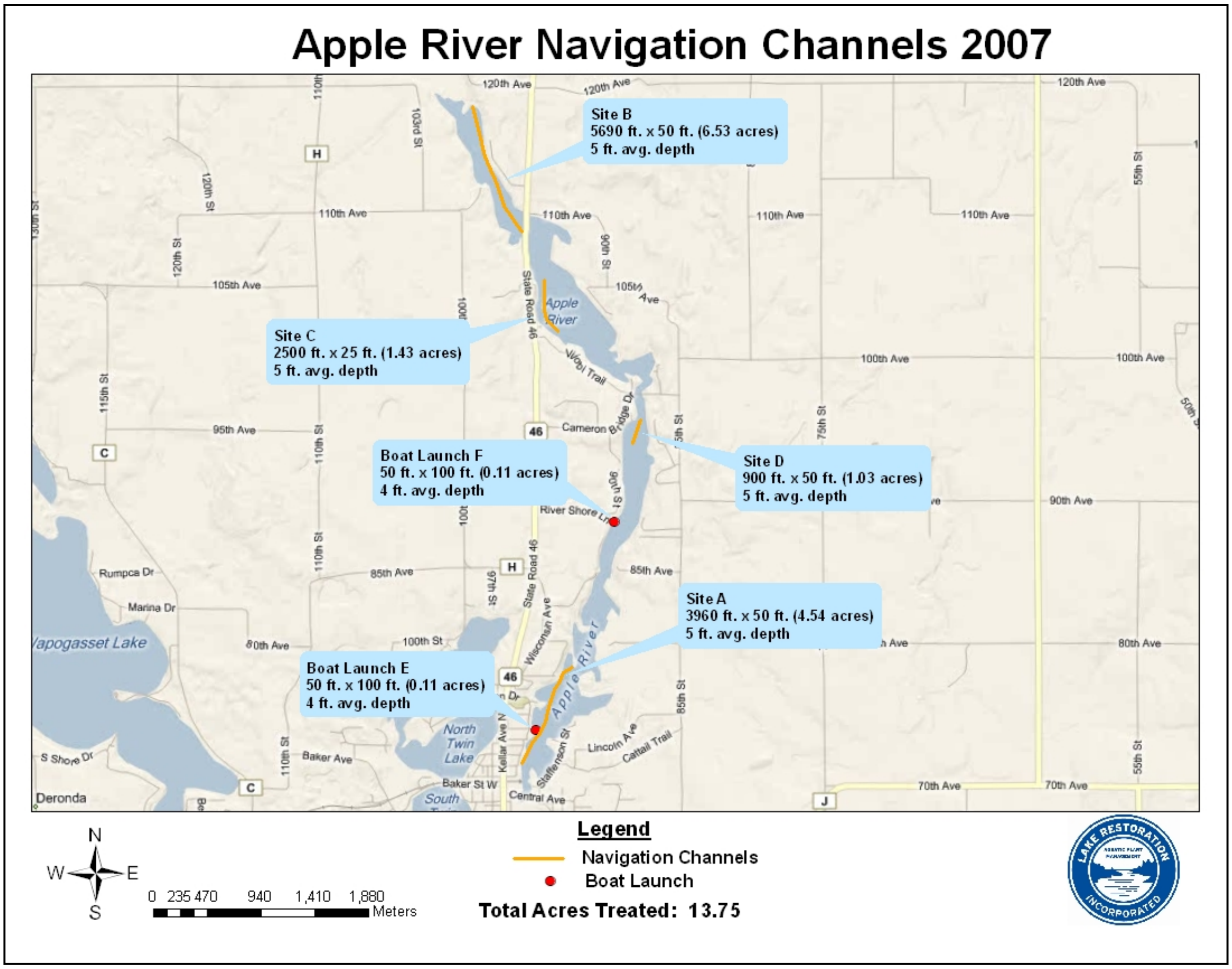


*Figure 26. Navigation Channel Locations 2007*

## 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. Recent Waterfront Herbicide Treatments on the Apple River Flowage[44]

| 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 |

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.[45] 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.

[44] Information from Department of Natural Resources Aquatic Plant Management permit applications, permits, and treatment records.
[45] Aquatic Plant Management Strategy. DNR Northern Region. Summer 2007.

**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 26. 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. Watercraft inspections and education for users (as through the Clean Boats, Clean Waters program) is recommended for busy weekends. The recommendations have not been carried out to date.

From the 2003 report:

> *Volunteers should be trained on the identification of exotic species of concern with an emphasis on Eurasian water milfoil and zebra mussels. Boat launches and immediately surrounding areas (out to 5' in the water and one to two hundred feet on each side of the launch) should be carefully inspected by wading or diving at least every other week. Rake sampling can be used to extend exotics inspections to deeper areas around launches where plants are less visible from the surface. Monthly to bimonthly inspections throughout the rest of the flowage would help ensure early detection of exotic species and increase the likelihood of controlling pioneering stands of exotics before they become well established.*

**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 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.

Because of a high concern for invasion of Eurasian water milfoil and other aquatic invasives, 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, partners, and funding sources for each action item. The implementation plan currently covers the first 1 1/2 years of the planning period. The implementation plan will be updated as needed to reflect changing budgets, partners, and new information.

**Adaptive Management Approach**

The plant management control methods and procedures will be reviewed each year to see if they are effective and cost efficient while 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 Flowage 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.

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. Better understand the flowage water and nutrient budgets and the sources of phosphorus from the watershed.

B. Evaluate the feasibility of and make progress toward the following water quality objectives:[46]

   In-flowage July/August average total phosphorus goal: 40 ug/L

   26% phosphorus reduction from total watershed

   40% phosphorus reduction from agricultural and urban lands

C. Manage curly leaf pondweed to remove nutrients from the flowage and from the Apple River downstream of the flowage.[47]

***Actions***[48]

1. **Enhance water quality sampling in the flowage by adding additional sample locations (at a minimum at the inflow and outflow of the Apple River and at the inflow of Beaver Brook) and testing for total suspended solids,** chlorophyll a, **total phosphorus, orthophosphate,** nitrate-nitrogen, ammonia-nitrogen and total Kjeldahl nitrogen**. (Objective A)**
2. **Measure flow near the Amery dam** and other selected locations**. (Objective A)**
3. Complete water quality study to evaluate watershed and other sources of phosphorus and other pollutants. (Objective A and B)

   Consider analysis of sediment cores and algal composition as part of this study.
4. Identify best management practices to limit the inputs of nutrients and sediment to the flowage and river. (Objective B)
5. Assess the nutrient impact of CLP dieback on the flowage nutrient budget. (Objective C)
6. Consider CLP management once navigation program is established and more is known about CLP growth in the flowage and success of CLP harvesting programs on other lakes. (Objective C)
   - Review areas of CLP growth following CLP mapping of the flowage.
   - Review success of CLP harvesting from trials on other lakes.
7. **Coordinate monitoring, studies and implementation of best management practices with the TMDL (total maximum daily load) project for Lake St. Croix. (Objective A, B, C)**

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[46] These water quality objectives are consistent with those established in the Lake St. Croix TMDL Report. December 2010.

[47] This objective will be considered for future management actions.

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

## 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 lakes.

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

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

***Actions***[49]

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 Eurasian Water Milfoil Rapid Response plan (Appendix D). (Objective C)**
4. **Encourage owners or the county to chemically treat 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)**
6. Consider installation and monitoring of surveillance cameras at boat landings. (Objective A)

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[49] 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***

3A. Allow access along designated common navigation channels if navigation becomes impaired.

3B. Collect free-floating plant fragments which create nuisance conditions.

3C. Allow access through individual waterfront corridors if navigation becomes impaired.

4. Maintain native aquatic plant functions.

***Objectives***

4A. 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.

4B. Avoid herbicide use near wild rice, especially when in early stages of growth (June and early July).

4C. Avoid cutting and uprooting wild rice seedlings.

4D. Manage curly leaf pondweed to encourage the growth of native plants in specific areas of the flowage.[50]

5. Minimize environmental impacts of aquatic plant management.

***Objective***

5A. 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.

[50] This objective will be considered for future management actions.

*Actions*

**Common Navigation Channels**

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

<u>Obtaining harvesting equipment</u>
A harvester rental trial was considered but not pursued in 2011.

Harvester purchase will be pursued for 2012. Options for harvesting equipment purchase and initial cost estimates are included in Appendix H. Equipment needed includes a harvester, shore or trailer conveyor, trucks or trailer to haul collected plants (could be rented), and trailer to haul harvester. Capital costs for this equipment range from $130,000 to $180,000. Annual operation cost for 80 days is estimated to be around $18,000.

Cooperative purchase and operation will be pursued with the City of Amery, Town of Lincoln, Apple River Association, and other interested organizations.

Amount/acres that could be harvested in a day are dependent largely upon the distance to disposal sites. A harvester travels about 1.5 mile/hour when harvesting. But, harvesting occurs only 40% of the time and travel for unloading is about 60% of the time. This amounts to a total of 0.6 acres of harvested area per hour. With 420 hours of harvest time, about 252 acres can be covered in a year.

<u>Harvester access and offload sites</u>
Access for harvester entry and plant material disposal will be developed on the north end of the flowage.

Existing public boat landing facilities will be used. These sites are shown in Figure 1. Additional sites are under investigation.

<u>Disposal sites</u>
Disposal sites will be identified. These may include farm fields, city yard waste areas, and local composting facilities (nursery operations). There is likely to be high demand for the material collected.

<u>Obtaining permits</u>
The Apple River Protection and Rehabilitation District will secure permits for harvester operations each year in February or March.

<u>Harvesting standards</u>
Cutting will occur only at depths greater than 4 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).

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. Harvesters may be used in the future to gather plant fragments for the purpose of flowage and downstream nutrient control.

Initial common channel locations will be as mapped in 27. The channel north of the Highway 46 bridge will be narrowed to no more than 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 channels will be offered <u>if</u> harvester time is available. Harvesting will occur up to 4 feet in depth and will be for multiple residences only.

Total acreage to be harvested (both cutting and harvesting/skimming only) is expected to be at least 30 acres (about twice the area of existing navigation channels) which will likely be harvested more than once each year. The remaining harvester time will be used to gather plant fragments. This area is expected to be 150-200 acres.

<u>Monitoring</u>
Harvester operators or flowage district representatives will monitor vegetative growth in designated navigation channels at least weekly and record level of 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.

<u>Nuisance reporting</u>
A telephone contact will be 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, but not harvest for resident access. Options for resident access corridors will be provided.

Recording

The district will investigate using a GPS unit to record and store harvester tracks. At a minimum, 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.

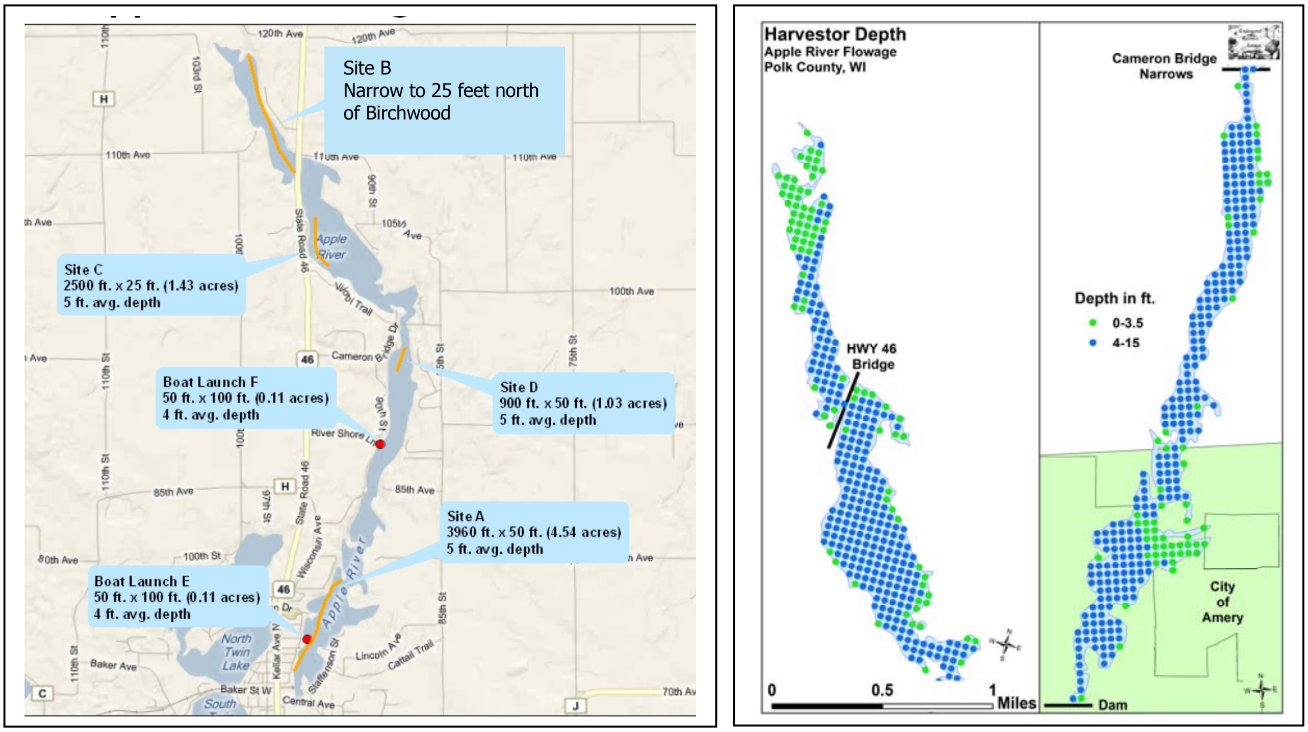


*Figure 27. Proposed Navigation Channels and Approximate Depth*

## Individual Access Corridors

Residents will be encouraged to remove aquatic plants limiting access along their docks by boating in this area or by using hand tools. 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.[51]

A clear method for individual access corridors beyond manual methods did not emerge. The top choices included a trial of a commercial weed mower and oversight of permits for chemical use.

A lake mower trial is proposed. This trial will be allowed for two sites in 2011. A permit is required because this is a mechanical method of management. A summary of the lake mower trial is included as Appendix H.

Property owners are responsible for covering the cost of individual access corridor maintenance.

An example procedure for chemical permits for individual access corridors is shown on the following page.

## CLP Management

Additional CLP management will be considered once the navigation program is established and more is known about CLP growth in the flowage and success of CLP harvesting programs on other lakes. (Objective 4D)

- Review areas of CLP growth following CLP mapping of the flowage.
- Review success of CLP harvesting from trials on other lakes.

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[51] These are requirements in regulation NR 109.

## Procedure for Individual Corridor Permitting and Monitoring

Document nuisance conditions (landowner/ herbicide contractor 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.
- 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.
- 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 CLP, PL and EWM with photos and descriptions.
Explain methods to avoid spread of invasive species.
Show maps of CLP and PL on the lakes.
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 2015.

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**
Department of Natural Resources Aquatic Invasive Species (AIS) grants are available to assist in funding some of the action items in the implementation plan. Maintaining navigation channels to alleviate nuisance conditions are an exception. Grants provide up to 75 percent funding. Applications are accepted twice each year with postmark deadlines of February 1 and August 1. With completion and approval of the aquatic plant management plan, funds will be available not only for education and planning, but also for control of aquatic invasive species. Pamela Toshner is the regional DNR contact for the program (715-635-4073).

**Lakes Planning Grants**
DNR Lakes planning grants are appropriate for water quality and education work. Grants provide up to 67 percent funding. Applications are accepted twice each year with postmark deadlines of February 1 and August 1. There are currently 2 categories of grants: large scale projects up to $25,000 in grant funds, and small scale projects: up to $3,000 in grant funds. Pamela Toshner is the regional DNR contact for the program (715-635-4073).

**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, 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. 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).

**River Planning Grants**
River planning grants are available from the Wisconsin Department of Natural Resources. These grants can be used for planning, gathering information and delivering educational programs. Applications are due May 1 of each year. Local government, non-profit organizations and qualified river organizations are eligible applicants. The grants provide up to 75% of the cost of a project up to $10,000. In-kind match is the federal minimum wage. Pamela Toshner is the contact person for this grant program (715-635-4062).

# Implementation Plan

| 1. Improve water quality on the Apple River Flowage and downstream on the Apple River. | | | | | | |
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| **Actions** | **Timeline** | **Cost 2011** | **Volunteer Hours 2011** | **Cost 2012** | **Volunteer Hours 2012** | **Responsible Party / Partners** |
| 1a. Write grant application to support water quality sampling (cost depends on grant type submitted). | Due 8/01/11 and 2/01/12 | | | | | Board<br>Polk County LWRD |
| 1b. Conduct water quality sampling and analysis | April through November | | | $11,000 to $22,000 | 450 to 900 | Board<br>Polk County LWRD<br>Amery High School<br>Apple River Association |
| 2. Measure flow at the Amery Dam | May | | 40 | | 40 | Amery High School |
| 3. Develop scope of water quality study | 2012 | | | | 15 | Polk County LWRD<br>Board |
| 7. Coordinate with St. Croix Lake TMDL | Ongoing | | 40 | | 40 | Board<br>Polk County LWRD |
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| **SUBTOTAL GOAL 1** | | **$0** | | **$11,000 to $22,000** | | |
| Potential grant funding (@ 67%) | | Grants start 04/1/12 at earliest | | $11,000 to $22,000 | Match from volunteer hours | DNR Lake Planning Grant |

| 2. Prevent introduction of aquatic invasive species. | | | | | | |
|---|---|---|---|---|---|---|
| **Actions** | **Timeline** | **Cost 2011** | **Volunteer Hours 2011** | **Cost 2012** | **Volunteer Hours 2012** | **Responsible Party / Partners** |
| 1. Clean Boats, Clean Waters (grant eligible) | Memorial Day through Labor Day | $0 | 100 | $2,400 | 200 | Board<br>Amery Lakes District<br>City of Amery |
| 2a. Monitor areas of high public use (grant eligible) | July/August | $0 | 40 | $500 | 40 | Consultant |
| 2b. Train volunteers to identify EWM and monitor. | July | $0 | 20 | $50 | 20 | Polk County LWRD |
| 3. Set up a Eurasian Water Milfoil Contingency Fund | 2011 Budget | $2,500 | 5 | $0 | 0 | Treasurer |
| 4. Control purple loosestrife | July/August | $0 | 10 | $0 | 10 | Polk County LWRD<br>Flowage Residents |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **SUBTOTAL GOAL 2** | | **$2,500** | **175** | **$2,950** | **270** | |
| Potential grant funding (@ 75%) | | Grants start 04/01/12 at earliest | | $2,212.50 | | DNR AIS Planning and Education Grant |

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 | Operation Cost 2011 | Capital Costs 2011 | Operation Cost 2012 | Capital Costs 2012 | Responsible Party / Partners |
|---|---|---|---|---|---|---|
| Identify and gain permission for landing/off-loading and disposal sites | May and June 2011 | | | | | Board<br>Harvester Operations Committee<br>DNR |
| Secure permits for harvester operation | June 2011 | | | | | Board |
| Refine harvester channel locations<br>(mark w/GPS) and<br>Develop harvesting records<br>Develop nuisance reporting methods | July and August 2011 | $500 | | | | Board<br>City of Amery<br>St. Croix Tribe<br>DNR<br>Consultant |
| Seek partners for harvester purchase (City of Amery<br>Apple River Association<br>Town of Lincoln) | June – October 2011 | | | | | Board<br>Harvester Purchase Committee |
| Install access site improvements (if needed) | Spring 2012 | | | $1,000 | | Board<br>Harvester Operations Committee |
| Apply for waterways commission grant for harvester purchase | Nov/Dec 2011 | $1,200 (grant application) | | | | Board<br>Consultant |

| 3. Maintain navigation for fishing, boating, and access to lake residences.<br>4. Maintain native aquatic plant functions.<br>5. Minimize environmental impacts of aquatic plant management. | | | | | | |
|---|---|---|---|---|---|---|
| **Actions** | **Timeline** | **Operation Cost 2011** | **Capital Costs 2011** | **Operation Cost 2012** | **Capital Costs 2012** | **Responsible Party / Partners** |
| Purchase harvester and related equipment | Jan/Feb 2012 | | | $18,900 | $130,000 - $150,000 | Board<br>Partners ID'd in 2011 |
| Conduct weed mower trial | June 2011 | $0 | | $0 | | Board<br>Polk County LWRD<br>DNR |
| Inspect individual corridor sites for permits. Consider options for corridor management. | June – Sept. 2011 and 2012 | 100 hours | | 100 hours | | APM Design Team<br>Board |
| **SUBTOTAL GOAL 3-5** | | **$1,700** | | **$19,900** | **$150,000** | |
| Potential grant funding (@ 40%) | | | | | $60,000 | Waterways Commission Grant |

| Public Education and Outreach | | | | | | |
|---|---|---|---|---|---|---|
| **Methods** | **Timeline** | **Cost 2011** | **Volunteer Hours 2011** | **Cost 2012** | **Volunteer Hours 2012** | **Responsible Party / Partners** |
| Website updates | Monthly | $100 | | $100 | | ARPRD Board and Education Committee |
| Meetings | Annually | $50 | | $50 | | ARPRD Board and Education Committee |
| Mailings and brochures | Ongoing | $500 | | $500 | | ARPRD Board and Education Committee |
| Newsletter | Annually | $50 | | $50 | | ARPRD Board and Education Committee |
| Special training | Annually | $0 | | $0 | | ARPRD Board and Education Committee |
| **SUBTOTAL EDUCATION** | | **$600** | | **$600** | | |
| Potential grant funding (@ 75%) plus credit for volunteer hours | | Grants start 04/01/12 at earliest | | $600 | | DNR AIS Planning and Education Grant |

<u>Total estimated operating costs for Aquatic Plant Management Plan</u>

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|---|---|
| June 15, 2011 – December 31, 2011: | $4,200 |
| | |
| January 1, 2012 – December 31, 2012: | $34,450 - $45,460 |
| Potential grant funding 2012: | ($$13,662.50 - $24,662.50) |
| Net expected 2012 costs: | $20,787.50 |
| | |
| Harvester capital costs: | $150,000 |
| Grant potential | ($60,000) |