An Aquatic Plant Lake Plan
for Golden Lake– Waukesha County, WI
November, 2017

Marine Biochemists services at Lonza
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Acknowledgements

Marine Biochemists would like to thank members of the Golden Lake Association for their financial commitment, as well as their time and dedication to the continued protection of this important resource. Many hours of volunteer time were spent attending meetings, recruiting volunteers, selecting vendors and planning their management activities, along with providing guidance on this Report.

The data contained within this Report are based, in part, upon countless hours of data collection by WI DNR—Science Service Staff (Nault, Van Egeren, et al) during the 2013-2014 Aquatic Plant Surveys. We wish to recognize their contributions, as well as the efforts of Heidi Bunk (WI-DNR Waukesha Office) for her Review of this, and previous Reports, along with the Aquatic Plant Management Plan (2015), assistance with Grants, Permitting, Plant Management advisement and on-site field supervision.

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Introduction

Golden Lake is an approximate 250 acre lake located principally in the Town of Summit, Waukesha County, Wisconsin. A portion of the lake lies in the far east portion of Jefferson County in the Town of Concord.

While the presence of Eurasian Watermilfoil (EWM) was first recorded by the WI DNR in 2005 during assessment surveys, it was not until 2011 that its' presence required a more formal investigation and a review of control options by the local Golden Lake Association. Marine Biochemists was contacted and invited in 2011 to conduct a brief survey of the lake and offer recommendations for control of EWM. In 2012, Marine Biochemists was hired to conduct a more formal lake-wide survey to accurately determine the distribution of EWM and offer recommendations for it's control. The Report, entitled "A Survey of the Distribution of Eurasian/Hybrid Watermilfoil in Golden Lake—Waukesha and Jefferson Counties, WI" was published in February of 2013.

Since 2012 The Golden Lake Association has used a variety of methods, including manual removal, 2,4-D treatments and Diver Assisted Suction Harvesting ("DASH") to managed the milfoil population. A number of Full Point Intercept (PI) Surveys (May and August, 2013, and September, 2014) and Partial PI Surveys (Fall, 2015 and 2016) have been conducted to monitor control results and to plan for future management activities.

With the assistance of a State Grant the Golden Lake Association contracted with Marine Biochemists to conduct a Full PI Survey in August, 2017. This survey was started on August 26 and was completed on September 8, using the same standard protocol and methodology used in the 2013/2014 surveys. This Report presents a summary of the data collected, along with a quantitative analysis and discussion of the results for the various management techniques employed by the Association since the initial Full PI survey was undertaken in 2013.

Survey Methodology

The protocol for the Full PI surveys called for the sampling the vegetation at 565 pre-determined sites within the lake. These locations were spaced apart by approximately 46 meters in general north-south and east-west transects across Golden Lake using waypoints (longitude and latitude coordinates) established by the WI DNR (see fig. #1).

During these surveys a crew navigated to each waypoints using a Global Positioning System (GPS). At each point where water depth was at or less than the maximum plant rooting depth (approximately 25-30 feet), plants were sampled using a rake head attached to either a Pole (P) or Rope (R). Water depth was recorded and the dominant bottom sediment type (muck, sand, rock) noted. Plants collected were identified to genus and/or species, individual plant species density (rake fullness for a single plant type) determined, along with total plant density (rake fullness for all plants). This data was then recorded for each site. An example of this "rake fullness" density determination is found on fig #3. Please also note that Inadequate depth, emergent plants (cattails) and/or excessive vegetation prevented access to some of these pre-selected "waypoints". This information was recorded as well during the surveys.

In 2015 and 2016, Partial PI Surveys were conducted that focused on the portion of the lake containing EWM/Hybrid down to a depth of approximately 14 feet. A map for these sites is found in figure 2.

Survey Results

Below are Tables comparing the abundance of both the most common native and non-native aquatic plant species found in Golden Lake during the 2013-2014 Full PI Surveys conducted by WI DNR and 2017 by Marine Biochemists using the P/I Survey Methodology.

Non-native Species Scientific Name	Common Name	# Sites Sept.-2017	# sites Sept.-2014	# sites Aug.-2013	# sites May,2013
Myriophyllum spicatum	Eurasian Watermilfoil	54	72	70	118
Potamogeton crispus	Curlyleaf Pondweed	1	1	0	4

Native Species Scientific Name	Common Name	Rank Sept.-2017	Rank Sept.-2014	Rank Aug.-2013	Rank May,2013
Chara, sp.	Chara	1	1	1	1
Najas flexilis	Slender naiad	2	8	7	na
Ceratophyllum demersum	Coontail	3	3	3	2
Vallisneria americana	Eelgrass	4	2	2	12
Stuckenia pectinata	Sago pondweed	5	4	4*	8
Nitella, sp.	Nitella	6	10	6	4
Potamogeton natans	Floating-Leaf pondweed	7	11	9	10
Utricularia	Common bladderwort	8	6	10	11
Potamogeton gramineus	Variable Leaf pondweed	9	7	4*	na
Potamogeton illoensis	Illinois Pondweed	10	5	5	5

The aquatic plant survey indicated that the lake contains a diverse aquatic plant community. Plants were collected at depths of up to 29 feet during the 2017 survey, and 30-33 ft. during the earlier surveys. Figures #4 and 5 detail the relationship between water depth and the number of sites where aquatic vegetation was found in both Table and Graph forms. Figure 6 provides the location of sites with aquatic vegetation (native or non-native).

The locations where AIS (Eurasian Watermilfoil and/or Curlyleaf Pondweed) were found are shown on Figures #7 and #8. It is important to note that Figure #7 provides Pre and Post Treatment Data showing a significant reduction of Eurasian Watermilfoil following the treatment on June 4, 2013.

It should be noted that treatments for the control of EWM/Hybrids have been conducted in all years since 2013-17 with the exception of 2014. Detail on these treatments will be discussed in greater detail in another section of this Report.

While Curlyleaf Pondweed has been observed in Golden Lake, very little has been detected during the formal PI Surveys due to survey timing. This species typically reaches a maximum biomass in late May/mid June, then dies back after the 4th of July. It may re-develop once again somewhat in late Fall once water temperatures have cooled.

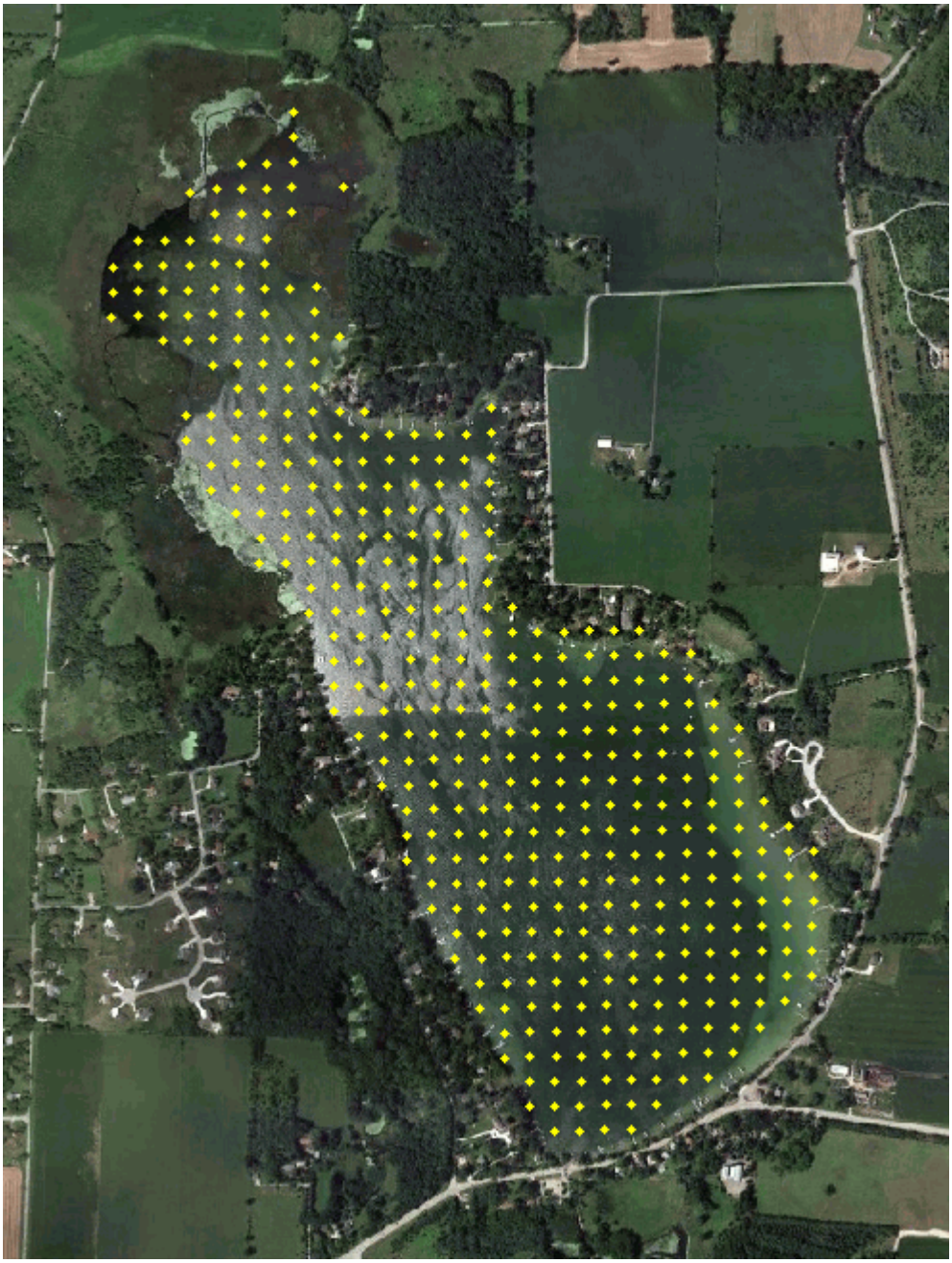
Figures 9-15 detail the location of the Top Seven Ranked Native Plant Species observed in Golden Lake during the 2017 survey. Maps of the distribution and rake fullness for these species during previous surveys are also provided as a comparison.

Further discussion of the Results and Comparison with prior surveys continues after the species maps on page 18.

Figure 1

Location of WI DNR Sampling Waypoints

Golden Lake, Waukesha/Jefferson Counties, WI



Total # of Sampling Points Visited: 435

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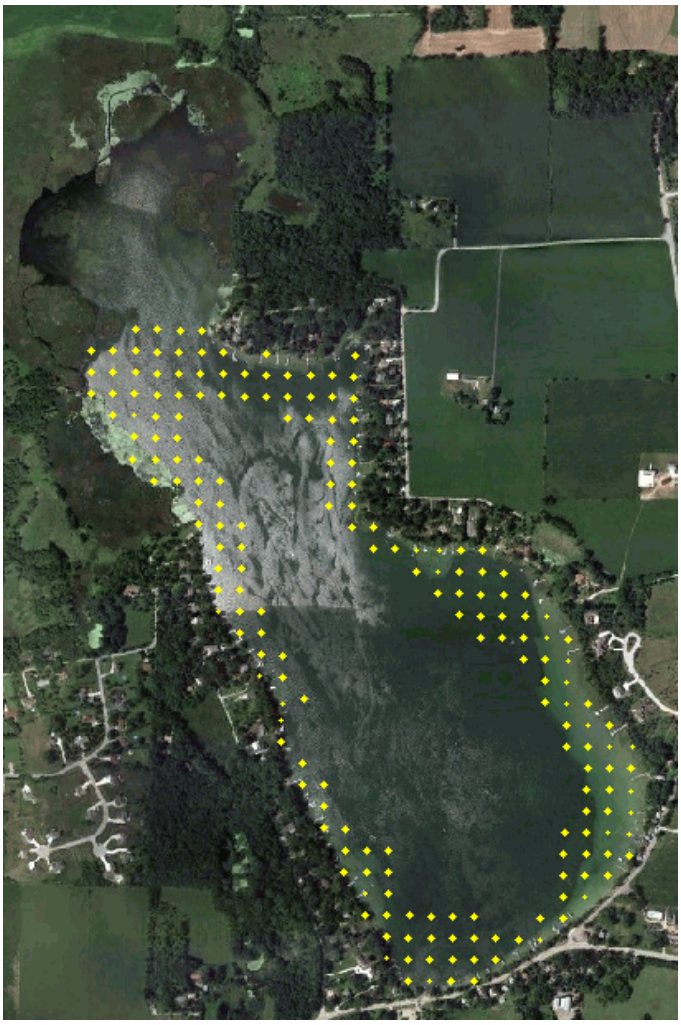
Figure 2

Location of WI DNR Sampling Waypoints (Partial PI Surveys 2015/16)

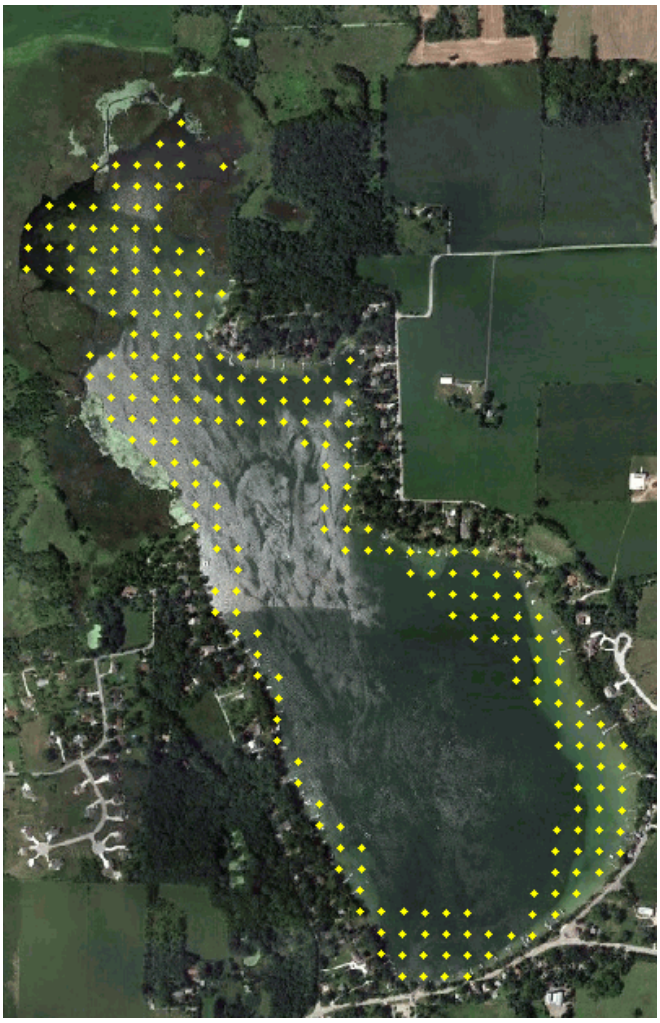
Golden Lake, Waukesha/Jefferson Counties, WI

2015



Sampling Points: 201

2016



Sampling Points: 250

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Figure 3

Aquatic Plant Fullness Ratings

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

Figure 4

Depth of Plant Colonization-Golden Lake, Waukesha/Jefferson Counties, WI

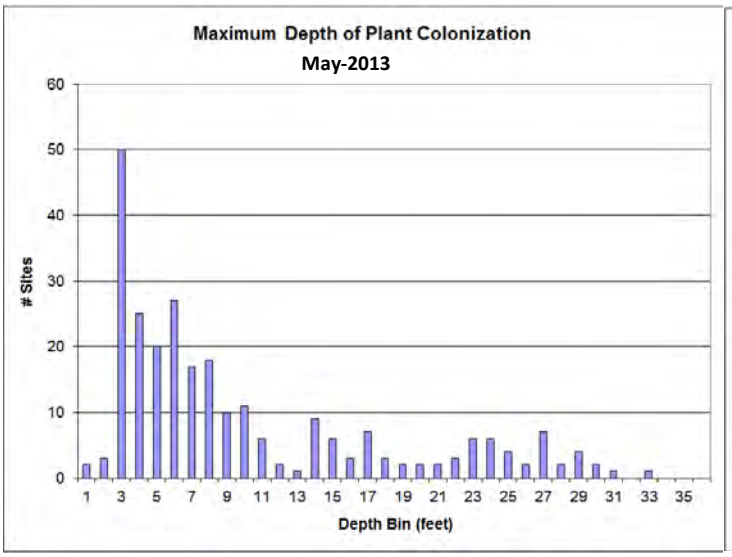
May, 2013—Sept., 2017 Full PI Surveys (Table Form)

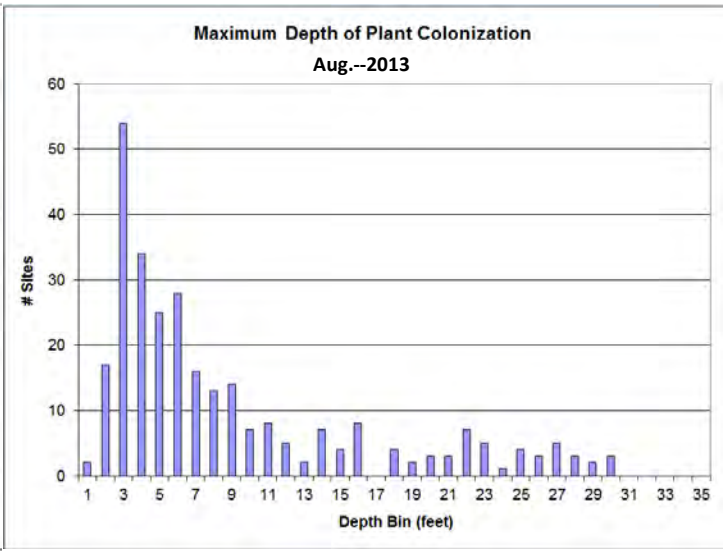
Depth (ft.)	May,. 2013	Aug., 2013	Sept., 2014	Sept., 2017
1	2	2	3	9
2	3	17	14	58
3	50	54	60	50
4	25	34	21	26
5	20	25	28	36
6	27	28	28	24
7	17	16	22	16
8	18	13	8	7
9	10	14	14	7
10	11	7	11	7
11	6	8	6	7
12	2	5	3	3
13	1	2	4	0
14	9	7	6	6
15	6	4	2	2
16	3	8	2	3
17	7	0	7	4
18	3	4	0	4
19	2	2	8	5
20	2	3	4	5
21	2	3	3	6
22	3	7	4	3
23	6	5	3	5
24	6	1	4	7
25	4	4	4	5
26	2	3	4	4
27	7	5	2	1
28	2	3	2	0
29	4	2	6	0
30	2	3	2	0
31	1			
32	0			
33	1			

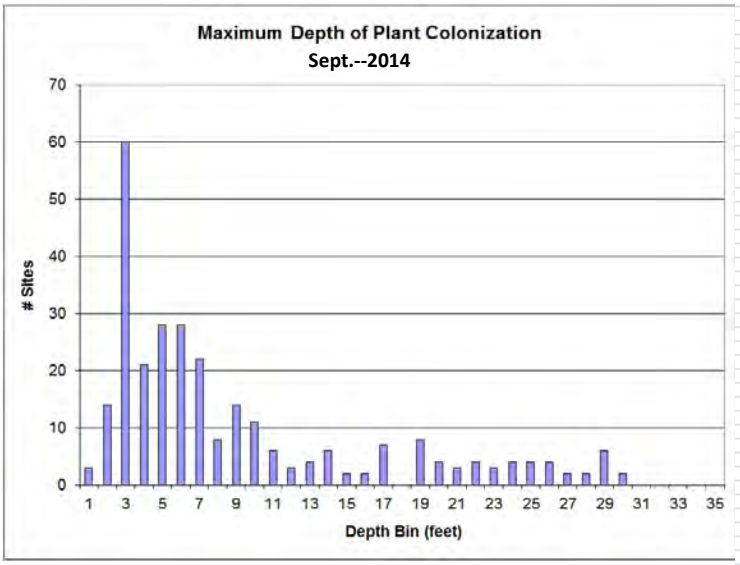
Figure 5

Depth of Plant Colonization-Golden Lake, Waukesha/Jefferson Counties, WI

Full PI Surveys (2013-17)







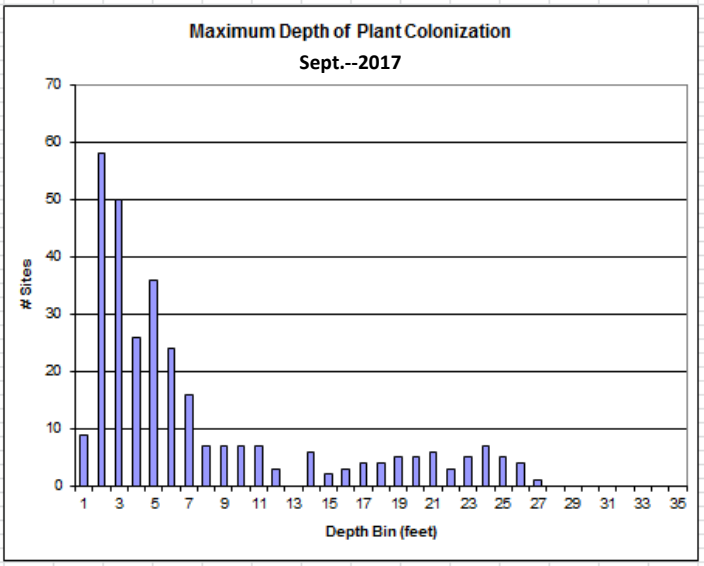


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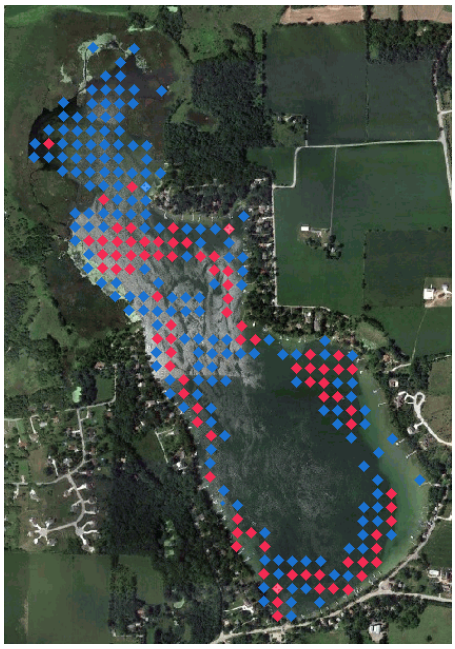
Figure 6

Golden Lake, Waukesha/Jefferson Counties, WI

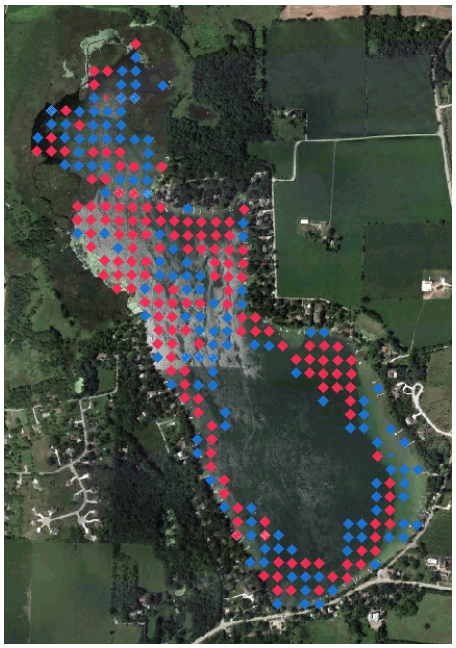
Sites with Aquatic Vegetation (all species)

May 20, 2013



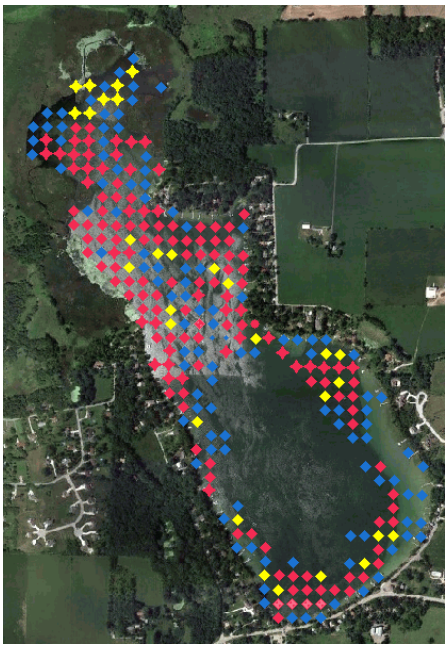
No. Vegetated Sites: 264

August 28, 2013



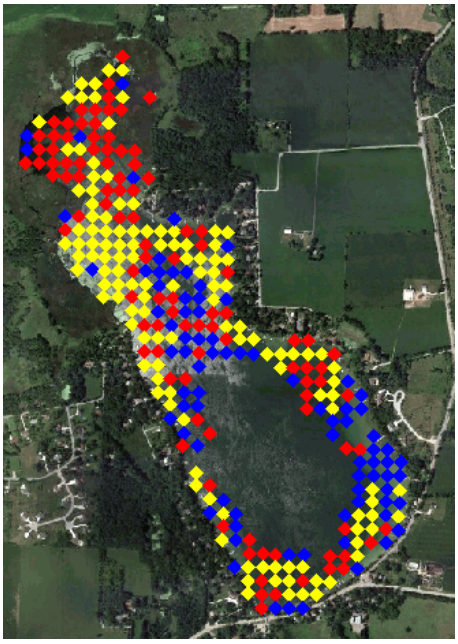
No. of Vegetated Sites: 289

September 2, 2014



No. of Vegetated Sites: 285

September 8, 2017



No. of Vegetated Sites: 310

Rake Fullness : 1 ◆
2 ◆
3 ◆

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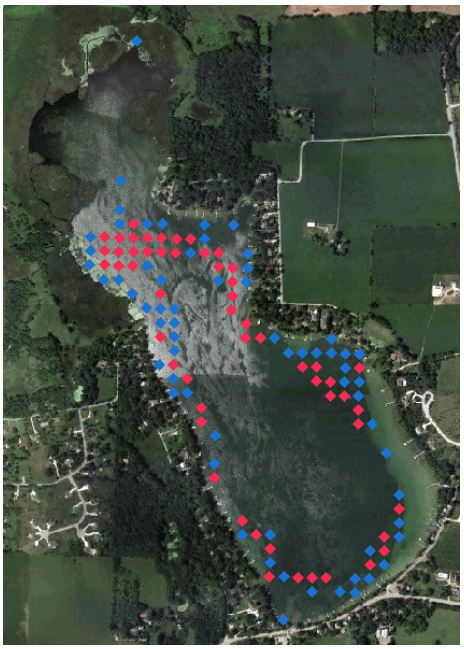
Figure 7

Golden Lake, Waukesha/Jefferson Counties, WI

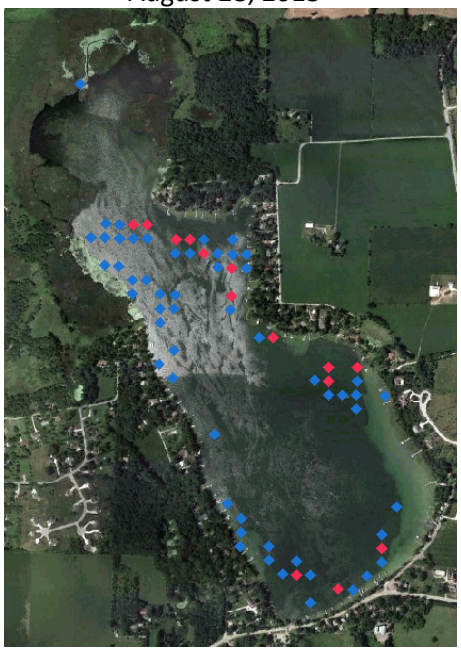
Sites with Eurasian/Hybrid Milfoil

May 20, 2013



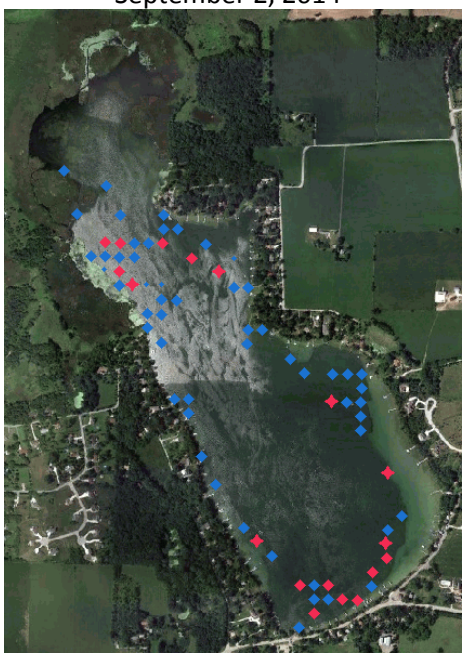
No. Sites: 118

August 28, 2013



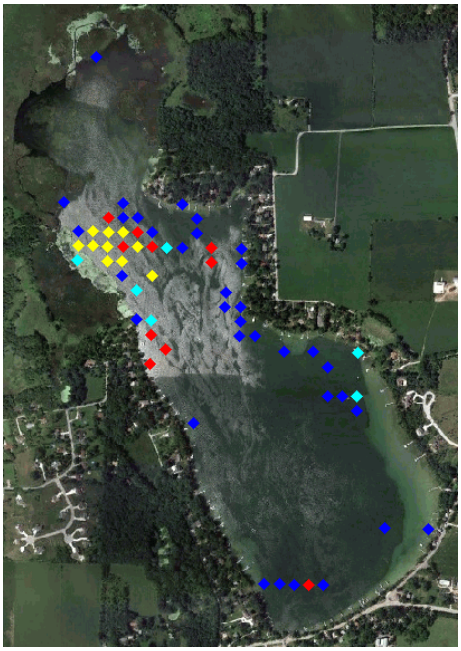
No. Sites: 70

September 2, 2014



No. Sites: 72

September 8, 2017



No. Sites: 54 Visual: 6 ◆

Rake Fullness : 1 ◆
2 ◆
3 ◆

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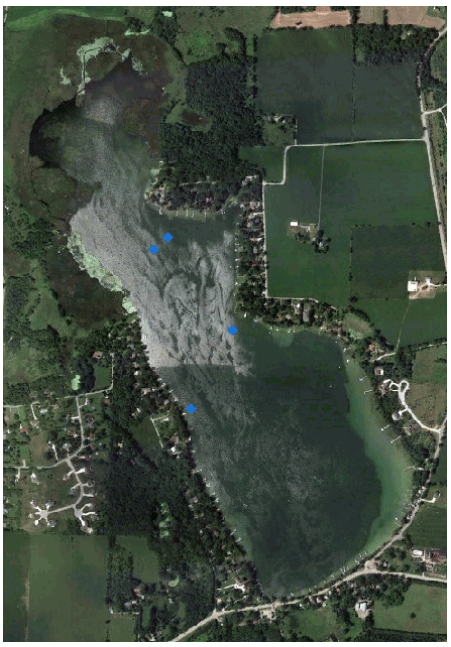
Figure 8

Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Curlyleaf Pondweed (*Potamogeton crispus*)

May 20, 2013



No. Sites: 4

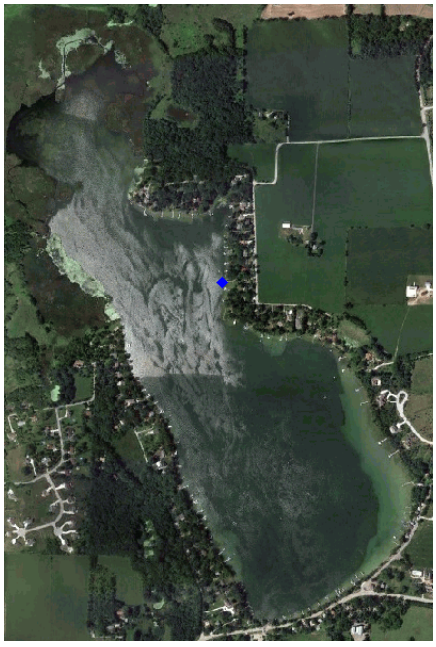
August 28, 2013

Note: No Observations Made on August 28, 2013 Survey

September 2, 2014

No. Sites: 1

September 8, 2017



No. Sites: 1

Rake Fullness : 1 ◆
2 ◆
3 ◆

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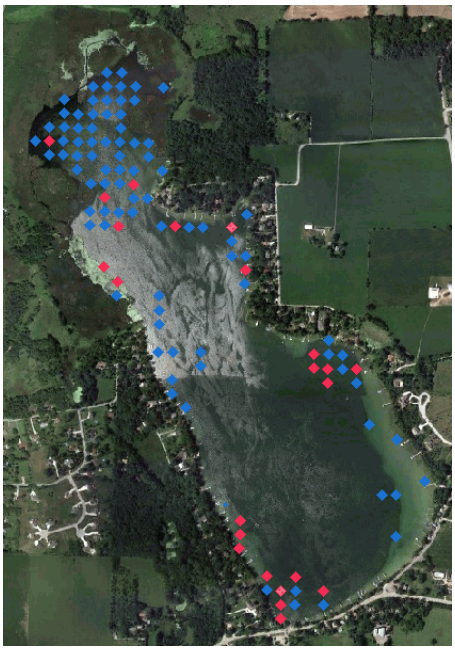
Figure 9

Golden Lake, Waukesha/Jefferson Counties, WI

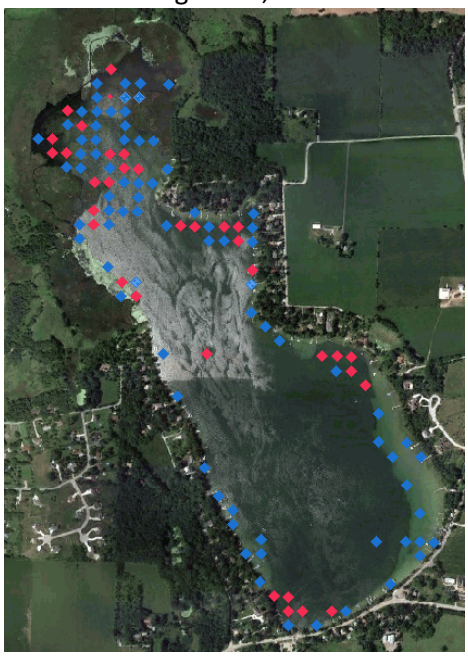
Sites with Chara (*Chara, spp*.)

May 20, 2013



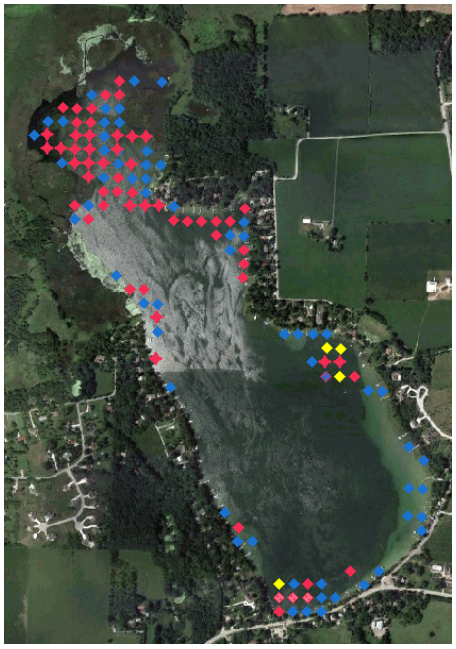
No. of Sites: 113 (Rank #1)

August 28, 2013



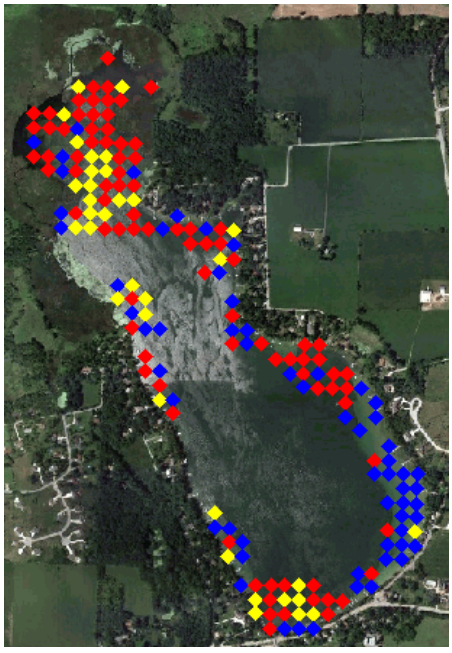
No. of Sites: 115 (Rank #1)

September 2, 2014



No. of Sites: 123 (Rank #1)

September 8, 2017



No. Sites: 181 (Rank #1)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Figure 10

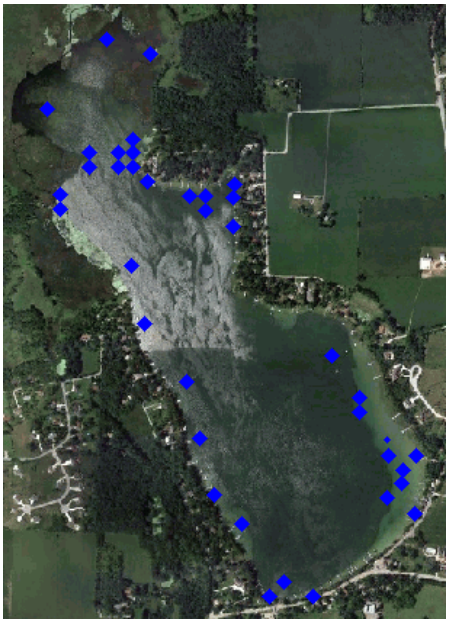
Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Slender Naiad (*Najas flexilis*)

May 20, 2013

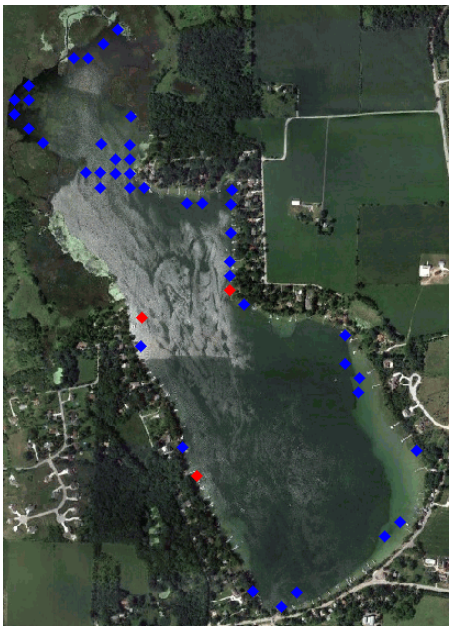
Note: No Observations Made on May 20, 2013 Survey

August 28, 2013



No. Sites: 38 (Rank #8)

September 2, 2014



No. Sites: 45 (Rank #8)

September 8, 2017

No. Sites: 86 (Rank #2)

Rake Fullness : 1 2 3

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Figure 11

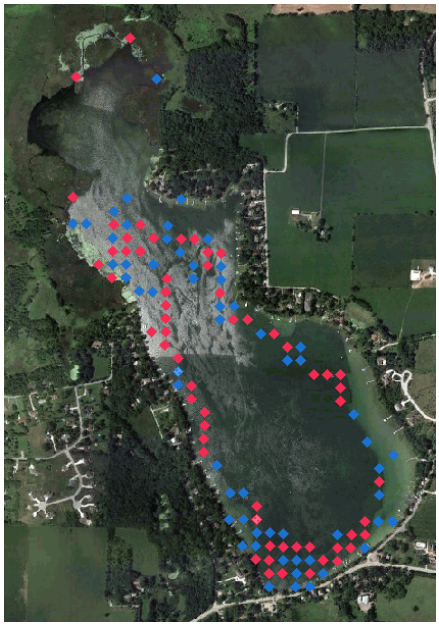
Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Coontail (*Ceratophyllum demersum*)

May 20, 2013

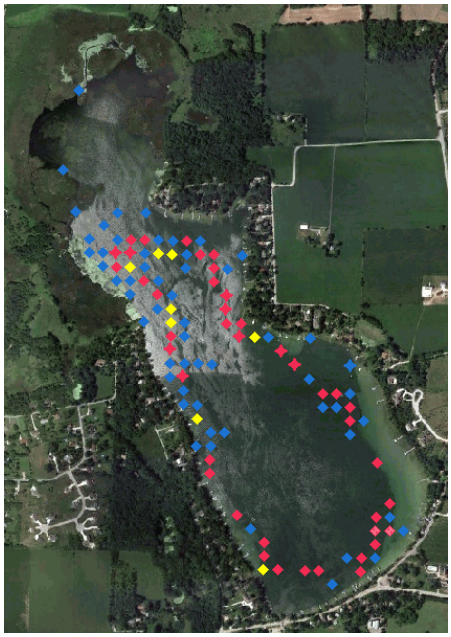
No. Sites: 64 (Rank #2)

August 28, 2013



No. Sites: 93 (Rank #3)

September 2, 2014



No. Sites: 106 (Rank #3)

September 8, 2017

No. Sites: 73 (Rank #3)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Figure 12

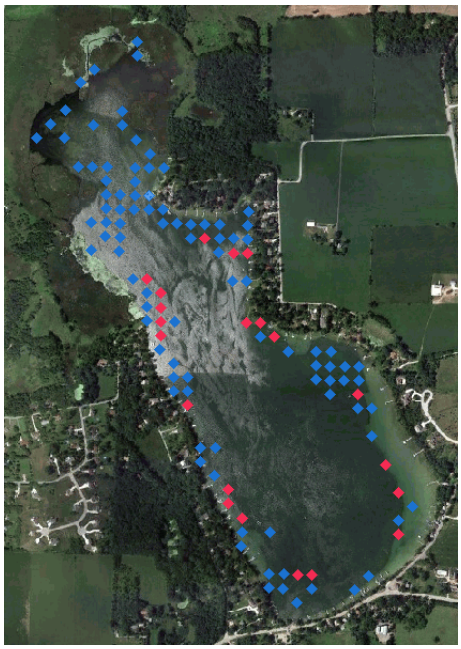
Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Eelgrass (*Vallisneria americana*)

May 20, 2013

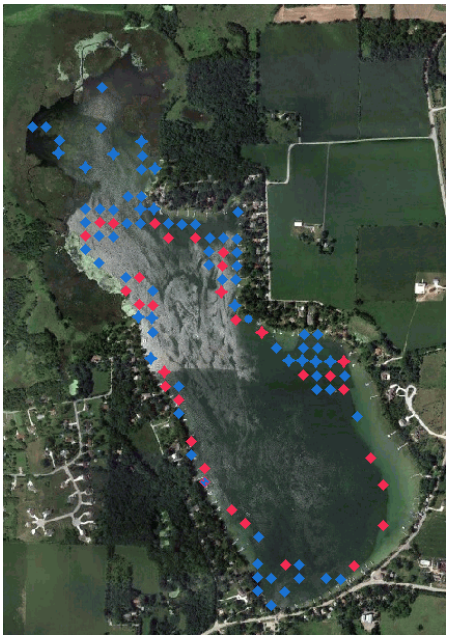
No. Sites: 3 (Rank #20)

August 28, 2013



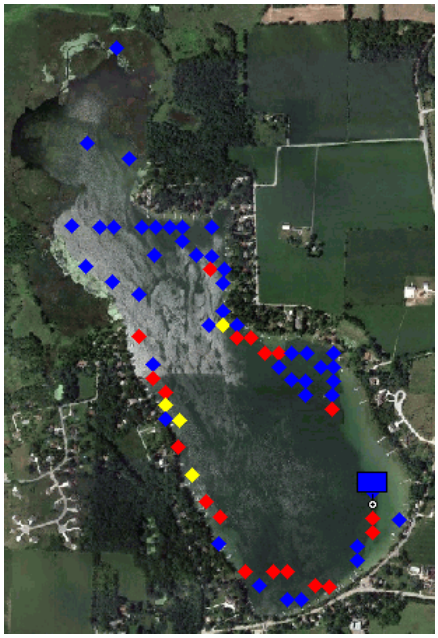
No. Sites: 113 (Rank #2)

September 2, 2014



No. Sites: 107 (Rank #2)

September 8, 2017



No. Sites: 68 (Rank #4)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Figure 13

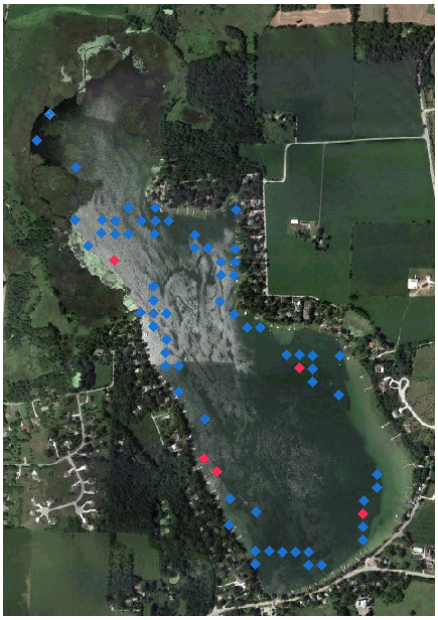
Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Sago Pondweed (*Stuckernia pectinata*)

May 20, 2013

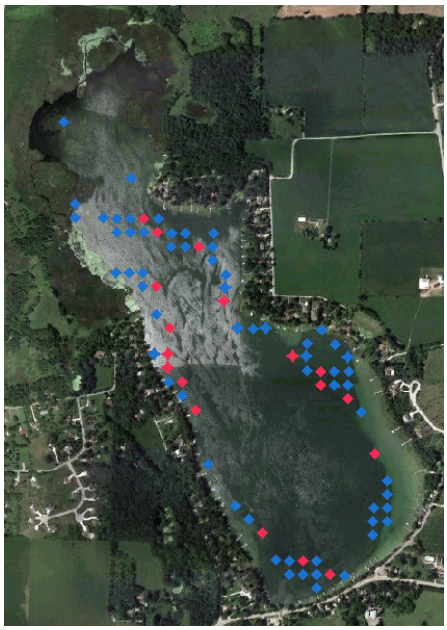
No. Sites: 16 (Rank #9)

August 28, 2013



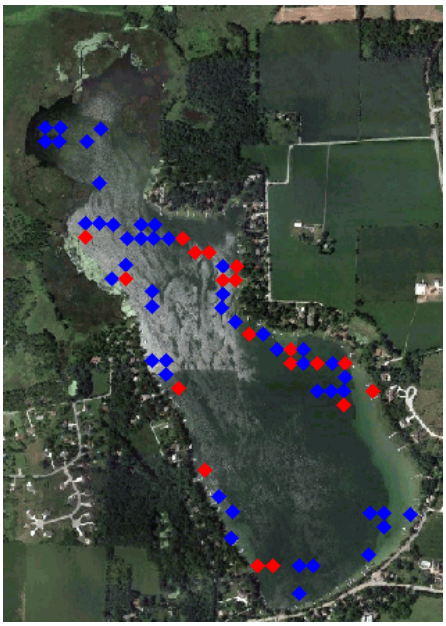
No. Sites: 68 (Rank #5)

September 2, 2014



No. Sites: 78 (Rank #4)

September 8, 2017



No. Sites: 66 (Rank #5)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Figure 14

Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Nitella (*Nitella, spp.*)

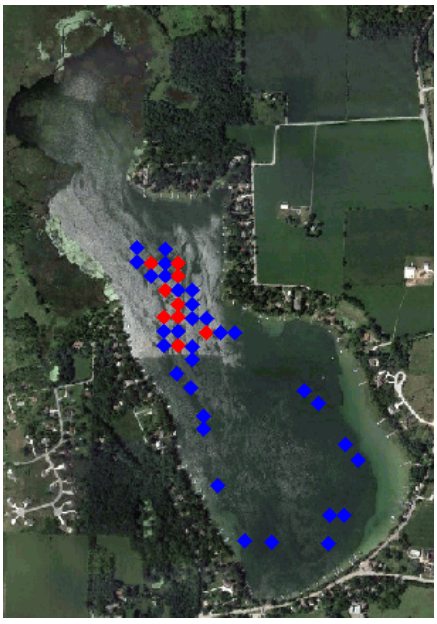
May 20, 2013

No. Sites: 44 (Rank #4)

August 28, 2013

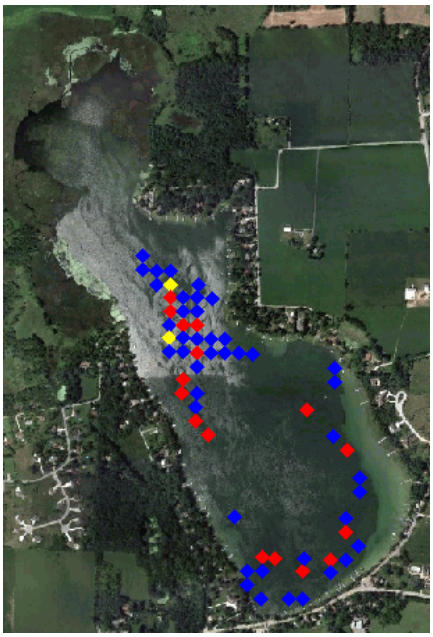
No. Sites: 39 (Rank #8)

September 2, 2014



No. Sites: 41 (Rank #4)

September 8, 2017



No. Sites: 60 (Rank #6)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Figure 15

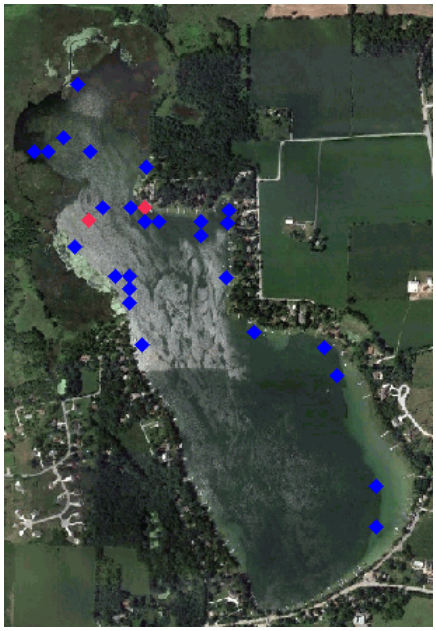
Golden Lake, Waukesha/Jefferson Counties, WI

Sites with Floating-leaf Pondweed (*Potamogeton natans*)

May 20, 2013

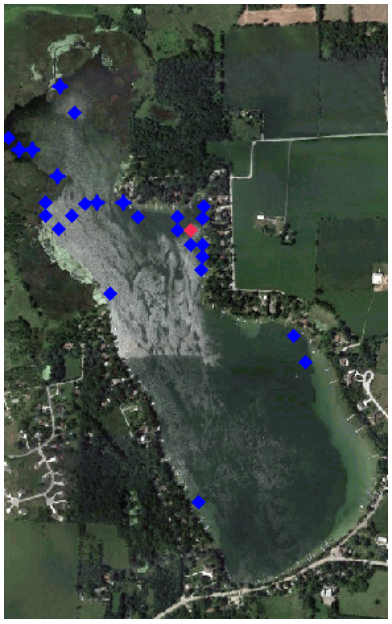
Note: No Observations Made on May 20, 2013 Survey

August 28, 2013



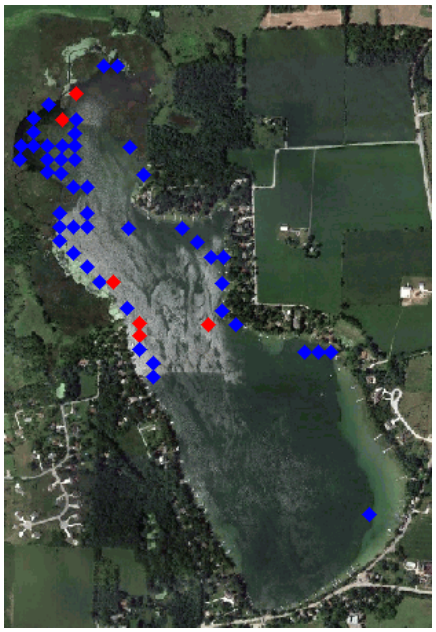
No. Sites: 28 (Rank #11)

September 2, 2014



No. Sites: 41 (Rank #9)

September 8, 2017



No. Sites: 54 (Rank #7)

Rake Fullness : 1 ◆
2 ◆
3 ◆

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Aquatic Plant Survey Results cont'd

Figure 17 (page 22) provides a Table of Summary Statistics , and Figure 16 (page 21), a Table of the Floristic Quality Index (FQI) for each of the four surveys. A brief discussion of the importance and meaning of this Data, and a comparison between them follows.

Total # of Sites w/ Vegetation

The number of sites having vegetation in Golden Lake during the four surveys were very similar in number. The lowest value (264) was recorded during the May 20, 2013 survey. This is most likely due to the timing of the survey, as some species of plants had not developed. The later (August/September) surveys recorded 289, 285 and 310 sites with vegetation (2013, 2014, 2017 respectively) .

Total # Sites Shallower Than Maximum Depth of Plants

The number of sites shallower than the maximum depth of plants for the surveys ranged from a low of 329 (2014) to a high of 351 (May, 2013), with the 2014 and 2017 values being 341 and 335, respectively. Changes in water clarity can increase/decrease the maximum rooting depth. While the Maximum Rooting Depth was higher in 2013 (32.5 feet) than in 2014 and 2017 ((29.5 and 27 feet), all are quite high and are an indicator of good water clarity.

Relative Frequency of Occurrence

Relative Frequency of Occurrence, presented as a percentage, is the number of sites shallower than the maximum depth that contained vegetation. The data for this statistic is provided below:

	5-20-13	8-28-13	9-2-14	9-8-17
Frequency of occurrence at sites shallower than maximum depth of plants	75.21	84.75	86.6	92.54

While the September, 2017 is significantly higher than the 2013 surveys, this should not necessarily be interpreted as "the lake getting weedier". While much of the bottom sediments within Golden Lake are of suitable consistency (silt, muck) and fertility for plant growth, expansive areas of relatively inorganic sand are present as well. Certain species of plants are able to adapt to this relatively inorganic sediments, and "sparsely" (below nuisance levels) colonize even "sandy" areas..

Simpson Diversity Index

The Simpson Diversity Index (SDI) measures the diversity of a plant population, using the number of species surveyed and the number of species per site. The decimal scale ranges from 0 (low diversity) to 1 (high diversity). The SDI for the surveys were 0.87 (May, 2013), 0.91 (Aug., 2013) and 0.92 (Sept., 2014) and 0.9 (Sept., 2017) This indicates that a high level of diversity has been maintained since the 2013 chemical treatment (35 acres) in Golden Lake.

Maximum Depth of Plants

Maximum depth of plants has ranged from 27 feet (Sept., 2017) to 32.5 ft. (May, 2013) for the surveys. The other two surveys recorded 30 ft. (Aug., 2013) and 29.5 ft. (Sept., 2014). The most common type of vegetation present at depths greater than 20 ft. was *Nitella*, a bottom growing, attached form of algae similar in appearance to *Chara*.

Aquatic Plant Survey Results cont'd

Average # of Species Per Site (Shallower than maximum depth) and Average # of Species (vegetated sites only)

The values for the surveys are highlighted below:

	5-20-13	8-28-13	9-2-14	9-8-17
Average number of all species per site (shallower than max depth)	1.56	2.37	2.69	2.55
Average number of all species per site (veg. sites only)	2.07	2.79	3.11	2.75

The values for May of 2013 are significantly lower than the Aug./Sept. surveys. The difference between these surveys is due to the lower number of species (Species Richness) being found in May, as opposed to later in the year. Changes in dominance of a one or two species (whether native or non-native) in a given year can cause fluctuations in this statistic.

Avg. # of Native Species/Site (shallower than max. depth) and Avg. # of Native Species/ Site (vegetated sites only)

The values for these statistics are also provide below in Table form as a reference:

	5-20-13	8-28-13	9-2-14	9-8-17
Average number of native species per site (shallower than max depth)	1.21	2.15	2.43	2.36
Average number of native species per site (veg. sites only)	1.67	2.57	2.81	2.57

When these are compared to the number's in the preceding Table, they are lower, which reflects year-to -year fluctuations in the native and non-native plant community. Also, the May, 2013 value was the lowest, a reflection of the time of season that the survey was conducted. The 2017 stats fall within the range collected during the August, 2013 and September, 2014 surveys.

Species Richness

Species richness is simply the number of species observed in the lake during the surveys. The number of species observed during the 2017 survey was the highest (29), and the May, 2013 survey (19), the lowest. The Species Richness for August, 2013 and September, 2014 surveys were (22) and (24), respectively. A number of plant species including *Vallisneria americana* (Eelgrass), *Potamogeton natans* (Floating-leaf pondweed), *Potamogeton gramineus* (Variable-leaf pondweed) and members of the genus ,*Najas* (Slender and/or Southern naiad) are known to form later in the growing season. Year to year changes in the weather (air/water temperatures) may also influence data collected early in the season.

Aquatic Plant Survey Results cont'd

Floristic Quality of Index

The Floristic Quality Index (FQI) is a measure of a plant community's closeness to an undisturbed condition. Urban lakes, or those with a high level of boat traffic have lower FQI's, meaning fewer species or lacking specific native species that are often associated with undisturbed conditions. The FQI for the surveys are as follows:

May, 2013	Aug., 2013	Sept., 2014	Sept., 2017
25.22	28.62	28.15	32.36

FQI's for any particular lake are often compared to regional or state-wide averages in order to provide perspective. FQI values representing the highest value of the lowest quartile, mean and bottom of the highest quartile of all Wisconsin lakes are 16.9, 20.9, and 27.5. This places Golden Lake in the good category in terms of disturbance. For additional perspective, the lowest FQI measured 3.0 (most disturbed), and the highest, 44.6 (most undisturbed).

The 2017 FQI for Golden Lake (32.36) is significantly higher than those previously recorded, and also places it well above the highest quartile (FQI>27.5) of all Wisconsin lakes.

This concludes the presentation and discussion of the Data collected from the three P/I Surveys conducted by WI DNR staff (2013-14) and Marine Biochemists (2015-17). The next section of this report will be a discussion of the Aquatic Invasive Species Management activities that have been implemented since 2013 and their results, along with a re-visit to the Golden Lake AIS Management Goals.

Figure 16

Summary of Golden Lake 2017 PI Survey Plant Data

Common Name	Species	Freq. of Occurrence within vegetated areas (%)	Average Rake Fullness	# sites where species found (does not include visuals)	# of visual sightings
Eurasian Watermilfoil	*Myriophyllum spicatum*	16.22	2.14	54	6
Curlyleaf Pondweed	*Potamogeton crispus*	0.3	1.0	1	0
Watershield	*Brasenia schreberi*	2.1	1.14	7	0
Coontail	*Ceratophyllum demersum*	21.92	1.49	73	0
Muskgrasses	*Chara*	54.35	1.85	181	1
Water star-grass	*Heteranthera dubia*	1.5	1.8	5	0
Northern water-milfoil	*Myriophyllum sibiricum*	0.3	1.0	1	0
Whorled water-milfoil	*Myriophyllum verticillatum*	0.3	1.0	1	0
Slender naiad	*Najas flexilis*	25.83	1.36	86	1
Southern naiad	*Najas guadalupensis*	1.2	1.0	4	0
Spiny naiad	*Najas marina*	2.4	1.5	8	0
Nitella	*Nitella*	18.02	1.33	60	0
Spatterdock	*Nuphar variegata*	0.9	1.33	3	3
White water lily	*Nymphaea odorata*	3.0	2.3	10	8
Pickerelweed	*Pontederia cordata*	0	0	0	2
Large-leaf pondweed	*Potamogeton amplifolius*	5.41	1.39	18	1
Leafy pondweed	*Potamogeton foliosus*	0.3	1.0	1	0
Fries' pondweed	*Potamogeton friesii*	0.9	1.67	3	0
Variable pondweed	*Potamogeton gramineus*	13.21	1.18	44	0
Illinois pondweed	*Potamogeton illinoensis*	6.91	1.13	23	0
Floating-leaf pondweed	*Potamogeton natans*	15.92	1.11	53	2
Long-leaf pondweed	*Potamogeton nodosus*	0.3	1.0	1	1
White-stem pondweed	*Potamogeton praelongus*	5.11	1.29	17	0
Small pondweed	*Potamogeton pusillus*	0.3	1.0	1	0
Clasping-leaf pondweed	*Potamogeton richardsonii*	0.6	1.0	2	0
Fern pondweed	*Potamogeton robbinsii*	0.3	1.0	1	0
Flat-stem pondweed	*Potamogeton zosteriformis*	3.90	1.69	13	0
Hardstem bullrush	*Schoenoplectus acutus*	0	0	0	14
Sago pondweed	*Stuckenia pectinata*	19.82	1.29	66	1
Cattail	*Typha sp.*	0	0	0	16
Common bladderwort	*Utricularia vulgaris*	14.41	1.25	48	0
Wild celery	*Vallisneria americana*	20.42	1.40	68	5

Figure 17

Floristic Quality Index (FQI) Golden Lake, Waukesha & Jefferson Counties, WI

Aquatic Plant Surveys (2013-2017)

Species present=1

Species	Common Name	C	5-20-13	8-28-13	9-2-14	9-8-17
Brasenia schreberi	Watershield	6	0	0	0	1
Ceratophyllum demersum	Coontail	3	1	1	1	1
Chara	Muskgrasses	7	1	1	1	1
Heteranthera dubia	Water star-grass	6	1	0	0	1
Myriophyllum sibiricum	Northern water-milfoil	6	0	0	0	1
Myriophyllum verticillatum	Whorled water-milfoil	8	0	0	1	1
Najas flexilis	Slender naiad	6	0	1	1	1
Najas guadalupensis	Southern naiad	8	1	1	1	1
Nitella	Nitella	7	1	1	1	1
Nuphar variegata	Spatterdock	6	0	1	1	1
Nymphaea odorata	White water lily	6	1	1	1	1
Pontederia cordata	Pickerelweed	8	0	1	0	0
Potamogeton amplifolius	Large-leaf pondweed	7	1	1	1	1
Potamogeton foliosus	Leafy pondweed	0	0	0	0	1
Potamogeton friesii	Fries' pondweed	8	1	1	1	1
Potamogeton gramineus	Variable pondweed	7	1	1	1	1
Potamogeton illinoensis	Illinois pondweed	6	1	1	1	1
Potamogeton natans	Floating-leaf pondweed	5	0	1	1	1
Potamogeton nodosus	Long-leaf pondweed	7	0	0	0	1
Potamogeton praelongus	White-stem pondweed	8	1	1	1	1
Potamogeton pusillus	Small pondweed	7	0	0	0	1
Potamogeton richardsonii	Clasping-leaf pondweed	5	0	0	0	1
Potamogeton robbinsii	Fern pondweed	8	1	1	1	1
Potamogeton zosteriformis	Flat-stem pondweed	6	1	1	1	1
Schoenoplectus acutus	Hardstem bullrush	6	0	1	1	0
Stuckenia pectinata	Sago pondweed	3	1	1	1	1
Typha sp.	Cattail	1	1	0	1	0
Utricularia vulgaris	Common bladderwort	7	1	1	1	1
Vallisneria americana	Wild celery	6	1	1	1	1
N = # of of species			17	20	21	26
mean C			6.1	6.4	6.1	6.4
FQI			25.22	28.62	28.15	32.36

Note: "C" is a Coefficient of Conservatism assigned to individual plant species, with higher ranking species more representative of a more natural, undisturbed condition. See Citations for additional information.

CITATION: **Nichols, SA. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management, 15(2):133-141.**

CITATION: **University of Wisconsin-Madison, 2001. Wisconsin Floristic Quality Assessment (WFQA). Retrieved October 27, 2009 from: http://www.botany.wisc.edu/WFQA.asp**

Figure 18

Summary Statistics

Golden Lake, Waukesha & Jefferson Counties, WI

Aquatic Plant Surveys (2013-2017)

	5-20-13	8-28-13	9-2-14	9-8-17
Total number of sites visited	366	367	342	442
Total number of sites with vegetation	264	289	285	310
Total number of sites shallower than maximum depth of plants	351	341	329	335
Frequency of occurrence at sites shallower than maximum depth of plants	75.21	84.75	86.6	92.54
Simpson Diversity Index	0.87	0.91	0.92	0.9
Maximum depth of plants (ft)**	32.5	30	29.5	27
Number of sites sampled using rake on Rope (R)	97	89	87	338
Number of sites sampled using rake on Pole (P)	266	270	255	0
Average number of all species per site (shallower than max depth)	1.56	2.37	2.69	2.55
Average number of all species per site (veg. sites only)	2.07	2.79	3.11	2.75
Average number of native species per site (shallower than max depth)	1.21	2.15	2.43	2.36
Average number of native species per site (veg. sites only)	1.67	2.57	2.81	2.57
Species Richness	19	22	24	29
Species Richness (including visuals)	21	25	25	34

Eurasian/Hybrid Watermilfoil Control Discussion

The surveys conducted in 2013-17 indicate that Golden Lake continues to a highly diverse and unique native aquatic plant community. EWM and its' hybrid, while present, have been greatly reduced in terms of Frequency (number of sites present, see figure 7, page 9) . The Tables below review the # of sites where EWM/Hybrid was found during the four Full PI and two Partial PI surveys:

Full PI Survey	# Sites EWM Present
May, 2013	118
August, 2013	70
September, 2014	72
September, 2017	54*

*Does not include Visual Observations at 6 sites

Partial PI Survey	# Sites EWM Present
October, 2015	45
August, 2016	58

While a number of external factors (drought, water clarity, etc) can influence the number of plants species present in a lake, as well as their dominance, control efforts targeted at EWM/Hybrid have been in place since 2013. These have had a significant impact. These include chemical controls using 2,4-D, manual removal (hand-pulling), as well as Diver Assisted Scuba Harvesting (D.A.S.H.).

A summary of the efforts follows:

Treatment with 2,4-D

Figure 18 (following page) details the distribution of EWM/Hybrid as it existed in October, 2012. Please note that this map was created by means of a visual survey using GPS to mark the boundaries of the EWM beds.

All areas of the lake, with the exception of Area G ("Sensitive Area") were treated on June 3, 2013 using either DMA4-IVM (2,4-D liquid) or Navigate (2,4-D granular). The total acreage treated was approximately 35.6 acres.

Figure 19 (page 24) shows the location of the survey points for both the "Full" and "Partial" Point-Intercept Surveys that have been conducted annually since 2013.

Figure 20 shows the distribution and density of EWM present during the years 2013-2017 during the Full (2013/14 & 2017) and Partial (2015-16) Surveys. Treatment areas for 2013 and 2015-17 are detailed as well.

Diver Assisted Suction Harvesting (D.A.S.H.)

Figure 21 shows the distribution of EWM in Golden Lake in Fall, 2015, and for each successive Fall (2016-17). It also shows the changes in density/distribution of EWM from year-to-year, as well as the location of D.A.S.H. efforts in 2015-16.

Hand Harvesting (Venture Crew)

EWM in shallow areas have been harvested by hand since 2015. Figures 22 and 23 are maps showing the location of EWM present within the harvested areas the Fall prior, and the Fall following the harvesting activities. Finally, a Map summarizing all EWM/Hybrid management activities is found on Figure 24

FIGURE 19

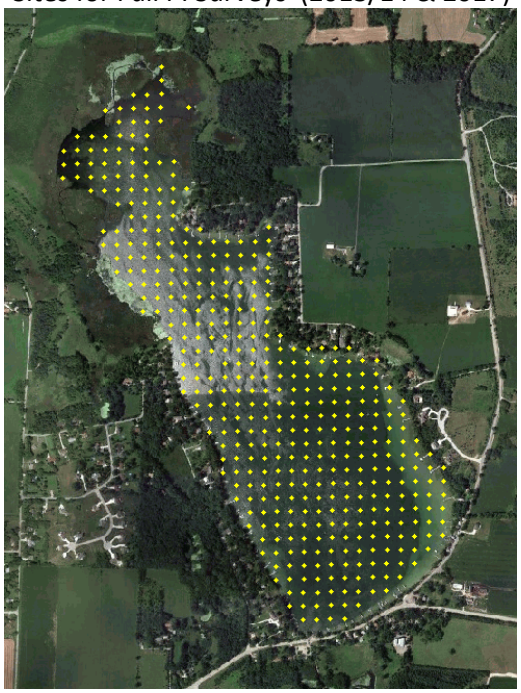

DISTRIBUTION OF MILFOIL, SPP IN GOLDEN LAKE-WAUKESHA COUNTY, WI
OCTOBER, 2012
G. 14.9 A
F. 8.0 A
D. 3.1 A
E. 7.8 A
A. 10.2 A
C. 1.1 A
B. 7.4 A
Marine Biochemists
6302 W. Eastwood Ct
Mequon, WI 53090
(888) 558-5106
www.marinebiochemists.co
Total Acreage: Approximately 52.5 acres

Figure 20

Golden Lake, Waukesha/Jefferson Counties, WI

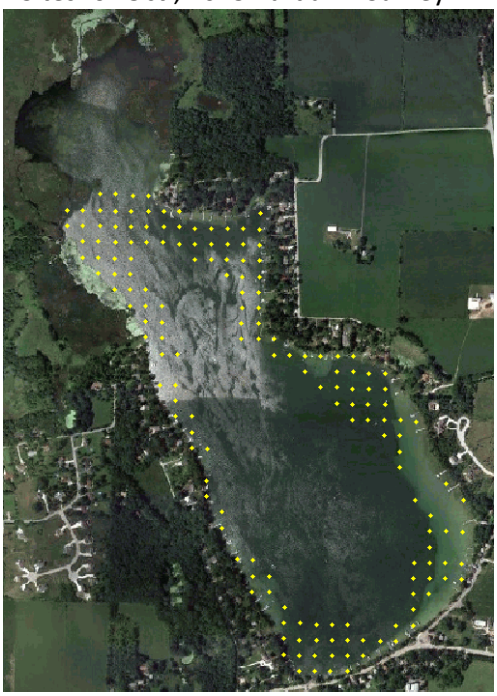
Location of Sampling Sites for Full & Partial PI Surveys

Sites for Full PI Surveys (2013/14 & 2017)



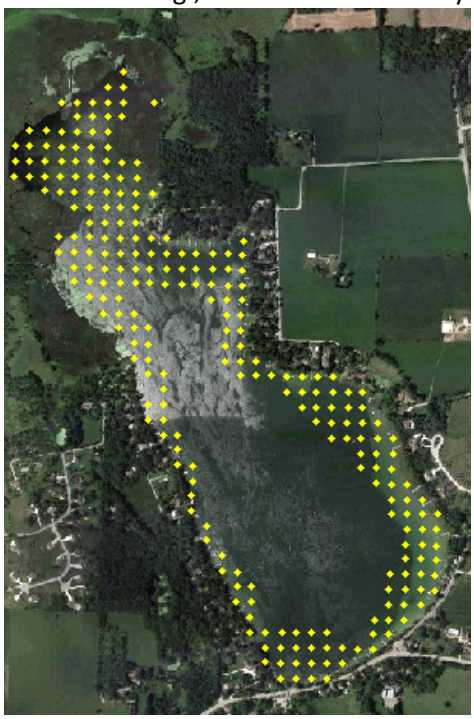
Total # Sites: 435 (approximate)

Sites for Oct., 2015 Partial PI Survey



Total # Sites: 167

Sites for Aug., 2016 Partial PI Survey



Total # Sites: 250

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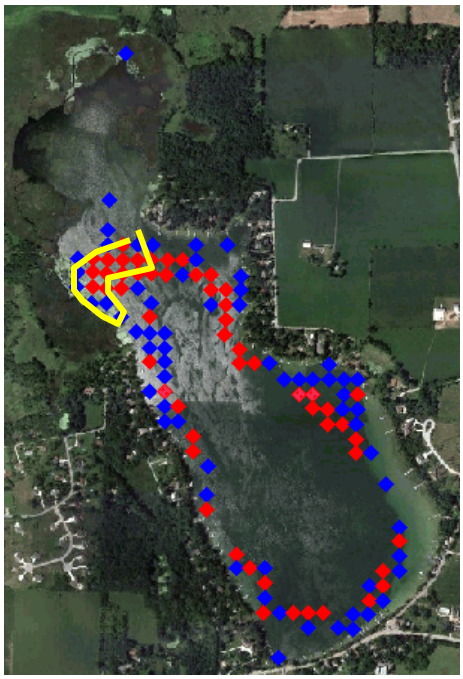
Figure 21

Comparison of EWM Sites Inside/Outside of Sensitive Area in Treatment Areas

Full PI Surveys (2013/14/17) and Partial PI Surveys (2015/16)

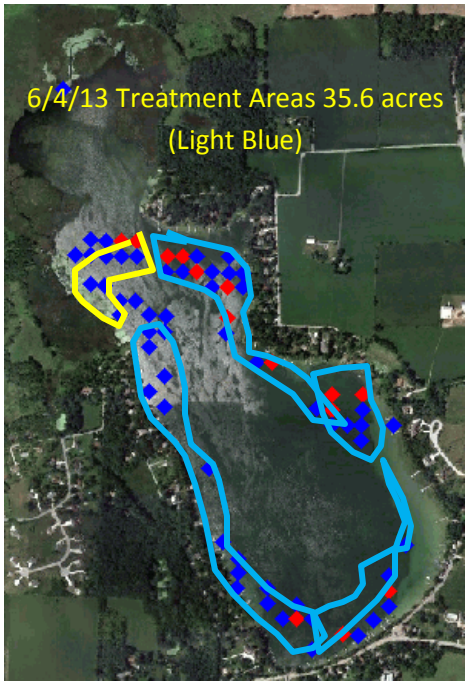
Pre-Treatment EWM Sites May,2013



EWM Sites Outside Sensitive Area: 89

Inside Sensitive Area Mgmt. Area: 27

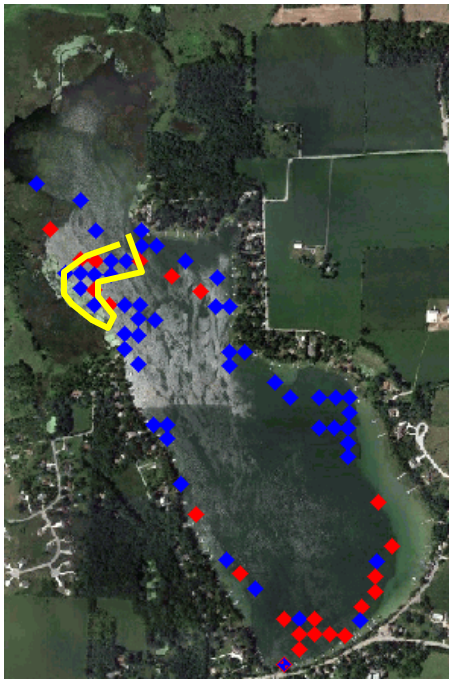
Post-Treatment EWM Sites Aug., 2013



EWM Sites Outside Sensitive Area: 53

Inside Sensitive Area Mgmt. Area: 17

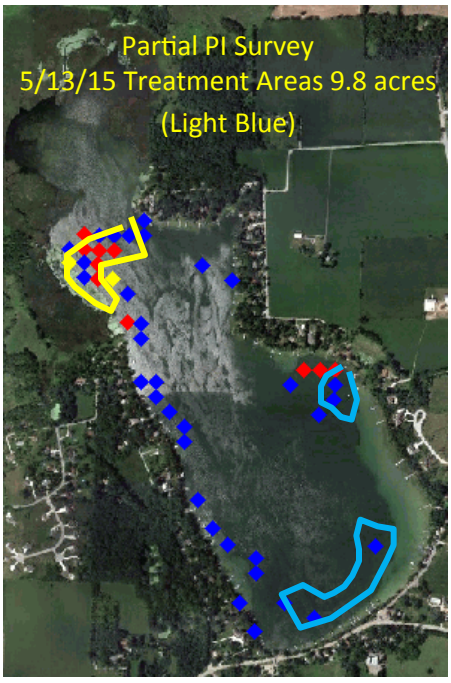
EWM Sites in Sept., 2014 (No Treatment)



EWM Sites Outside Sensitive Area: 53

Inside Sensitive Area Mgmt. Area: 19

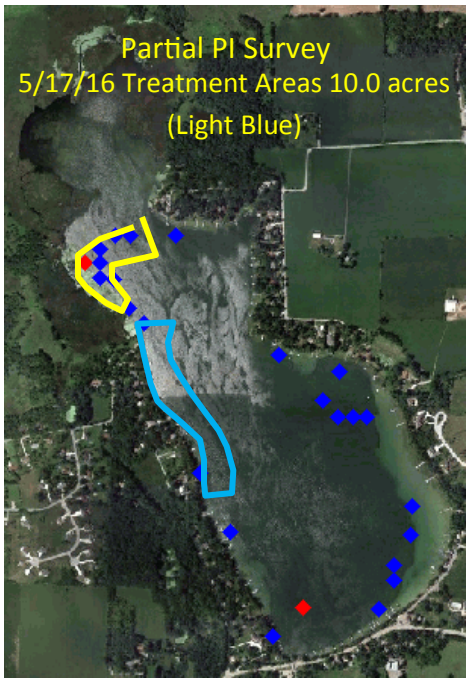
Post-Treatment EWM Oct., 2015



EWM Sites Outside Sensitive Area: 28

Inside Sensitive Area Mgmt. Area: 17

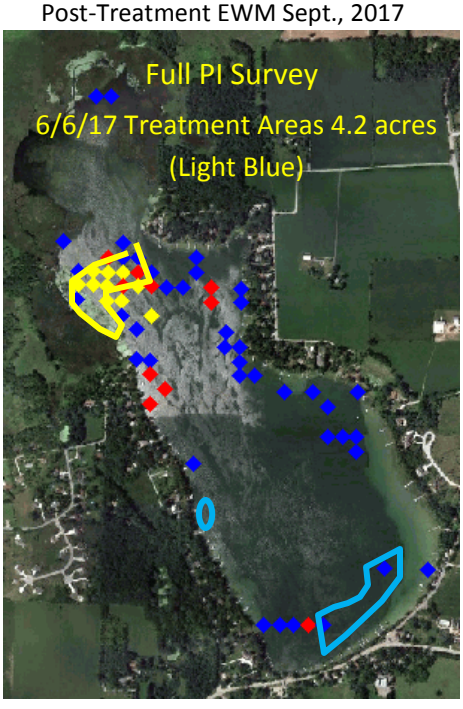
Post-Treatment EWM Aug., 2016



EWM Sites Outside Sensitive Area: 17

Inside Sensitive Area Mgmt. Area: 8

Post-Treatment EWM Sept., 2017



EWM Sites Outside Sensitive Area: 38

Inside Sensitive Area Mgmt. Area: 20

Rake Fullness : ◆ 1

◆ 2

◆ 3

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Figure 22

EWM Distribution within Golden Lake and location of

Diver Assisted Scuba Harvesting (D.A.S.H.) Treatments

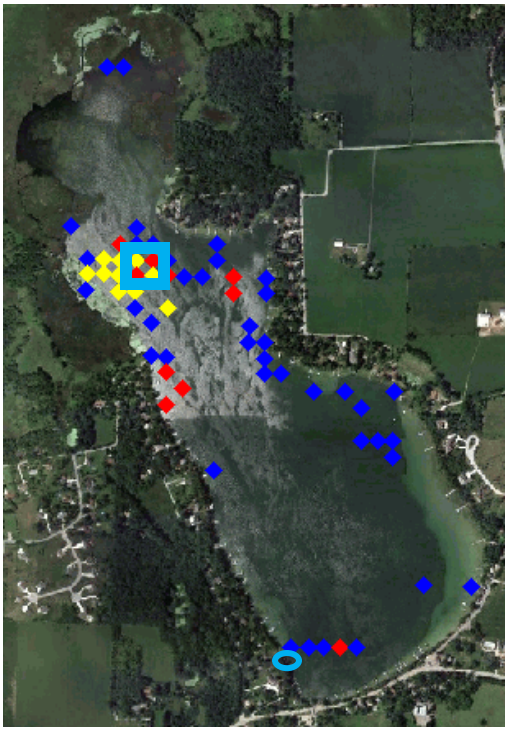
Oct., 2015 Pre Harvest

Aug., 2016 PI (Post) w D.A.S.H. (Light Blue)

D.A.S.H. conducted on 6-20-2016

Note: Mostly CLP harvested with some EWM

Sept., 2017 PI (Post) w D.A.S.H. (Light Blue)



D.A.S.H. conducted on June 20-23, 2017

Note: Harvesting limited to eastern half of Sensitive Area due to limited budget /amount of EWM present.

Rake Fullness : ◆ 1

◆ 2

◆ 3

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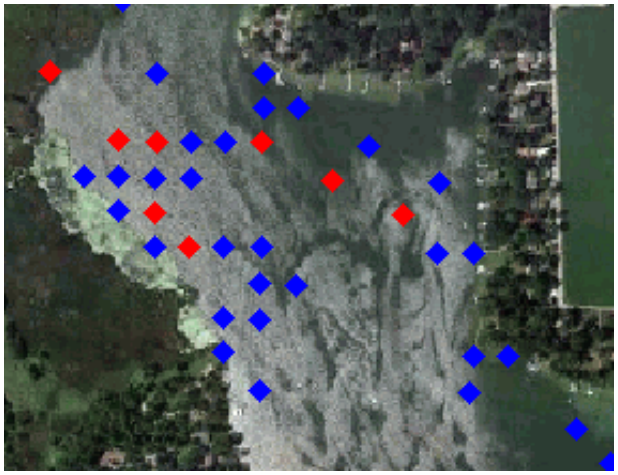
Figure 23

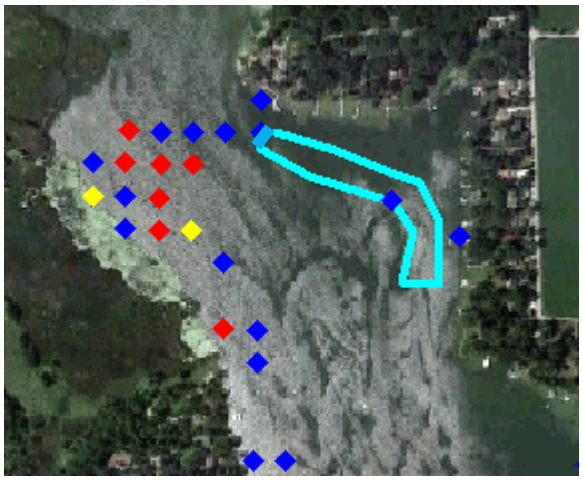
EWM Distribution within Golden Lake and location of

Hand Harvesting (Venture) Treatments

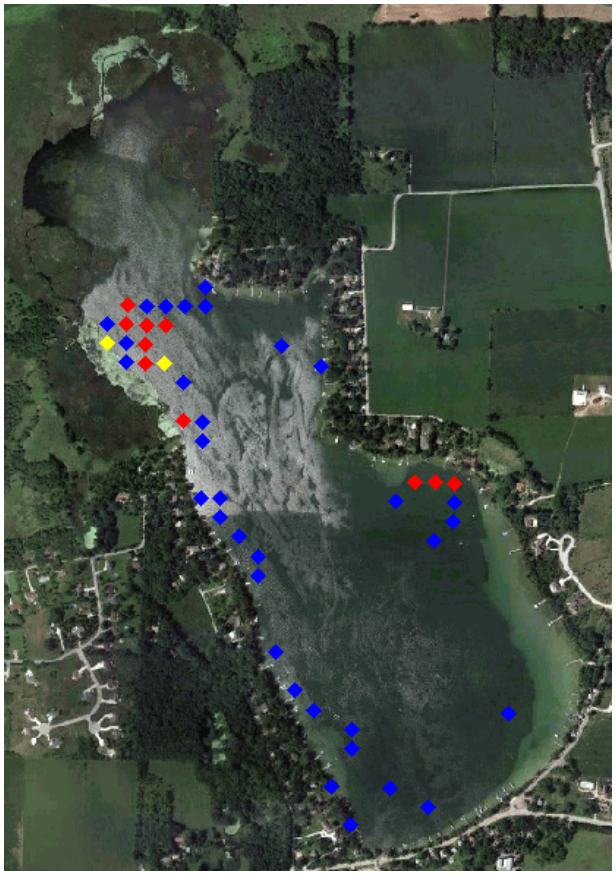
Sept., 2014 PI (Pre-Harvest)



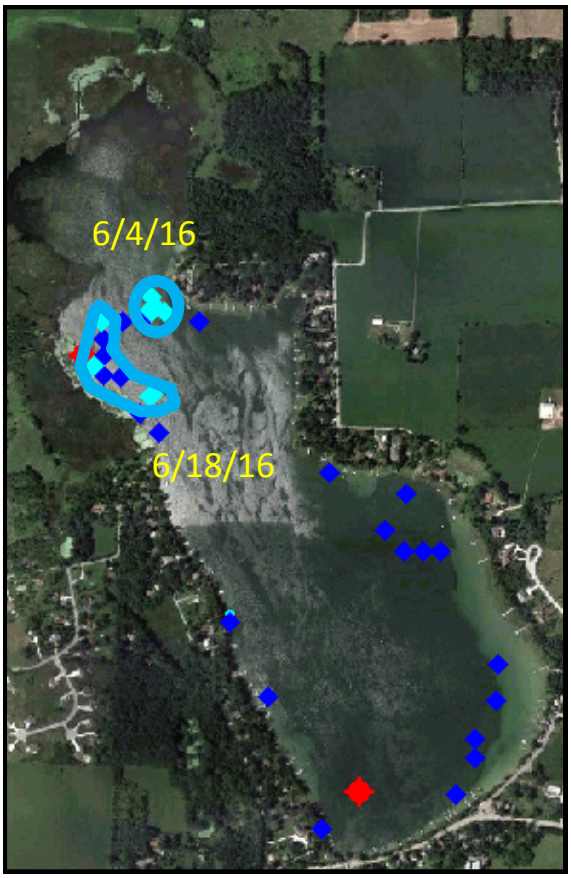
Oct., 2015 PI (Post) w Venture-Harvest Superimposed



Oct., 2015 PI (Pre-Harvest)



Aug., 2016 PI (Post) w Venture-Harvest Superimposed



Rake Fullness : 1

2

3

Venture Location:

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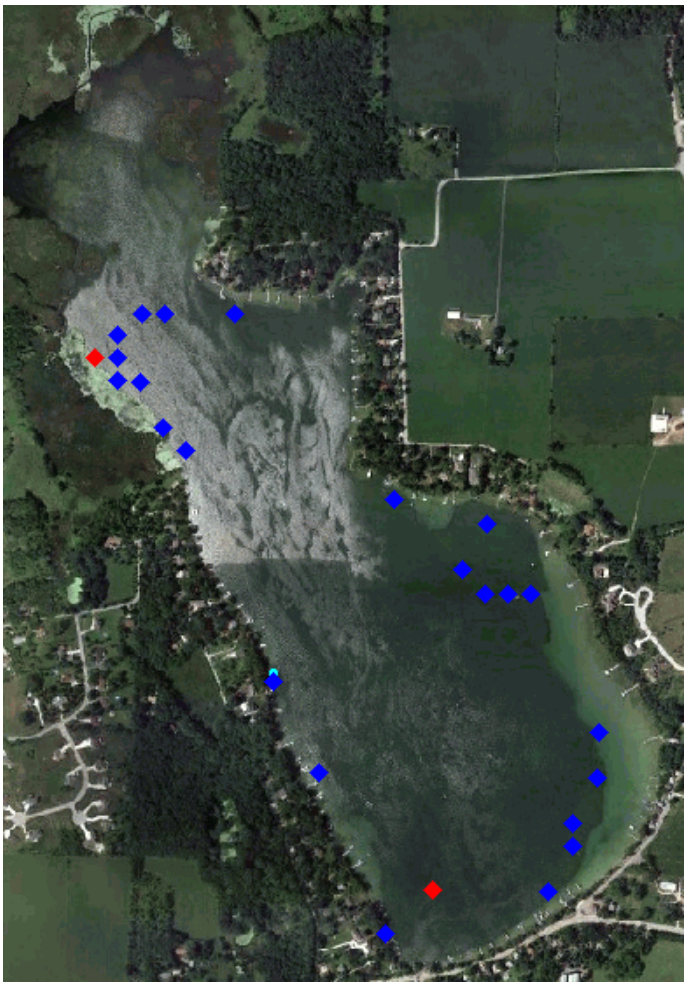
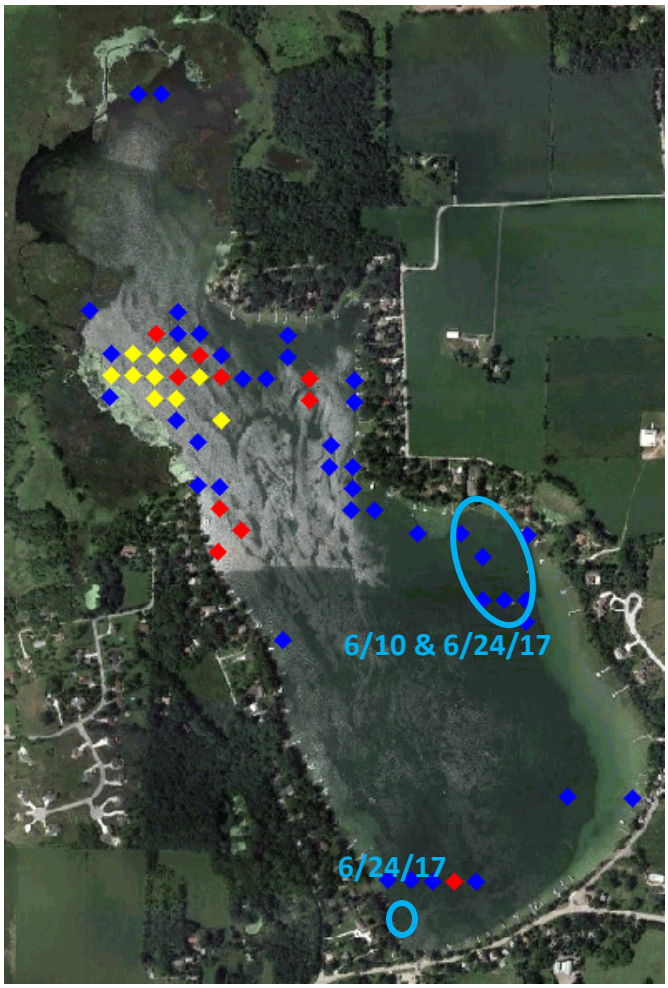
Figure 24
EWM Distribution within Golden Lake and location of
Hand Harvesting (Venture) Treatments

August., 2016 PI (Pre)



Sept., 2017 PI (Post) w Venture-Harvest Superimposed

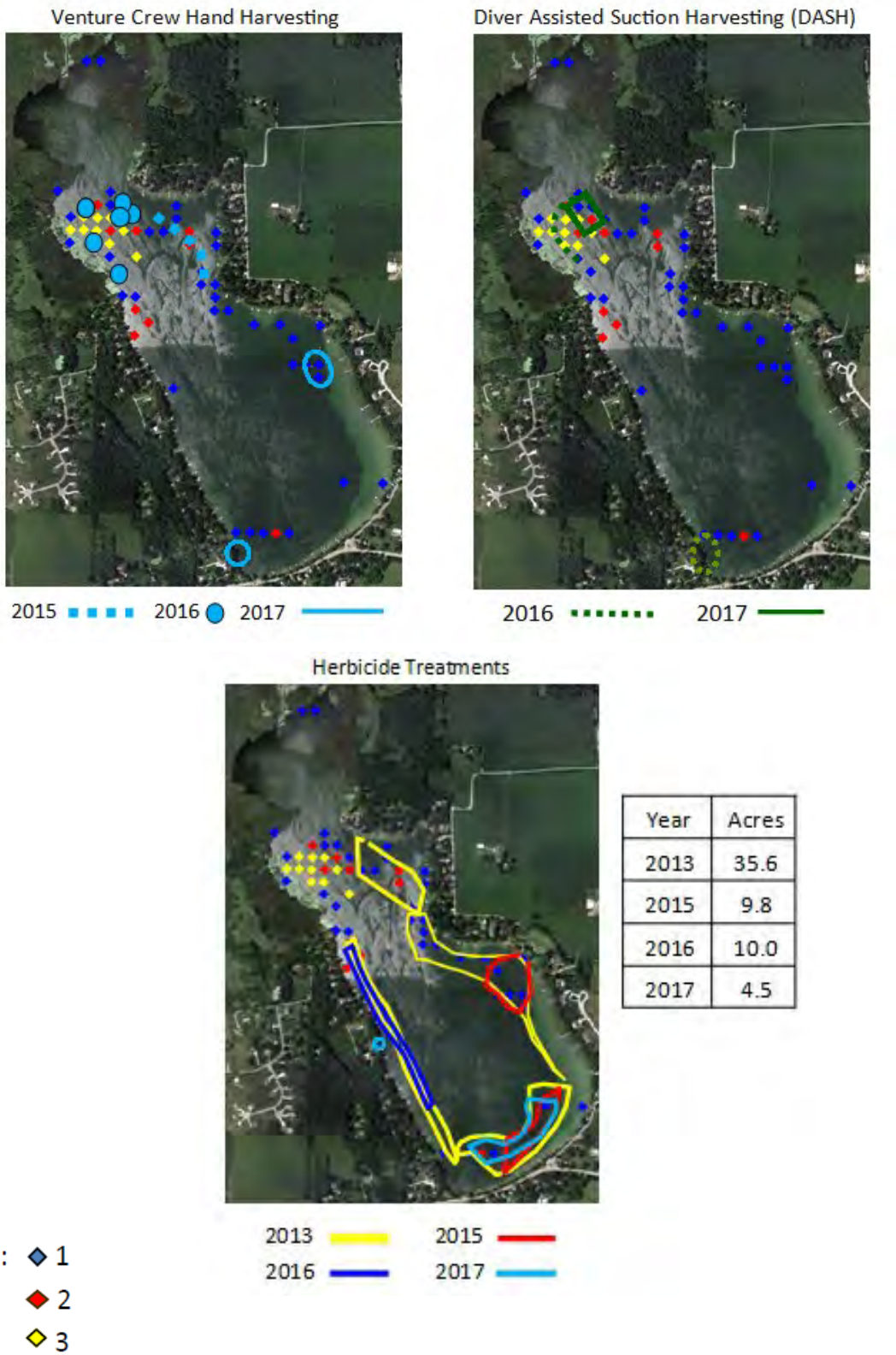


Rake Fullness : 1
2
3

Venture Location:

Figure 25

Summary of All Management Activities on Golden Lake 2013-17



Year	Acres
2013	35.6
2015	9.8
2016	10.0
2017	4.5

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Golden Lake Management Plan Goals:

As part of the Aquatic Plant Management Plan for Golden Lake (2015), the Association adopted the following criteria *that requires management* (page 37 of 2015 Lake Management Plan):

- Presence of EWM/Hybrid at greater than 25 Points (15% of total number of waypoints in area less than 13 ft. in depth and an average density (Rake Fullness) of greater than (1).
- Areas that have a Rake Fullness greater than (2), or areas where EWM "tops out" and interferes with recreation

While the goal of 25 points was almost met in 2016 (25 points Sept 2016 Partial PI Survey, Figure 20), Milfoil has re-bounded both in and out-side the Sensitive Areas. While the Average Rake Fullness for sites outside of the Sensitive Area remain fairly consistent at 1.21 (high of 1.46 in May, 2013 Survey), the Average Rake Fullness for the Sensitive Area has increased dramatically to 2.21, well beyond the 1.46 May, 2013 Survey, prior to the 2013 treatment.

An Analysis of the number of sites having EWM present during each of the (4) Full P/I Surveys is provided below:

Area	# Sites EWM Present May, 2013	# Sites EWM Present Aug., 2013	# Sites EWM Present Sept., 2014	# Sites EWM Present Sept., 2017
Inside Sensitive Area	27	17	19	20
Outside Sensitive Area	89	53	53	38
Total	118	70	72	58

A discussion of the Results for each of the management strategies employed by the Golden Lake Association follows:

Analysis of Eurasian/Hybrid Watermilfoil Treatment Results

Chemical Controls

It is quite apparent that the initial treatment in May, 2013 had a very positive impact in terms of reducing the amount of EWM in Golden Lake. The number of sites having EWM present in dropped from 118 in May, 2013 to 70 in August, 2013. Herbicidal effects were even observed in the Sensitive Area, which did not receive direct treatment with 2,4-D.

EWM increased slightly in regards to frequency, with 72 sites overall in 2014. This was due to an increase in the number of sites present in the Sensitive Area (19 sites vs. 17). EWM was again reduced in 2015 following the May herbicide treatment. While the number of sites within the Sensitive Area decrease slightly (19 sites to 17), a more marked decrease was found in the areas outside of the Sensitive Area (53 sites to 28). While this can be attributed, in part, to a reduction in the number of sampling points (Partial PI vs. Full), there was a considerable reduction in EWM frequency (and density) within the treatment area along the south shore (see Figure 20, page 26).

The Partial PI Survey in 2016 showed a further decrease in the amount of EWM, down from a total of 45 sites (28 outside, 17 inside Sensitive Area), respectively to only 25 (17 Outside, 8 within Sensitive Area). There was a significant decrease within the treatment area along the west shore.

Cont'd on following page

Diver Assisted Scuba Harvesting (DASH)

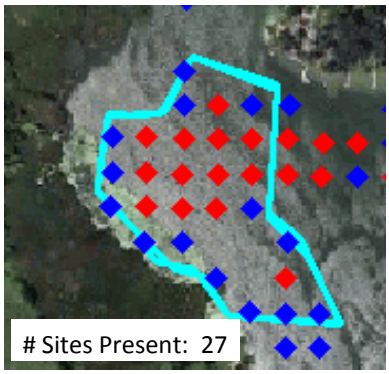
The initial year of DASH, June 2016, had a positive impact in eliminating the presence of Curly Leaf Pondweed (CLP) in Golden Lake's Sensitive area. In May 2016, a visual survey was performed prior to the commencement of DASH in the Sensitive Area. This visual survey determined that CLP was the predominant invasive with only minimal EWM in the area. DASH removed 12,985 pounds or 371 bags (measuring 19 inches x 32 inches) with an average weight of 35 pounds of invasive plants. A year later, a visual review of the area during its' growing season in May and June 2017, indicated very small amounts of CLP. The 2017 PI Survey also noted 0 sites (for CLP) in the Sensitive Area. DASH was effective in the removal of CLP.

The second year of DASH, June 2017, four days of harvesting EWM was done in the eastern portion of the Sensitive Area with significant EWM and the location of the most boat traffic. This year DASH removed 15,250 pounds of weeds or 305 compacted bags weighing 50 pounds each. Due to high cost and limited grants funds, the western EWM was not harvested. Limited effectiveness was shown in the areas harvested (Fig. 21). Future EWM management should consider that one year with only 4 days of DASH EWM removal was not enough to determine DASH effectiveness. The Golden Lake Association has been informed by the DNR that DASH removal's best results occur when removal is performed over 4-5 years in an area of concentration.

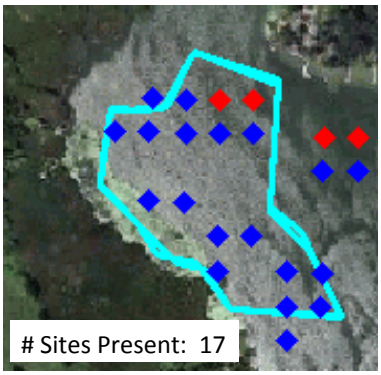
Based on the results of the 2017 Survey, the number of points of EWM has increased in the Sensitive Area (Figure 20) and the rake fullness has increased to 2.21 while other parts of the lake are at 1.21 rake fullness. Repetition of DASH for subsequent years harvesting all the EWM present should be considered to determine its impact and effectiveness to maintain and preserve the Sensitive Area's ecological resources.

A comparison of EWM present within the Sensitive Area during each of the PI Surveys if provided below:

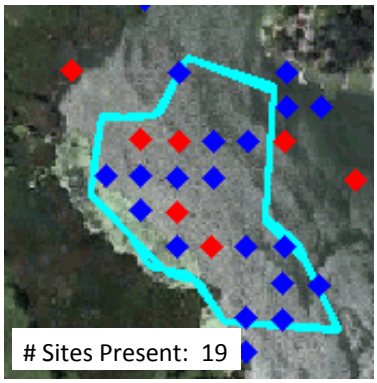
EWM Sites—May, 2013



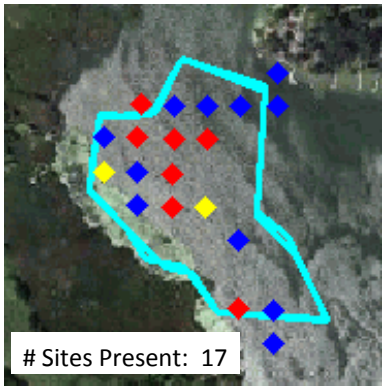
EWM Sites Aug., 2013



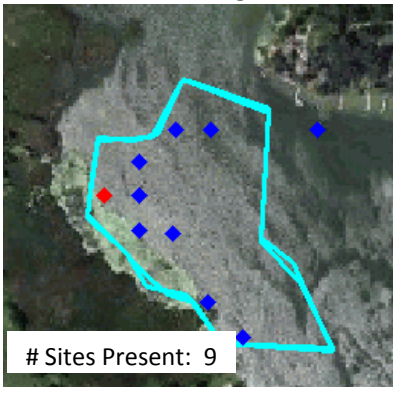
EWM Sites Sept., 2014



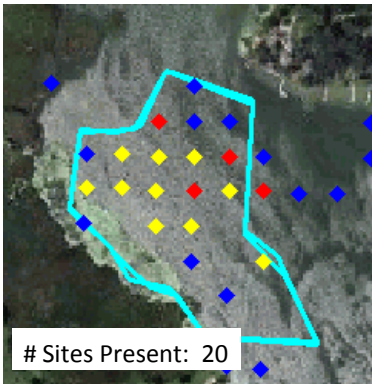
EWM Sites Oct., 2015



EWM Sites Aug., 2016



EWM Sites Sept., 2017



Rake Fullness : ◆ 1
◆ 2
◆ 3

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Hand Removal (Venture Crew)

The initial year of Venture, 2015, had a positive impact maintaining a reduction in EWM from post-harvest 2015 to post-harvest 2016 (Fig. 22). The area of harvest was north of Rhino Point outside of the Sensitive Area. The amount of EWM harvested was 151 cubic feet. Prior to Venture hand pulling there were 7 sites on the September 2014 PI Pre-Harvest (Fig. 22). After harvesting, subsequent PI's showed 1 site on both the October, 2015 and August, 2016 PI Surveys, both with rake density 1. After 2 seasons (2016-2017) of no harvesting performed in this area, the Sept 2017 PI has shown an increase of EWM in the area (Fig. 23).

In 2016, Venture conducted 2 days of hand pulling, removing 114 cubic feet of invasive plants. The first dive was off the north shore around the northeastern border of the Sensitive Area. Harvest site is pictured in light blue in (Fig 22) August, 2016 PI (Post) photo. Prior to harvesting, there were 3 sites of milfoil on the pre-harvest October, 2015 (Fig. 22) and after harvest there were no sites on the August, 2016 PI (Fig. 23). A year later the Sept. 2017 PI (Post) (Fig 23) showed effectiveness in 2 of the 3 sites. The one site that showed minimal EWM was in the Sensitive Area. This can also be seen on page 32 EWM Sites Sept., 2014 through Sept 2017 by comparing the 3 points at the northeastern corner of the Sensitive Area border.

The second 2016 Venture was on 3 sites of the western shore in the Sensitive Area - see Fig 22 August, 2016 PI (Post) Venture harvest - 3 western light blue dots. Here, harvesting assisted in removing remaining scattered CLP and some (minimal) EWM. Venture 2016 CLP removal was effective, resulting in 0 sensitive area sites for CLP (see Sept. 8, 2017 Fig. 8) Venture 2016 EWM removal on the western Sensitive edge was not as effective as seen a year later with an increase in sites and density (see page 32 EWM sites Sept 2017).

In 2017, 239 cubic feet of EWM was harvested. The first hand pulling was conducted in the bay 500 feet off of the east shore at the end of Krueger Road. Two years (2013 and 2015) of herbicide treatment had been applied there. Prior to this harvest, 5 sites with minimal milfoil were present (Fig 23 August, 2016 pre-harvest). Although milfoil was removed here, the site number (5) and density (minimum, Fullness = 1) have remained the same but some of the sites have been relocated. The final 2017 hand pull was done north of the Boat launch due its high boat traffic. No EWM was noted in the area (Sept 2017 PI) after the hand pull as seen in Fig 23.

To summarize:

1. DASH in 2016 harvested significant amounts of CLP with good results as no CLP was indicated in this area in the 2017 PI Study.
2. DASH 2017 was the first year of EWM Sensitive Area harvest and limited funds reduced the area of harvest. It is difficult to determine effectiveness because of the limited area of focus and limited number of days of harvest. Information from the DNR indicates harvesting over a 4+ years period is needed to determine its' effectiveness.
3. Venture 2015 hand pull significantly reduced EWM north of Rhino Point outside of the Sensitive Area for a period of 2 years post-harvest. As of Sept 2017 there is an increase of EWM here.
4. Venture 2016 helped to eliminate the CLP in the Sensitive Area not harvested by DASH and had an influence in reducing EWM off the northwest shore.
5. Venture 2016 helped to reduce the EWM just outside of the Sensitive Area on the north. Venture 2017 control site along the east bay off Krueger Rd maintained the number of EWM sites of EWM at the same level.
6. Venture 2017 control site near the boat launch showed good results with no EWM remaining.
7. DASH and Venture have shown some positive results during the initial years of harvesting on Golden Lake and therefore should be considered as viable options for EWM management in future years and grant applications.

Hand Removal (Venture Crew) cont'd.

8. Venture is best suited for small concentrated areas of AIS and clumps of AIS spread out over an area. Venture is a cost-effective removal option that is 75% reimbursable via DNR Grants.
9. DASH is best suited for highly concentrated, larger areas of AIS. DASH is a costly removal option. DASH is an expensive removal option that is 75% reimbursable via DNR Grants.

Recommendations for 2018

A graph detailing the Frequency of Occurrence for EWM during the surveys, along with a Table indicate average Rake Fullness is found on the following page (Figure 25).

Based upon the Association's desires and any DNR limitations, chemical controls may or may not be required for 2018. While EWM in most of the lake is relatively sparse (Rake Fullness of 1) and infrequent (mixed in with population dominated by native species), problem areas may quickly redevelop and require attention in 2018. For this reason, the Association may wish to plan for a treatment in 2018.

Figure 26 details the location of significant populations of EWM that remain. The first area (Area #1) is along the west shore immediately south of the Sensitive Area. It has relatively dense EWM at regular intervals at the north end. The frequency of EWM observations, as well as the density of plants decreases to the south. This bed is expected to be a maximum of 5-6 acres in size in 2018. Smaller, but relatively dense (Rake Fullness of 2) populations are also found in Areas #2 and 3.

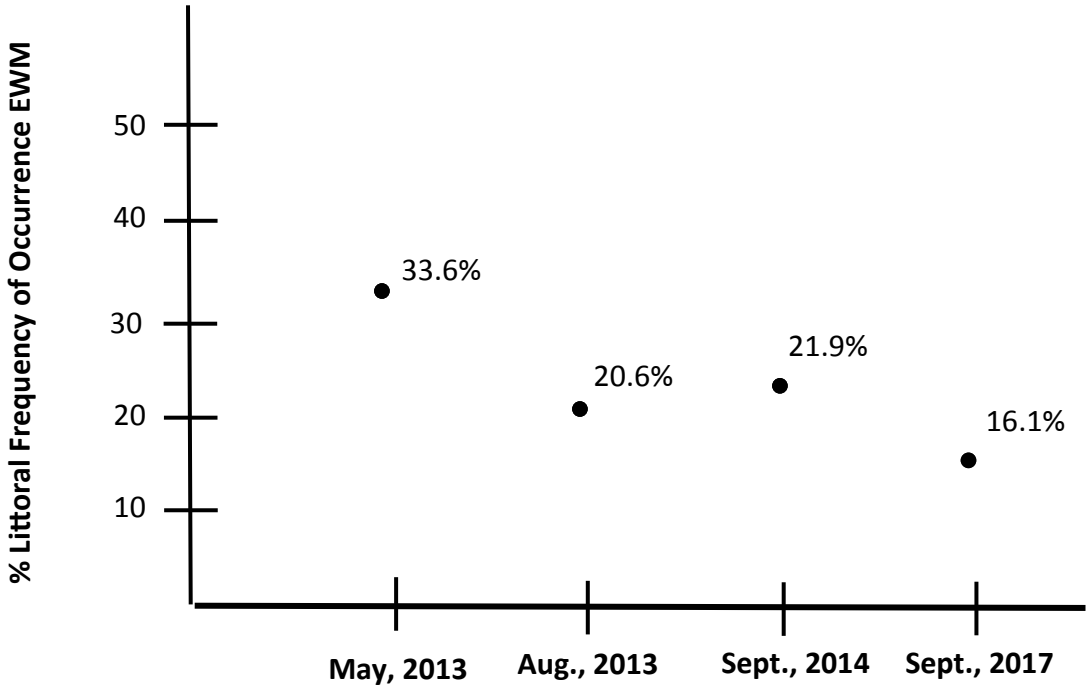
The final area is the Sensitive Area itself, with a dense canopy reaching the surface (see Figure 26). While the "worst" growth (Rake Fullness >2) is focused on an area approximately 8 acres in size, the overall size of the infestation is approximately 13-15 acres.

The Golden Lake Association Board has met and reviewed this Survey and its Conclusions. Board Conclusion: Chemical Treatment, Hand Removal and DASH are all viable options for AIS management. Based upon yearly AIS growth, DNR Grant availability and Association funds, the Association will be continue these management activities in 2018 and forward.

An Update to the Aquatic Plant Management Plan prepared in 2015 begins on page 37 with a discussion of Aquatic Plant Management Alternatives.

Figure 26

Frequency of Occurrence—Golden Lake, Waukesha/Jefferson Counties, WI



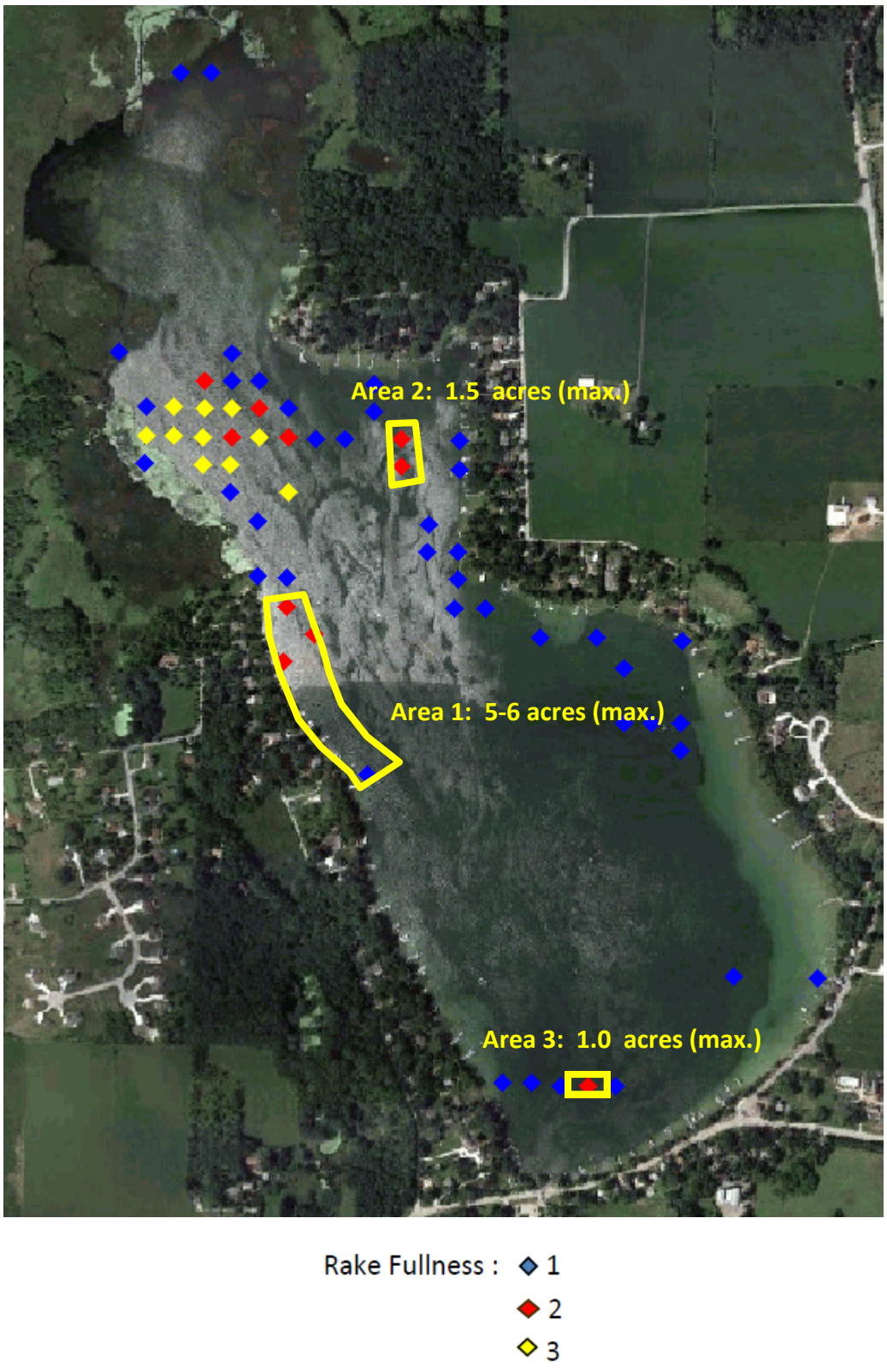
Avg. Rake Fullness for EWM—Golden Lake, Waukesha/Jefferson Counties, WI

Survey Date	May,, 2013	Aug., 2013	Sept., 2014	Sept., 2017
Avg. Rake Fullness	1.33	1.20	1.25	1.56

Figure 27

Areas of Golden Lake Requiring

Management of Eurasian/Hybrid Watermilfoil in 2018



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Aquatic Plant Management Alternatives

As indicated in the Introduction, the primary intent of the 2017 survey was to document the aquatic plant community of Golden Lake and monitor it for any changes. With this information in hand the Lake Association decided to take this opportunity to review the entire plant community, both native and non-native, and review all potential plant management options.

Once it has been determined that plants, whether by species (native and/or non-native), abundance, or location within high-use recreational waters are causing a nuisance, an attempt can be made to review and select amongst the control alternatives available. These can be selected based upon the degree of control desired, species present, growth habits of the nuisance plant, location in the lake, size and/or depth of the proposed control area, as well as applicable regulations. Several control methods are currently available to lake residents or organizations within the State of Wisconsin. These include:

1. *Manual (physical) Removal*, including hand-pulling, raking, or cutting (DASH and Venture hand harvesting). Labor intensive, these are best suited to relatively shallow, near-shore areas. State regulations currently allow residents to manually cut/pull and remove aquatic vegetation along their shoreline *without a state (DNR) permit* providing that the activity occurs along *no more than thirty (linear) feet of shoreline* if the vegetation targeted consists of *native aquatic plant species.* If *more than thirty feet of shoreline is to be managed*, a permit is required except for instances where the target species is non-native (invasive), such as the case of Eurasian Watermilfoil and/or Curlyleaf Pondweed. Finally, when the frontage is within a WI DNR designated Sensitive Area a NR109 permit is required for hand removal. DASH removal requires a DNR Permit as does the larger scale use of Venture hand pulling.

2. *Habitat Manipulation* can include temporary activities, such as the installation of bottom-barriers, or more permanent, such as the deposition of sand on the lake bottom . In either event a permit is required. Dredging (permit required), may also be an option for plant control under some limited circumstances.

3. *Biological Controls,* include plant eating fish (White Amur or Grass Carp), and insects . It is important to note that the import of the White Amur is banned within the State of Wisconsin. Milfoil Weevils, once popular, are currently not commercially available. Their introduction into a lake requires an approved WI DNR permit.

4. *Public Information and Education,* includes informing the public about the benefits of native plant population, how to identify aquatic invasive species, preventing their spread, and the tools available for control, along with regulations pertaining to their use. This includes the Clean Boats Clean Waters program for boaters.

5) *Aquatic Herbicides and/or Algaecides* are chemical compounds specifically formulated to control excessive plant and/or algae growth. These products may be used for aquatic plant control only if they are registered for use by the United States Environmental Protection Agency (USEPA) and the Wisconsin Department of Agriculture (DATCP) in lakes, ponds, etc. Their application is regulated under a permit system by the WI DNR. Further, the type of product that can be applied to a public body of water by individuals is limited to granular formulations to sites under 0.25 acres in size, unless it is applied by an certified applicator (WDATCP).

6. *Mechanical harvesting* involves the cutting and collection of aquatic plants using a single large piece of equipment mounted on a pontoon-type barge. Once full of plants, the harvester returns to shore to off-load the plants. On larger lakes, transport barges are used to collect plants from the harvester for transport to and unloading site. Harvesters are available in a number of sizes. The largest can cut swaths of vegetation up to 10 feet wide at depths of 0-6 feet deep.

Proposed Aquatic Plant Management Plan

The surveys conducted indicate that Golden Lake contains a highly diverse and unique native aquatic plant community. It also contains significant amounts of both EWM and its' Hybrid. These all can create conflicts with lake users if they develop in great enough density in high use areas.

The Data suggests that selective controls, such as 2,4-D, can be effective in controlling EWM in a manner that has minimal effect upon *most* native species of plants. Native species dominate the shallow (up to 4 feet in depth), near-shore plant community, whereas EWM becomes more noticeable beginning at the 5-ft. contour and increases in abundance with depth. In Golden Lake, EWM typically becomes problematic, forming dense canopies that impede motor traffic and shade native plant species between 5-12 feet.

Native plant species also occur at densities that can impede recreational activities, such as swimming and boating within high use areas. Manual and mechanical techniques are generally preferred for control of native plants, as they control, rather than kill the entire plants.

As a healthy and diverse native aquatic plant population is a necessary component of a lake ecosystem, it is important to manage them, if desired, in a manner that protects them in the long term by limiting controls to areas where they *significantly impair the waters' recreational usage.* Aquatic plants play a vital role in the health of a lake system, including:

- Serve as a food source for waterfowl
- Provide habitat for small fish and the aquatic insects they feed upon.
- Contribute to good water clarity by binding up sediments that would otherwise be stirred up by wind and wave action. They can also assist in reducing the likelihood of troublesome algal blooms (both filamentous and/or plank - tonic, "Pea Soup" variety) by taking up space and nutrients (phosphorus and nitrogen).
- Native plants by their presence can reduce the severity of invasions by non-native species, such as Curly-leaf Pond- weed and/or Eurasian Watermilfoil.

We therefore recommend a strategy that favors protection of the native aquatic plant community while providing for their control in *high use recreational areas*. Rather than an *eradication* strategy for Eurasian and Hybrid Watermilfoil, we recommend a strategy that minimizes the formation of dense surface canopies that can interfere with recreational use and may pose a risk to the native plant populations.

Recommended control measures will now be discussed in greater detail in the following Section of this Report.

Recommended Aquatic Plant Control Strategies

The following are recommend to be considered in the Golden Lake Management Plan.

A. Information and Education

The Association is encouraged to disperse information to their residents regarding the importance of plants, the controls available, as well as the circumstances where control may be necessary. Information can be distributed by many forms of media, including:

1) Electronic: Via email or website.
2) Newsletter: Via e-mail, or website.
3) Availability of Literature at regular Meetings.
4) Volunteer Opportunities such as participation in the Clean Boats, Clean Waters, for example.
5) Posting of Educational Signs at Boat Launch.
6) Association representation at annual Wisconsin Association of Lakes conferences.

Examples of a variety of Educational Materials available through the WI DNR is located in Appendix B.

B. Manual (Physical) Removal

Hand removal can be an effective tool in small, relatively shallow, near-shore areas. Residents should be encouraged to utilize this technique in and around piers and swim areas.

Residents should also be notified that a permit for this activity is required *unless:*

- *Removal of plants is restricted to less than thirty feet of shoreline and is not assisted by mechanical means (ex., suction removal)*
- *Plants targeted include Eurasian Watermilfoil or Curlyleaf Pondweed (Aquatic Invasive Species)*
- *Area of removal is not located within Golden Lake's Sensitive Area.*

Residents may remove plants themselves, or hire individuals/firms qualified to do this work. A list of vendors offering manual removal services is located in Appendix C.

C. Hand Harvesting via Venture Crew

This method of removal utilizes scuba divers skilled in AIS identification. The trained divers are best suited to remove AIS in areas that are relatively shallow, are less dense or in relatively small clumps spread out in a specified area. The divers remove AIS plants including roots. The AIS is placed in netted bags, given to support team members in kayaks/boats and taken to shore. Once on shore, the AIS is placed in containers and taken to a proper disposal site. Support team members in kayaks/boats net AIS fragments to negate the effects of fragmentation. This method of harvesting is best done in early summer, while the AIS is growing and plant structure is strong. This method is cost effective, but requires substantial number of volunteers to support the dive staff. A DNR permit is required for this removal option.

D. Diver Assisted Suction Harvesting (DASH)

Diver Assisted Suction Harvesting (DASH) is best utilized in removal in large, high-density beds of EWM or other AIS. Surface supplied air allows divers skilled in AIS identification to remain underwater for an indefinite period, greatly improving efficiency and allowing a more systematic approach to a large AIS stands. Once underwater, a team of two divers removes the roots and plants and feeds them into a 50-ft. suction hose. The entire plant is then transported via suction hose to the deck of a boat at which point the AIS is pumped into large mesh nets for collection. Water from this process is then returned to the lake and only AIS remains in the nets. Support team's net fragments to negate the effects of fragmentation. The collection boat takes the mesh nets to shore, where they are off loaded to a truck for disposed at a proper site. This method of harvesting is best done while the AIS is growing and plant structure is strong. DASH is an expensive AIS control option. The number of volunteers need to support the method is less than Venture hand harvesting. A DNR permit is required for this removal option.

E. *Mechanical Harvesting*

Mechanical harvesting of native aquatic plants, or in beds containing a mixture of both native and non-native species is often recommended, as needed, to maintain recreational access. A permit from the WI DNR will be required for this activity.

While at the time of this Report there are no immediate plans for harvesting, due to both to limited funds and the perceived need (frequency of conflicts with native plants), this will continue to be evaluated in the future. Areas where Mechanical Harvesting may be considered by the WI DNR include maintenance of private or public access within high-use recreational areas. It also be necessary to provide for "skimming" of floating fragments on any future harvesting plans.

Considerations for the pursuit of mechanical harvesting include:

- Accurate determination of the location and size of area(s) and depth to be harvested.
- Species present (low vs. "tall" growing species) and contour of the lake bottom.
- Areas requiring harvesting may vary year to year based upon weather, degree of plant growth, etc.
- Start Date: A typical start date of approximately June 1 is anticipated. Weather, growth stage of plants, and DNR permit restrictions may require a later or earlier start.
- Frequency of Harvesting: A maximum of (4) monthly harvests between June and September is anticipated.
- Disposal Site: A disposal site must be clearly identified by address and /or location on a map accompanying the DNR Permit Application.

Costs for harvesting on an annual basis will be dependent upon the size of the area (acreage) to be harvested and the number of times it will be conducted during the year (two to four times/season is typical). Contractors typically have a "Minimum" per visit cost of $3000.00-$4000.00, and the typical (average) per acre cost of approximately $500.00.

Cont'd on following page

Mechanical Harvesting cont'd

The following Table lists some of the commonly accepted Advantages and Disadvantages of Mechanical Harvesting.

Advantages	Disadvantages
Water can be used immediately following treatment.	Regrowth may occur quickly (2-4 weeks)
Majority of cut plants are removed—Less plant material left to decay.	Not all cut plants are removed. Fragments may form floating mats and/or generate new plants (Milfoil)
Some plant material is left behind to serve as habitat for fish, aquatic insects, etc.)	Removal of some non-target organisms (fish, aquatic insects, etc.) is likely to occur.
Provides for a limited amount of nutrient removal, along with plants	May be cost prohibitive, depending on number of harvests required in a season.
Control can be confined to a well defined area.	Efficiency (acres/day) varies widely, dependent upon plant density, distance to plant un-loading site, and wind.

Finally, due to a variety of reasons there are a limited number of Harvesting Contractors in the State of Wisconsin. Thus, their schedules are typically fairly full with time allotted on a "first come, first serve" basis. New clients are encouraged to contact them early in the year (January) before there is fully "Booked" for the season.

F. Herbicides

As indicated earlier, the Association has elected to have areas infested with EWM treated using formulations of 2,4-D. The use of selective herbicides to control *dense, mono-typical stands of Milfoil (or Curlyleaf Pondweed) is recommended.* It is important to note that other tools may be used (as mentioned earlier) to control smaller, isolated infestations, or plants interspersed with native plant species.

While harvesting of native plants is recommended in the event that their density should become problematic, its' use is likely restricted to waters greater than three feet in depth. Therefore, in the instance where the degree of infestation is too severe to remove plants by manual means, some other tool may be needed. It is under these circumstances where treatment for native species may *be* appropriate. While treatment of native plant species *is not recommended at this time, it is not the intent of this Plan to expressly prohibit it in the future.* While the WI DNR does not prohibit treatment of native plants, it is strongly discouraged except for instances where especially dense infestations in shallow waters (less than 3 feet) make recreational areas virtually impassable.

While herbicide treatments for control of aquatic vegetation may be cost-effective, their use does have limitations and/or disadvantages, including:

- While effective, control is limited in length (months) requiring re-treatment
- While some herbicides are narrow-spectrum (only control a limited number of species), negative impacts may be observed on desirable (native) species.
- May contribute to the accumulation of dead, decaying plant material
- Nutrients within the dying plant are released. This may, or may not, in turn, affect algal production. This will be dependent upon a variety of factors, including treatment area size, water temperature, depth, etc.

Any proposed treatment will require DNR permit approval. DNR Permit may or may not *require supervision on the day of treatment.* WI DNR has requested the Association's acceptance of a proposal to conduct a Pre-Treatment Survey in lieu of an *on-site supervision on the day of treatment.* Such practice is commonplace on other lakes in southeast Wisconsin to avoid treatment delays.

Herbicide Treatment Options

Option A. Spot-Type Applications

Spot-Treatment with 2,4-D alone for control of Eurasian Watermilfoil on Golden Lake is considered by the WI DNR as a viable option for control. DNR recommendations for "Spot-Treatment" suggest that 2,4-D may be used at a concentration of up to 3.5 ppm, up to approximately ten acres.

A concentration of 2.5-3.5 ppm liquid 2,4-D equates to approximately 1.75-2.5 gallons of product applied per acre-ft. of water. Depending on the portion of Golden Lake being treated, a good estimate of average depth would be five to seven feet. Thus, fifty to seventy acre-ft. of water (maximum) may be treated with a minimum /maximum of 87.5 – 175 gallons of 2,4-D for treatment area ten acres in size.

A herbicide treatment plan should allow for a second treatment, if needed, later in the season. This should not add appreciably to the risk upon native species, particularly if applied late in the Fall when most native plant species are entering dormancy. This would offer a higher likelihood that any "problem areas" developing later in the season be addressed before they reach a size where an entire lake treatment is required.

Option B. Whole Lake, Low Concentration Treatments

The concept of a whole-lake, or epilimnetic treatment using a combination of Aquathol-K and liquid 2,4-D has been discussed and has been judged *to be unnecessary and unaffordable at the present time*. However, the population of Eurasian/Hybrid Watermilfoil in Golden Lake can be expected to change over time, and it is the Objective of this Plan to identify and consider all potential treatment alternatives, both for now and for the future.

Ongoing research in Wisconsin has provided for treatments of an entire lake volume, or the entire epilimnion of a lake. Entire lake volume treatments can be conducted in relatively shallow lakes where thorough vertical mixing occurs and thus, no thermocline exists. Epilimnetic treatments occur once a thermocline forms in lakes of sufficient depth, and after the depth at which the thermocline forms can be measured. Both occur early in the season when AIS target plant biomass is at a minimum, native species are for the most part, dormant, and water temperatures are cool. This results in a relatively long herbicide half-life and exposure time that allows for lower herbicide concentrations to be used.

The costs of most of the Options available for Epilimnetic Treatment of Golden Lake are cost prohibitive. However, these should not be dismissed entirely in the future as cost-sharing may be available through AIS Grants (WI DNR).

While an entire lake, epilimnetic treatment for Golden Lake may be appropriate at some time in the future, *it is not recommended at this current time* for the following reasons:

1. Higher costs in comparison to "Spot" treatments: Current DNR research regarding lake-wide treatments seem to indicate that more than one season of control *may be obtained* at certain 2,4-D concentrations. However, until this Research is complete, we cannot be sure if these higher treatment costs will be offset by a greater length of control.
2) Lack of solid Bathymetric (water volume) Data: This makes it difficult to precisely determine the quantity of liquid 2,4-D herbicide (in gallons) required to achieve the desired target (part per billion) concentration.
3) The relatively low abundance (density and number of locations) of Eurasian/Hybrid Watermilfoil at present.

On the other hand, the milfoil population is subject to change and thus, this type of treatment remain in consideration for the future under the following conditions:

1) Accurate determination of lake volume within certain depth contour becomes available. This may, or may not require an updated bathymetric survey of the lake using modern methods. Annual monitoring of the thermocline will also assist with planning.
2) The Associations' Objective to control AIS *within an acceptable level changes* to *one to control it lake-wide to the greatest extent possible.*
3) That spot treatments fail to maintain control of the nuisance and the Milfoil population returns to unacceptable distribution and density.

Proposed EWM/Hybrid Milfoil Spot Treatment Strategy

For the immediate future we recommend limiting treatments to applications of no more than 175 gallons of liquid 2,4-D at one time. Concentrations to be applied will range from 2 to 3.5 ppm. This may be changed in the future according to need (success of prior years treatment) , anticipated costs, and availability of funds. As stated earlier, a second treatment could be conducted later in the year, if warranted.

The actual treatment size and timing will be determined by a variety of criteria that will be used to monitor the EWM/ Hybrid population. These will include:

1) A comparison of the current lake conditions relative to prior surveys. Survey data and visual survey data exists for multiple years. Milfoil growth representing a minimum of 2 on a "Rake Fullness" scale of 1-3 is an "unacceptable" condition that requires management.

2) Point Intercept Data , including Frequency (# site Milfoil present), and Density and Distribution. The Association can use the number of sites (existing PI Points) where Milfoil found as one criteria. Golden Lake's goal is to maintain at 15% of total waypoints. While lakes within the "Eco-Region" (Southern Wisconsin Till Plains or SWTP) vary widely in terms of their Frequency of Occurrence, the average for the region is significantly lower, approximately 17%.

3) Density: Density Data can be collected on a survey date, with it being measured on a Rake Fullness Scale (0-3) for Milfoil. At the end of the survey, Rake Fullness can be tabulated with the Result of the Sum being divided by the number of points where Milfoil was present. By this measure, an average density closer to "1" would be much more favorable than one closer to "2" .

A discussion of the methods used to collect this EWM/Hybrid data follows.

G. Aquatic Plant Monitoring

We recommend an annual Fall Survey of all PI points at 13 feet or less in depth, with the exception of the far north end of the lake. Data collected will include Absence/Presence of Milfoil, Depth and Rake Fullness. Criteria which will require a chemical treatment will include:

1) Presence of EWM/Hybrid at greater than 25 points (15% of total number of waypoints in area less than 13 ft. in depth) **and** an average density (Rake Fullness) of greater than (1).

2) Areas that have a Rake Fullness of (2), or areas where Milfoil tops out and interferes with recreation (navigation/ swimming).

The data from the Fall surveys can then be used to project treatment requirements for the following year, as well as compare the Milfoil population year to year. Survey costs in the range of $1,500.00-$2,000.00 can be anticipated.

The Association will attempt to conduct a full "Point Intercept" Survey every five years or so. Survey cost in the range of $5,000.00-$6,000.00 can be anticipated .

Page 44 lists (in Table Form) the Association's recommended activities. The Appendix contains the original DNR Sensitive Area Assessment conducted in 2006, as well as other helpful information for the Association's consideration.

H. Miscellaneous Considerations and Recommendations

The importance of knowing, with a high degree of accuracy, either the entire lake volume, or the volume that lies above a certain depth contour is important. Without this information it is very difficult to begin discussing the feasibility of cost of large scale treatments. The cost of a Bathymetric Survey will be approximately $5,000.00.

In the future it may be necessary to conduct a treatment of the entire lake. A whole lake treatment can be partially funded (75%) via an Aquatic Invasive Species Grant administered by the Wisconsin DNR.

Finally, while not specifically required to be discussed in this Plan, implementation of a Water Sampling Program to monitor the quality of water runoff from the surrounding watershed is recommended. A Draft of the specific Protocol, is provided in the Appendix.

Figure 28

Summary of the Golden Lake -Waukesha & Jefferson Counties, WI

Aquatic Plant Management Plan—Recommended Activities

Information and Education	Ongoing. Obtain literature regarding Invasive Species for distribution to members and /or post Boat Launch with information regarding AIS. Attendance at annual Wisconsin Association of Lakes Conference and participation in Clean Boats Clean Waters program, as needed.
Physical Removal	Educate and promote removal in pier/swim areas, by property owner. Thirty feet of shoreline may be maintained by manual means w/o WI DNR permit approval. Removal along greater than 30 ft. of shore requires WI DNR Permit (Exception for non-native species). DNR Permit is required if property is within Sensitive Area for any removal activity. Continue the use of Venture Crew hand pulling in select areas with AIS (WI DNR Permit required).
DASH and Mechanical Harvesting	Continued use of DASH in Sensitive Area of lake for control of AIS. Need for DNR Grant funds for DASH is essential because of its cost. Mechanical harvesting and collection of plants will not be conducted in immediate future due to limited need and relatively high expense. This will be under continued consideration in future for management of primarily native plant populations.
Herbicide Treatments	Annual “Spot” treatments (1-2x/yr.) for selective control of Aquatic Invasive Species (AIS). Objective: To minimize formation of plant beds dominated by AIS and impacts upon recreation. Control Milfoil within Association established standards. Evaluate lake-wide treatment options, if needed in future. Recommended when 25 acres (or more) of lake have EWM at density of (1.5)or greater and total number of points present is equal or greater than 105.
Aquatic Plant Monitoring	Annual Fall Survey for EWM/Hybrid Milfoil using prescribed methodology. Identify number of PI Points with Milfoil and Rake Fullness (Density), where present. Full PI Survey recommended by WI DNR every three to five years.

APPENDIX

Aquatic Plant Survey and Management Plan
for Golden Lake—Waukesha and Jefferson Counties, WI
March , 2015 (Updated November, 2017)

Appendix A. 2006 DNR Sensitive Area Assessment

Appendix B. Examples of Educational/Informational material Available for Lake Groups

Appendix C. Potential List of Suppliers for Aquatic Plant Management Services

Appendix D. Water Sampling Project Protocol (Proposed)

Appendix E. Historical (1998) Map by J. Prah showing EWM Distribution on Golden Lake

Golden Lake (Waukesha and Jefferson Counties, Wisconsin) Integrated Sensitive Area Report

Assessment Dates:	August 30, 2005 September 20, 2005
Number of Sensitive Areas Surveyed:	1
Site Evaluators:	Heidi Bunk, Lakes Biologist Bob Kudis, Golden Lake Association Board Dave Perry, Golden Lake Association Board Sue Beyler, Fisheries Biologist Tami Ryan, Wildlife Biologist Supervisor
Authors:	Mike Hemmingsen, Water Resources Specialist Heidi Bunk, Lakes Biologist

General Lake Information

Golden Lake is located within the Town of Summit in Waukesha County and the Town of Concord in Jefferson County. The lake has a maximum depth of 46 feet, a surface area of approximately 250 acres, and is located in a terminal moraine. The lake has primarily a sandy bottom and the main source of water is through groundwater percolation and precipitation. A deep marsh at the far northern end of the lake contains multiple dredged channels. These channels drain intermittently in a northwest direction to the marshland located adjacent to Goose Lake (SEWRPC 2003). Public access to Golden Lake is available through a public boat launch located on the southeastern shoreline of the lake.

Golden Lake has a watershed (drainage area) of about 490 acres. The watershed consists of approximately 85 percent rural land use, and about 15 percent urban land use. Wetlands, woodlands, surface waters, and other open spaces comprise about 300 acres or 60 percent of the total land cover. Agricultural land use makes up about 120 acres or 15 percent of the total land cover. Residential land use comprises about 55 acres or 10 percent of the total land cover. Commercial, recreational, and transportation infrastructure land use makes up the remaining 15 acres. Waukesha County does not include any of the Golden Lake watershed in its urban development plan.

Waterfowl are reported to make migratory and resident use of the extensive wetlands at the north end of the lake. Northern pike, largemouth bass and panfish are common in the lake and walleyed pike are present according to a 2001 DNR report. Fish surveys conducted in 1974 and 1978 by the DNR showed grass pickerel, lake chubsucker, bluegill, largemouth bass, walleyed pike, northern pike, rock bass, warmouth, black crappie, golden shiner, mimic shiner, blacknose shiner, pumpkin seed, and yellow perch to all be present in Golden Lake.

Exotic Species

Exotic species, most notably zebra mussels, Eurasian watermilfoil, and purple loosestrife have invaded many lakes in Wisconsin including Golden Lake. Boaters traveling from lake to lake often facilitate the propagation of exotic species. The introduction of exotic species into a lake ecosystem can lead to a decline in the native plant population and cause problems with nutrient loading. In addition, the disturbance of lake sediments from human activity (boating, plant harvesting, chemical treatments, etc.) enhances the colonization and/or expansion of exotic species. Two simple steps to prevent the spread of exotic species include: 1) Removing aquatic plants, animals, and mud from trailers and boats before leaving the boat launch and 2) Draining water from boats, motors, bilges, live wells, and bait containers before leaving the boat launch.

Eurasian watermilfoil is present in Golden Lake. Eurasian watermilfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. This non-native milfoil has a tendency to establish large monocultures (colonies of single plants) and outcompete many native plants. These dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

The regenerative ability of Eurasian watermilfoil is an obstacle when attempting to control this species. Fragments of Eurasian watermilfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of the lake or downstream to additional lakes in the drainage system and create new colonies. Chemical treatment is often used when an isolated stand of Eurasian watermilfoil is identified. A few lakes have successfully used the milfoil weevil to suppress milfoil populations. However, the most effective "treatment" of exotic milfoil is prevention through public education.

Curly-leaf pondweed is another submerged, exotic species found Golden Lake. Like Eurasian watermilfoil, curly-leaf often grows into large, homogenous stands. It can crowd out native vegetation, create navigational problems, and limit fish movement. Curly-leaf pondweed dies off in mid-summer, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreasing water quality.

The unusual life cycle of curly-leaf pondweed makes management difficult. The plant germinates as temperatures decrease in fall. Curly-leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice-off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly-leaf. To control the species in lakes, the plant must be combated before turions become viable. Most plant harvesters have not started cutting when curly-leaf is most susceptible and a small window of opportunity exists for chemical treatment. Therefore, prevention through public education is once again very important.

Purple loosestrife, a hardy perennial native to Europe, is another exotic species common to Wisconsin and Golden Lake. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, and around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Dense stands of purple loosestrife plants often out compete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled, but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius trasversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003). Lastly and most importantly, prevention through public education plays an important role in the management of this species.

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources (Woodford and Meyer 2003, Garn 2002). Therefore, many communities have chosen to go beyond minimum standards to ensure protection of our natural resources. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet are not very effective in reducing nutrient loading. Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, citizens living on Golden Lake and the community at large should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat (see Greene 2003). This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Department personnel conducted a Golden Lake sensitive area designation survey on August 30, 2005 and September 20, 2005, following the Wisconsin Department of Natural Resources' sensitive area survey protocol. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation and zoning, fisheries, lake biology, and wildlife.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water*. Department resource managers determined that the area located on the north side of Golden Lake met this definition (Figure 1). This area is locally known as either the "marsh area" or "kettle area".

Overview of Sensitive Area Designations

Sensitive areas often have aquatic or wetland vegetation, terrestrial (land) vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or logs). These areas provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A designated sensitive area alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem, and/or may feature an endangered plant or animal. Information presented in a sensitive area report may discourage certain permits from being approved within these sites.

Whole Lake Recommendations:

Several recommendations from Department staff pertain to Golden Lake as a whole rather than to the sensitive area:

1. Native aquatic plant beds should be protected and maintained.
2. Prevent the spread of exotic species through sign postings, education, etc. and control exotic species where established.

3. Comply with State and Local Shoreland Zoning standards by maintaining no-cut buffers and setbacks, removing non-conforming structures, and limiting impervious surfaces.
4. Create shoreland buffers and maintain existing buffers, especially in areas not currently developed.
5. Monitor water quality for early detection of changes and possible degradation.

Resource Value of Sensitive Area– Golden Lake

The sensitive area on Golden Lake is located in the northern basin of the lake, locally known as the "Kettle" or "Marsh Area". This sensitive area, with its rich ecological diversity, serves as a nutrient buffer for reducing algae blooms, a biological buffer reducing the likelihood of exotic species invasions, a physical buffer against shoreline erosion, a micro-habitat increasing biodiversity, and allows for sediment stabilization.

The substrate (lake bottom) in Golden Lake's sensitive area consists of sand, silt with marl, muck and detritus. The water depth is about 3 ft in most places, getting shallower near the lilly pads (2 feet of less water depth), and reaching 8 feet at the entrance to the kettle. Sediment depth ranged from 6 inches to 4 feet throughout the kettle area.

Sensitive area habitat is located along the shoreline, near-shore terrestrial (land), and littoral (vegetated edge of lake) zones. The shoreland buffer in this sensitive area is made up of approximately 70 percent wetland, 25 percent wooded area, and is 5 percent developed. The wetland consists primarily of deep marsh containing cattail, yellow water lilly, and soft stem bulrush. Large woody cover is not present in the water along the shoreline of this sensitive area. Herbaceous plants are dominant, covering at least 75% of the shoreline buffer zone. Shrubs cover up to 25 % of the shoreline buffer. Trees are common along one quarter to one half of the shoreline buffer zone. Lawns are present along approximately 5% of the shoreline buffer zone. This area has unique aesthetics and has undergone very little human influence; therefore the natural scenic beauty (NSB) rating of this sensitive area is listed as "outstanding".

The sensitive area also provides life requisites for a variety of wildlife species. Submergent, floating, and emergent vegetation within the sensitive provides nest sites, nest building materials, and nutritional values for birds and mammals. Wild celery predominates and is one of the most valuable duck foods. All parts of the plants are consumed. Sago pondweed is also present and is by far the most valuable pondweed species for wildlife. All parts of the plant are consumed including its tubers and large seeds. The seeds of the soft stem bulrush are also an important food source for ducks, geese, marsh birds and shorebirds. Geese and muskrats consume the bulrush stems and underwater parts as well. Bulrush also provides important nesting cover for waterfowl and marsh birds and provides concealing protection from predators. Cattails are also

abundant and provide food and nesting material for muskrats and geese. This emergent vegetation also serves as shelter and nesting cover for songbirds.

The shoreline of Golden Lake provides a relatively uninterrupted tree canopy with variation in understory canopy. This vegetational structure, next to a large water body, provides important habitat as a travel corridor for a variety of mammals, as well as feeding, nesting, roosting, and migratory habitat for a variety of songbirds. The northern shoreline is especially valuable due to its lack of development and marsh habitat.

During the sensitive area survey on September 20, 2005, a marsh hawk, a species of special concern, was observed in the area. A pied-billed grebe was also observed. A sandhill crane was heard during the August 30, 2005 survey. Loons, ducks, geese, great blue herons, song birds, frogs and muskrats are either heard or seen at various times throughout the year (Bob Kudis and Dave Perry, personal observations). The presence of these animals indicates good wetland quality.

The extensive development of the main basin of Golden Lake has reduced the quality of the available wildlife habitat. The sensitive area provides suitable shelter, nesting area, and feeding areas for sandhill cranes, white tail deer, loons, ducks, geese, great blue herons, songbirds, frogs and muskrat. Table 1 displays all the plants found in the sensitive area and their level of abundance. 21 species and/or taxa of plants were observed during the surveys on August 30, 2005 and September 20, 2005.

Important fish habitat components present in this sensitive area include emergent vegetation, submergent vegetation, floating leaf vegetation, and sand bottom used for spawning. Northern pike, smallmouth bass, largemouth bass, panfish, perch, suckers and minnows use this sensitive area for spawning, nursery areas, feeding, and for protective cover. Walleye use the sensitive area as a nursery, feeding area, and for protective cover. See Table 2 for a summary of plants and substrates utilized by fish in Golden Lake.

Table 1. Plants observed in sensitive area

	Emergent	**Submergent**	**Floating**	**Exotic**
PRESENT (0-25% Cover)		*Ceratophyllum* (coontail) *Myriophyllum sibiricum* (northern watermilfoil) *P. amplifolius* (large-leaf pondweed) *P. praelongus* (white-stemmed pondweed) *P. richardsonii* (clasping-leaf pondweed)		*Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed) *Lythrum* (purple loosestrife)
COMMON (26-50% Cover)	*Pontederia* (pickerelweed)	*Utricularia* (bladderwort) *Najas marina* (Spiney naiad)	*Nuphar advena* (yellow water lily) *P. natans* (floating-leaf pondweed)	
ABUNDANT (51-75% Cover)		*P. zosteriformis* (flat-stemmed pondweed) *P. illinoensis* (Illinois pondweed)	*Nymphaea odorata* (white water lily)	
DOMINANT (76-100% Cover)	*Scirpus* (bulrush) *Typha* (cattail)	*Vallisneria* (wild celery) *Najas flexilis* (Slender naiad) *Chara* (muskgrass) *Stuckenia pectinata* (sago pondweed)		

Table 2. Sensitive area habitat utilized by resident fish species of Golden Lake

Fish Species	**Spawning**	**Nursery**	**Feeding**	**Protective Cover**
Walleye		water lily, milfoil, sago	sago, milfoil	sago, milfoil
Northern Pike	Aquatic plants (emergent)	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	sand, gravel, rubble	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Smallmouth Bass	sand, gravel, rubble	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Bluegill and Pumpkinseed	sand	water lily, wild celery, milfoil	water lily, wild celery, milfoil	water lily, wild celery, milfoil

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Yellow Perch	milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	milfoil, pondweeds	milfoil, pondweeds
Suckers	gravel	water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago
Minnows	Variable depending on species	water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago

Management Recommendations for Sensitive Area #1

1. Post "Exotics Alert" sign at boat landing. (Already Present)

2. Maintain current levels of erosion and nutrient runoff control.

3. Protect emergent aquatic plants.

4. No mechanical harvesting except for a navigational channel.

5. No chemical treatment should be allowed except to target an infestation of an exotic species such as purple loosestrife, Eurasian water milfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.

6. No alteration of the littoral zone unless to improve spawning habitat.

7. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Rip Rap
Aquatic plant screens	Sea Walls

8. Boardwalks will be allowed on a case by case basis to provide open water access only for a riparian landowner. Watercraft moored at the boardwalk must be able to navigate the water without any additional dredging. The number of moorings allowed will be less than "reasonable use" as defined by state law.

9. New piers will only be permitted in the very southern portion of the kettle where the existing water depth fifty feet from shore is at least 3 feet. The number of slips allowed will be less than "reasonable use" as defined by state law.

10. The Golden Lake Association should consider pursuing an ordinance to establish a "Slow, No Wake" zone for the sensitive area. This ordinance would need to be established on a local level through both the Town of Summit and the Town of Concord.

11. Recommendations regarding **local and county zoning**:

- Strictly enforce shoreland and wetland ordinances
- Restrict/limit subdivision of existing undeveloped parcels
- Require a buffer/"no touch" zone for grading projects. This buffer/"no touch" zone should be at least 100 feet from the edge of the wetland back into the (landward) upland portion of parcels.
- Require a buffer/"no touch" zone for grading projects located along steep slopes. The zone should extend at least 100 feet from the edge of a steep slope towards the landward side of the parcel.
- Grading proposals should be strictly examined for superior erosion control and nutrient management plans.

Conclusion

Development proposals along the shoreline of Golden Lake's sensitive area should be carefully studied to prevent any further loss of habitat. This report identifies the biological components of the sensitive area, identifies sensitive area characteristics, and poses management recommendations for the sensitive area. The sensitive area provides the key fish nursery and the main wildlife refuge for Golden Lake.

In summary, the ecological community of the sensitive area has distinctly unique features when compared to the waterbody as a whole. This site provides a visual and audible buffer from shoreline structures, roads, and boat traffic. Aquatic plant types present in the sensitive area include emergents, algae, potamogetons (pondweeds), exotics, free floating, floating leaf, and submergents. Wet edge plants include rushes and herbs. Game fish, panfish, and forage fish heavily utilize the sensitive area. Wildlife species include upland wildlife, furbearers, songbirds, waterfowl, shore birds, raptors (turkey vultures, marsh hawks) amphibians and reptiles. This site offers a buffer against invasive non-native species (exotic species), and could be used to educate citizens about wetlands and sensitive areas.

Wisconsin lakes attract many users, all of whom are affected by water quality. Golden Lake attracts a diverse group of patrons, inevitably creating conflict between conservationists and recreational users. Therefore, the objective must be to create and maintain a balance between recreational use and preservation of habitat. This is essential to the long term water quality for Golden Lake. An integrated approach to lake management that includes the public and all of the lakes' governing units will help to maintain this balance. Improving or at least maintaining water quality in Wisconsin lakes is critical. By protecting and restoring lake habitat, Golden Lake will continue to sustain healthy ecosystems and responsible recreational opportunities for years to come.

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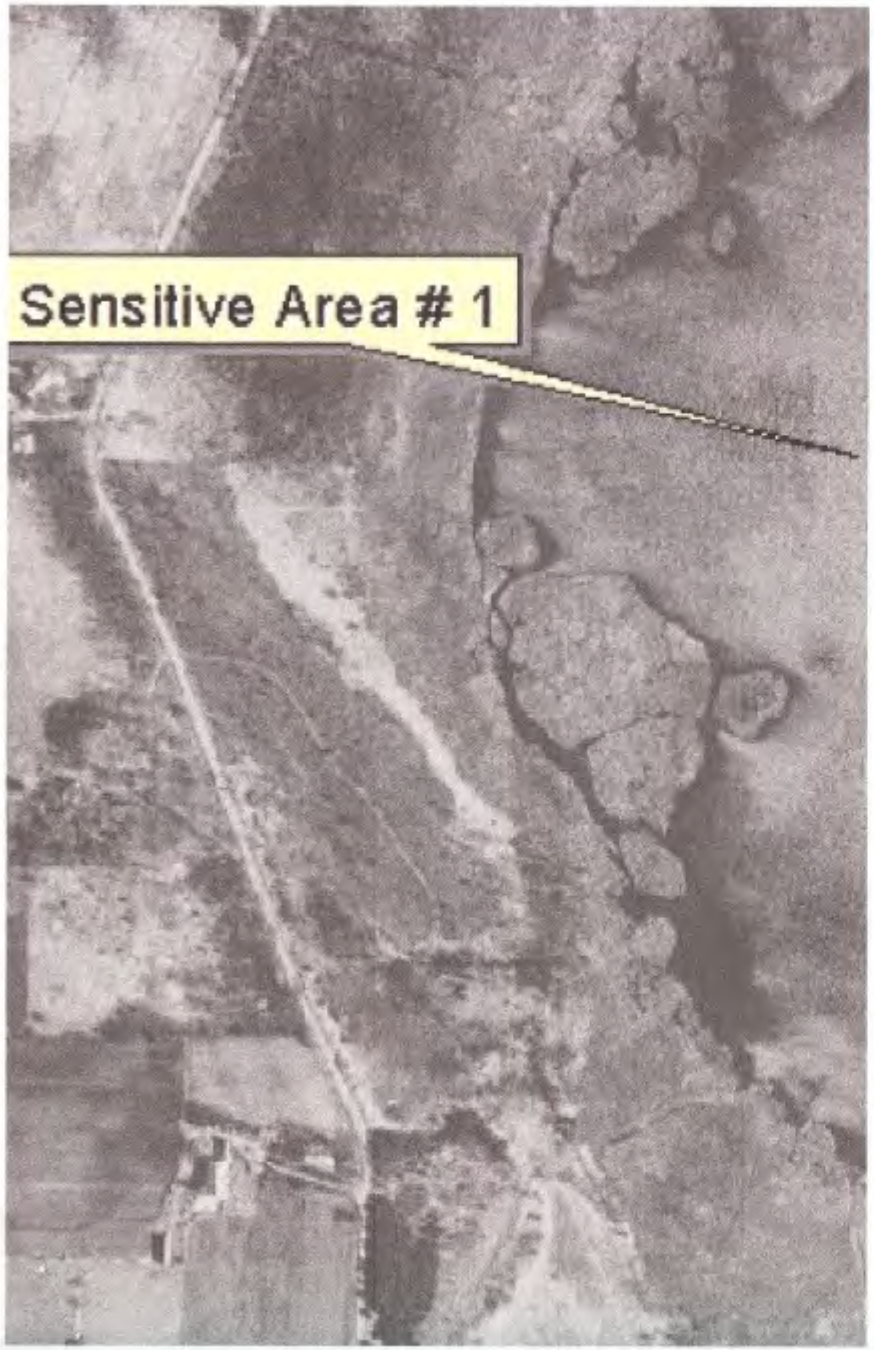
Sensitive Area # 1


Sensitive Area
D
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Appendix B

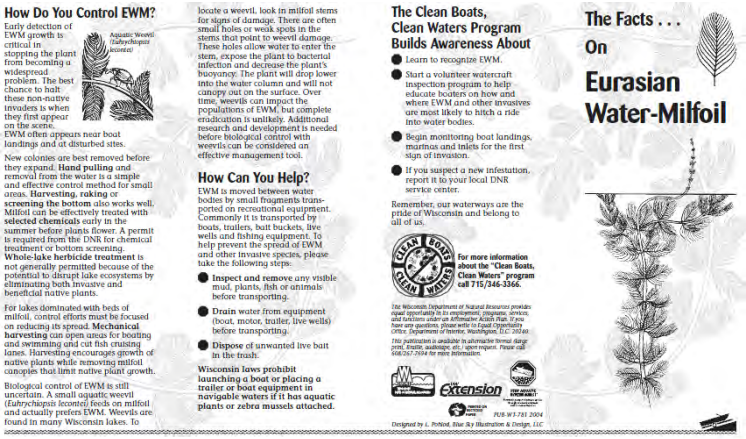
Example of Boat Launch Signage Available through UW Extension

www.uwsp.edu/cnr/uwexlakes/CBCW/pubs.asp

Appendix B cont'd.

Example of Literature Available through UW Extension

www.uwsp.edu/cnr/uwexlakes/CBCW/pubs.asp



How Do You Control EWM?

Early detection of EWM growth is critical in stopping the plant from becoming a widespread problem. The best chance to halt these non-native invaders is when they first appear on the scene. EWM often appears near boat landings and at disturbed sites.

Aquatic Weevil (Eubychiopsis lecontei)

New colonies are best removed before they expand. **Hand pulling** and removal from the water is a simple and effective control method for small areas. **Harvesting, raking** or **screening the bottom** also works well. Milfoil can be effectively treated with **selected chemicals** early in the summer before plants flower. A permit is required from the DNR for chemical treatment or bottom screening. **Whole-lake herbicide treatment** is not generally permitted because of the potential to disrupt lake ecosystems by eliminating both invasive and beneficial native plants.

For lakes dominated with beds of milfoil, control efforts must be focused on reducing its spread. **Mechanical harvesting** can open areas for boating and swimming and cut fish cruising lanes. Harvesting encourages growth of native plants while removing milfoil canopies that limit native plant growth.

Biological control of EWM is still uncertain. A small aquatic weevil (*Eubychiopsis lecontei*) feeds on milfoil and actually prefers EWM. Weevils are found in many Wisconsin lakes. To locate a weevil, look in milfoil stems for signs of damage. There are often small holes or weak spots in the stems that point to weevil damage. These holes allow water to enter the stem, expose the plant to bacterial infection and decrease the plant's buoyancy. The plant will drop lower into the water column and will not canopy out on the surface. Over time, weevils can impact the populations of EWM, but complete eradication is unlikely. Additional research and development is needed before biological control with weevils can be considered an effective management tool.

How Can You Help?

EWM is moved between water bodies by small fragments transported on recreational equipment. Commonly it is transported by boats, trailers, bait buckets, live wells and fishing equipment. To help prevent the spread of EWM and other invasive species, please take the following steps:

- **Inspect and remove** any visible mud, plants, fish or animals before transporting.
- **Drain** water from equipment (boat, motor, trailer, live wells) before transporting.
- **Dispose** of unwanted live bait in the trash.

Wisconsin laws prohibit launching a boat or placing a trailer or boat equipment in navigable waters if it has aquatic plants or zebra mussels attached.

The Clean Boats, Clean Waters Program Builds Awareness About

- Learn to recognize EWM.
- Start a volunteer watercraft inspection program to help educate boaters on how and where EWM and other invasives are most likely to hitch a ride into water bodies.
- Begin monitoring boat landings, marinas and inlets for the first sign of invasion.
- If you suspect a new infestation, report it to your local DNR service center.

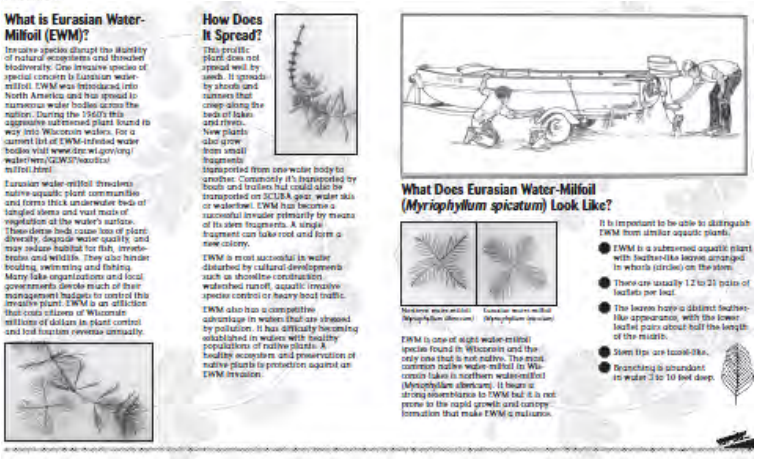
Remember, our waterways are the pride of Wisconsin and belong to all of us.

For more information about the "Clean Boats, Clean Waters" program call 715/346-3366.

PUB-WT-781 2004

Designed by L. Potford, Blue Sky Illustration & Design, LLC

The Facts . . . On Eurasian Water-Milfoil



What is Eurasian Water-Milfoil (EWM)?

Invasive species disrupt the stability of natural ecosystems and threaten biodiversity. One invasive species of special concern is Eurasian water-milfoil. EWM was introduced into North America and has spread to numerous water bodies across the nation. During the 1960's this aggressive submersed plant found its way into Wisconsin waters. For a current list of EWM-infested water bodies visit www.dnr.wi.gov/org/water/wm/GEWS/waterbio/milfoil.html

Eurasian water-milfoil threatens native aquatic plant communities and forms thick underwater beds of tangled stems and vast mats of vegetation at the water's surface. These dense beds cause loss of plant diversity, degrade water quality and may reduce habitat for fish, invertebrates and wildlife. They also hinder boating, swimming and fishing. Many lake organizations and local governments devote much of their management budgets to control this invasive plant. EWM is an affliction that costs citizens of Wisconsin millions of dollars in plant control and lost tourism revenue annually.

How Does It Spread?

This prolific plant does not spread well by seeds. It spreads by shoots and runners that creep along the beds of lakes and rivers. New plants also grow from small fragments transported from one water body to another. Commonly it's transported by boats and trailers but could also be transported on SCUBA gear, water skis or waterbed. EWM has become a successful invader primarily by means of its stem fragments. A single fragment can take root and form a new colony.

EWM is most successful in water disturbed by cultural developments such as shoreline construction, watershed runoff, aquatic invasive species control or heavy boat traffic.

EWM also has a competitive advantage in waters that are stressed by pollution. It has difficulty becoming established in waters with healthy populations of native plants. A healthy ecosystem and preservation of native plants is protection against an EWM invasion.

What Does Eurasian Water-Milfoil (*Myriophyllum spicatum*) Look Like?

EWM is one of eight water-milfoil species found in Wisconsin and the only one that is not native. The most common native water-milfoil in Wisconsin lakes is northern watermilfoil (*Myriophyllum sibericum*). It bears a strong resemblance to EWM but it is not prone to the rapid growth and canopy formation that make EWM a nuisance.

It is important to be able to distinguish EWM from similar aquatic plants.

- EWM is a submersed aquatic plant with feather-like leaves arranged in whorls (circles) on the stem.
- There are usually 12 to 21 pairs of leaflets per leaf.
- The leaves have a distinct feather-like appearance, with the lower leaflet pairs about half the length of the midrib.
- Stem tips are limp-like.
- Branching is abundant in water 2 to 10 feet deep.

Eurasian Water-Milfoil
(*Myriophyllum spicatum*)

Highly invasive plant, able to form dense mats near the surface that entangle motor boat propellers and interfere with swimming. Spread by watercraft and trailers.

- Delicate feather-like leaves. Leaflets are mostly the same length.
- Leaves are usually limp when out of water.
- Leaves arranged in whorls (circles) of 3 to 5 around stem.
- Usually 12 to 21 leaflet pairs per leaf.
- Long spaghetti-like stems.

If you suspect a new infestation, report it to your local DNR service center.

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Northern Water-Milfoil
(*Myriophyllum sibericum*)

One of the seven native milfoils found in Wisconsin. A valuable plant that offers shade, shelter and foraging opportunities for fish.

- Rigid feather-like leaves forming a Christmas tree shape. The lower leaflets are usually quite long.
- Leaves usually stiff when out of water.
- Leaves arranged in whorls (circles) of 4 to 6 around stem.
- Usually 7 to 10 leaflet pairs per leaf.
- Stem is usually whitish or whitish green in color.

PUB-WT-394 2004

Appendix C

Potential Supplier List

Aquatic Plant Management Services

I. Physical (Manual) Removal

Venture Crew 519
Mike Whittlieff
(608) 449-3028
email: mwittlieff@sbcglobal.net

Sweeney's Aquatic Weed Removal, LLC
David Sweeney
262 501-0533
email: aquaticweedremovers@gmail.com
website: www.aquaticweedremovers.com

II. Diver Assisted Suction Dredging

EcoWaterways
Pat Dalman
W346 S4109 Virgin Forest Drive
Dousman, WI 53118
262 468-6510 (Pat)
414-659-1953 (Gregg)

III. Mechanical Harvesting

Midwest Aquatics
Dave Fetzer
N105 W14564 Wilson Dr.
Germantown, WI 53022
Local (262) 385-5874

ClearWater Plant Harvesters, LLC
7135 Fairway Dr.
Crystal Lake, IL 60014
815 322-6630
www.clearwaterharvesters.com

Appendix D

Proposed Water Quality Sampling Project Protocol

Proposed Water Sampling Project-Golden Lake, Oconomowoc WI February 6, 2015

There is a water quality preservation concern at Golden Lake located in Waukesha and Jefferson Counties. Golden Lake has had a significant increase in aquatic vegetation of both native and nonnative species over the past five to seven years. It is well known that excess phosphorus entering lakes from watershed runoff can feed nutrients stimulating aquatic plant and algae growth. Furthermore, just a small increase in phosphorus entering the lake water can spur substantial lake aquatic plant and algae growth. Additionally, other chemicals in lake water such as nitrogen and chlorophyll A are indicators of lake water quality and overall lake health.

A decade ago, just prior to the increase in aquatic growth in Golden Lake, there was a widening of Wisconsin state Highway 18. This highway is located within the lakes watershed. It winds along the public boat launch through some residential properties and agricultural land. Ever since the widening of the highway, several longtime residents in the area have noticed and reported a change in the storm water runoff towards the lake due to relocation of drainage pipes along and under Hwy. 18. This change has caused storm water to drain into ditches along Hwy.18 that ultimately drain into the lake rather than onto adjoining farmlands as it previously did. Additionally, downhill from this area several inlet pipes are located at Golden Lake's shoreline.

Although there has been concern with the significant watershed alteration and increased aquatic growth there has never been a thorough investigation of potential pollutant sources. Therefore, in order to determine whether Golden Lake's water quality is being impacted by storm water runoff that may be contaminated, a water sampling study is proposed. Beginning in the spring of the year and concluding in the fall, water samples will be taken during * **five to seven sampling events**. These sampling events will occur during two low flow or no rain events and then during three to five storm events. The water samples will be taken at various locations including the deep hole of the lake. Temperature will also be taken at each site and a Secchi disk reading for water clarity will be done at the Deep Hole. The water samples will be sent to an approved lab.
All water samples will be analyzed for

- Total Suspended Solids (TSS)/ conductivity,(quart bottle)
- Total Phosphorus (TP), (250ml bottle)
- Dissolved Phosphorus (DP) (60ml bottle)
- Ammon N (250ml bottle)
- Available Nitrogen (TKN) (250ml bottle)
- ChorA AT THE DEEP HOLE ONLY (quart bottle)

***Cost: $2,030.00 - $2,841.30** Range is for 5-7 sampling events and **includes** coolers, sample bottles, preservatives and shipping (Davy Labs). SF Analytic prices too high $3,571-$4,999.40

In this manner, we will identify any pollutant runoff sources that are currently affecting Golden Lake's water quality and impacting its conservation and recreational use. This information is necessary to determine how to proceed in order to preserve and protect Golden Lake's water quality for the future.

Appendix E

Sketch Map of Eurasian Watermilfoil Distribution in Golden Lake (1998) by Lake Resident