INTRODUCTION

Initially, this project was designed to implement control methods to target the established infestation of curly-leaf pondweed (CLP) within the lake, with a secondary goal of reducing the pioneer infestation of Eurasian water milfoil (EWM). While CLP populations have decreased over the course of the project, EWM populations have become more established.

The purpose of this report is to relay information regarding the herbicide treatments conducted in 2008 targeting CLP and EWM on Mount Morris Lake. 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 2008, but calls on data collected during 2006 and 2007. These data were summarized in March 2008 within the report entitled Mount Morris Lake 2006-2007 AIS Project Update.

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 the 2006-2007 annual report, 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 were completed following protocols disbursed by the Wisconsin Department of Natural Resources (WDNR) in April 2007. This protocol calls for the monitoring of target plants and native plants before and after treatments. Quantitative sampling 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 location 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 was conducted to access short-term 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 2 samples of the substrate; 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.

Statistical Analysis of Pre- and Post Treatment Survey Data

Scientists often rely on the use of statistical analysis to understand whether the observed differences in nature are merely a product of chance or can be attributed to a particular factor. In the case of the pre- and post treatment monitoring surveys completed on Mount Morris Lake, the particular factor we are concerned with is the herbicide treatment. The desired result is a decrease in AIS within the treatment areas. The amount of AIS is measured with the sub-sampling surveys and expressed in terms of percent frequency of occurrence. The AIS frequency is a percentage of sub-sampling sites that contain AIS relative to the total sub-sampling sites. For example if a treatment site has 20 sub-sampling locations and 5 of those locations contained AIS, then the AIS frequency would be 25%.

As a part of the treatment monitoring, the sub-sampling sites are visited before and after the treatments to produce the pre- and post treatment data. By comparing those data, we can see if there is more, less, or the same amount of AIS before and after the treatment. As mentioned above, the desired result is to have less AIS after treatment. If there is a difference between the pre- and post treatment data, statistical analysis is used to determine if the difference is sufficient to be attributed to the treatment or if the difference may have occurred randomly. If the difference is sufficient, it is considered to be *significantly different*, if it is not sufficient, it is considered to be *insignificantly different*. In the end, a significant difference can be attributed to some factor, while an insignificant difference can only be attributed to random chance.

With guidance from WDNR Integrated Sciences, a Chi-square distribution analysis (alpha = 0.05) was used to determine if the quantitative data collected before the treatment are statically different from the data collected after the treatment. The alpha value is set such that we consider the results statistically significant when the test is 95% confident that the results are truly different and non-random.

The caveat to all of this is that we assume that the differences observed were caused by the herbicide treatment, but truly, without having comparable data from a non-treatment site (control group), this cannot be absolutely certain. For example, was the reduction in AIS caused by inter-annual variations caused by competitive dynamics between species, fluctuating water levels, natural plant cycles, or changes due to climatic conditions? Without a true experimental design that uses a control site, we cannot absolutely answer that question. In the end, it is impractical to take the risk of not treating a colony of AIS within a lake just to make sure that the results of the studies are scientifically sound; therefore making the educated-assumption that the difference is caused by the herbicide treatment is reasonable.

Pretreatment Survey – April 30, 2008

Map 1 displays the areas that were proposed for treatment in May 2008 based on 2007 field surveys. The proposed treatment areas include all areas treated in 2007 (27.1 acres), an additional 1.6 acres of expansion to Site C-08, and 1.4 acres of EWM to be treated. Areas that only contain CLP (Sites A-08 and D-08) were proposed for treatment using Aquathol K®, a contact herbicide, at 1.5 mg/L. Areas that contain EWM and not CLP (Sites E-08 and F-08) were proposed to be treated with Navigate® (granular 2,4-D) at 100 lbs/acre, a common systemic

herbicide used to control this species. Areas that contain both EWM and CLP (Sites B-08 and C-08) were to be experimentally treated with a combination treatment of Aquathol K® at 1.5 mg/L and Weedar 64® (liquid 2,4-D) at 1.0 mg/L. The dose of Weedar 64® proposed for treatment is less than would be suggested if it were the only chemical being used, but based upon recent studies conducted by the U.S Army Corps of Engineers, it was thought that the dose should be adequately high due to the synergistic effects caused by the chemical's use in combination with Aquathol K®.

Two field crews from Onterra were on the lake during this field survey. The weather conditions on the day of the survey were sunny with light wind. Viewing the AIS on Mount Morris Lake from the surface was effortless because of the optimal weather conditions and the clarity of the water at that time of year. An aqua scope and submersible video camera were used to aid in the survey. The ambient air temperature was 41°F and the surface water temperature was approximately 50°F.

The purpose of this survey was to refine the treatment areas used in the conditional permit to more accurately and effectively coordinate the control method. During the survey, it was determined that the proposed treatment areas seemed to accurately portrait the extents of the CLP within the lake and no changes were made to these areas. However, the two EWM colonies (Sites E-08 and F-08) proposed for treatment with Navigate® were removed from treatment as an insignificant amount of this invasive species were located to warrant chemical treatment. These areas would be visited later in the growing season where hand-removal control methods may be implemented. The revised treatment recommendations were accepted by the Mount Morris Lake Management District (MMLMD) and the WDNR, and considered the *final* treatment areas. These data were then provided to the herbicide applicator.

During this field visit, ecologists visited 59 point intercept locations to be used in the monitoring of the chemical treatments. At these locations, native and non-native plant occurrence was documented using the methodology described above.

Curly-leaf Pondweed Turion Survey – July 3, 2008

At the same 59 points visited during the pretreatment vegetations survey, two Ponar dredge samples were taken at each location to determine if the chemical treatments were depleting the turion abundance within the sediment. Although notes were collected at each of these locations relating to the health of the CLP present, these data were used as qualitative reference only. An examination of the condition of CLP at this stage in its growing season is not truly valid whereas completely healthy CLP plants would likely be senescent at this time.

EWM Hand Removal & Peak biomass Survey – September 17, 2008

During this survey, all previously known occurrences of EWM were visited to determine the efficacy of the chemical application and to provide an accurate account of all EWM locations within the lake to aid in coordinating the 2009 management actions. The conditions were warm (77°F) and hazy. At this time of year the EWM has reached its peak biomass, so the plants have nearly reached the surface, making viewing this plant optimal.

During this survey, numerous EWM occurrences were mapped within Site C-08 including a large colony located along the west part of this basin (Map 2). The EWM within this colony dominated the native plant community and was found to be canopying at the surface in some areas.

Two certified divers from Onterra scoured an area near the boat landing and in Emerald Lake (Lake E). While no EWM was detected near the boat landing, numerous occurrences were removed from Emerald Lake. The divers carefully extracted the entire plants from the soft sediments, stuffed the plants into mesh bags underwater, and then off-loaded the bags onto the boat once they were full.

Water Quality Monitoring

Stakeholders were solicited to help monitor the water quality in Mount Morris Lakes during the growing seasons of this 4 year project. In the first year, volunteers were trained to collect water quality samples from the deep holes of basins C and D. 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.

In 2008, water quality samples were taken up until the middle of July when the unfortunate passing of the volunteer lake monitor took place. The MMLD is coordinating with a new volunteer to continue the water quality monitoring during the final two years (2009-2010) of the current project.

CONCLUSIONS AND RECOMMENDATIONS

Table 1 displays the results of the pretreatment point-intercept vegetation surveys conducted within the treatment areas on Mount Morris Lake. Chi square analysis shows that the CLP occurrence is statistically decreasing over the course of the project.

Table 1. Percent occurrence of select aquatic plants from 2006-2007 pretreatment surveys. * = non-native plant species.

Species	2006 % Occurrence	2007 % Occurrence	2008 % Occurrence
Curly-leaf pondweed*	58.5	40.7	25.4
Eurasian water milfoil*	0.0	2.5	5.1
Coontail	32.2	11.9	26.3
Muskgrasses	75.4	85.6	80.5
Elodea	44.9	35.6	23.7
Northern water milfoil	22.9	1.7	6.8

A rake fullness rating of 1-3 was used to determine abundance of the CLP at each location. Figure 1 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 (Table 1), a reduction in CLP density was also documented (Figure 1). During

the 2006 pretreatment survey, 44.8% of the point-intercept locations that contained CLP exhibited a rake fullness rating greater than 1. In 2007, the percentage of a rake fullness rating greater than 1 was reduced to 23.3% and further reduced in 2008 to only 5.3%.

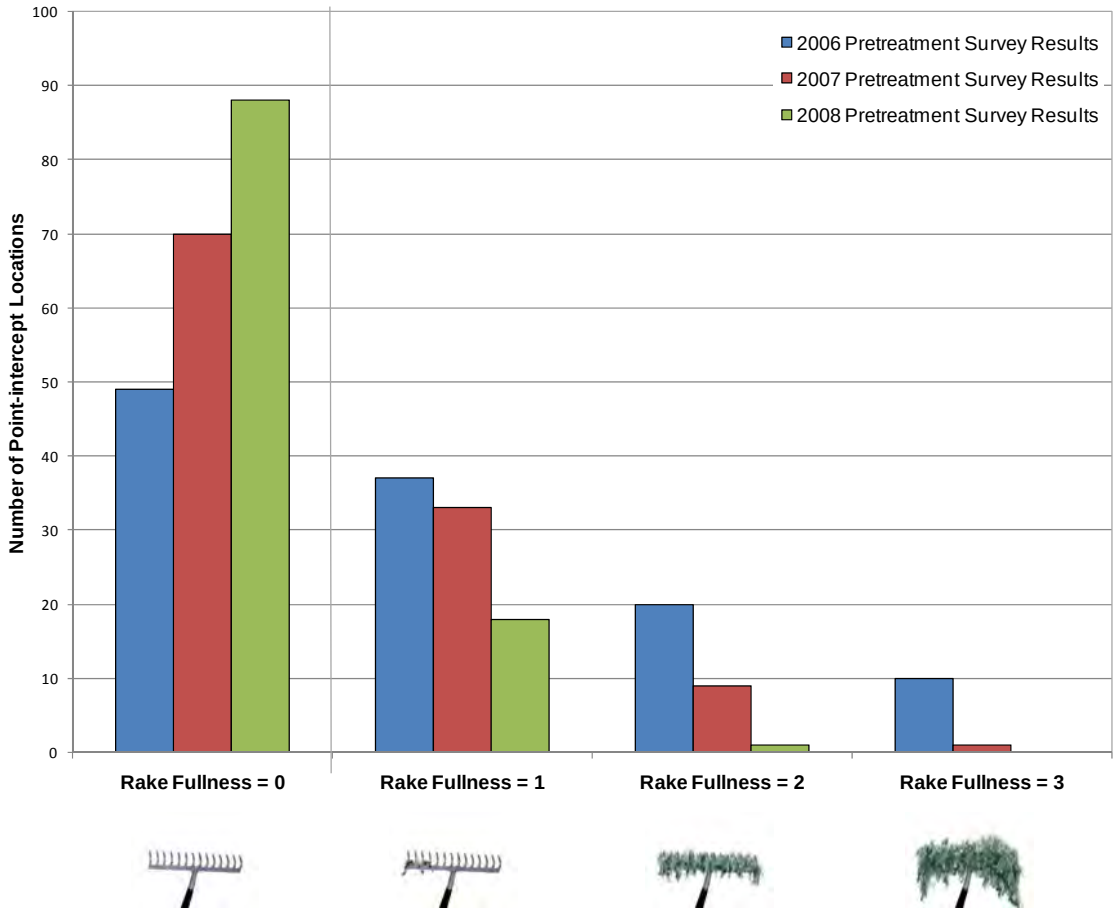


Figure 1. CLP rake fullness distribution from 2006-2008 pretreatment surveys on Mount Morris Lake. This data is based on the 59 point-intercept locations shown in Appendix A – Map.

The observed reductions in CLP occurrence and density may be a function of the reduction in turions. The length of time that a turion remains viable in the sediment is unknown but it is thought to be between 2-5 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 only a slight reduction (statistically insignificant) in turion prevalence over the last three years.

This project is one of the first to attempt to quantify 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% (21007), and 27% (2008) of the total turion counts. Please note that these sample locations were not the same between the two years. The 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 2008 supports this hypothesis. Also, many areas of Mount Morris Lake are covered with a carpet of muskgrasses (Table 1), 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.

Table 2. Analysis of CLP turion data collected in 2006-2007 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

Most native plants should be at very low biomass (or not even started growing yet) during the pretreatment surveys. However, it is important to understand the effects of the contact herbicide on some of the lake's native plants. The MMLD coordinates mechanical harvesting activities on the system, mainly targeting coontail and elodea (common water weed). Chi square analysis shows that coontail populations have not statistically changed and elodea has significantly decreased within the treatment areas during the past three years. Because these plants are not rooted and are largely influenced by water movement, the observations may be independent of the herbicide treatments.

A statistically significant reduction in northern water milfoil occurrence has been documented within the treatment areas during the past three years as well as a statistically significant increase in EWM occurrence with these areas. Northern water milfoil, a dicot, should not be susceptible to the herbicide (endothall) used to control CLP in 2006 and 2007. Although the 2,4-D applied in Lake C in 2008 targets dicot species, its timing should not have caused mortality to the northern water milfoil. It is likely that the observed differences are a function of timing (e.g. the northern water milfoil has not yet emerged from the soil during the time of the surveys), or that increased EWM occurrences may be displacing the native milfoil species. The latter is one of the chief concerns associated within an AIS infestation.

The vast majority of the increased occurrences of EWM are within Site C-08 (Map 2). The experimental treatment using a combination of Aquathol K® (endothall) at 1.5 mg/L and Weedar 64® (liquid 2,4-D) at 1.0 mg/L was shown to be effective on CLP, but not effective on EWM. As stated above, the liquid 2,4-D concentration was lower than would be independently applied, but synergistic effects were thought to make the dose effective. John Skogerboe, scientist from the US Army Corps of Engineers, initially recommended a lower dose (1.0 mg/L) of endothall be used in conjunction with the 2,4-D to control the EWM. Concerns were raised whether the low dose of endothall would effectively control the CLP and therefore a higher dose (1.5 mg/L) was chosen.

It is unclear if simply increasing the dose of 2,4-D would result in increased treatment effectiveness. The contact herbicide endothall, while effectively controlling the CLP, may be inhibiting the EWM from up taking the systemic herbicide (2,4-D). While it may appear that the EWM has been controlled as evidenced by removal of the exposed foliage, a significant amount

of the systemic herbicide was not taken up by the EWM to kill the plant. The EWM simply re-sprouts from its root crown.

With the aid of Schmidt's Aquatic Plant Control, a slightly different treatment strategy has been developed for 2009 (Map 2). It is proposed that each AIS be targeted separately. Early in May 2009, a treatment aimed at controlling EWM in Lake C using Navigate® (granular 2,4-D) at 150 lbs/acre is recommended. After a contact time of at least 72 hours, Aquathol K® at 1.5 mg/L would be applied to the CLP treatment areas. By applying the contact herbicide a few days later, the EWM will have adequate time to uptake the systemic herbicide, which will lead to death of the plants.

In 2004, surface total phosphorus values in Lake D spiked at over 40 µg/L during July. These concentrations coincide with the large-scale die off of CLP within the Lake. During July of 2006-2008, almost no such spike can be observed (Figure 2); especially at the magnitude that was observed in 2004 before treatments occurred (40 µg/L). One noticeable spike was observed on Lake C in early June of 2008. This spike is likely not attributed to the die-off of CLP which would have occurred closer to the beginning of May when the herbicide treatment was conducted. Norwegian Lake and Porters Lake both drain into Mount Morris Lake at Lake C. Based upon data collected by the USGS at a nearby river (Montello River), stream flows spiked during early- to mid-June at levels over 8 times higher than reported during other times of the year. The large amount of flow likely flushed the nutrient-laden wetlands along the Mount Morris tributaries, causing the observed spike.

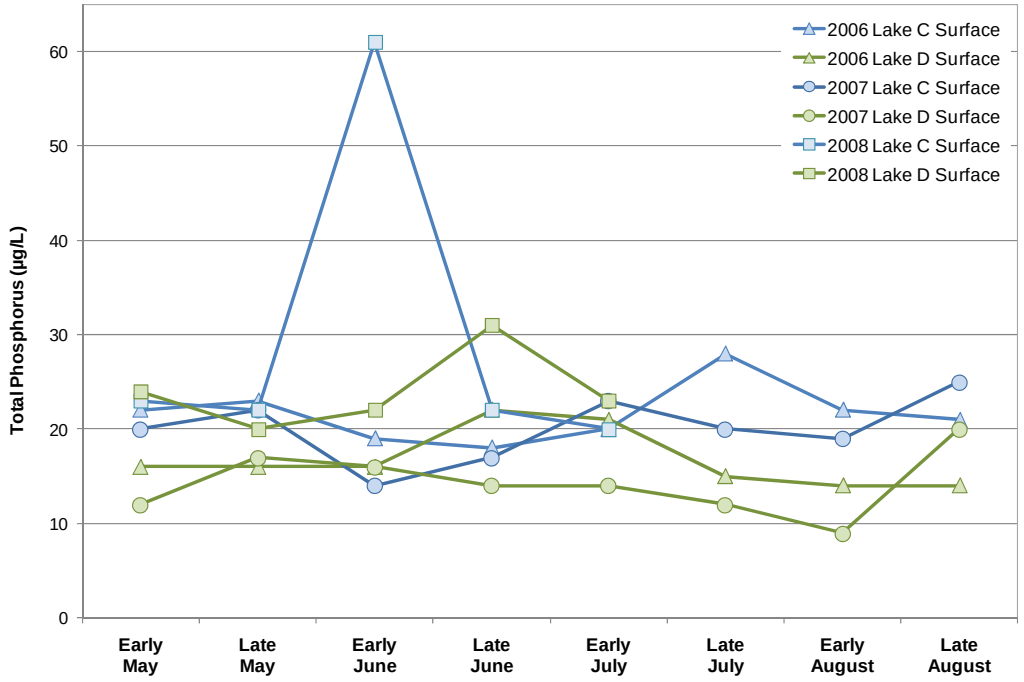
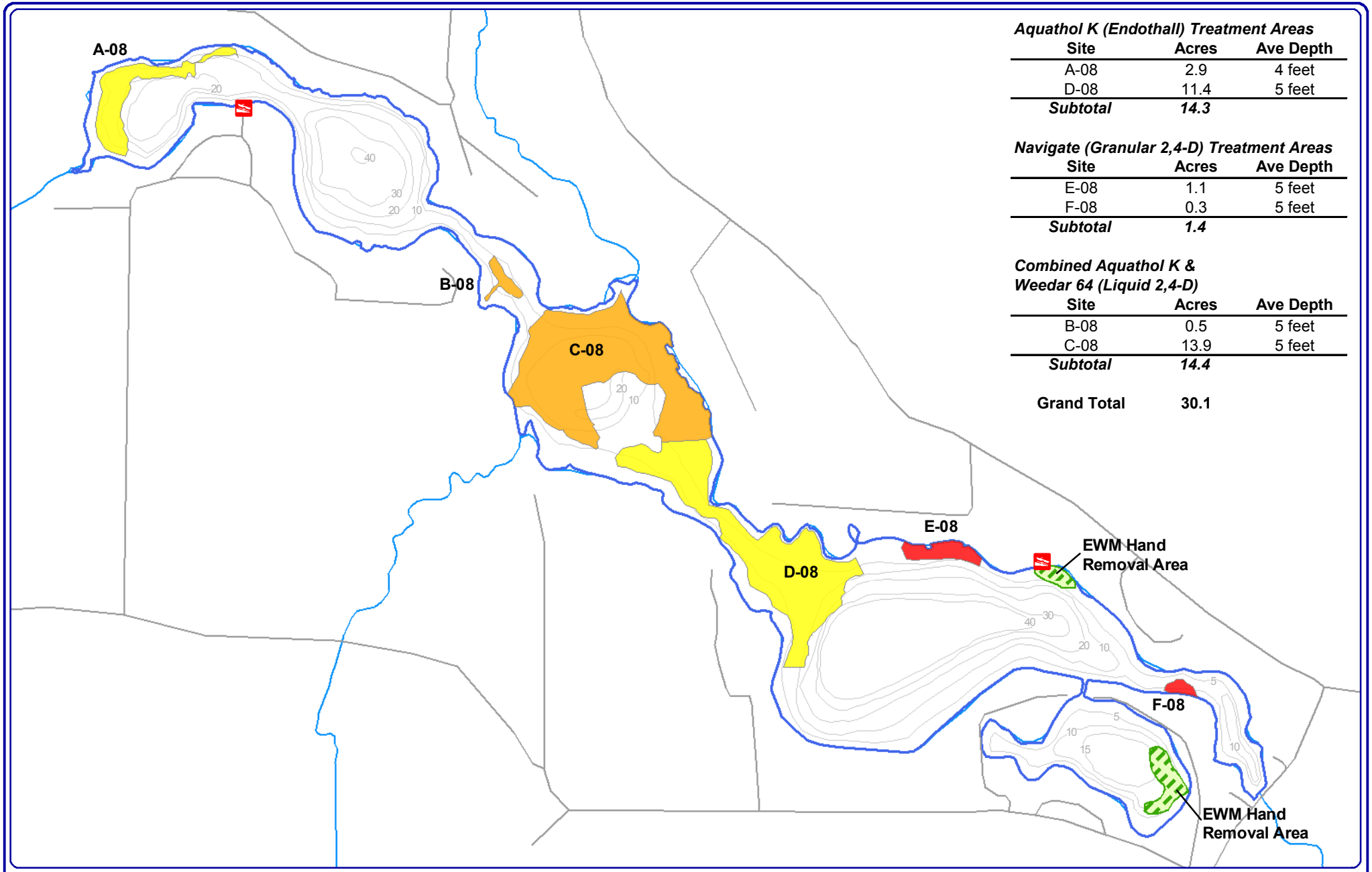


Figure 2. Surface total phosphorus values from Mount Morris Lake.

It is perceived that the management of AIS within Mount Morris Lake has yielded some significant successes. Curly-leaf pondweed occurrences are continuing to decline, likely as the turion base is becoming exhausted. Phosphorus spikes related to the large die-off of this species have not been observed within the last 3 years, likely because the biomass of CLP has been considerably reduced since 2004. While the use of herbicides to control EWM on the system were not met with success, the hand removal operations have shown to be considerably effective. The use of hand removal control methods for EWM are proposed for use in Emerald Lake next year (Map 2).

In lakes without AIS, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. Although CLP and EWM exist in Mount Morris Lake, monitoring for new colonies is essential to successful control. In 2006, volunteers from the MMLD were trained on AIS identification and field data collection. An increased commitment by MMLD members are needed to monitor for these new occurrences to properly coordinate effective management control methods.



Aquathol K (Endothall) Treatment Areas

Site	Acres	Ave Depth
A-08	2.9	4 feet
D-08	11.4	5 feet
Subtotal	***14.3***	

Navigate (Granular 2,4-D) Treatment Areas

Site	Acres	Ave Depth
E-08	1.1	5 feet
F-08	0.3	5 feet
Subtotal	***1.4***	

Combined Aquathol K & Weedar 64 (Liquid 2,4-D)

Site	Acres	Ave Depth
B-08	0.5	5 feet
C-08	13.9	5 feet
Subtotal	***14.4***	
Grand Total	**30.1**	

N W E S

800

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
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www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Aquatic Plants: Onterra, 2007
Bathymetry: WDNR (Digitized by Onterra)
Map date: February 20, 2009
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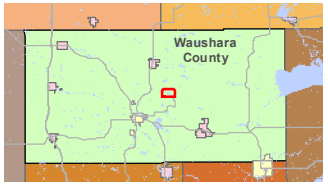


Extent of large map shown in red.

Legend

2008 Proposed Treatment Areas

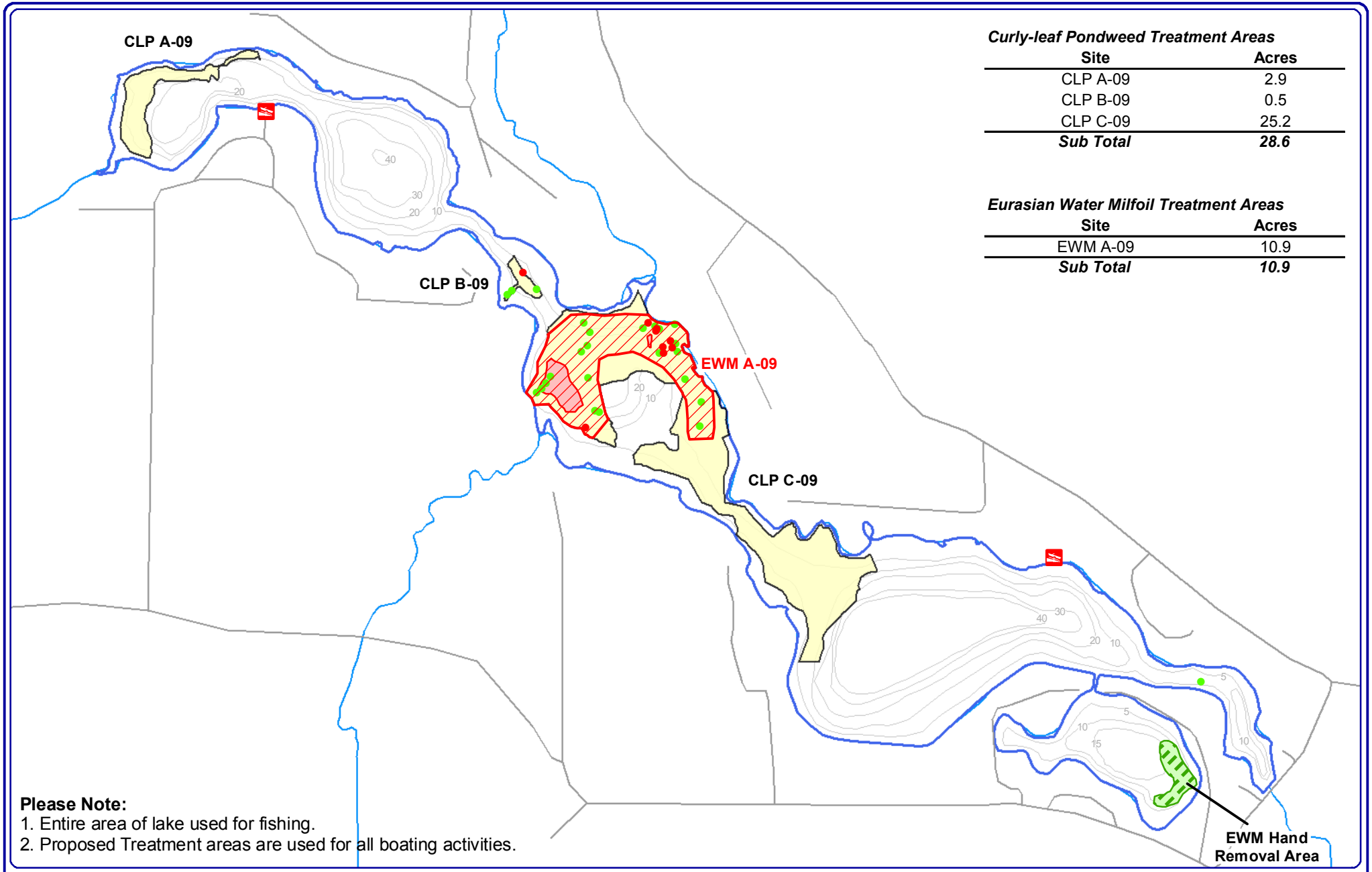
- Aquathol K (1.5 mg/L)
- Combined Aquathol K (1.5 mg/L) & Weedar 64 (1.0 mg/L)
- Navigate (100 lbs/acre)

Map 1

Mt. Morris Lake

Waushara County, Wisconsin

2008 Proposed EWM & CLP Treatment Areas



Curly-leaf Pondweed Treatment Areas

Site	Acres
CLP A-09	2.9
CLP B-09	0.5
CLP C-09	25.2
Sub Total	***28.6***

Eurasian Water Milfoil Treatment Areas

Site	Acres
EWM A-09	10.9
Sub Total	***10.9***

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

N W E S

800

Feet

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Sources:
Roads & Hydro: WDNR
Aquatic Plants: Onterra, 2008
Bathymetry: WDNR (Digitized by Onterra)
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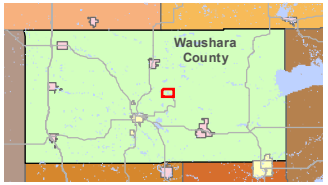

Extent of large map shown in red.

Legend

2009 Proposed Treatment Areas
- Aquathol K (1.5 mg/L)
- Navigate (150 lbs/acre)

2007 EWM Survey Results
- Single or Few Plants

2008 EWM Survey Results
- Single or Few Plants
- Highly Dominant Colony

Map 2

Mt. Morris Lake

Waushara County, Wisconsin

2009 Proposed EWM & CLP Treatment Areas