INTRODUCTION

In 2006, the Mount Morris Lake Management District (MMLMD) received Wisconsin Department of Natural Resources (WDNR) grant funds to complete a five year treatment and treatment monitoring program for aquatic invasive species (AIS) within the lake. The two species of concern in Mount Morris Lake are curly-leaf pondweed (CLP) and Eurasian water milfoil (EWM). Along with reporting the results from conducted in 2009 targeting CLP and 2010 targeting EWM on Mount Morris Lake, this report serves to summarize the five-year project. It includes a description of the methods used to evaluate the treatments and the criteria used to determine if they were successful. Its frame of reference begins with the spring pretreatment survey completed during April 2010, but calls on data collected during 2006 – 2009.

As the biology of these two exotic AIS differ greatly, the strategies used to control their spread and density within Mount Morris Lake differed as well. Because CLP, an annual plant, produces reproductive structures that may sprout years after the initial parent plant is gone, a strategy was devised that included treating similar acreage year after year. The goal for CLP control was to reduce the plant's occurrence through the lake and as a result, minimize its spread during summer harvesting activities. In part, this would be achieved by reducing the turion (reproductive structure) base within the infected areas of the lake. To accomplish this, the same areas and roughly same acreage were treated annually for five years with a contact herbicide (endothall).

On the other hand, the perennial EWM reproduces primarily through auto-fragmentation in which fragments of the plant disperse through the lake and colonize new areas. As a result, this populations of EWM are very difficult to control. When surveys in 2006 turned up only a small isolated location of this plant within Mount Morris Lake, it was decided that controlling and even possibly eradicating the plant was an achievable goal due to its limited presence. Unfortunately this pioneer infestation spread into other areas of the lake, and by 2008 14.4 acres of the plant were being treated with a systemic herbicide (2,4-D).

Map 1 displays the areas that were proposed for treatment in May 2010 based on 2009 summer field surveys. The proposed CLP treatment areas included all areas treated in 2009 (28.6 acres), while the EWM treatment areas were proposed at 10.9 acres. Following an April 22 field survey, these areas were refined to 26.2 acres and 14.9 acres for CLP and EWM, respectively (Map 1). Treatments occurred on April 29 and May 3 by Schmitt's Aquatic Plant Control. Liquid 2,4-D was applied at 2.0 mg/L to EWM treatment areas first, and several days later the Aquathol K was applied to areas containing CLP at 1.5 mg/L. By applying the contact herbicide a few days later, the EWM would have adequate time to uptake the systemic herbicide, leading to plant mortality. At the time of the first treatment the water temperature was approximately 55°F with slight winds (5 mph) from the south. During the second treatment, the water temperature was 60°F with slight winds coming from the northwest.

TREATMENT MONITORING

Determining the success or failure of chemical treatments on AIS is often a difficult task because the criteria used in determining success or failure is ambiguous. Most people involved with AIS

management, whether professionals or laypersons, understand that the eradication of AIS from a lake, or even a specific area of a lake, is nearly, if not totally, impossible. Most understand that achieving control is the best criteria for success. Similar to previous annual reports, two different methods of evaluation were used to understand the level of control that was achieved by the chemical treatment that year and as the project progressed. A qualitative assessment was determined for each treatment site by collecting spatial data with a sub-meter Global Positioning System (GPS), in addition to, comparing detailed notes from the pre- and post treatment observations.

Quantitative monitoring of the treatments was completed following methodology developed by Onterra in 2005, previous to the creation and distribution of protocols by the Wisconsin Department of Natural Resources (WDNR) in April 2007. Like the WDNR protocol, the methodology calls for the monitoring of target plants and native plants before and after treatments. Quantitative sampling of CLP was conducted the spring previous to the treatment (pretreatment) and the spring following the treatment (post treatment). Because of the life cycle of this plant, a post treatment survey a few weeks following the treatment would not differentiate if a reduction in occurrence can be attributed to the herbicide application or the natural die-off of this species.

At each of 59 sample locations, two rake-tow samples were collected yielding data reflecting non-native and native plant presence, rake fullness ratings of each plant species, water depth, and substrate type. The pretreatment surveys are conducted annually to guide each year's control program. This will ensure that chemicals are used sparingly within the system and practical hand-removal areas will be selected. It also allows Onterra ecologists the opportunity to monitor and quantify the success of the previous year's management effort. Post treatment monitoring is conducted to assess treatment effects. The same point-intercept locations were visited and CLP presence was recorded as well as details reflecting its condition (health). Also at each location, a Ponar dredge was also used to extract two substrate samples; and by using a mesh screen, the sediment was sifted through until CLP turions could be isolated and counted. The collection of these data are aimed at determining if turion production is being stifled, and if the turion base within the sediment is being depleted over time. Data regarding turion abundance was collected in 2006 – 2009.

In addition to plant and turion presence, data was collected regarding water column phosphorus concentrations, which can be influence by the die-off of CLP in June / July. Near-surface and near-bottom samples were collected twice a month May – August and analyzed for total and soluble reactive (ortho) phosphorus by the Wisconsin State Laboratory of Hygiene. Lake stakeholders were solicited to help monitor this water quality parameter during the course of the project. These data were collected from 2006 – 2009.

2010 TREATMENT AND PROJECT STUDY RESULTS

Table 1 shows the treatment acreage in Mount Morris Lake for the duration of the five year project. Some of each year's CLP and EWM treatment areas overlapped, and as a result in 2008 several areas were treated both with endothall to target CLP and 2,4-D to target EWM. As explained in the 2009 annual report, it is believed that the use of this "cocktail" blend may have resulted in the removal of the above-ground biomass of EWM plants by the contact herbicide,

not allowing the foliar uptake of the systemic herbicide. The root crown of the EWM plant would not be affected, allowing it to rebound later in the summer. In the years to follow (2009 and 2010) a different strategy was utilized involving a split treatment of 2,4-D to target EWM, followed a few days later by an endothall treatment within CLP treatment areas.

Table 1. EWM and CLP treatment acreage on Mount Morris Lake during the course of the AIS Treatment Monitoring Project.

	2006	2007	2008	2009	2010
CLP	31.6	27.1	28.6	28.6	26.2
EWM	0.0	0.0	14.4	10.9	14.9

Over the course of the past five years, CLP occurrence has decreased substantially within the treatment areas (Figure 1). Decreases are observed each year except in 2009-2010, when CLP occurrence increased from 4.2% to 13.6%. While this increase is statistically valid, it does not warrant concern as there are several variables that explain the increase in CLP occurrence.

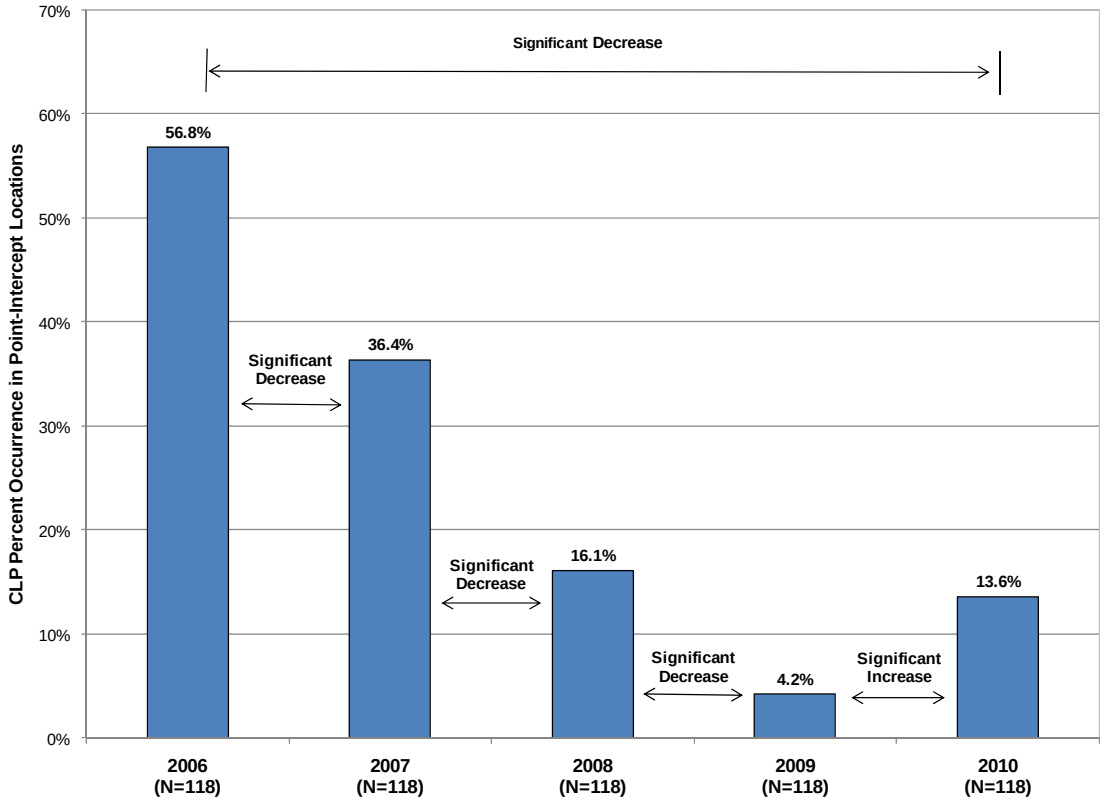


Figure 1. CLP percent occurrence from 2006-2010 pretreatment surveys on Mount Morris Lake. This data is based on the 59 point-intercept locations within CLP treatment areas.

In managing CLP, the primary objective is to deplete the turion base that lies within the sediment. These turions may produce CLP plants the year following their dispersal from the parent plant, or several years later. The increased presence of CLP in 2010 likely indicates that environmental factors were favorable to sprout buried turions. While this means that more plants

were sampled in this year, it also means that the turion base has depleted further. In the long run, this is beneficial in the MMLMD's attempt to control this exotic plant.

Each year, a rake fullness rating of 1-3 was used to determine abundance of the CLP at each point-intercept sampling location. Figure 2 displays the number of point-intercept locations exhibiting each of the rake fullness ratings within Mount Morris Lake. These data show that along with the observed reduction in CLP occurrence (Figure 1) in years 2006-2009, a reduction in CLP density was also documented. During the 2006 pretreatment survey, almost half (44.8%) of the point-intercept locations that contained CLP exhibited a rake fullness rating greater than 1. In 2009, no sample locations contained rake fullness rating greater than 1, indicating that along with documenting a decrease in CLP occurrence, the density of CLP has also been significantly reduced throughout the course of the project.

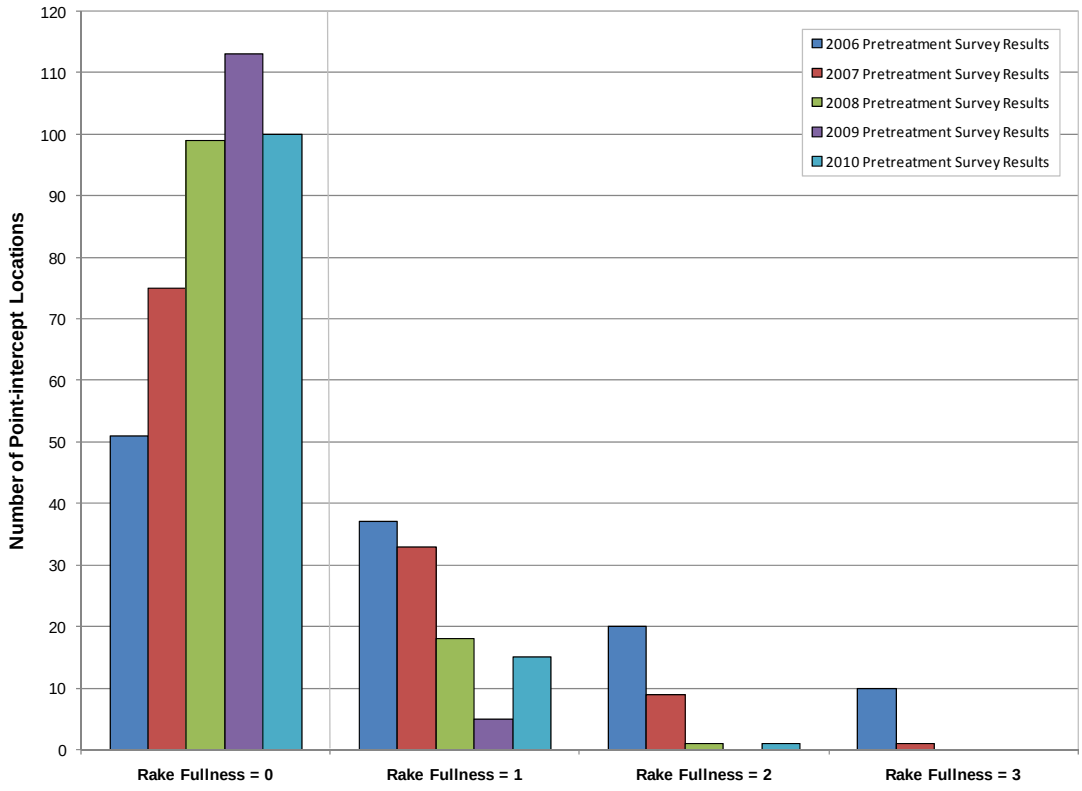


Figure 2. CLP rake fullness distribution from 2006-2009 pretreatment surveys on Mount Morris Lake. This data is based on the 59 point-intercept locations within CLP treatment areas.

The length of time that a turion remains viable in the sediment is unknown, but it is thought to be about 5-7 years, perhaps longer if anoxic (void of oxygen) conditions exist. Bottom sediment disturbances such as carp or harvesting activities (both applicable to Mount Morris Lake) can expose buried turions where they are able to sprout. Table 2 shows a slight reduction in turion prevalence from 2006-2008 and a considerable reduction from 2008-2009. Turion data was not collected in 2010.

Table 2. Analysis of CLP turion data collected in 2006-2009 after each year's chemical treatment occurred.

Year	Total	% Prevalence	Average	Range
2006	102	25.0	0.9	1-14
2007	135	23.2	1.2	1-23
2008	116	22.9	1.0	1-21
2009	66	16.9	0.6	1-18

This project is one of the first to attempt to quantify changes in the CLP turion base over time. While the methodology devised has proven to be an accurate way to collect turions, some limitations have been discovered. Each year, two sample locations have contributed 39% (2006), 52% (2007), and 27% (2008) of the total turion counts. In 2009, one sample location accounted for 36% of all turions encountered. Please note that these sample locations were not the same between these years. Mount Morris 2006-2007 Annual Report suggests that 'hot spots' of turion accumulation occur, most likely due to subtle differences in bathymetry, substrate type, and submersed aquatic vegetation, and have the potential to significantly influence the data. The data collected in 2009 supports this hypothesis. Also, many areas of Mount Morris Lake are covered with a carpet of muskgrasses, a macro algae, which the Ponar dredge has difficulty 'cutting' through, possibly under-representing the amount of turions that exist within sample locations that contain this type of vegetation.

As previously mentioned, water column phosphorus concentration data was collected as a part of this project by MMLMD volunteers and Onterra staff. In lakes with dense CLP occurrences, the water quality of the lake can be affected following the die-off of the CLP and are most often seen in raised total phosphorus levels. As Figure 3 shows, increased phosphorus levels in Lake D during 2004 coincide with the late June die-back of CLP.

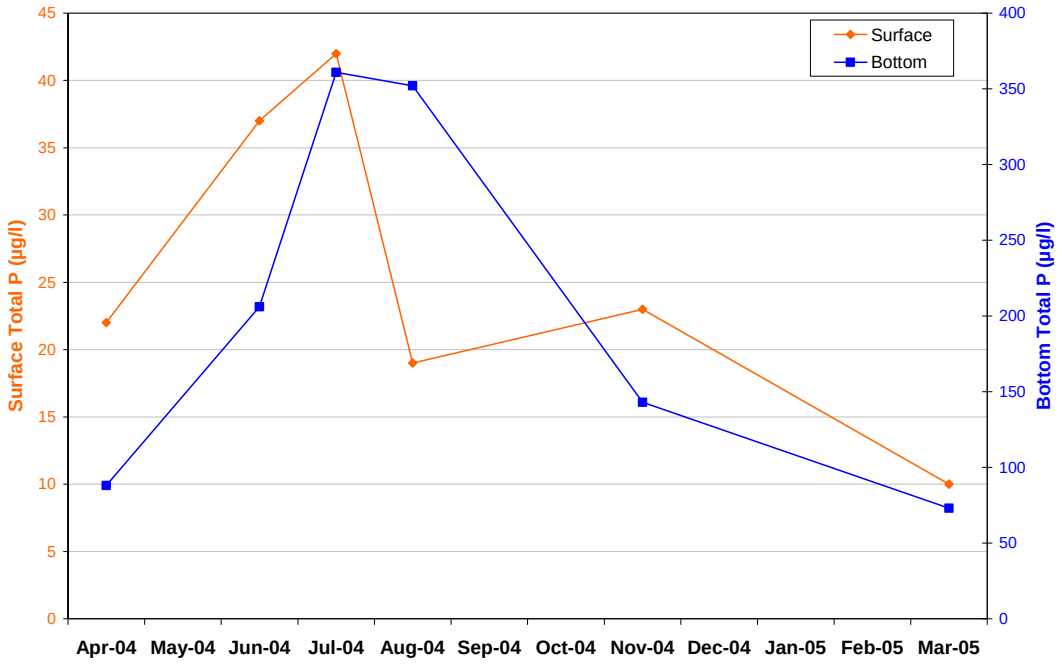


Figure 3. Total phosphorus concentrations in Mount Morris Lake D during portions of 2004 and 2005.

The observed spikes shown on Figure 4 from early June 2008 (Lake C) and late June 2008 (Lake D) are most likely not attributable to the die-off of CLP plants, but rather to the anomalous weather that mid and lower Wisconsin had during this year. On the weekend of June 7 & 8 of 2008, a massive stalled frontal boundary of extremely moist air produced heavy rains across much of the state, resulting in all-time daily rainfall records being set at four climate stations in southern Wisconsin (USGS 2008 publication 2008-5235, "Flood of June 2008 in Southern Wisconsin" by F.A. Fitzpatrick et al.). This intense rain event, along with others occurring several days later on June 12, affected much of southern Wisconsin and most areas of mid-state (including Mount Morris Lake) to a relatively lesser degree. The extreme rain events caused massive flushing of wetlands within Mount Morris Lake's watershed, resulting in nutrient-rich waters flowing through Mount Morris Lake first in Lake C, then weeks later in Lake D.

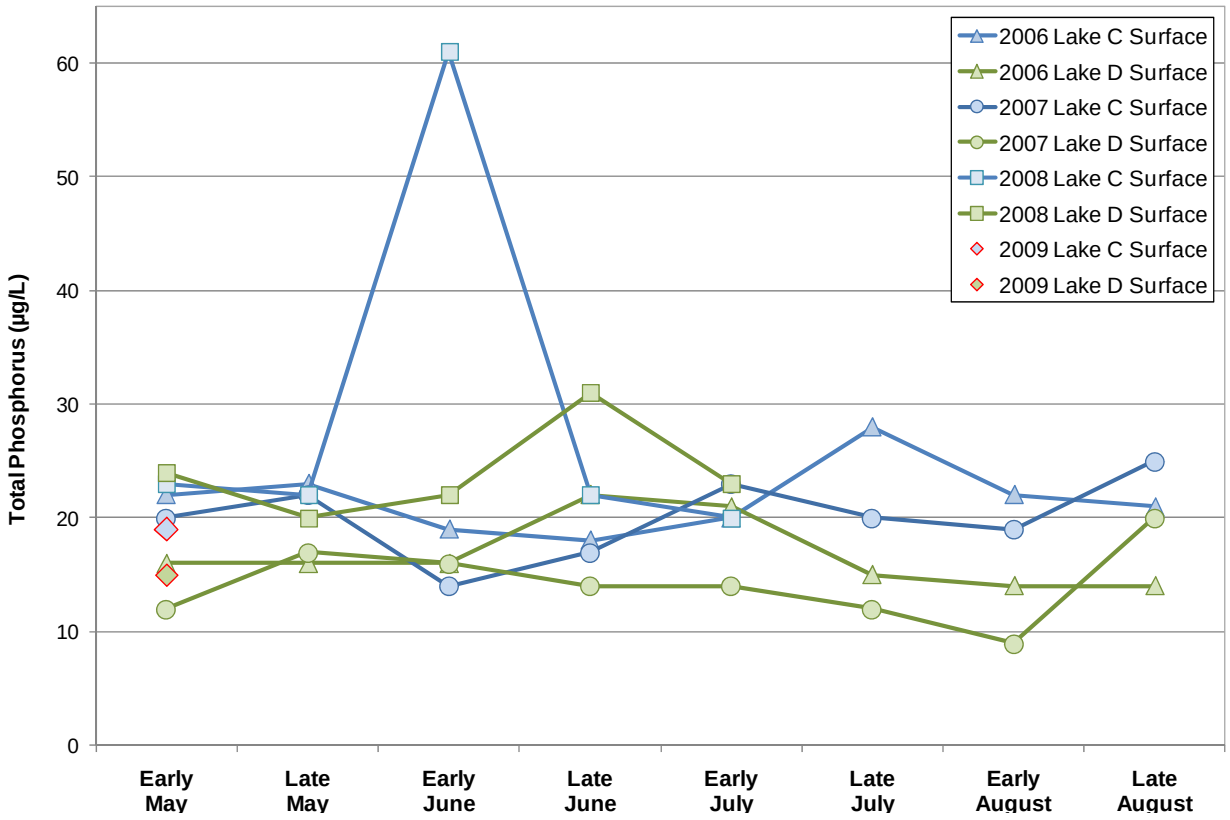


Figure 4. Surface phosphorus concentration data collected in Lake C and Lake D of Mount Morris Lake, 2006 – 2009. Samples collected by MMLMD volunteers and Onterra staff.

EWM has emerged as a secondary aspect of this AIS Treatment Monitoring Project. In 2006, only several plants were known of, residing in the area of the public boat launch on Lake C. Hand removal efforts were deployed at this time, followed by monitoring of the lake for more occurrences. Eventually, herbicide treatments were required in 2008 to address expanding colonies in numerous areas in the lake. In Emerald Lake, hand removal efforts in 2006 – 2008 appear to have been successful at removing EWM from this part of the system as no occurrences were discovered in the east side of this lake. Only several plants were discovered in 2010 in the west bay of Emerald Lake, and these were pulled during the 2010 post treatment survey by Onterra staff (Map 2). Between 2009 and 2010, there were considerable strides made in controlling EWM density within Lake A and Lake C. While occasional EWM plants still exist in Lake A, the amount observed during summer 2010 post treatment surveys does not warrant a treatment. The amount of treatable acreage decreased by 71% from 2009 to 2010 (14.9 acres to 4.3 acres, respectively).

Compared to the previous EWM herbicide treatments of over 10 acres, the proposed treatment for 2011 is the smallest one yet. Approximately 4.3 acres of scattered EWM is proposed for treatment within Lake C (Map 2). While the conditional treatment map indicates the presence of EWM in other areas Mount Morris Lake, primarily in Lake A and Lake C, this area of proposed treatment was the densest and most colonized within the system in summer of 2010. Prior to the

2011 treatment, Onterra ecologists will visit the lake and survey all known EWM locations to see if other areas warrant treatment or if the proposed treatment area has changed in size or shape.

The reduction of CLP occurrence over the course of the project has been promising, as is the observed depletion of the turion base. At this time, the most logical course of action would be to submit a conditional treatment permit using the 2010 treatment areas as a potential 2011 treatment. The purpose of the conditional permit is to allow the treatment strategy to be routed to the various departments within the WDNR to get approval far in advance of the treatment. The conditional permit can be slightly altered based upon the May surveys and most likely wouldn't require all the departments to review again during a period when time constraints are much greater. A spring 2011 survey will be conducted to evaluate if treatment is required in these areas (Map 2). It is more than likely that the treatment acreage will be reduced, based upon the advances seen in the past five years within these CLP treatment areas.

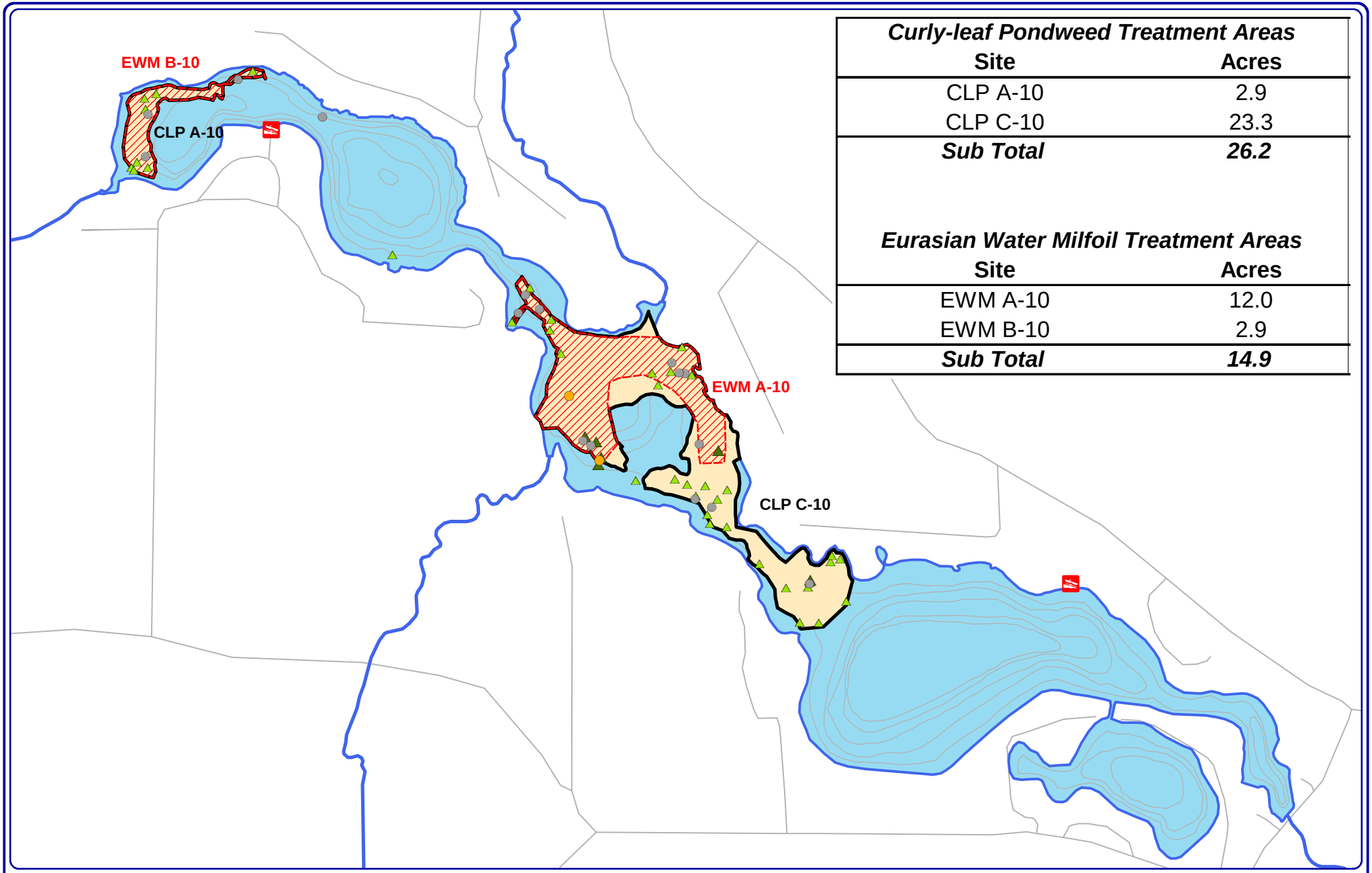
Again, with the aid of Schmidt's Aquatic Plant Control, the same treatment strategy developed for 2010 will be used in 2011 (Map 2). Each AIS will be targeted separately. Early in May 2011, a treatment with DMA IV (liquid 2,4-D) aimed at controlling EWM (4.3 acres) in Lake C is recommended. After a contact time of at least a few days, Aquathol K at 1.5 mg/L would be applied to the CLP treatment areas (proposed at 26.2 acres).

When the AIS Treatment Monitoring Project first began in 2006, several project goals were defined including:

1. Reduce CLP within the lake and as a result, minimize its spread through harvesting
2. Control or possibly eradicate small amounts of EWM that exists
3. Minimize additional AIS introductions
4. Prepare the MMLMD to continue management & control efforts past five-year project

Upon reviewing the data and comparing to the goals established at the beginning of the project, it is evident that the project has been successful in most aspects. CLP control has been met, with both qualitative and quantitative data supporting a decrease in abundance and density. While EWM has been successfully controlled in Emerald Lake via hand removal methods, continued efforts are needed in the main body of Mount Morris Lake, particularly in Lake A and Lake C. However, the EWM population has been decreasing within the lake and as a result, the smallest treatment in recent years is proposed for 2011. The goal of further minimizing additional AIS introductions has been met by MMLMD volunteers constructing informative signage at the boat landings on the lake.

Because volunteerism is low in the MMLMD, the District will likely need to rely on the aid of professionals to continue AIS control efforts. Currently the MMLMD is updating their lake management plan and as a part of this process, a long term AIS control strategy will be developed. The results of the multi-year control project will be valuable to creating realistic management goals for the MMLMD.



Curly-leaf Pondweed Treatment Areas	
Site	**Acres**
CLP A-10	2.9
CLP C-10	23.3
Sub Total	***26.2***

Eurasian Water Milfoil Treatment Areas	
Site	**Acres**
EWM A-10	12.0
EWM B-10	2.9
Sub Total	***14.9***

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Sources:
Roads & Hydro: WDNR
Aquatic Plants: Onterra, 2009 & 2010
Map date: March 8, 2011
File name: Map1_2009EWM_CLP_T2010.mxd

Project Location in Wisconsin

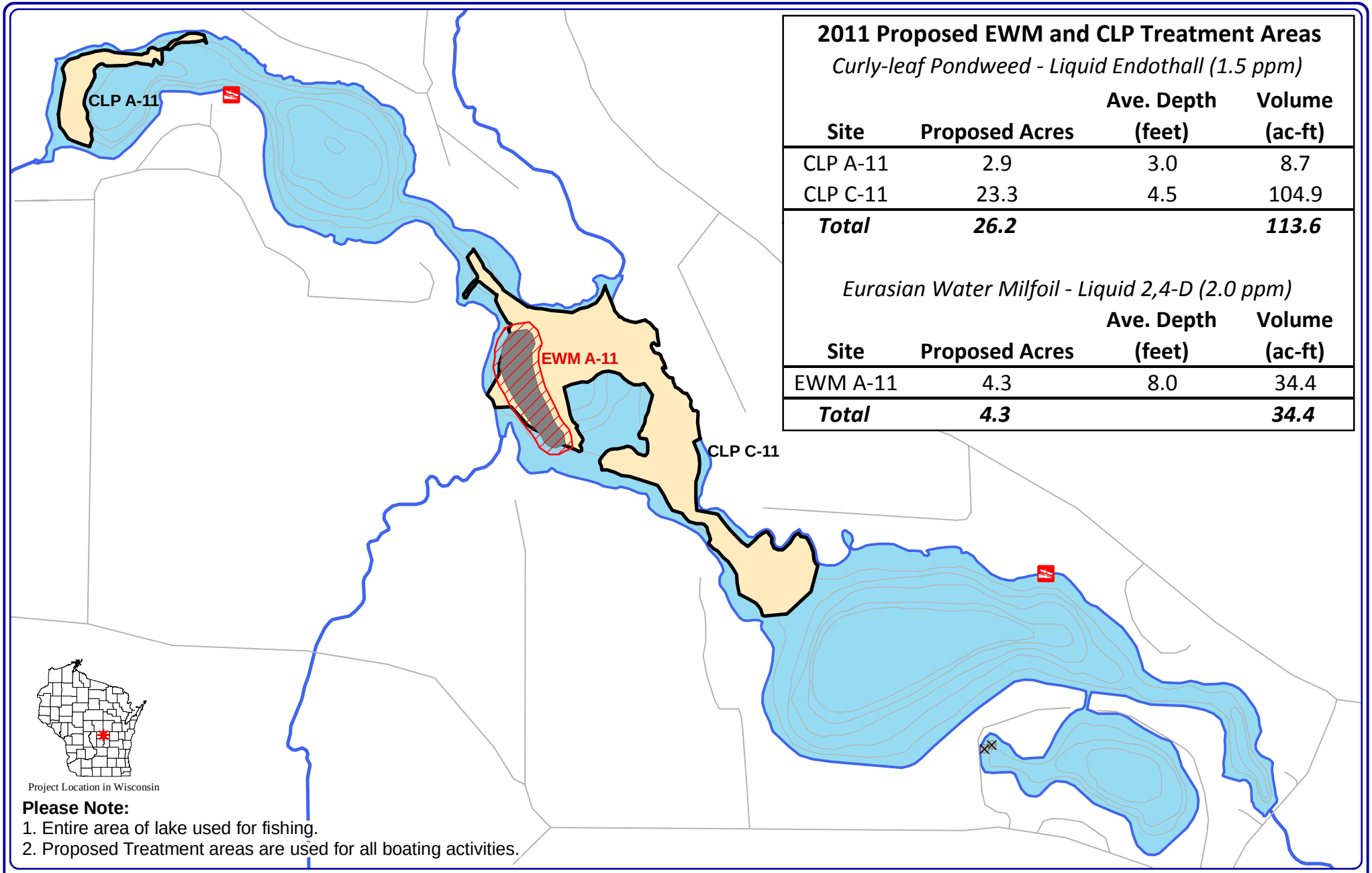
June 2009 and April 2010 Pretreatment EWM Survey Results
- Single or Few Plants
- Small Plant Colony

June 2009 and April 2010 Pretreatment CLP Survey Results
- Single or Few Plants
- Several Clumps / Small Plant Colony

2010 Final Treatment Areas
- Aquathol K (1.5 mg/L)
- Navigate (150 lbs/acre)

Map 1
Mt. Morris Lake
Waushara County, Wisconsin

2009 & Early 2010 AIS Survey Results & 2010 Treatment Areas



2011 Proposed EWM and CLP Treatment Areas

Curly-leaf Pondweed - Liquid Endothall (1.5 ppm)

Site	Proposed Acres	Ave. Depth (feet)	Volume (ac-ft)
CLP A-11	2.9	3.0	8.7
CLP C-11	23.3	4.5	104.9
Total	***26.2***		***113.6***

Eurasian Water Milfoil - Liquid 2,4-D (2.0 ppm)

Site	Proposed Acres	Ave. Depth (feet)	Volume (ac-ft)
EWM A-11	4.3	8.0	34.4
Total	***4.3***		***34.4***

Project Location in Wisconsin

Please Note:
1. Entire area of lake used for fishing.
2. Proposed Treatment areas are used for all boating activities.

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Sources:
Roads and Hydro: WDNR
Aquatic Plants: Ontera, 2010
Map Date: March 8, 2011
File Name: Map2_CLP_EWM_T2011_Cond1.mxd

Legend

2011 Proposed Treatment Areas
- CLP Treatment Areas
- EWM Treatment Areas

2010 EWM Survey Results
- Single or Few Plants
- Single or Few Plants *(Removed with rake)*
- Scattered

Map 2

Mt. Morris Lake

Waushara County, Wisconsin

2010 EWM Locations & Proposed 2011 Treatment Areas