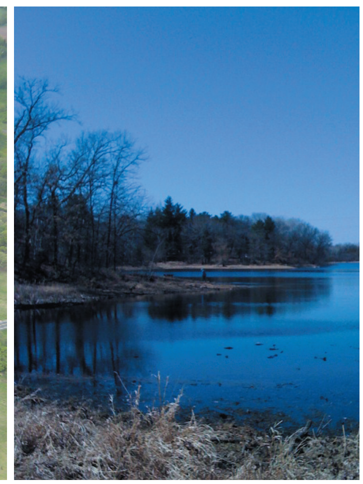
Prepared by:
Emmons & Olivier Resources, Inc.
for the Brown's Creek Watershed District

Masterman Lake Management Plan

November 2010

water | ecology | community

EOR

Document Component Specs
Text: Staples • multipurpose paper, 24 lb. text – 50% post-consumer fibers, FSC Certified.
Back Cover: Neenah Paper • Esse • Texture, Sapphire • 100 lb. cover • 30% post-consumer fibers, Green Seal® Certified
Wire Binding: Manufactured using recycled high carbon steel

Table of Contents

Project Background ... 1
- Regulatory Setting ... 1

Lake Data Analysis ... 3
- Bathymetry ... 3
- Water Level ... 5
- Lake Substrate ... 6
- Zooplankton ... 7
- Phytoplankton ... 7
- Aquatic Vegetation ... 8
- Fisheries ... 10
- Water Quality ... 10

Source Assessment ... 13
- Watershed Loading ... 13
- WiLMS In-Lake Model ... 16
- Conclusions ... 16

Issue & Goal Identification Process ... 17

Implementation Plan ... 18
- Homeowner BMP Program ... 18
- Monitoring Program ... 18

References ... 19

Appendix A1 Masterman Lake Spring Macrophyte Survey ... 20

Appendix A2 Masterman Lake Fall Macrophyte Survey ... 21

Appendix B Masterman Lake Zooplankton Survey ... 22

Appendix C Fish Assessment of Lake Masterman ... 23

Appendix D Buckthorn Removal Guidance ... 34

Appendix E March 2010 Public Meeting Participants ... 38

List of Figures

Figure 1. Masterman Lake location within the Brown's Creek Watershed District........................2
Figure 2. Masterman Lake water depth. 4
Figure 3. Historic Masterman Lake levels. 5
Figure 4. Zooplankton community. 7
Figure 5. Aquatic vegetation distribution. 9
Figure 6. 2009 average monthly water temperature profiles. 12
Figure 7. 2009 average monthly dissolved oxygen profiles. 12
Figure 8. Masterman Lake watershed land cover. 14

List of Tables

Table 1. Summary of lake level recording. 6
Table 2. Summary of phytoplankton population. 8
Table 3. Growing season means 2006-2009. 10
Table 4. Landcover descriptions from MLCCS database and areal photography......................15
Table 5. Subwatershed total phosphorus loading. 16

PROJECT BACKGROUND

The Brown's Creek Watershed District (BCWD) Board of Managers identified development of management plans for District lakes as a priority implementation activity in their 2007 Watershed Management plan. Masterman Lake (DNR ID# 82-126W) is the third lake in the District to have a management plan developed. Masterman Lake and its entire 230-acre watershed are located in the City of Grant, Minnesota, in the central portion of the Brown's Creek Watershed District (Figure 1).

Masterman Lake is a shallow 38-acre lake with a largely undeveloped shoreline. The lake does not have an active lake association but several residents have expressed a genuine interest improving the lake through a lake management plan.

Regulatory Setting
Masterman Lake is identified as a Public Water Wetland by the Minnesota Department of Natural Resources (DNR) and as such is under the jurisdiction of the DNR. Public waters are all water basins and watercourses that meet the criteria set forth in Minnesota Statutes. The DNR regulates activities below the Ordinary High Water (see water level section for further information). Typical activities regulated by the DNR include modification to control structures, beach improvements and aquatic vegetation management.

The Brown's Creek Watershed District has the authority to protect and enhance water quality for lakes within its jurisdiction. The BCWD developed watershed Rules, which protect resources from negative impacts associated with land development activities. The rules primarily address the effect changes in land use have on stormwater runoff quality. The District also pursues ways in which to enhance its resources through actively managing its resources. Development of this plan is the first step towards managing the quality and character of Masterman Lake.

The City of Grant has a role in managing the lake through its zoning ordinances, specifically its shoreland ordinance, which controls the placement of structures around the lakeshore. The City also administers the Wetland Conservation Act (WCA), which regulates the draining and filling of wetland areas.

The Washington Conservation District (WCD) conducts monitoring of lake levels and water quality on behalf of the Brown's Creek Watershed District. The WCD also collaborates with the District on water quality improvement through a stewardship assistance program.

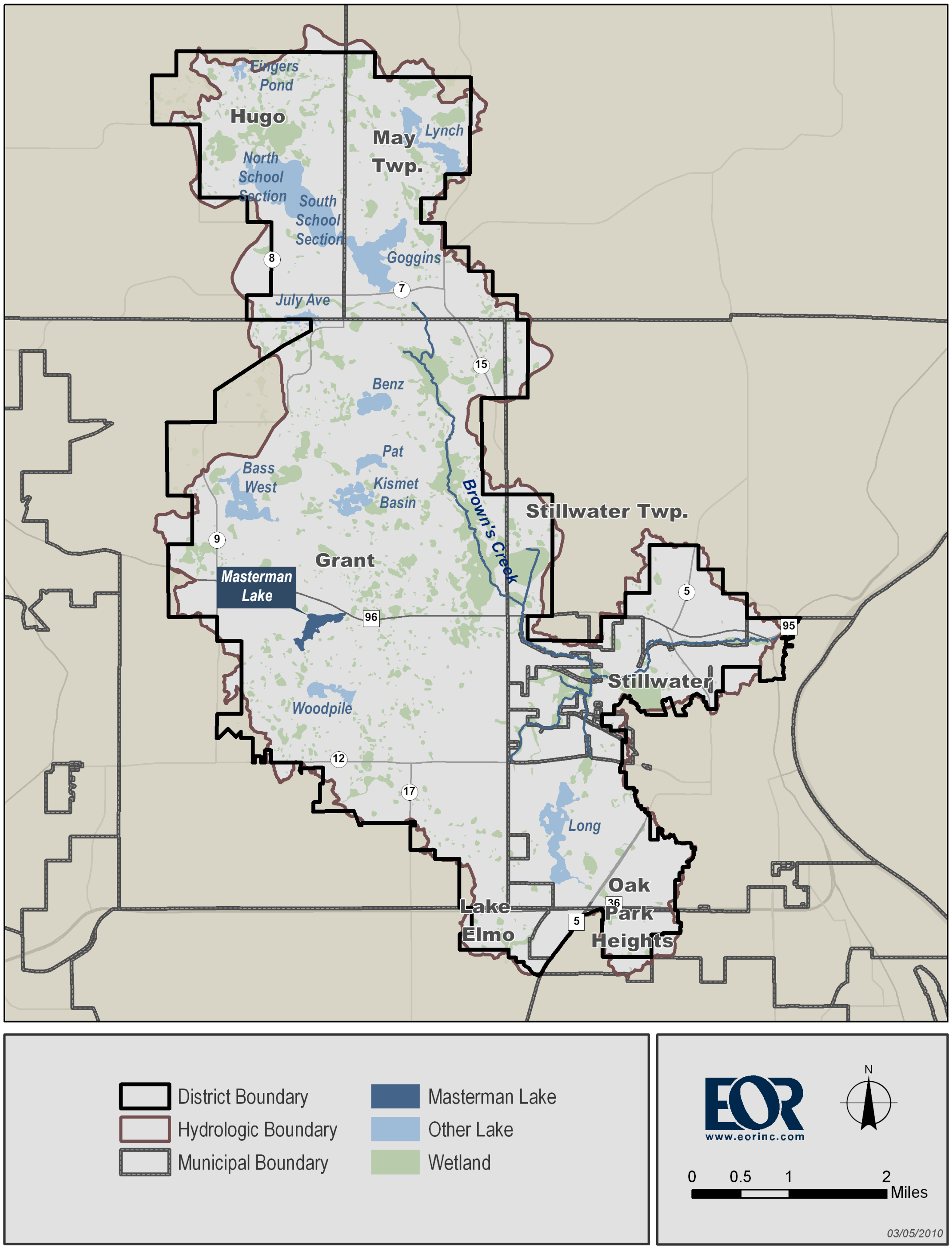


Figure 1. Masterman Lake location within the Brown's Creek Watershed District.

LAKE DATA ANALYSIS

The initial phase of the management planning process focused on data gathering and analysis. While some data had been previously collected on the lake, many aspects of the lake and its watershed had not been measured, quantified and analyzed.

Bathymetry

A bathymetric survey was conducted on Masterman Lake in April 2009. The elevation of the bottom of the lake (944.8 ft) was surveyed and compared to the elevation at the lake outlet (953.8) to determine depth as shown in the bathymetric map in Figure 2. The bathymetry data was used to derive various lake characteristics such as volume and mean depth, which are used in developing the water quality model described later in the report. The depth of the lake is fairly uniform (7 to 9 feet) with little relief. By Minnesota Pollution Control Agency (MPCA) standards, the lake is considered a shallow lake.

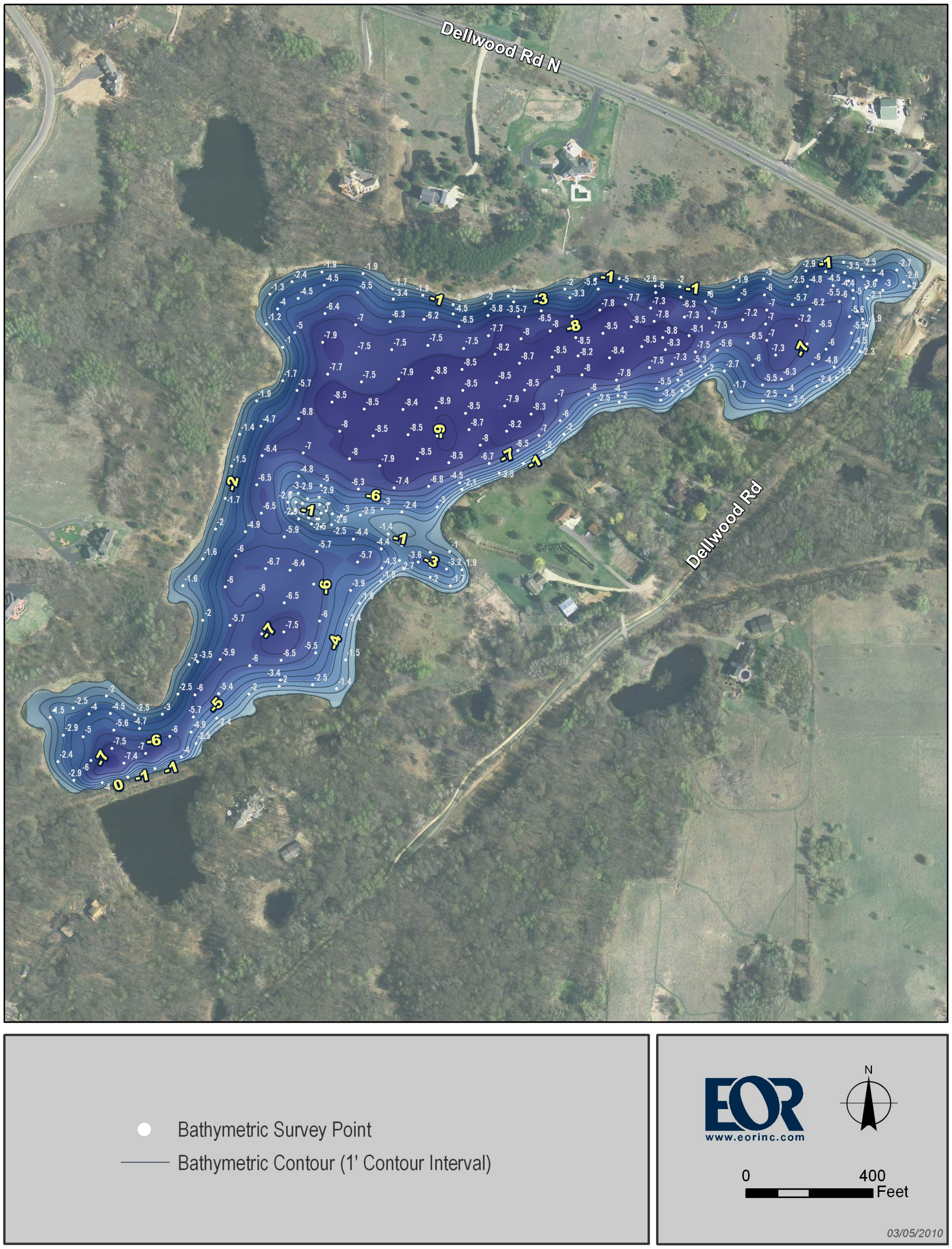


Figure 2. Masterman Lake water depth.

Water Level
Water levels on Masterman Lake have been recorded since 1996 as shown in Figure 3 and summarized in Table 1. Masterman Lake drains through a 24-in culvert through Highway 96 and into a ditch on the north side of Highway 96. The Minnesota Department of Transportation does not keep records regarding the construction and maintenance of this culvert due to its relatively small size. The control structure for the lake is actually an 18-in culvert on the north side of Highway 96 through the old railroad bed. The elevation of the invert of the culvert is 953.2, whereas the pipe through Highway 96 is at elevation 953.8. During the April 2009 survey, sediment at the pipe through Highway 96 was at 955.2, establishing the temporary control elevation as shown in Figure 3. Reconstruction of Highway 96 will entail replacement of the culverts. All sediment at the upstream end of the culvert through Highway 96 is to remain.

The outlet elevation (953.8) and the control elevation as of an April 2009 survey (955.2) are shown in Figure 3 to illustrate the fact that the lake frequently falls below both of these elevations (especially in recent years) at which time water does not flow out of the lake.

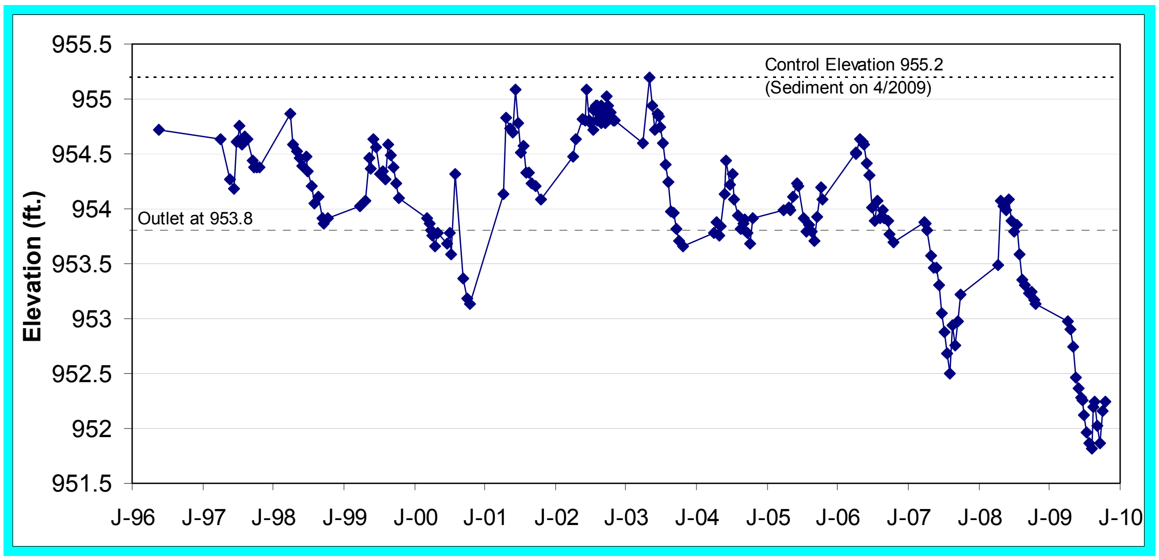


Figure 3. Historic Masterman Lake levels.

Table 1. Summary of lake level recording.

DNR Parameters	Masterman Lake Data
Period of record	06/05/1996 - 10/28/2009
# of readings	201
Highest recorded	955.2 ft (05/15/2003)
Lowest recorded	951.8 ft (08/18/2009)
Recorded range	3.4 ft
OHW elevation	955.7 ft
Datum	NGVD 29 (ft)

Lake Substrate

The lake bottom sediment was assessed and determined to consist of 12 to 18 inches of moderately decomposed organic matter. The lake bottom was fairly consistent with only slight variations in the small bays and narrow. Soft substrate means that the lake is susceptible to disturbance of the bottom sediment as a result of wave action from boat propellers and storm events causing reduced transparency and release of phosphorus into the water column.

Zooplankton

Zooplankton samples were taken from the Lake in 2009 and identified to the species level (complete zooplankton survey data can be found in Appendix B). Rotifers are small (0.01 to 1 mm long) multi-cellular organisms that feed on bacteria and algae. Copepods and Cladocerans are crustaceans ranging from 0.3 to 5.0 mm long and utilize rotifers as a valuable live food source. These larger organisms are favorite fish food, especially for pan fish. All groups are size selective omnivores (with some specialist predators and some that primarily consume bacteria and algae). This means that you can judge the relative capacity for algal bloom control by relative dominance of zooplankton.

Figure 4 is a simple way to show community dominance and its seasonal change. Rotifer (smaller organism) dominance shown usually indicates a decent amount of planktivory by pan fish on the larger crustacean groups. Lack of normal littoral vegetation can produce this effect, removing refugia from predation; the effect can also be due to over-stocking pan fish. Excess planktivory by fish can suppress the 'grazing potential' of the plankton community, suppressing trophic controls on algal blooms. The crustacean copepod population decreases from May to September. Conversely, populations of rotifera and the crustaceans of the order Cladocera increase from May to September. However, the population change is slight. Overall, Masterman Lake exhibits a balanced community of zooplankton, which implies a balance, in turn, with the community of pan fish.

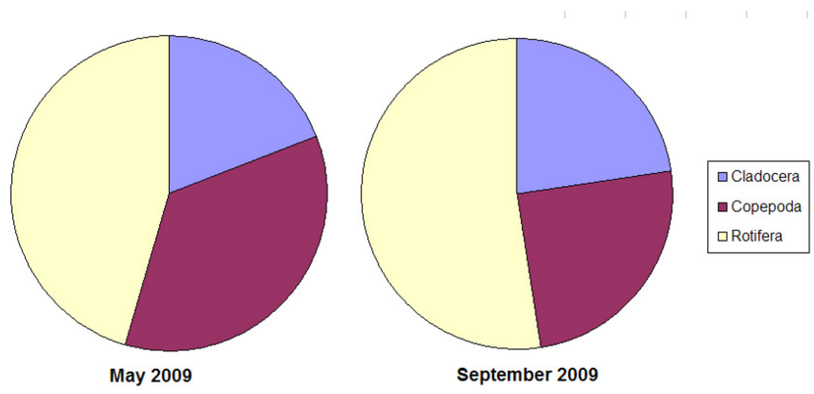


Figure 4. Zooplankton community.

Phytoplankton

Spring algae show a bloom of groups that are adapted to thrive under ice and in colder waters, while fall algal blooms of blue-green algae are much more severe, particularly *Anabaena affinis*. *Anabaena sp.* is blue-green algae capable of producing noxious odors but cannot produce toxins. Some golden algae are present in fall blooms, but the most abundant components are blue-green algae. *Microcystis sp.*, capable of producing noxious odors and toxins, is the second most common algae genera but present at less than half the magnitude of *Anabaena sp*. This indicates that algal blooms could be a concern but toxins are not as likely to be.

Table 2. Summary of phytoplankton population.

Season	Three* most common algae genera**	Ecological notes
May 2009	*Pseudanabaena limnetica*	Blue-green algae capable of producing noxious taste and odors but cannot produce toxins
	Dinobryon cylindricum	*Dinobryon sp.* is golden algae characteristic of oligotrophic environments
	Cryptomonas sp.	Algae that often blooms under ice or in deep water; does not produce toxic byproducts
Fall 2009	*Anabaena affinis*	*Anaebaena sp.* is blue-green algae capable of producing noxious odors but cannot produce toxins
	Microcystis sp.	Blue-green algae capable of producing noxious odors and toxins
	Mallomonas caudata	*Mallomonas sp.* is golden algae characteristic of oligotrophic environments
	Chroococcus sp.	Blue-green algae characteristic of oligotrophic environments

* In fall 2009, *Mallomonas caudata* and *Chroococcus sp.* were equal in count.
** Genera include species name where only one species in a genera was identified.

Aquatic Vegetation

To better understand the ecology of Masterman Lake an aquatic vegetation survey was conducted to survey the species and density of aquatic plants living within Masterman Lake. The survey was conducted in early June and early September 2009 using the point intercept method (Madsen, 1999) where the plant species and density is recorded at each site. Twenty-six sampling locations were spread evenly throughout the lake.

The summarized survey data in Figure 5 identifies the regions where species were found. Ribbon leaf pondweed (*Potamogeton epihydrus*) and white water lily (*Nymphaea odorata*) were collected in the greatest densities of all the species identified. Ribbon leaf pondweed was found throughout the open water areas of the lake. White water lily grows along nearly the entire circumference of the lake. Several additional species were found in the lake at very low density. Of particular note are the high quality species: spatterdock (*Nuphar variegate*) and arrowhead (*Sagittaria graminea*). Common waterweed (*Elodea canadensis*) can be weedy or aggressive but is native. Coontail (*Ceratophyllum demersum*) is a minor food for waterbirds and is commonly found in plant communities that include waterweeds and pondweeds. No Eurasian watermilfoil or any other non-native species was identified in the surveys. In general, the riparian zone adjacent to the lake is in good ecological condition with very few areas of mowed, maintained lawn. Data from the summer and fall macrophyte survey data is found in Appendix A1 and A2.

The Masterman Lake macrophyte community is very healthy. The lake is well populated, and no species found in the survey are exotic or significant contributors to internal phosphorus loading.

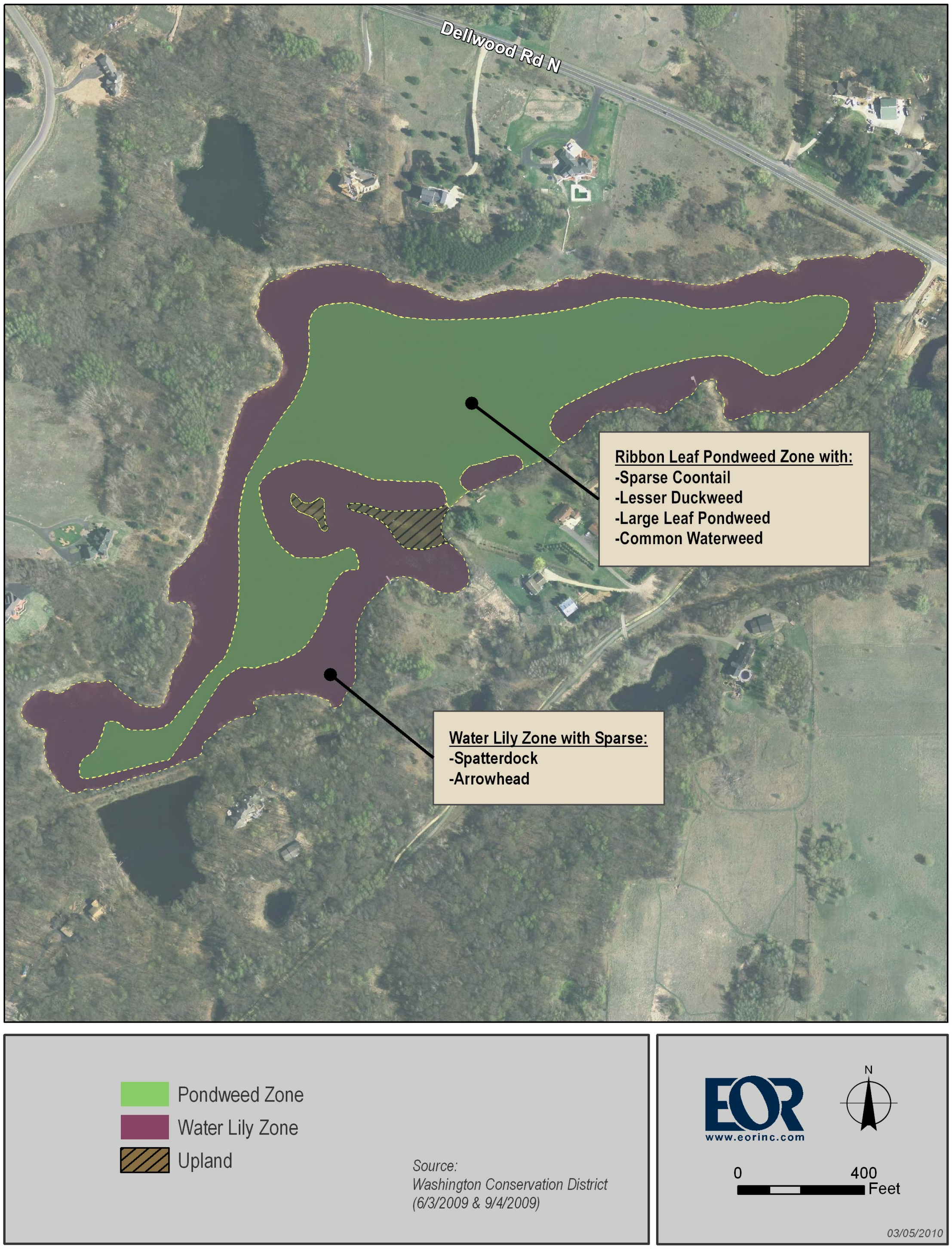


Figure 5. Aquatic vegetation distribution.

Fisheries

In August 2009, EOR, Inc. contracted for a fish survey with Blue Water Science with a permit granted from the Minnesota DNR (MnDNR) (Blue Water Science, 2009). The objectives were to characterize the fish community in Lake Masterman through trapnetting. Turtle were also surveyed for the study. See Appendix C for the complete study including methodology and results. The main findings were:

- Black bullhead, largemouth bass, northern pike and pumpkin seed were found.
- The fish community has a low density.
- Largemouth bass had a relatively high count but most of the fish were young-of-the-year and were 3 inches or less in length. There are at least a couple of year classes of largemouth bass.
- Northern pike ranging from 18-21 inches were the most common size class.
- Snapping turtles and painted turtles were found; painted turtles far outnumbered snapping turtles.

Fish survey results indicate a well-balanced fish population within Masterman Lake. Though black bullheads were high in number, several other species are present in respectable size and quantity. Residents indicate that crappie historically had high populations, but these were not found in the 2009 survey. It is likely that crappie are present even though they were not found in the three-day survey; however, changes in fish community have likely occurred.

Water Quality

Comparison to Eutrophication Standard

The water quality of Masterman Lake has been regularly monitored since 2006. The monitoring consists of bimonthly sampling for chlorophyll a, Secchi depth and total phosphorus from April through October. Chlorophyll a is a pigment found in most plants and algae. Its presence in lake water is an indicator of the amount of biological activity, primarily algal growth. Secchi depth is a direct measurement of the clarity of lake water, and total phosphorus concentration is an indication of the amount of this vital lake nutrient. Table 3 indicates the growing season (June through September) means for each of these monitored parameters along with the eutrophication criteria for shallow lakes within the North Central Hardwood Forests (NCHF) Ecoregion as established by the MPCA.

Table 3. Growing season means 2006-2009.

Water Quality Parameter	Growing Season Mean 2006-2009	Eutrophication Standard (shallow lakes)
Total Phosphorus* (µg/L)	52	< 60
Chlorophyll a (µg/L)	15	< 20
Secchi depth (m)	1.9	> 1.0

* 2009 total phosphorus data available only through July.

In general the water quality for Masterman Lake meets the NCHF Ecoregion shallow lake criteria for all three parameters: total phosphorus, chlorophyll-a, and Secchi depth.

However, these data classify Masterman Lake as a eutrophic lake meaning it is fertile and can experience severe algal blooms. Total phosphorus is the parameter exhibiting levels that trigger the eutrophic classification of Masterman Lake; chlorophyll a and secchi depth border on mesotrophic levels which would indicate a healthy lake with fertility enough to support a diverse fish and macrophyte community but not causing severe algal blooms.

Eutrophication (an expression of lake fertility) within lakes is directly correlated to the amount of nutrients available for plant and algal growth. The most important of these nutrients is total phosphorus. The following section assesses the sources of total phosphorus being delivered to the lake.

Lake Stratification

Understanding lake stratification is important to the development of both the nutrient budget for a lake as well as ecosystem management strategies. Lakes that are dimictic (mix from top to bottom in the spring and fall) can have very different nutrient budgets than lakes that are completely mixed multiple times throughout the year.

Temperature difference typically causes stratification in a lake because water density changes with water temperature. Dissolved oxygen is a measure of the amount of oxygen dissolved in water that is available for aquatic organisms such as fish and macroinvertebrates. Dissolved oxygen can also have significant implications as a result of stratification. As cooler, denser water is trapped at the bottom of a lake, it can become devoid of oxygen affecting both aquatic organisms and sediment chemistry.

Masterman Lake temperature and dissolved oxygen profiles for 2009 are shown in Figure 6 and Figure 7. Temperature and dissolved oxygen data were recorded from 2006 to 2009. However, only 2009 data is presented here. Data indicate the lake did not permanently stratify (thermally) in 2009. This is typical for shallow lakes. Dissolved oxygen decreases with depth. When the dissolved oxygen gets below around 2 mg/L in the bottom then phosphorus will be released from sediments. It could be that oxygen gets low in the bottom part of the lake, but data are inconclusive since the lowest probe can often be a reading of dissolved oxygen in the sediment rather than the water column.

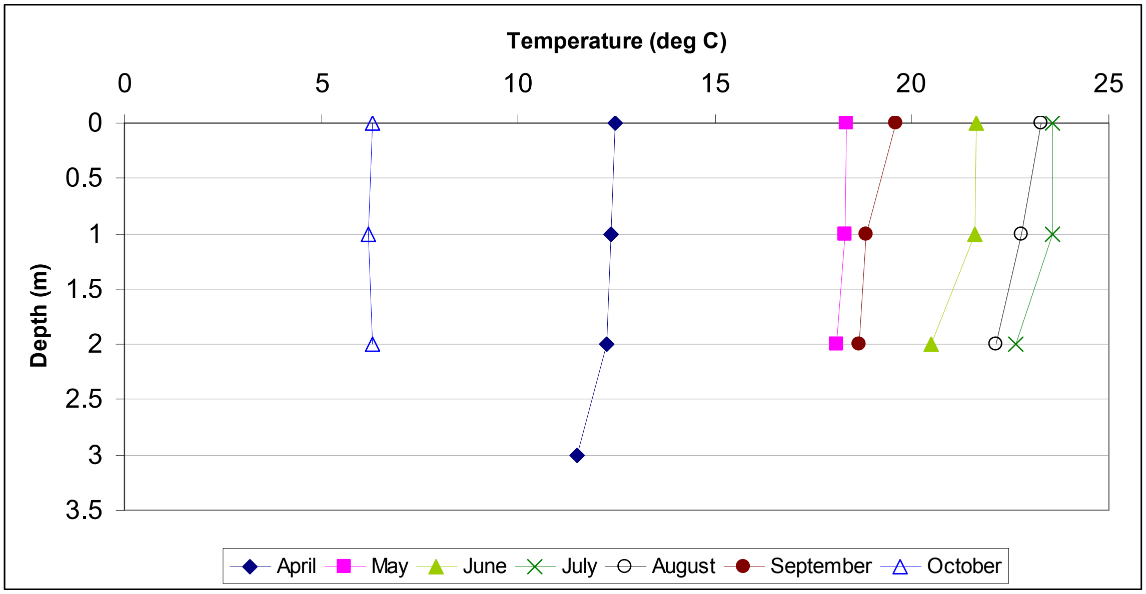


Figure 6. 2009 average monthly water temperature profiles.

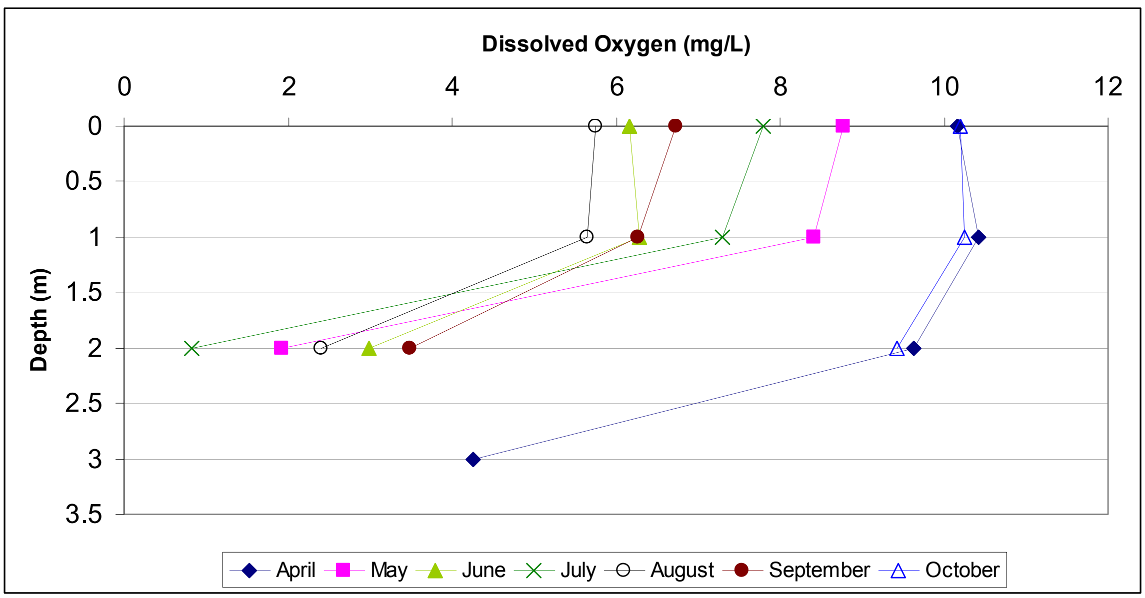


Figure 7. 2009 average monthly dissolved oxygen profiles.

SOURCE ASSESSMENT

In an effort to determine the specific sources of total phosphorus in the Masterman Lake system, water quality modeling was conducted. The models attempt to simulate the total phosphorus dynamics of the lake and its watershed. The primary sources of total phosphorus available for plant and algal growth are from atmospheric deposition, surface water runoff from watershed and release from the lakes sediment. Atmospheric deposition comes with rainfall washing airborne dirt and dust particles, which contain small amounts of total phosphorus. The calculation is based solely on the lake surface area and average precipitation amounts. In the case of Masterman Lake it was estimated that the average annual total phosphorus loading from atmospheric deposition is 5 lbs/year. Total phosphorus is also washed into the lake off the land surfaces of the watershed. The various land surfaces within the watershed contribute varying levels of total phosphorus. Finally, the sediment within the lake contains phosphorus, which can be released when oxygen levels fall within the lake. The following sections discuss the modeling used to determine the source of total phosphorus available for plant and algal growth.

Watershed Loading

The first source of total phosphorus to be assessed was the contribution from watershed loading. Export coefficients were used to assess the loading of total phosphorus from various land surfaces within the watershed. Data from the Minnesota Land Cover Classification System (MLCCS) was paired with aerial photography to identify natural communities and landuses (single family residential, roads and agriculture) within the watershed. Export coefficients were assigned to each of these natural communities and landuses. Figure 8 depicts the land cover within the Masterman Lake watershed.

Table 4 identifies the MLCCS landuses and those landuses identified through aerial photography; it also provides the export coefficient for each landuse. Agricultural land, roads and residential lots have the greatest export of phosphorus on a per acre basis. However, the majority of the watershed is made up of natural communities including forest, grasses or wetland, which are lower contributors of phosphorus on a per acre basis. Table 5 identifies the watershed total phosphorus loading on a subwatershed basis. On a per acre basis, each watershed contributes very similar loads; there is no particular subwatershed that requires special attention in the development of management actions.

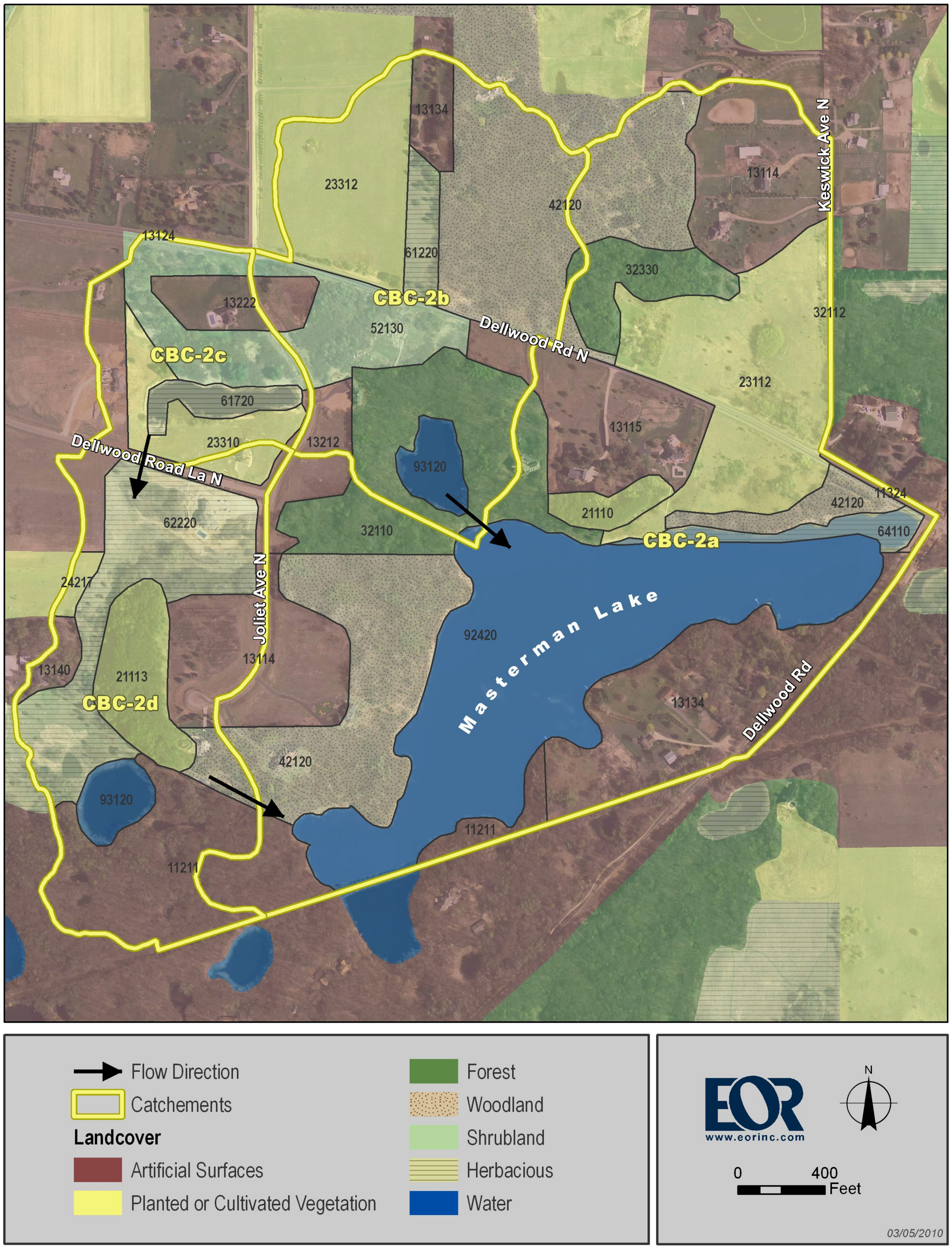


Figure 8. Masterman Lake watershed land cover.

Table 4. Landcover descriptions from MLCCS database and areal photography.

MLCCS Code OR from Aerial Photography	Landcover Description	Export Coefficient (lb/ac-yr)
11211	Oak (forest or woodland) with 4-10% impervious cover	0.10
11324	Planted mixed coniferous/deciduous trees with 11-25% impervious cover	0.10
13114	Short grasses and mixed trees with 4-10% impervious cover	0.16
13115	Long grasses and mixed trees with 4-10% impervious cover	0.16
13124	Short grasses and mixed trees with 11-25% impervious cover	
13134	Short grasses and mixed trees with 26-50% impervious cover	0.16
13140	51% to 75% impervious cover with perennial grasses and sparse trees	0.16
13212	Non-native dominated long grasses with 4-10% impervious cover	0.16
13222	Non-native dominated long grasses with 11-25% impervious cover	0.16
21110	Upland soils with planted, maintained, or cultivated coniferous trees	0.10
21113	Red pine trees on upland soils	0.10
23112	Long grasses with sparse tree cover on upland soils	0.16
23310	Upland soils with planted or maintained grasses and forbs	0.16
23312	Long grasses and forbs on upland soils	0.16
24217	Hayfield	0.18
32110	Oak forest	0.10
32112	Oak forest mesic subtype	0.10
32330	Aspen forest saturated	0.10
42120	Oak woodland-brushland	0.10
52130	Non-native dominated upland shrubland	0.13
61220	Medium-tall grass non-native dominated grassland	0.16
61720	Mixed emergent marsh - intermittently exposed	0.10
62220	Grassland with sparse conifer or mixed deciduous/coniferous trees - non-native dominated vegetation	0.16
64110	Water lily	0.10
92420	Floating vascular vegetation - Permanently flooded littoral aquatic bed (Masterman Lake)	N/A
93120	Floating vascular vegetation - Intermittently exposed aquatic bed	0.10
Aerial photography	agriculture	0.71
Aerial photography	Low density single family residential	0.30
Aerial photography	Local road	0.70

Table 5. Subwatershed total phosphorus loading.

Subwatershed	Acres	Average Annual TP Load (lbs)	Normalized Average Annual TP Load (lb/ac)
CBC-2a	150	19	0.12
CBC-2b	53	13	0.25
CBC-2c	19	3.2	0.17
CBC-2d	46	7.7	0.17

WiLMS In-Lake Model

After determining the total phosphorus loading from atmospheric deposition and watershed loading, an internal loading model was built. The Wisconsin Lake Modeling Suite (WiLMS) Version 3.3 was developed by the Wisconsin Department of Natural Resources. The model uses an annual time step and predicts growing season mean total phosphorus concentration in lakes. The WiLMS model was used to determine the loading of total phosphorus, which would result in the growing season mean total phosphorus concentration of 52 µg/L. The WiLMS model prediction identified an in-lake concentration of 53 µg/L based on watershed loading and atmospheric deposition. Model results do not suggest that internal loading is a major contributor of phosphorus to the lake. However, in-lake data (see *Zooplankton* and *Phytoplankton*) do suggest that internal loading occurs to some degree.

Conclusions

The fact that Masterman Lake has not exhibited severe algal blooms despite the levels of phosphorus exhibited in the lake suggests that the aquatic biology of the lake is providing significant water quality control. In fact, the fish and zooplankton community data indicate that these communities are in balance with each other and with themselves. Similarly, the macrophyte community is well established and healthy. These characteristics appear to be enabling the consumption of algae, the uptake of phosphorus and, ultimately, the prevention of algal blooms not uncommon in lakes with phosphorus levels like that at Masterman Lake. The relatively undeveloped riparian zone is also likely providing an effective buffer to potential phosphorus loads in stormwater runoff.

ISSUE & GOAL IDENTIFICATION PROCESS

As part of the planning process input was gathered from the local stakeholders and the BCWD staff and managers to identify the issues of concern relating to Masterman Lake. Another key to the planning process is developing goals to achieve an outcome that satisfies the concerns. In January of 2009 the BCWD Board of Managers initiated the planning process to develop a lake management plan for Masterman Lake. In March of 2010 a meeting was held with lakeshore residents and residents of the watershed to discuss past lake data, resident observations, issues concerning the residents and goals the residents have for this process.

The following is a list of issues that was developed through the various discussions during this process:

- Lake water levels
- Trash and erosion caused by foot traffic at northeast end of lake where DNR property meets the lake
- Erosion of riparian zone in areas of buckthorn establishment
- Exploitation of fisheries, especially by non-residents

The goals for this project were developed from the analysis of the present conditions in Masterman Lake and the watershed and the concerns of the BCWD and the local stakeholders. There is limited opportunity to manage Masterman Lake water levels. Reconstruction of Highway 96 has enabled preservation of existing water levels to the greatest extent feasible (see *Water Level* on page 5 for further discussion).

Water Quality Goal

Manage the nutrient inputs (watershed loading and internal loading) to Masterman Lake to prevent degradation of current water quality.

A - Reduce nutrient loading from the watershed through stabilization of the riparian zone via buckthorn removal and re-establishment of native vegetation.
B - Maintain current balance of in-lake biology.

Fisheries Management Goal

Maintain the fishery to ensure the existing balance of the fishery is maintained.

IMPLEMENTATION PLAN

The following implementation plan summarizes the potential actions to be taken within the Lake and it's watershed to meet the goals identified through the public involvement process. Participants of the March 2010 public meeting are listed in Appendix E.

Homeowner BMP Program
Riparian zone restoration for erosion control will be implemented through education and training of riparian zone homeowners. Buckthorn removal will be the focus of restoration. Homeowners will be trained on the methods for removal, the importance of annual follow-up on re-growth, and the need to ensure a healthy repopulation of vegetation through natural processes or through supplemental seeding or planting. See Appendix D for initial guidance. General principles for healthy natural shoreline vegetation will also be a component of the program.

Five Year Residential BMP Program Cost Estimate - $5,000

Monitoring Program
In-lake monitoring of TP concentrations, Chlorophyll-a concentrations, Secchi depth and dissolved oxygen and temperature profiles will continue to be performed bimonthly during the open water season to ensure the maintenance of good water quality in Masterman Lake. Macrophyte surveys will continue bi-annually and fish surveys will continue every three years to trigger timely action if either of these existing healthy communities undergo degradation. The monitoring program cost estimate does not include equipment costs.

Five Year Monitoring Program Cost Estimate - $10,000

REFERENCES

Blue Water Science. 2009. Fish Assessment of Lake Masterman (ID #82-0126), Washington County, Minnesota in 2009. Prepared for Emmons & Olivier Resources Inc., and the Minnesota DNR.

Madsen, J. D. (1999). Point Intercept and Line Intercept Methods for Aquatic Plant Management. APCRP Technical Notes Collection. TN APCRP-M1-02. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

APPENDIX A1 MASTERMAN LAKE SPRING MACROPHYTE SURVEY

Masterman Lake Macrophyte Survey
Surveyors: Erik Anderson, Jason Carlson
Date: 6/3/2009
Start Time: 12:00
Water Surface Elevation: 952.36 ft

Species Density (1-very sparce (barely any in rake tines, 4-very dense covering all of rake tines)
Species density estimate graphic () http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Depth at Point (ft)	4.2	3.0	3.5	4.0	4.5	3.5	4.0	4.5	4.5	4.0	5.0	5.0	4.5	4.5	6.0	4.0	6.0	3.0	6.0	4.5	4.5	4.5	4.0	4.0	4.0	4.0
Species Present (1,2,3 or 4-Yes, 0 or blank-No)																										
cattail_broad-leaved (Typha latifolia)																										
cattail_narrow-leaved (Typha angustifolia)																										
reed canary grass (Phalaris arundinacea)																										
3 square bullrush (Scirpus americanus)																										
common arrowhead (Sagittaria latifolia)																										
white water lily (Nymphaea odorata)		3	3															2								3
spatterdock (Nuphar variegata)		1																					1			
watershield (Brasenia schreberi)																										
water marigold (Bidens beckii)																										
greater duckweed (Spirodela polyrhiza)																										
lesser duckweed (Lemna minor)																										
sago Pondweed (Potomogeton pectinatus)																										
flatstem Pondweed (Potomogeton zosteriformis)																										
ribbon leaf pondweed (Pontomageton epihydrus)	4	4	2	4	2	4	4	4	4	4	4	4	3	4	4	1	3	3	4	3	4	4	3	4	3	4
large leaf pondweed (Potamogeton amplifolius)									1																	
Illinois pondweed (Potamogeton illinoensis)																										
curly leaf pondweed (Potomageton crispus)																										
coontail (Ceratophyllum demersum)	1	1	1												1											
eurasian water milfoil (Myriophyllum spicatum)																										
common waterweed (Elodea canadensis)	1		1			1					1	2		1	2	1										
Glyceria sp.																										
Potamogeton sp. (more investigation needed for ID)																										
algae present																										

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

APPENDIX A2 MASTERMAN LAKE FALL MACROPHYTE SURVEY

Masterman Lake Macrophyte Survey
Surveyors: Erik Anderson, Adam King
Date: 9/4/2009
Start Time: 10:45
Water Surface Elevation: 951.92 ft

Species Density (1-very sparce (barely any in rake tines, 4-very dense covering all of rake tines)
Species density estimate graphic () http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Depth at Point (ft)	3.0	3.0	3.5	4.0	3.0	4.5	5.0	3.5	4.5	4.0	6.0	5.5	4.5	6.0	6.0	3.5	6.5	3.5	6.0	3.0	6.0	4.0	3.5	3.5	4.5	3.0
Species Present (1,2,3 or 4-Yes, 0 or blank-No)																										
cattail_broad-leaved (Typha latifolia)																										
cattail_narrow-leaved (Typha angustifolia)																										
reed canary grass (Phalaris arundinacea)																										
3 square bullrush (Scirpus americanus)																										
grass-leaved arrowhead (Sagittaria graminea)																1										
common arrowhead (Sagittaria latifolia)																										
white water lily (Nymphaea odorata)		2	2	3	3					2			2					2		2			3	2		4
spatterdock (Nuphar variegata)		1	1																							
watershield (Brasenia schreberi)																										
water marigold (Bidens beckii)																										
greater duckweed (Spirodela polyrhiza)																										
lesser duckweed (Lemna minor)						1																				
sago Pondweed (Potomogeton pectinatus)																										
flatstem Pondweed (Potomogeton zosteriformis)																										
ribbon leaf pondweed (Pontomageton epihydrus)	4	4	3	4	4	4	4	4	4	2	4	4	4	3	4		4	2	4	1	4	3	4	4	4	
large leaf pondweed (Potamogeton amplifolius)																										
Illinois pondweed (Potamogeton illinoensis)																										
curly leaf pondweed (Potomageton crispus)																										
coontail (Ceratophyllum demersum)			1																							
eurasian water milfoil (Myriophyllum spicatum)																										
common waterweed (Elodea canadensis)															1											
Glyceria sp.																										
Potamogeton sp. (more investigation needed for ID)																										
algae present																										

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

APPENDIX B MASTERMAN LAKE ZOOPLANKTON SURVEY

Washington Co. CD Zooplankton 2009

EcoAnalysts, Inc.

	Water Body	**Masterman Lake**	**Masterman Lake**
	Site	**82-0126**	**82-0126**
	Tow Length	**2m tow**	**2m tow**
	Collection Date	**05-12-2009**	**09-15-2009**
	Collection Device	**153um x 8"diam**	**153um x 8"diam**
	Collection Note	**Net lowered once**	**Net lowered once**
	EcoAnalysts Sample ID	**5327.1-1**	**5327.1-2**
	Volume of Sample Received	**250mL**	**250mL**
	Whole Sample Boivolumes	**5.00mL**	**3.00mL**
	Percent Counted - Fine Count	**44.97%**	**3.70%**
	Percent Counted - Coarse Count	**9.19%**	**5.92%**
FINE COUNT			
Rotifera	Ascomorpha ecaudis	0	3
	Asplanchna brightwellii	0	0
	Asplanchna priodonta	0	41
	Bdelloidea	10	0
	Brachionus angularis	0	0
	Brachionus caudatus	0	0
	Collotheca sp.	0	0
	Conochiloides dossuarius	0	1
	Conochilus unicornis	58	206
	Euchlanis dilatata	0	0
	Euchlanis sp.	4	0
	Filinia terminalis	0	0
	Kellicottia bostonensis	1	2
	Keratella cochlearis	43	0
	Keratella cochlearis f. tecta	0	0
	Keratella quadrata	0	0
	Lecane inermis	0	0
	Lecane intrasinuata	7	0
	Lecane mira	46	0
	Lophocharis sp.	0	0
	Monostyla lunaris	8	0
	Polyarthra euryptera	0	2
	Polyarthra vulgaris	14	0
	Synchaeta oblonga	6	0
	Trichocerca capucina	0	1
	Trichocerca cylindrica	0	0
	Trichocerca multicrinis	0	0
	Trichocerca rousseleti	0	0
	Trichocerca similis	0	0
	Trichotria tetractis	7	0
	FINE COUNT SUB TOTAL	**204**	**256**
Not included in target:	*nauplii*	*396*	*77*
COARSE COUNT			
Crustacea	Alona costata	2	0
	Alona sp.	0	2
	Bosmina longirostris	17	36
	Calanoid - copepodites	11	0
	Ceriodaphnia dubia	10	8
	Ceriodaphnia lacustris	0	0
	Chydorus sphaericus	23	13
	Cyclopoid - copepodites	140	55
	Daphnia dubia	0	8
	Daphnia galeata mendotae	0	0
	Daphnia rosea	28	0
	Daphnia sp.	0	1
	Diacyclops thomasi	0	0
	Diaphanosoma birgei	0	43
	Diaphanosoma sp.	1	0
	Diaptomidae	0	37
	Harpacticoida	2	0
	Leptodiaptomus siciloides	0	0
	Mesocyclops edax	6	27
	Skistodiaptomus pallidus	0	0
	Streblocerus serricaudatus	5	0
	Tropocyclops prasinus mexicanus	0	2
	COARSE COUNT SUB TOTAL	**245**	**232**
	GRAND TOTAL	**449**	**488**

APPENDIX C FISH ASSESSMENT OF LAKE MASTERMAN

Lake Masterman, August 12, 2009

Fish Assessment of Lake Masterman (ID #82-0126), Washington County, Minnesota in 2009

Survey Dates: August 11 - 13, 2009

MnDNR Permit Number: 15925

Submitted to:
EOR, Inc and
MnDNR

Prepared by:
Steve McComas
Blue Water Science
St. Paul, Minnesota

August 2009

Introduction

Lake Masterman is a 40-acre lake, located in Washington County, Minnesota.

In August 2009, EOR, Inc. contracted for a fish survey with Blue Water Science with a permit number 15925 granted from the MnDNR. The objectives were to characterize the fish community in Lake Masterman.

Methods

Four standard trapnets were used for two days for a total of eight lifts to survey fish in Lake Masterman. The trapnet was a MnDNR-style with a 4 x 6 feet square frame with two funnel mouth openings and 50-feet lead. Net mesh size was ½ inch (bar length). Four standard trap nets were set on Tuesday morning August 11, 2009. Four nets were fished for the following 2 days (August 12, 13). Trapnet locations are shown in Figure 1 and pictures of a typical trapnet are shown in Figure 2.

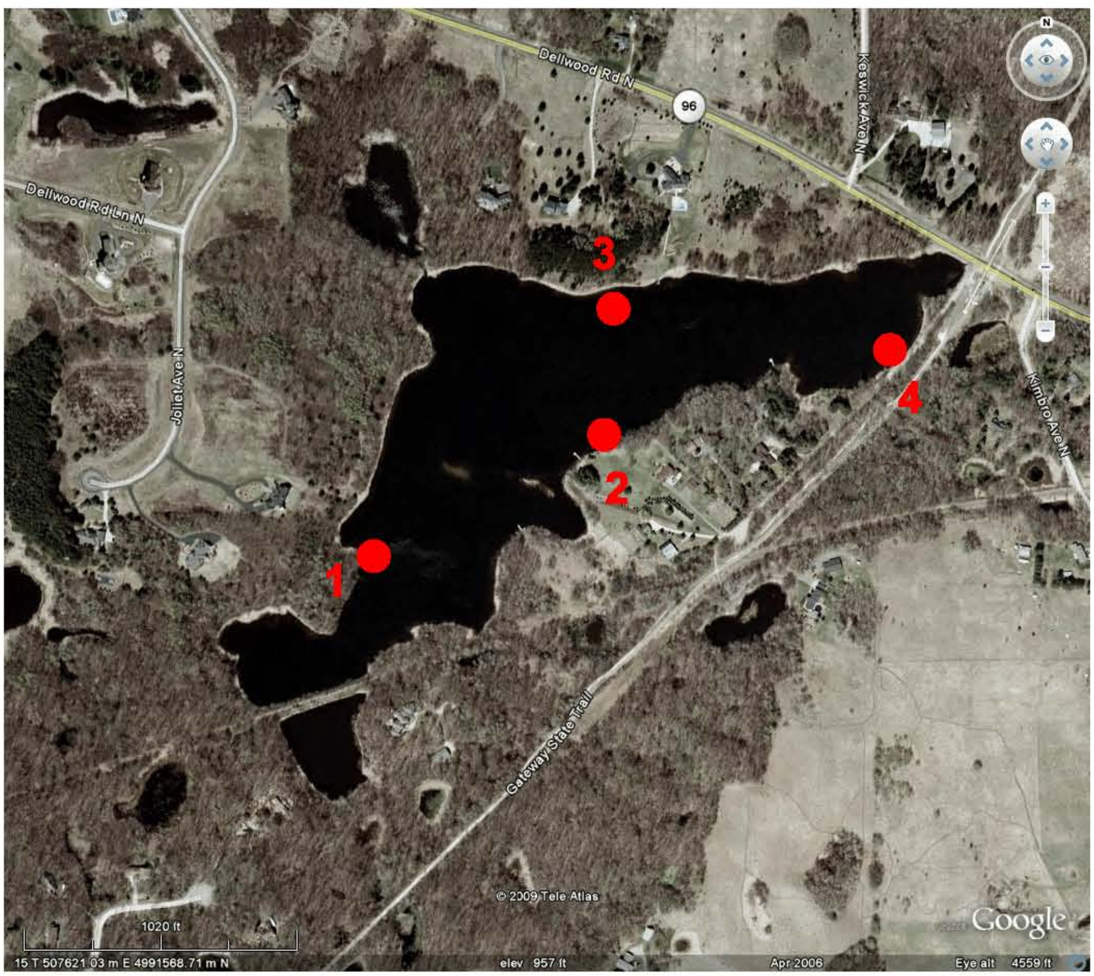


Figure 1. Map of trapnet sets.

A trapnet is a live fish trap. Fish run into the 50-foot lead net and follow it back through a series of hoops with funnel mouths. Fish end up in the back hoop.

A handheld net is used to remove the fish from the back of the trapnet.

Fish are transferred to tubs, then they are counted and measured.

Figure 2.

Results

A total of four fish species were sampled in Lake Masterman on August 12 and 13, 2009. Black bullheads were the most abundant species followed by largemouth bass. The number of largemouth bass caught per net was high with the average haul of 6.1 per net (Table 1). This is above the normal range of 0.5 to 2 largemouth bass per lift for a lake like Lake Masterman.

Bullheads, northern pike, and pumpkinseed sunfish were found in moderate numbers and were within a normal range for lakes of the Lake Masterman type, as defined by the MnDNR.

Table 1. Lake Masterman trapnet results for the fish survey conducted in August 2009.

Net	Black Bullhead	Largemouth Bass	Northern Pike	Pumpkin-seed
Wednesday (8/12)				
1	4	0	0	0
2	0	1	0	4
3	17	0	2	0
4	8	36	1	6
subtotal	29	37	3	10
Thursday (8/13)				
1	3	0	1	0
2	0	1	3	1
3	24	1	4	0
4	10	10	1	3
subtotal	37	12	9	4
Total Fish (8 nets)	66	49	13	14
Fish/ Trapnet (8 lifts)	**8.3**	**6.1**	**1.5**	**1.8**
MnDNR Normal Range	1 - 25	0.5 - 2	NA	1 - 8

Fish lengths are shown in Table 2. Black bullheads were mostly 8 - 9 inches and may have be stunted. Largemouth bass were represented by fish that were from 3 inches up to 7.5 inches in length. Northern pike were present, their lengths were only up to 28 inches. Their population would be able to keep black bullheads under control.

Table 2. Length frequency of fish species (as total length) for the Lake Masterman fish survey.

Size Range (in)	Black Bullhead (n=66)	Largemouth Bass (n=49)	Northern Pike (n=12)	Pumpkinseed (n=14)
< 3		25		
2.5		1		
3		15		2
3.5		1		1
4		2		2
4.5				
5		1		3
5.5		1		4
6				1
6.5		1		1
7		1		
7.5		1		
8	7			
8.5	35			
9	24			
9.5				
10				
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18			1	
18.5			1	
19			3	
19.5			1	
20			2	
20.5				
21			3	
21.5				
22				
22.5				
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28			1	

Representative Fish Species of Lake Masterman

Figure 3. Top left: Pumpkinseed sunfish.
Top right: Black bullhead.
Bottom left: Northern pike.
Bottom right: Largemouth bass.

Turtle Results: Snapping turtles and painted turtles were also sampled in the trapnets and were common in Lake Masterman. The number of turtles was typical for a lake like Masterman that has a high percentage of a natural shoreline area.

Table 3. Painted turtle and snapping turtle catch per net for the two netting days and the two day total and number per lift.

Net	Painted Turtles	Snapping Turtles
Wednesday (8/12)		
1	36	2
2	8	0
3	10	0
4	12	2
subtotal	66	4
Thursday (8/13)		
1	2	3
2	2	0
3	11	1
4	8	1
subtotal	23	5
Total Fish (8 nets)	89	9
Fish/ Trapnet (8 lifts)	**11.1**	**1.1**

Conclusions

The fish community has a low density based on trapnet catches. Largemouth bass had a relatively high count but most of the fish were young-of-the-year and were 3 inches or less in length.

There are at least a couple of year classes of largemouth bass.

Northern pike from 18-21 inches were the most common size class.

Steve McComas (Blue Water Science) and Pat Conrad are working up fish from the trapnet.

Appendix A

Minnesota DNR Fish Permit

From: "Steve McComas" <mccomas@pclink.com>
To: <gerald.johnson@dnr.state.mn.us>; <rodmen.smith@dnr.state.mn.us>
Cc: <Pconrad@eorinc.com>
Subject: Masterman Lake fish survey
Date: Wednesday, August 05, 2009 11:36 AM

Hello All,

Blue Water Science will be conducting a fish survey in Masterman Lake, Washington County, starting on Tuesday, August 11, 2009. We will set 4 fyke nets in the lake. They will be removed by Friday (August 14). All fish will be weighed and measured and returned to the lake. The fish surveys are sponsored by EOR, Inc. This survey is conducted under permit number 15925.

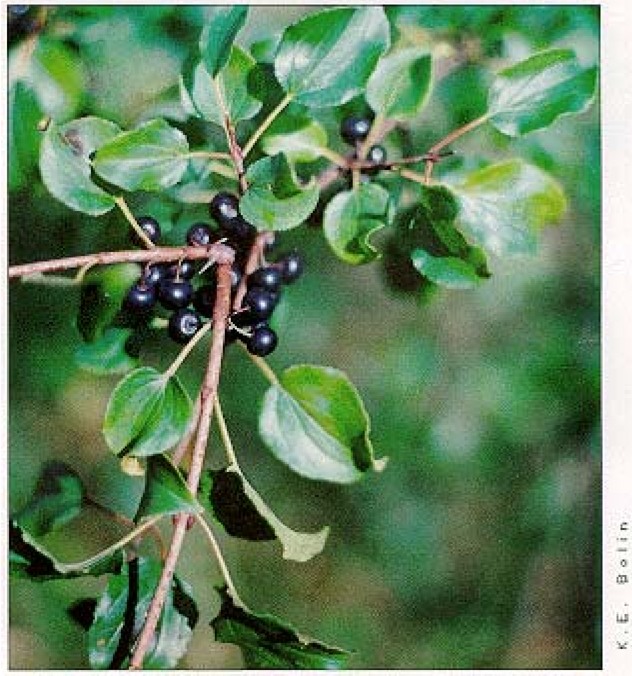
Thank you,

Steve McComas
Blue Water Science
550 South Snelling Avenue
St. Paul, MN 55116
651.690.9602

APPENDIX D BUCKTHORN REMOVAL GUIDANCE

Common (European) Buckthorn (*Rhamnus cathartica L.*)

Native Range: Eurasia



European Buckthorn, *Rhamnus cathartica* leaves and mature berries

Description: Common buckthorn is a shrub or small tree in the buckthorn family (Rhamnaceae) that can grow to 22 feet in height and have a trunk up to 10 inches wide. The crown shape of mature plants is spreading and irregular. The bark is gray to brown, rough textured when mature and may be confused with that of plum trees in the genus Prunus. When cut, the inner bark is yellow and the heartwood, pink to orange. Twigs are often tipped with a spine. In spring, dense clusters of 2 to 6, yellow-green, 4-petaled flowers emerge from stems near the bases of leaf stalks. Male and female flowers are borne on separate plants. Small black fruits about 1/4 inch in cross-section and containing 3-4 seeds, form in the fall. Leaves are broadly oval, rounded or pointed at the tip, with 3-4 pairs of upcurved veins, and have jagged, toothed margins. The upper and lower leaf surfaces are without hairs. Leaves appear dark, glossy green on the upper surface and stay green late into fall, after most other deciduous leaves have fallen.

A similar problem exotic species is *Rhamnus frangula*, glossy buckthorn. Glossy buckthorn does not have a spine at twig tips, leaves are not toothed, and the undersides of the leaves are hairy.

Several native American buckthorns that occur in the eastern U.S. that could be confused with the exotic species. If in doubt, consult with a knowledgeable botanist to get an accurate identification. Carolina buckthorn (Rhamnus caroliniana), is a lovely native shrub that has finely toothed leaves somewhat resembling those of black cherry, and are smooth on the underside; it produces attractive fruits from August to October. Alder buckthorn (Rhamnus alnifolia), is a low-growing shrub that may grow to a maximum of 3 feet in height, and has leaves with 6-7 pairs of veins.

Ecological Threat: Exotic buckthorns tend to form dense, even-aged thickets, crowding and shading out native shrubs and herbs, often completely obliterating them. Dense buckthorn seedlings prevent native tree and shrub regeneration. In fire-adapted ecosystems such as savannas and prairies, the lack of vegetation under buckthorn prohibits fires. Buckthorn control is also of interest to small grain producers; the shrub is an alternate host of the crown rust of oats, which affects oat yield and quality.

Distribution in the U.S.: Common buckthorn has become naturalized from Nova Scotia to Saskatchewan, south to Missouri, and east to New England.

Habitat in the U.S.: Common buckthorn prefers lightly shaded conditions. An invader mainly of open oak woods, deadfall openings in woodlands, and woods edges, it may also be found in prairies and open fields. It is tolerant of many soil types, well drained sand, clay, poorly drained calcareous, neutral or alkaline, wet or dry.

Background: Common buckthorn was introduced to North America as an ornamental shrub, for fence rows, and wildlife habitat. Introduction of buckthorn was based on its hardiness and ability to thrive in a variety of soil and light conditions.

Methods of Reproduction & Dispersal: Common buckthorn is a dioecious plant, meaning that each plant produces only male or female flowers and fruiting trees are always female. Most of the fruits fall directly beneath the shrubs, creating a dense understory of seedlings characteristic of common buckthorn stands. The plentiful fruit is eaten by birds and mice and is known to produce a severe laxative effect, helping distribute seeds through birds, often far from the parent plant. Buckthorn often establishes beneath trees at the edges of forests and fields.

Current Management Approaches: Mechanical, physical and chemical methods are available for control of common buckthorn and glossy buckthorn (*Rhamnus frangula*), also an invasive exotic plant. Prescribed fire is one method proposed for controlling buckthorn seedlings in fire-adapted natural areas, from late March to early May, most recently by Boudreau and Willson. In the upper Midwest conduct burns as soon as leaf litter is dry; resprouts will be less vigorous due to low carbohydrate levels. Burning every year or every other year in established stands may be required for 5-6 years or more. Unfortunately, buckthorn seedings often grow in low litter areas, unsuitable for frequent prescribed fire. In dense stands, seedlings and saplings may be cut and dropped on site, creating fuel for future fires. Buckthorn seedlings appear vulnerable to fire, perhaps due to their poorly established root structure. Fire will top kill a mature plant, but resprouting does occur. Uprooting of 1/2 inch diameter seedlings by hand or up to 1 1/2 inch diameter using a weed wrench is effective, but care should be taken to avoid excessive disturbance to the soil, which can release buckthorn seeds stored in the soil.

Careful application of herbicides has been found to effectively control buckthorn in Illinois. The McHenry County, Illinois, Conservation District (MCICD) reports excellent results using a triclopyr herbicide at the rate of 1:4 herbicide:water with dye on cut stumps during the growing season, from late May to October. The product label suggests avoiding treatment during the spring sap flow. To extend the work season, the use of a triclopyr herbicide was also applied to cut stumps during winter and was reported to be effective by MCICD and the Minnesota Region V State Parks.

Frill application (applying herbicide into the cambial layer of fresh cuts on the tree trunk) using the 1:4 rate of triclopyr herbicide with oil and dye was also effective. Experiments at the University of Wisconsin Arboretum report good results using a mixture of 1 part triclopyr herbicide to 7 parts oil on cut stumps, or a 1 part triclopyr herbicide to 16 parts oil mixture applied as a basal bark treatment to stems less than 3 inches across. For fall applications, the Minnesota Department of Natural Resources, Region V State Parks Resource Management has used a 1 part glyphosate herbicide to 5 parts water mixture applied immediately to cut stumps using a hand sprayer. Initial checks indicated over 85 percent control at the test site.

USE PESTICIDES WISELY: ALWAYS READ THE ENTIRE PESTICIDE LABEL CAREFULLY, FOLLOW ALL MIXING AND APPLICATION INSTRUCTIONS AND WEAR ALL RECOMMENDED PERSONAL PROTECTIVE GEAR AND CLOTHING. CONTACT YOUR STATE DEPARTMENT OF AGRICULTURE FOR ANY ADDITIONAL PESTICIDE USE REQUIREMENTS, RESTRICTIONS OR RECOMMENDATIONS.

NOTICE: MENTION OF PESTICIDE PRODUCTS ON THIS WEB SITE DOES NOT CONSTITUTE ENDORSEMENT OF ANY MATERIAL.

Suggested Alternative Plants: For home landscaping and wildlife plantings many native low trees and shrubs are available from commercial nurseries. Examples include American elder (*Sambucus canadensis*), Black chokeberry (*Aronia melanocarpa*), and Juneberry (*Amelanchier alnifolia*). Please contact your local native plant society for recommendations of plants native to your particular area.

SOURCE: Plant Conservation Alliance, Alien Plant Working Group (22 April 1999).

Author: Susan Wieseler, Minnesota Department of Natural Resources, Rochester, MN.

Editor: Jil M. Swearingen, National Park Service, Washington, DC.

Photographs: Kathy Bolin, Minnesota Department of Natural Resources.

References

Archibold, O. W., D. Brooks, and L. Delanoy. 1997. An investigation of the invasive shrub European Buckthorn, *Rhamnus cathartica* L., near Saskatoon, Saskatchewan. Canadian Field Naturalist 111(4): 617-621.

Boudreau, D., and G. Willson. 1992. Buckthorn research and control at Pipestone National Monument (Minnesota). Restoration and Management Notes 10:1 94-95.

Converse, C. 1985. Element Stewardship Abstract, *Rhamnus cathartica*. The Nature Conservancy.

Glass, S. 1994. Experiment finds less herbicide needed to control Buckthorn (Wisconsin). Restoration and Management Notes 12:1 93.

APPENDIX E MARCH 2010 PUBLIC MEETING PARTICIPANTS

Name	Affiliation
Karen Kill	BCWD
Craig Leiser	BCWD
Rick Vanzwol	BCWD
Pat Conrad	EOR
Nancy-Jeanne LeFevre	EOR
Gene Eastlund	Resident
Gary Erichson	Resident
Mark Erichson	Resident
Doug Jackson	Resident
Sharon Jackson	Resident
Susan Jacobsen	Resident
John Lane	Resident
Mats Ludwig	Resident
Brian Ozzeilo	Resident
Dennis Todora	Resident
Jim Voegeli	Resident