AIS Invasive Species Control Grant Kettle Moraine Lake ACEI-059-09

Kettle Moraine Lake
1/1/2013

2009

Overview

Maps showing May 09 distribution of Eurasian watermilfoil and curlyleaf pondweed were provided by the applicator (Figure 1 and Figure 2). According to the applicator the application was conducted on May 11. Seven sample sites were established to collect water samples for endothall and 2,4-D residual analysis (Figure 3). Site KM1 is meant to be in the deep hole, and sites KM6 and KM7 are meant to be at or near what appears to be water lily beds on the aerial photo. Water samples were collected by lake volunteers at mid depth for all locations at specified sample intervals (Table 1). Following completion of each sample interval, 2-3 drops of muriatic acid were added to the sample to fix the herbicide.

Endothall residual concentrations are presented (Figure 4). Application rates for endothall are based on active ingredient (ai) while residual concentrations are determined as acid equivalent (ae). A target concentration of 1000 ug/L ai is equivalent to 700 ug/L ae. The half live for endothall determined by a linear regress using log transformed data was 5.64 days. The half life seems short, however the data indicates that initial concentrations in probable target areas were between 500 and 900 ug/L ae. The herbicide was dissipated through the entire lake during the first 3 DAT, and then the herbicide degraded at a slower rate to 21 DAT.

Residual concentrations of 2,4-D are presented (Figure 5). Application rates and residual concentrations are all determined as ae. The average concentration for all stations ranged between 100 and 150 ug/L ae through 5 DAT and was below 100 ug/L ae at 7 DAT. The average half live computed from a linear regression using log transformed data was 14.65 days, longer than endothall.

Table 1. Kettle Moraine Lake Sample Intervals

Sample Interval	Samples per Interval	Total Samples
Pre	7	7
3 HAT	7	14
1 DAT	7	21
2 DAT	7	28
3 DAT	7	35
5 DAT	7	42
7 DAT	7	49
14 DAT	7	56
21 DAT	7	63
28 DAT	7	70
35 DAT	7	77
42 DAT	7	84
56 DAT	7	91

Figure 1. Eurasian Watermilfoil distribution on Kettle Moraine Lake on May 1, 2009

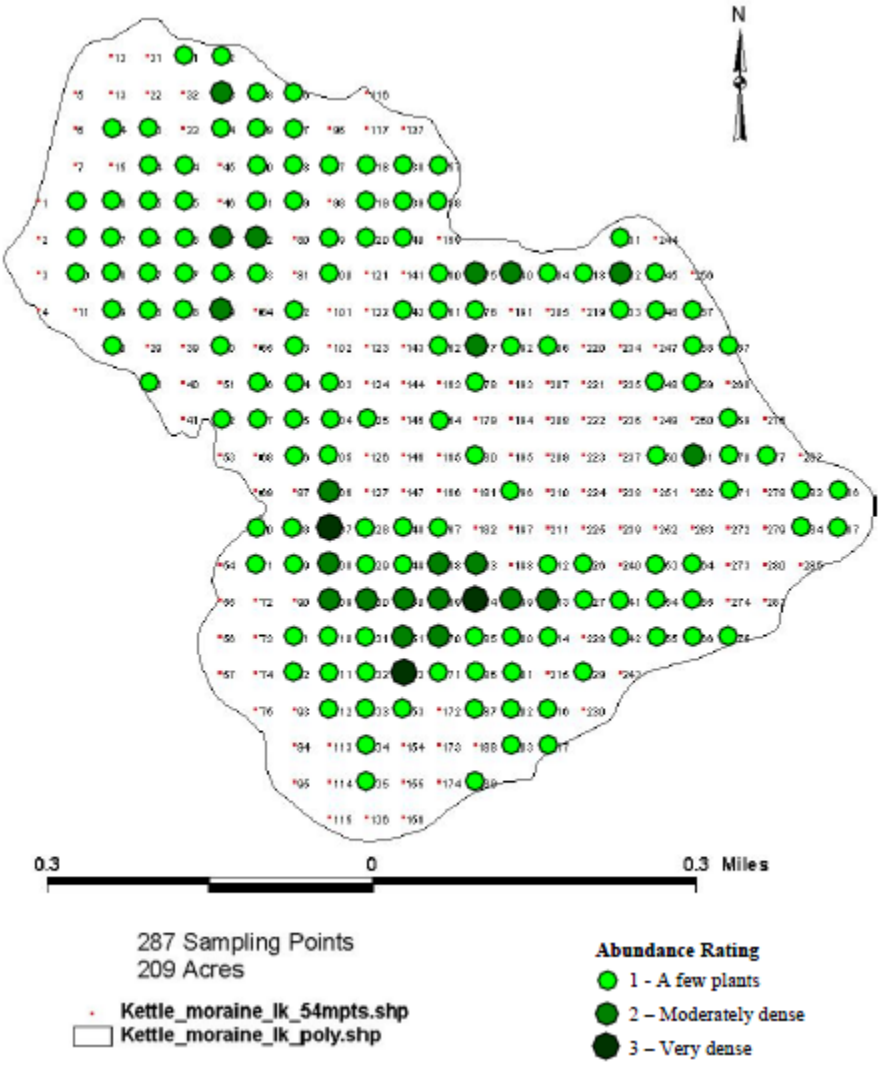


Figure 2. Curly-leaf pondweed distribution on Kettle Moraine Lake on May 1, 2009

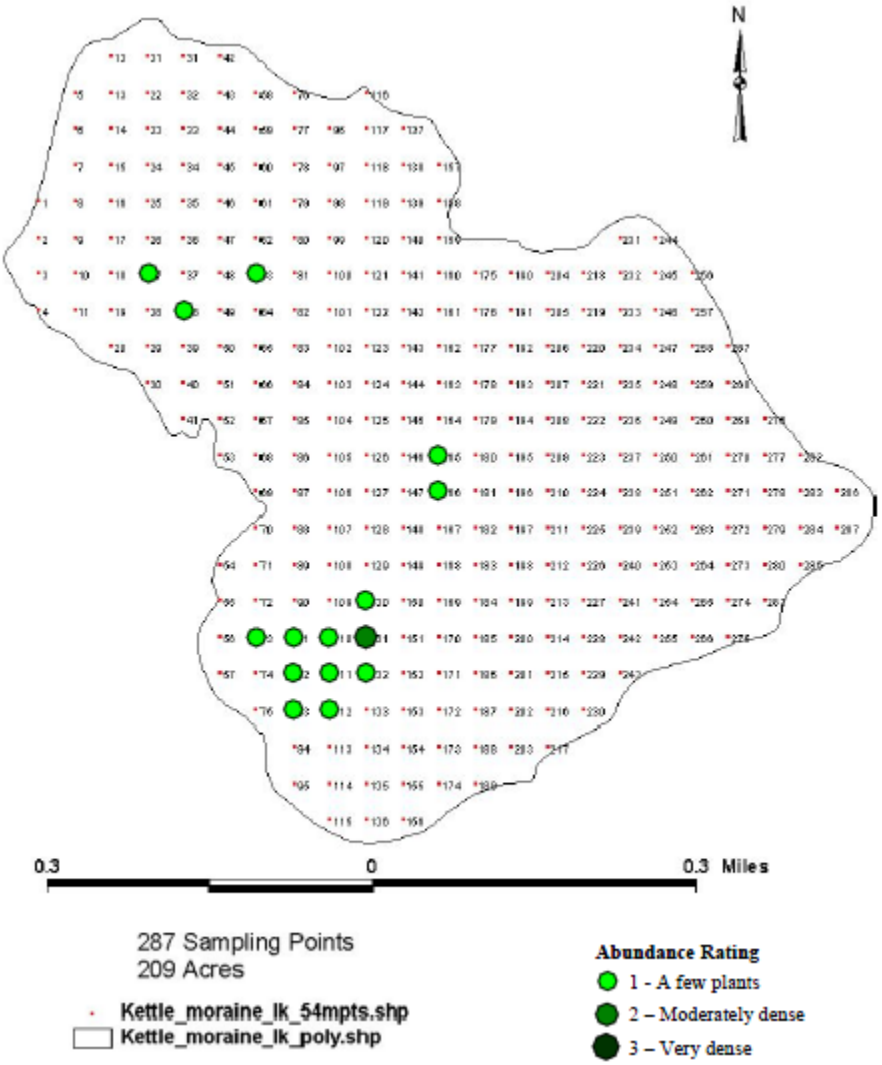


Figure 3. 2009 Kettle Moraine Lake herbicide residual sample locations

Figure 4. 2009 Kettle Moraine endothall residual concentrations

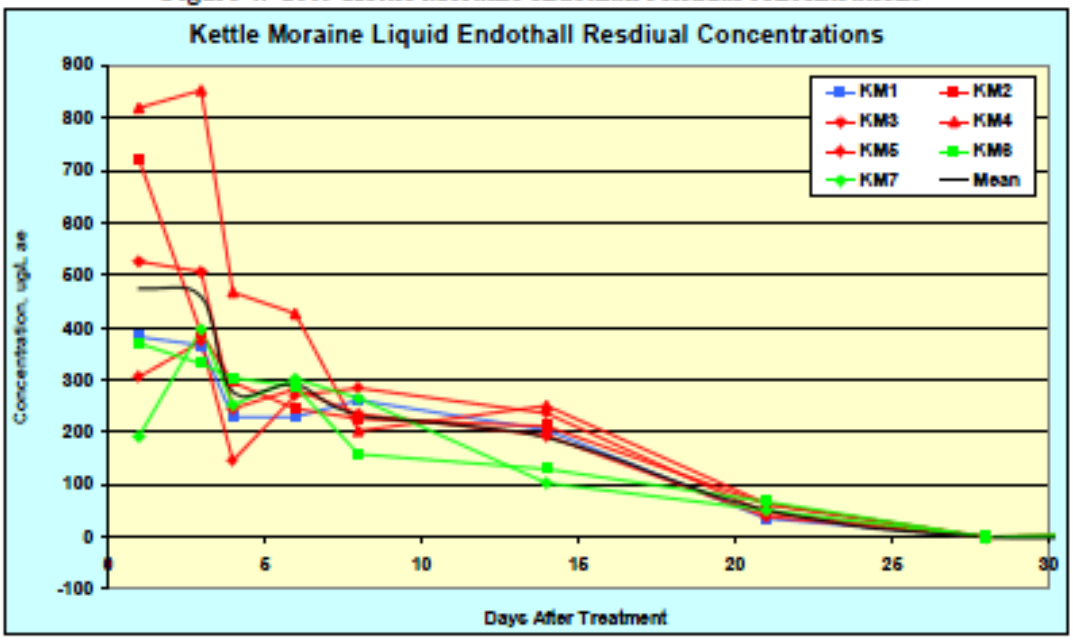
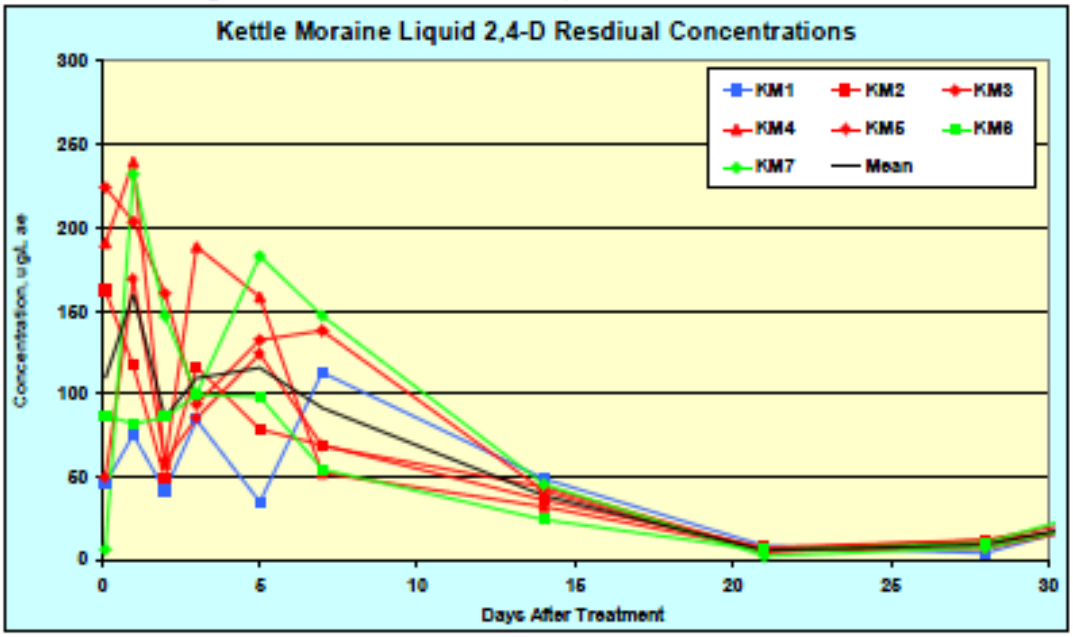


Figure 5. 2009 Kettle Moraine 2,4-D residual concentrations

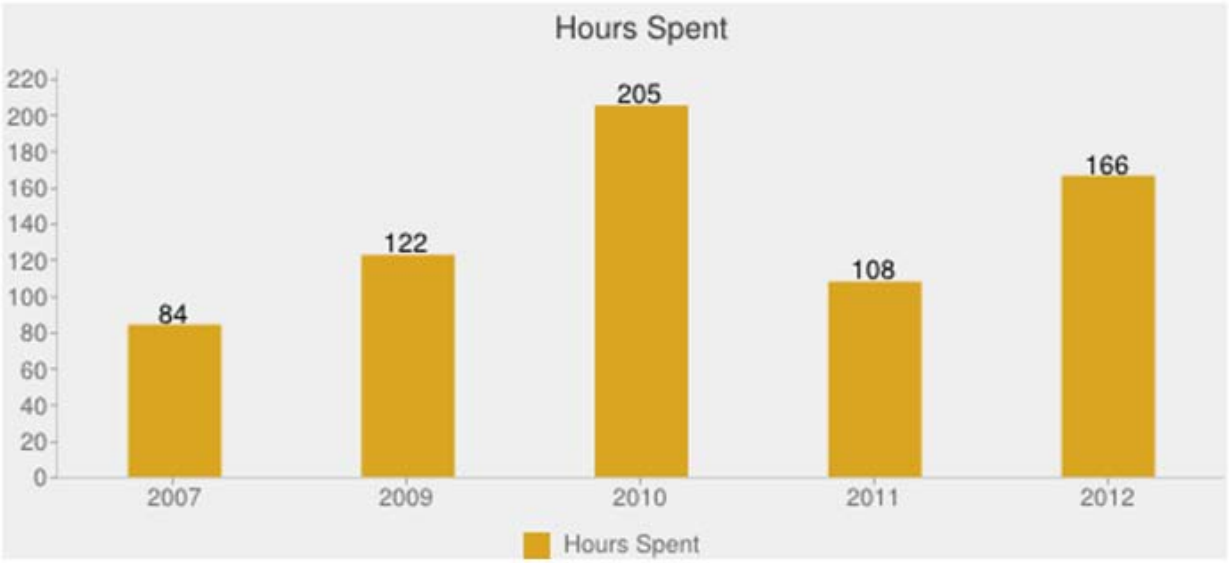


Chemical Treatment:

On May 11, 2009 the areas indicated, totaling 130 acres, were treated with the dual herbicide approach. Endothall was applied at a rate of 1.0 ppm and 2,4-D was applied at a low dose rate of 0.1 ppm.

Non-Chemical Treatments:

- Lake property owners conduct raking along shoreline
- Conduct visual lake inspections
- Secchi readings
- Water samples and chemical dispersion measurements
- CBCW



Water Quality Management:

Wisconsin Department of Natural Resources

Lake Water Quality 2009 Annual Report

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE

Site Name	Storet #
Kettle Moraine Lake - Deep Hole	203059

Date	SD (ft)	SD (m)	Hit Bottom	CHL	TP	TSI (SD)	TSI (CHL)	TSI (TP)	Lake Level	Clarity	Color	Perception
06/06/2009	7.5	2.3	NO			48			NORMAL	CLEAR	BROWN	3-Enjoyment somewhat impaired (algae)
06/14/2009	7.5	2.3	NO			48			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
06/20/2009	7.5	2.3	NO			48			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
06/28/2009	8	2.4	NO			47			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
07/03/2009	6.5	2	NO			50			NORMAL	MURKY	BROWN	2-Very minor aesthetic problems
07/11/2009	7	2.1	NO			49			NORMAL	MURKY	BROWN	2-Very minor aesthetic problems
07/26/2009	8	2.4	NO			47			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
08/01/2009	8.5	2.6	NO			46			NORMAL	CLEAR	BROWN	1-Beautiful, could not be nicer
08/09/2009	9.5	2.9	NO			45			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
08/15/2009	9	2.7	NO			45			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
08/23/2009	9	2.7	NO			45			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
08/29/2009	9	2.7	NO			45			NORMAL	CLEAR	BROWN	1-Beautiful, could not be nicer

Date	Data Collectors	Project
06/06/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/14/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/20/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/28/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/03/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/11/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/26/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/01/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/09/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/15/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/23/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/29/2009	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole

SD = Secchi depth measured in feet converted to meters; Chl = Chlorophyll a in micrograms per liter(ug/l); TP = Total phosphorus in ug/l, surface sample only; TSI(SD), TSI(CHL), TSI(TP) = Trophic state index based on SD, CHL, TP respectively; Depth measured in feet.

Wisconsin Department of Natural Resources **Wisconsin Lakes Partnership**

Report Generated: 04/15/2013

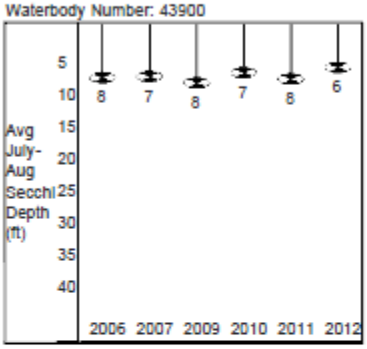
Secchi Readings:

Secchi Graph

Wisconsin Department of Natural Resources

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2006	7.5	7.5	7.5	6
2007	7.4	7	7.5	5
2009	8.3	6.5	9.5	8
2010	6.8	6.5	7.5	6
2011	7.8	7	8.5	7
2012	6	5	7	6

Report Generated: 01/14/2013

dnr.wi.gov

The Official Internet site for the Wisconsin Department of Natural Resources
101 S. Webster Street . PO Box 7921 . Madison, Wisconsin 53707-7921 . 608.266.2621

2009 Results:

This summer you requested information regarding an aquatic plant survey that staff from the Research Bureau of the Department of Natural Resources conducted on June 22nd and 23rd, 2009 on Kettle Moraine Lake in Fond du Lac County, WI. The plant survey was conducted as part of a statewide Eurasian water milfoil monitoring project. This data will be used by the Department to understand the variation in milfoil growth among lakes across the state, how aquatic plant populations respond to management regimes, and how plant communities change over time. Kettle Moraine Lake is one of the lakes chosen for this project because they met certain physical criteria (size, region, presence of milfoil, timing of milfoil establishment, etc.) for this study.

Point-Intercept Sampling Method

Based on parameters specific to Kettle Moraine Lake, we mapped a 287-point sampling grid over the entire lake. Using GPS technology, we navigated by boat to each of the pre-determined grid points. Of the 287 total points, we sampled 278 navigable points that fell within the depth range of plant growth (called *littoral area*). At each of these points we used a two-sided rake sampler to sample approximately 2.5 feet along the bottom. After pulling the plants to the surface, the rake was assigned a fullness rating of 1-3 to estimate density of plant growth (see Figure 1). Each individual plant species on the rake as well as any dislodged by the rake and floating were given similar fullness ratings to estimate abundance. We also recorded visual sightings of species within six feet of the sample point, and depth and substrate (lake bottom) type at each point. Any additional species seen in the lake during a general boat survey were recorded separately from the point-intercept data. In addition, quantitative biomass samples were taken at 10% of the points that fell within the littoral area. Biomass data is currently being processed in our lab.

Species frequencies of occurrence reflect the percentage of times a species was found out of a larger population of points sampled. Littoral frequency of occurrence (given in Table 1) indicates how often a species was found considering only areas that are less than or equal to the maximum depth of plant growth. Voucher specimens have been sent to the Stevens Point Herbarium, therefore all species identifications are subject to change pending verification.

Table 1: Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is sampled divided by the total number of points at which depth was less than or equal to the maximum depth of plant growth. Thus, we consider only sites in the lake at which, given light requirements, the growth of plants is possible.

Common Name	**Scientific Name**	**% Frequency of Occurrence (Littoral)**
Waterweed	*Elodea* spp.	64.39
Coontail	*Ceratophyllum demersum*	62.59
Muskgrasses	*Chara* spp.	43.88
Slender naiad	*Najas flexilis*	31.29
Hybrid pondweed	*Potamogeton X scoliophyllus*	8.63
Watershield	*Brasenia schreberi*	8.27

White water lily	*Nymphaea odorata*	7.91
Creeping bladderwort	*Utricularia gibba*	5.04
Wild celery	*Vallisneria americana*	4.32
Spatterdock	*Nuphar variegata*	3.60
Water star-grass	*Heteranthera dubia*	2.88
Sago pondweed	*Stuckenia pectinata*	2.52
Common bladderwort	*Utricularia vulgaris*	2.52
Illinois pondweed	*Potamogeton illinoensis*	2.16
Curly-leaf pondweed*	*Potamogeton crispus**	1.80
Stoneworts	*Nitella* spp.	1.80
Eurasian water milfoil*	*Myriophyllum spicatum**	1.44
Small bladderwort	*Utricularia minor*	1.08
Small duckweed	*Lemna minor*	1.08
Bur-reed	*Sparganium* sp.	1.08
Grass	Poaceae sp.	1.08
Stiff water-crowfoot	*Ranunculus aquatilis*	0.72
Variable pondweed	*Potamogeton gramineus*	0.72
Long-leaf pondweed	*Potamogeton nodosus*	0.72
Large duckweed	*Spirodela polyrhiza*	0.72
Southern naiad	*Najas guadalupensis*	0.72
Large-leaf pondweed	*Potamogeton amplifolius*	0.36
White-stem pondweed	*Potamogeton praelongus*	0.36
Northern water milfoil	*Myriophyllum sibiricum*	0.36
Water bulrush	*Schoenoplectus subterminalis*	0.36

Forked duckweed	*Lemna trisulca*	0.36
Pickerelweed	*Pontederia cordata*	Visual
Hardstem bulrush	*Schoenoplectus acutus*	Visual
Common watermeal	*Wolffia columbiana*	Visual
Swamp loosestrife	*Decodon verticillatus*	Visual
Creeping spikerush	*Eleocharis palustris*	General Survey
Cattail	*Typha* sp.	General Survey
Filamentous algae	Algae spp.	39.93
Freshwater sponge	Spongillidae spp.	11.15

***** = species non-native and potentially invasive in WI

Survey Summary

Total Number of Points	287
Navigable Points within Depth Range of Plant Growth	278
Maximum Depth of Plant Growth (feet)	17.00
Number of Species in Lake (including general survey)	39

Figure 1: Description of rake fullness ratings used during the point-intercept survey.

Fullness Rating	Coverage	Description
1		Only few plants on rake head.
2		Rake head is about half full; the rake is covered but the tines are still visible.
3		The rake is completely covered and tines are not visible.

Figure 2: A map of the approximate location of Eurasian water milfoil.

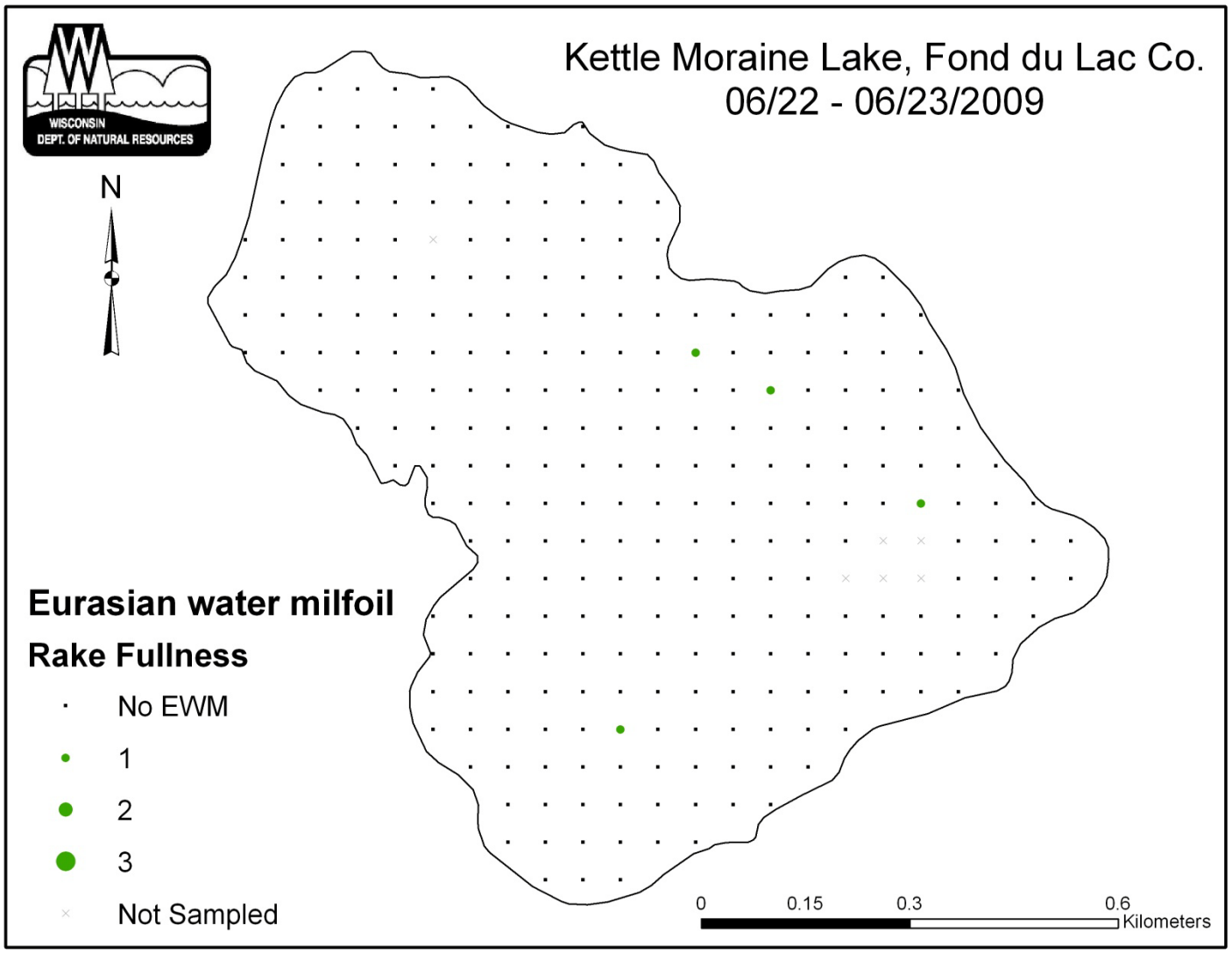
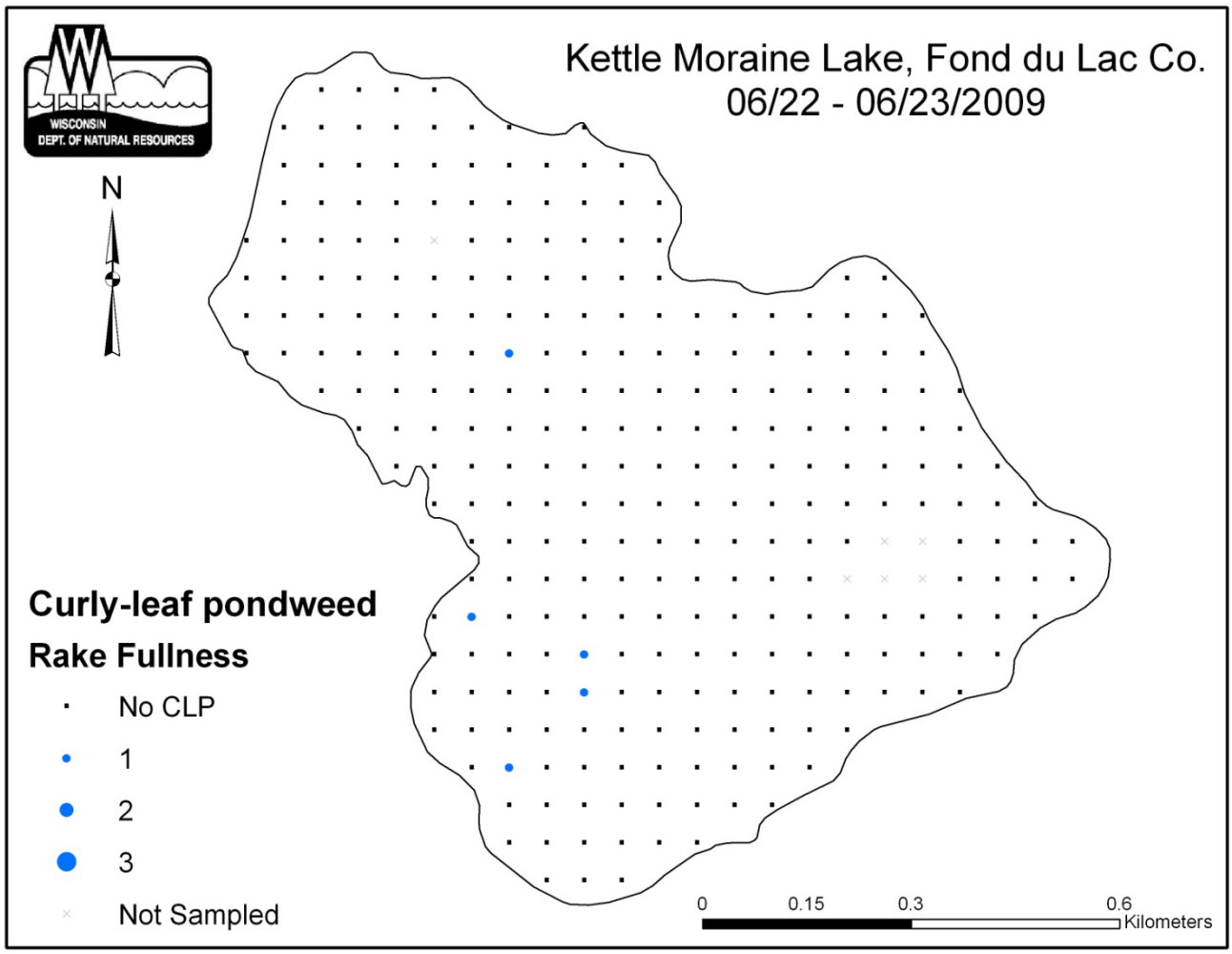


Figure 3: A map of the approximate location of Curly-leaf pondweed.



Please note that while this study conforms to statewide protocol and standards for baseline data collection, it may not be suitable for management purposes. For information as to whether this survey meets requirements for management plans or permitting requirements, please contact your local DNR lake manager.

2010

Overview

On 20 April 2010, 124 acres of Eurasian watermilfoil infested areas were treated in Kettle Moraine Lake with a liquid formulation of 2,4-D. The lake wide target concentration was 250 ug/L ae. Endothall applied as Aquathol K was applied to 38 acres of curly-leaf pondweed infested areas on the same day. Endothall was applied at a target rate in infested areas of 700 ug/L ae (~1000 ug/L ai). Five sites were located in the lake for herbicide residual sampling, 4 in treated areas (sites 2, 3, 4, and 5) and one in an untreated area (site 1) (Figure 1). Water samples were collected by lake volunteers at mid depth for all locations at specified sample intervals (Table 1). Following completion of each sample interval, 2-3 drops of muriatic acid were added to the sample to fix the herbicide.

Endothall concentrations were less than the target concentration at all sample locations but were similar including the untreated site indicating that the herbicide was rapidly dissipated throughout the lake (Figure 2). Concentrations of 2,4-D were also rapidly dissipated throughout the lake similar to endothall (Figure 3). The average lake wide 2,4-D concentration was 147 ug/L ae from 1 to 7 days after treatment (DAT) compared to the lake wide target concentration of 250 ug/L ae. By 14 DAT 2,4-D concentrations were less than the irrigation restriction level of 100 ug/L ae. Lake wide endothall concentrations were lower in 2010 compared to concentrations in 2009 (Figure 4). Lake wide 2,4-D concentrations were higher in 2010 compared to concentrations in 2009 (Figure 5).

Table 1. Kettle Moraine Lake Sample Schedule

Sample Interval	Samples per Interval	Total Samples
1 DAT	4	4
3 DAT	4	8
5 DAT	4	12
7 DAT	4	16
14 DAT	4	20
21 DAT	4	24
28 DAT	4	28
35 DAT	4	32
42 DAT	4	36
56 DAT	4	40

Figure 1. Eurasian watermilfoil distribution on Kettle Moraine Lake on April 20, 2010 (123.8 acres).

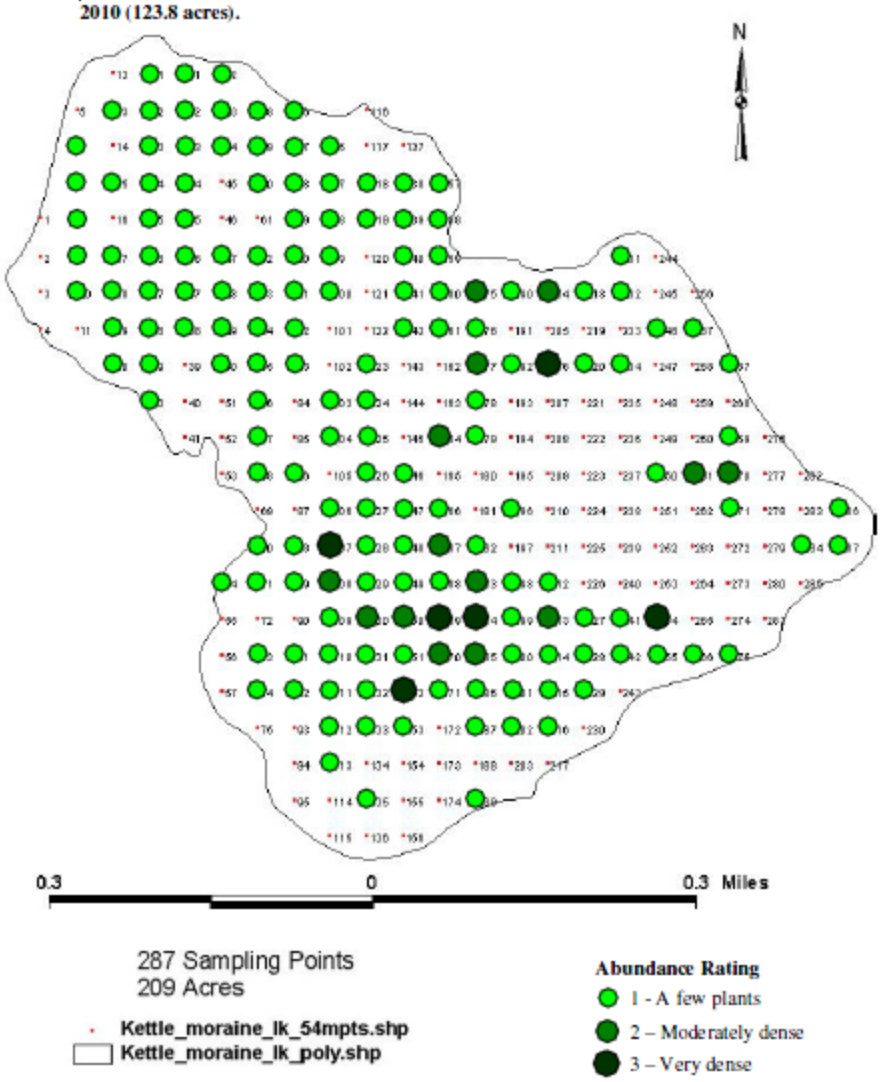


Figure 2. Curly-leaf pondweed distribution on Kettle Moraine Lake on April 20, 1010 (37.9 acres).

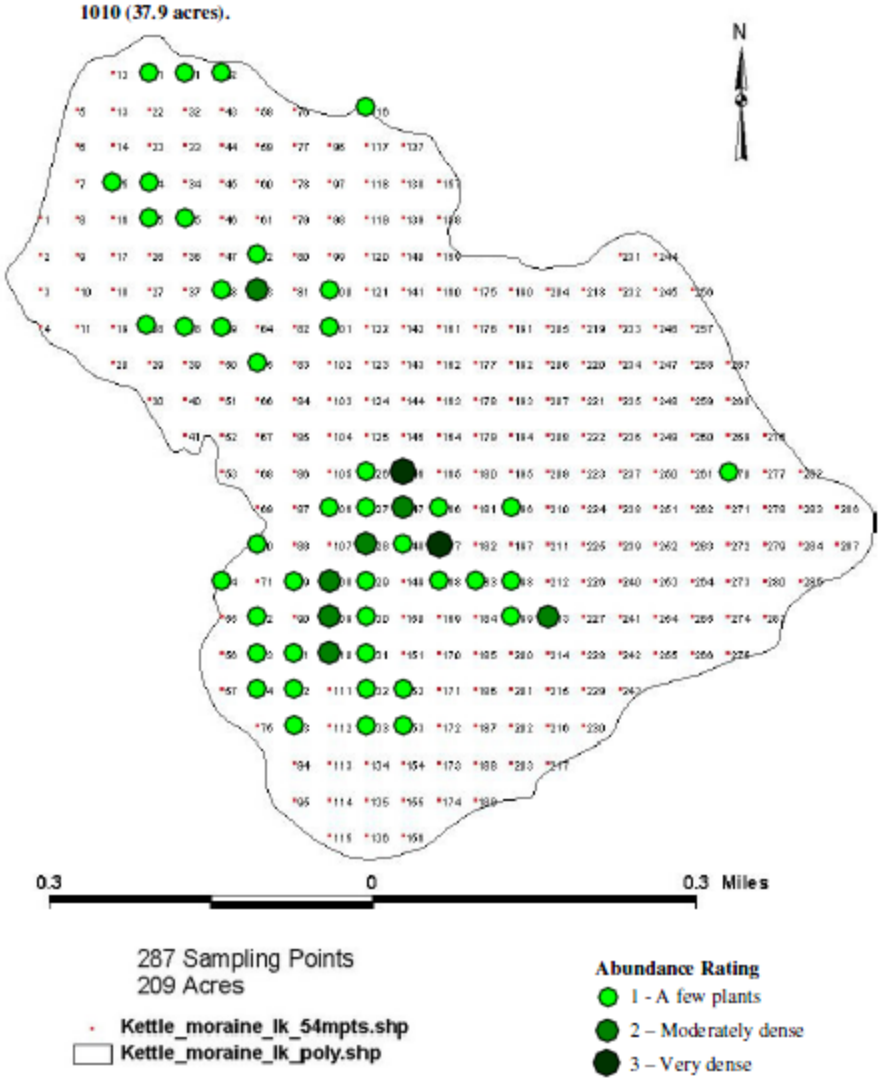


Figure 1. Kettle Moraine Lake Herbicide Residual Sample Locations, 2010

Figure 2

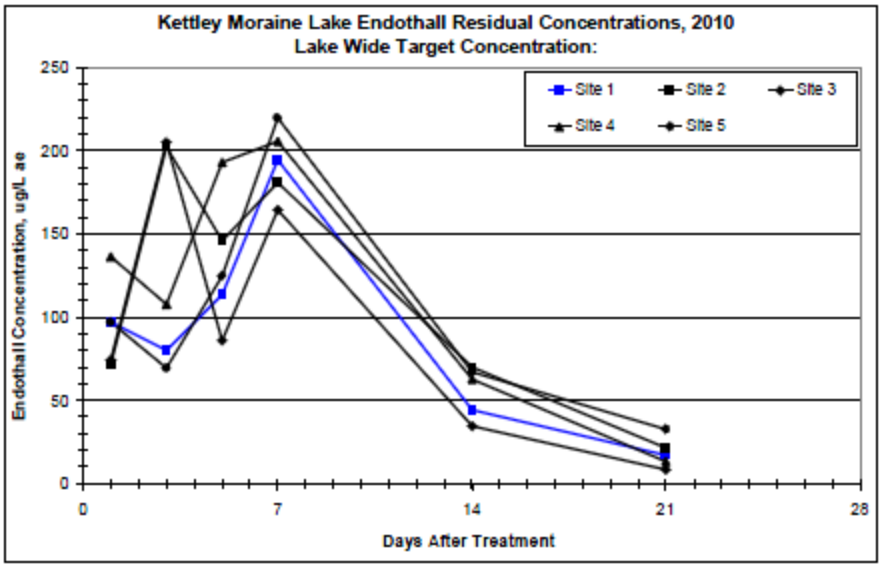


Figure 3

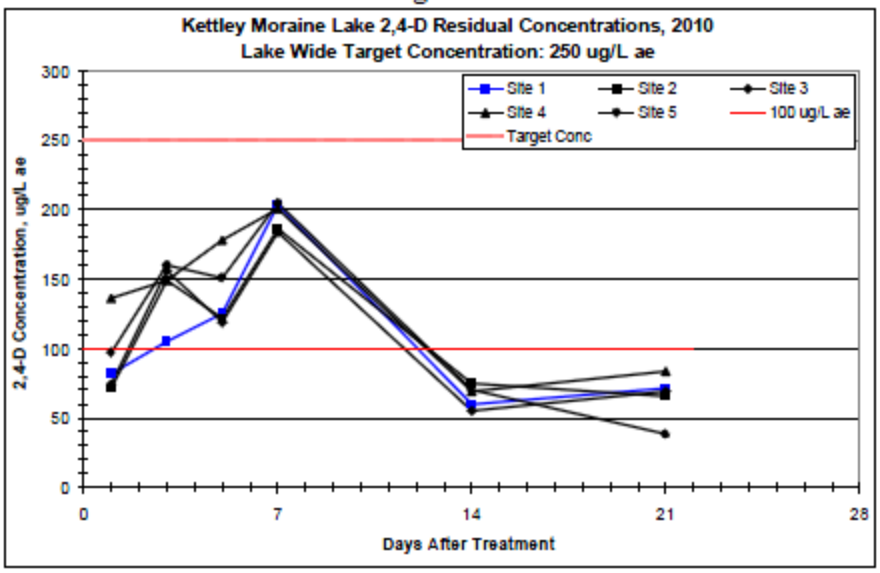


Figure 4

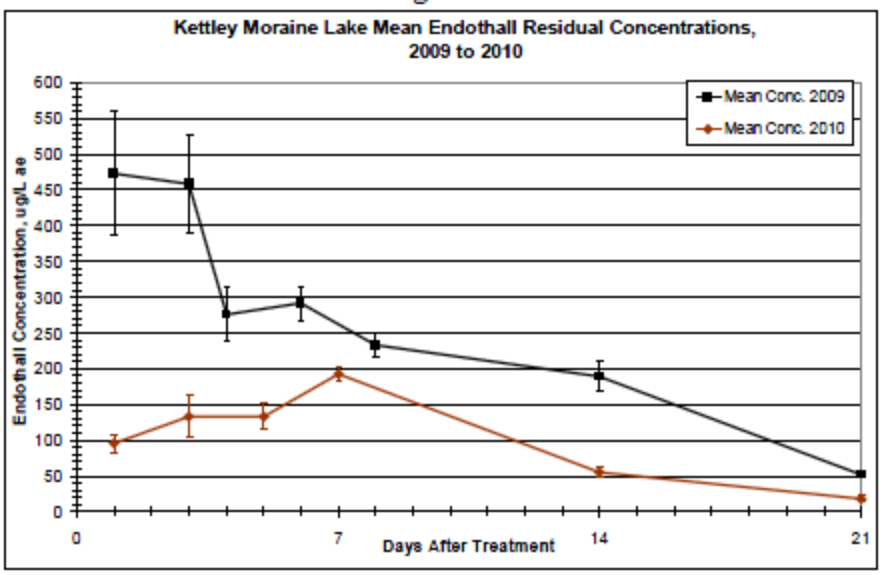
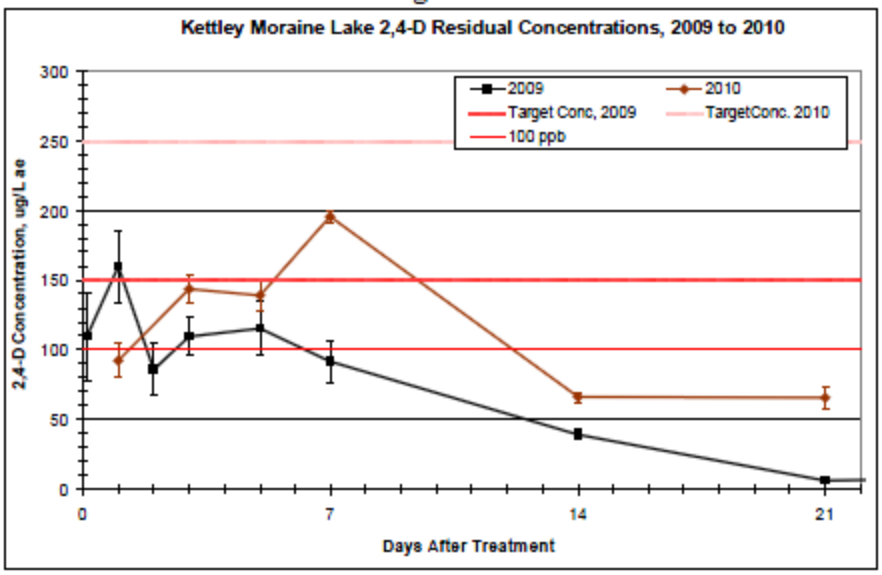


Figure 5

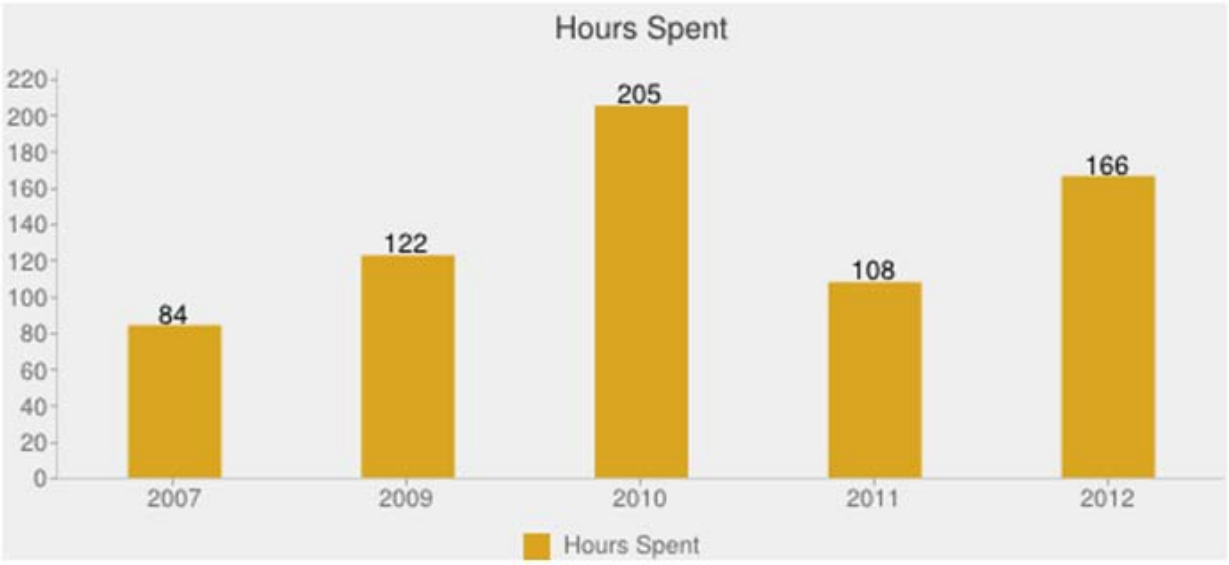


Chemical Treatment:

On April 20, 2010, 124 acres of Eurasian Watermilfoil infested areas were treated in Kettle Moraine Lake with a liquid formulary of 2, 4-D. The lake wide target concentration was 250 ug/L ae. Endothal applied as Aquathol K was applied to 38 acres of curly-leaf pondweed infested areas on the same day. Endothal was applied at a target rate in infested areas of 700 ug/L ae (~1000 ug/L ai). Five sites were located in the lake for herbicide residual sampling, 4 in treated areas (sites 2, 3, 4, and 5) and one in an untreated area (site 1) (Figure 1).

Non-Chemical Treatments:

- Lake property owners conduct raking along shoreline
- Conduct visual lake inspections
- Secchi readings
- Water samples and chemical dispersion measurements
- Dissolved oxygen readings post AIS chemical treatments
- CBCW
- A Weevil evaluation was done by Brenda Nordin and determined to not be a feasible approach for non-chemical treatment of EWM



Water Quality Management:

Wisconsin Department of Natural Resources

Lake Water Quality 2010 Annual Report

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE

Site Name	Storet #
Kettle Moraine Lake - Deep Hole	203059

Date	SD (ft)	SD (m)	Hit Bottom	CHL	TP	TSI (SD)	TSI (CHL)	TSI (TP)	Lake Level	Clarity	Color	Perception
06/05/2010	8	2.4	NO			47			HIGH	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
06/12/2010	7.5	2.3	NO			48			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
06/18/2010	8	2.4	NO			47			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
06/27/2010	8.5	2.6	NO			46			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
07/04/2010	7.5	2.3	NO			48			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
07/16/2010	7	2.1	NO			49			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
07/31/2010	6.5	2	NO			50			NORMAL	MURKY	BROWN	2-Very minor aesthetic problems
08/07/2010	6.5	2	NO			50			NORMAL	MURKY	BROWN	2-Very minor aesthetic problems
08/13/2010	7	2.1	NO			49			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
08/27/2010	6.5	2	NO			50			NORMAL	MURKY	BROWN	2-Very minor aesthetic problems
09/04/2010	7	2.1	NO			49			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems

Date	Data Collectors	Project
06/05/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/12/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/18/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/27/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/04/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/16/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/31/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/07/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/13/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/27/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
09/04/2010	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole

SD = Secchi depth measured in feet converted to meters; Chl = Chlorophyll a in micrograms per liter(ug/l); TP = Total phosphorus in ug/l, surface sample only; TSI(SD), TSI(CHL), TSI(TP) = Trophic state index based on SD, CHL, TP respectively; Depth measured in feet.

Wisconsin Department of Natural Resources **Wisconsin Lakes Partnership**

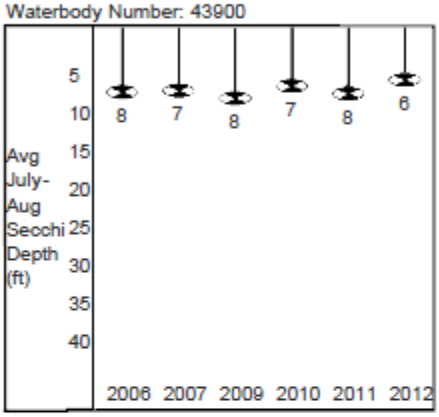
Report Generated: 04/23/2013

Secchi Readings:

Wisconsin Department of Natural Resources

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2006	7.5	7.5	7.5	6
2007	7.4	7	7.5	5
2009	8.3	6.5	9.5	8
2010	6.8	6.5	7.5	6
2011	7.8	7	8.5	7
2012	6	5	7	6

Report Generated: 04/23/2013

2010 Dissolved Oxygen Measurements

2010Kettle Moraine Lake Water Sampling			
Endothall and 2,4-D Analysis			
Date	**27-Apr**		
	Sample		
Site	**Interval**	**Time**	**DO2**
KM1	**1DAT**	**16:27**	**8.2**
KM2	**1DAT**	**16:20**	**8.7**
KM3	**1DAT**	**16:34**	**9.1**
KM4	**1DAT**	**16:15**	**8.2**
KM5	**1DAT**	**16:31**	**8.4**
Date	**29-Apr**		
	Sample		
Site	**Interval**	**Time**	**DO2**
KM1	**3DAT**	**13:48**	**9.15**
KM2	**3DAT**	**13:40**	**9.3**
KM3	**3DAT**	**13:59**	**8.9**
KM4	**3DAT**	**13:30**	**9.1**
KM5	**3DAT**	**13:53**	**9.1**
Date	**1-May**		
	Sample		
Site	**Interval**	**Time**	**DO2**
KM1	**5DAT**	**15:15**	8.65

KM2	**5DAT**	**15:09**	8.89
KM3	**5DAT**	**15:34**	8.99
KM4	**5DAT**	**15:01**	8.7
KM5	**5DAT**	**15:28**	8.6
Date	**3-May**		
	Sample		
Site	**Interval**	**Time**	**DO2**
KM1	**7DAT**	**7:33**	8.89
KM2	**7DAT**	**7:24**	8.8
KM3	**7DAT**	**7:42**	8.78
KM4	**7DAT**	**7:17**	8.73
KM5	**7DAT**	**7:39**	8.6
Date	**9-May**		
	Sample		
Site	**Interval**	**Time**	**DO2**
KM1	**14DAT**	**16:30**	**8.5**
KM2	**14DAT**	**16:21**	**8.35**
KM3	**14DAT**	**16:42**	**8.55**
KM4	**14DAT**	**16:15**	**8.75**
KM5	**14DAT**	**16:37**	**8.5**
Date	**16-May**		
	Sample		

Site	Interval	Time	DO2
KM1	21DAT	6:21	8.91
KM2	21DAT	6:11	8.78
KM3	21DAT	6:44	8.94
KM4	21DAT	6:03	9.2
KM5	21DAT	6:38	8.8

2010 Results:

This summer you requested information regarding an aquatic plant survey that staff from the Research Bureau of the Department of Natural Resources conducted on June 21, 2010 on Kettle Moraine in Fond du Lac County, WI. The plant survey was conducted as part of a statewide Eurasian water milfoil monitoring project. This data will be used by the Department to understand the variation in milfoil growth among lakes across the state, how aquatic plant populations respond to management regimes, and how plant communities change over time. Kettle Moraine is one of the lakes chosen for this project because they met certain physical criteria (size, region, presence of milfoil, timing of milfoil establishment, etc.) for this study.

Point-Intercept Sampling Method

Based on parameters specific to Kettle Moraine, we mapped a 287- point sampling grid over the entire lake. Using GPS technology, we navigated by boat to each of the pre-determined grid points. Of the 287 total points, we sampled 274 navigable points that fell within the depth range of plant growth (called *littoral area*). At each of these points we used a two-sided rake sampler to sample approximately 2.5 feet along the bottom. After pulling the plants to the surface, the rake was assigned a fullness rating of 1-3 to estimate density of plant growth (see Figure 1). Each individual plant species on the rake as well as any dislodged by the rake and floating were given similar fullness ratings to estimate abundance. We also recorded visual sightings of species within six feet of the sample point, and depth and substrate (lake bottom) type at each point. Any additional species seen in the lake during a general boat survey were recorded separately from the point-intercept data. In addition, quantitative biomass samples were taken at 10% of the points that fell within the littoral area. Biomass data is currently being processed in our lab.

Species frequencies of occurrence reflect the percentage of times a species was found out of a larger population of points sampled. Littoral frequency of occurrence (given in Table 1)

indicates how often a species was found considering only areas that are less than or equal to the maximum depth of plant growth. Voucher specimens have been sent to the Stevens Point Herbarium, therefore all species identifications are subject to change pending verification.

Table 1: Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is sampled divided by the total number of points at which depth was less than or equal to the maximum depth of plant growth. Thus, we consider only sites in the lake at which, given light requirements, the growth of plants is possible.

Common Name	**Scientific Name**	**% Frequency of Occurrence (Littoral)**
Waterweeds	*Elodea* sp.	83.21
Coontail	*Ceratophyllum demersum*	54.74
Muskgrasses	*Chara* sp.	54.38
Southern waternymph	*Najas guadalupensis*	43.80
Illinois pondweed	*Potamogeton illinoensis*	22.99
Creeping bladderwort	*Utricularia gibba*	10.22
Watershield	*Brasenia schreberi*	7.66
White water lily	*Nymphaea odorata*	5.47
Water star-grass	*Heteranthera dubia*	4.01
Sago pondweed	*Stuckenia pectinata*	4.01
Wild celery	*Vallisneria americana*	3.65
Large Duckweed	*Spirodela polyrhiza*	1.82
Nitella	*Nitella* sp.	1.46
Eurasian water milfoil*	*Myriophyllum spicatum**	1.09*
Northern water milfoil	*Myriophyllum sibiricum*	1.09
Spatterdock	*Nuphar variegata*	1.09
Stiff water crowfoot	*Ranunculus aquatilis*	1.09
Small bladderwort	*Utricularia minor*	1.09
Common bladderwort	*Utricularia vulgaris*	1.09
Small duckweed	*Lemna minor*	0.73
Water bulrush	*Schoenoplectus subterminalis*	0.73
Common watermeal	*Wolffia columbiana*	0.73
Curly-leaf pondweed*	*Potamogeton crispus**	0.36*
Swamp loosestrife	*Decodon verticillatus*	0.36
Bushy pondweed	*Najas flexilis*	0.36
Pickerelweed	*Pontederia cordata*	0.36
Variable pondweed	*Potamogeton gramineus*	0.36
Floating-leaf pondweed	*Potamogeton natans*	0.36
Milfoil	*Myriophyllum* sp.	0.36
Hardstem bulrush	*Schoenoplectus acutus*	General Survey
Three-square bulrush	*Schoenoplectus pungens*	Boat Survey
Arrowhead	*Sagittaria* sp.	Boat Survey

Common bur-reed	*Sparganium eurycarpum*	Boat Survey
Filamentous algae		15.69
Moss		0.36
Freshwater sponge		14.60

***** = species non-native and potentially invasive in WI

Survey Summary

Total Number of Points	287
Navigable Points within Depth Range of Plant Growth	274
Maximum Depth of Plant Growth (feet)	15.0
Number of Species in Lake (including general survey)	36

Fullness Rating	Coverage	Description
1		Only few plants on rake head.
2		Rake head is about half full; the rake is covered but the tines are still visible.
3		The rake is completely covered and tines are not visible.

Figure 1. Description of rake fullness ratings used during the point-intercept survey.

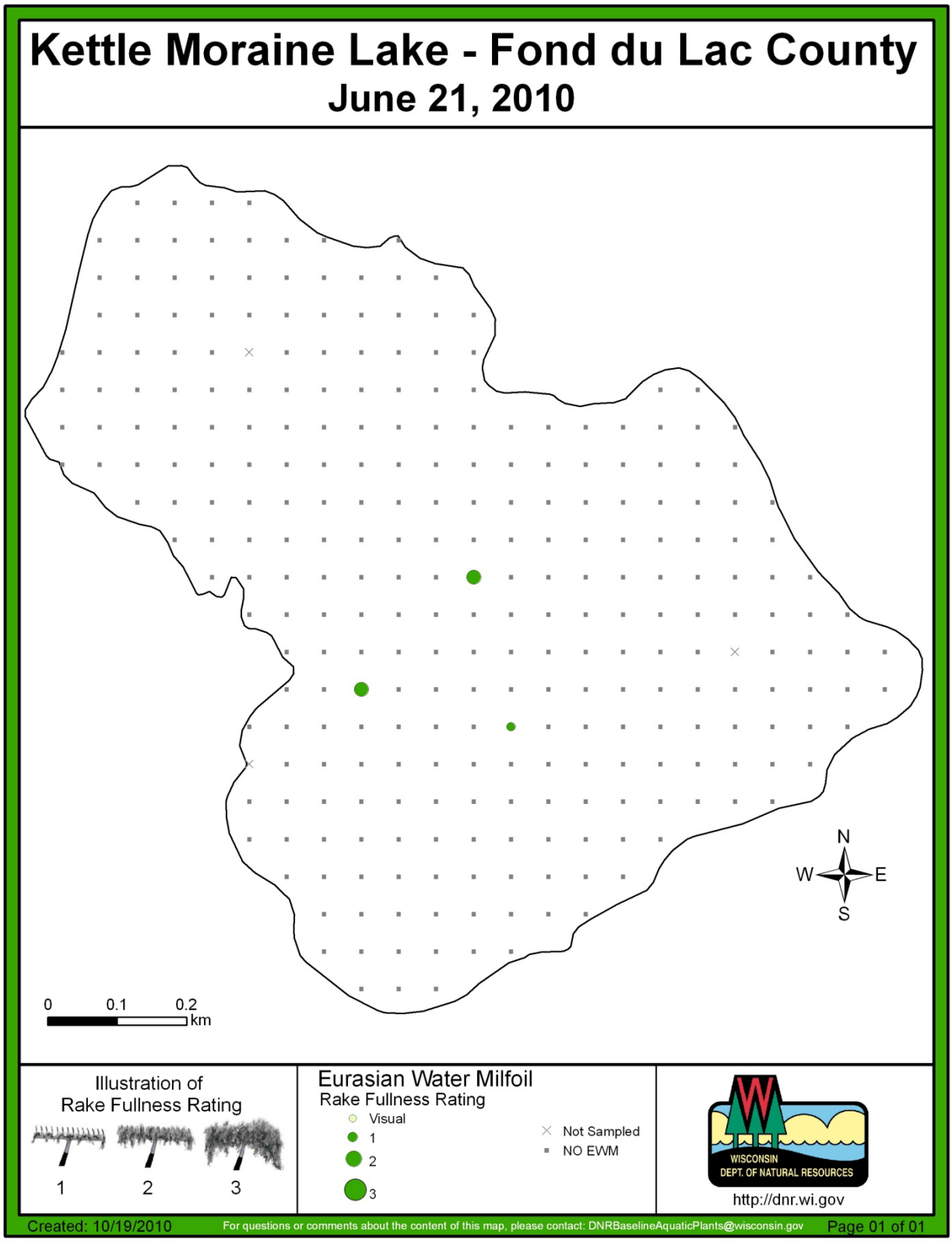


Figure 2. A map of the approximate location of Eurasian water milfoil.

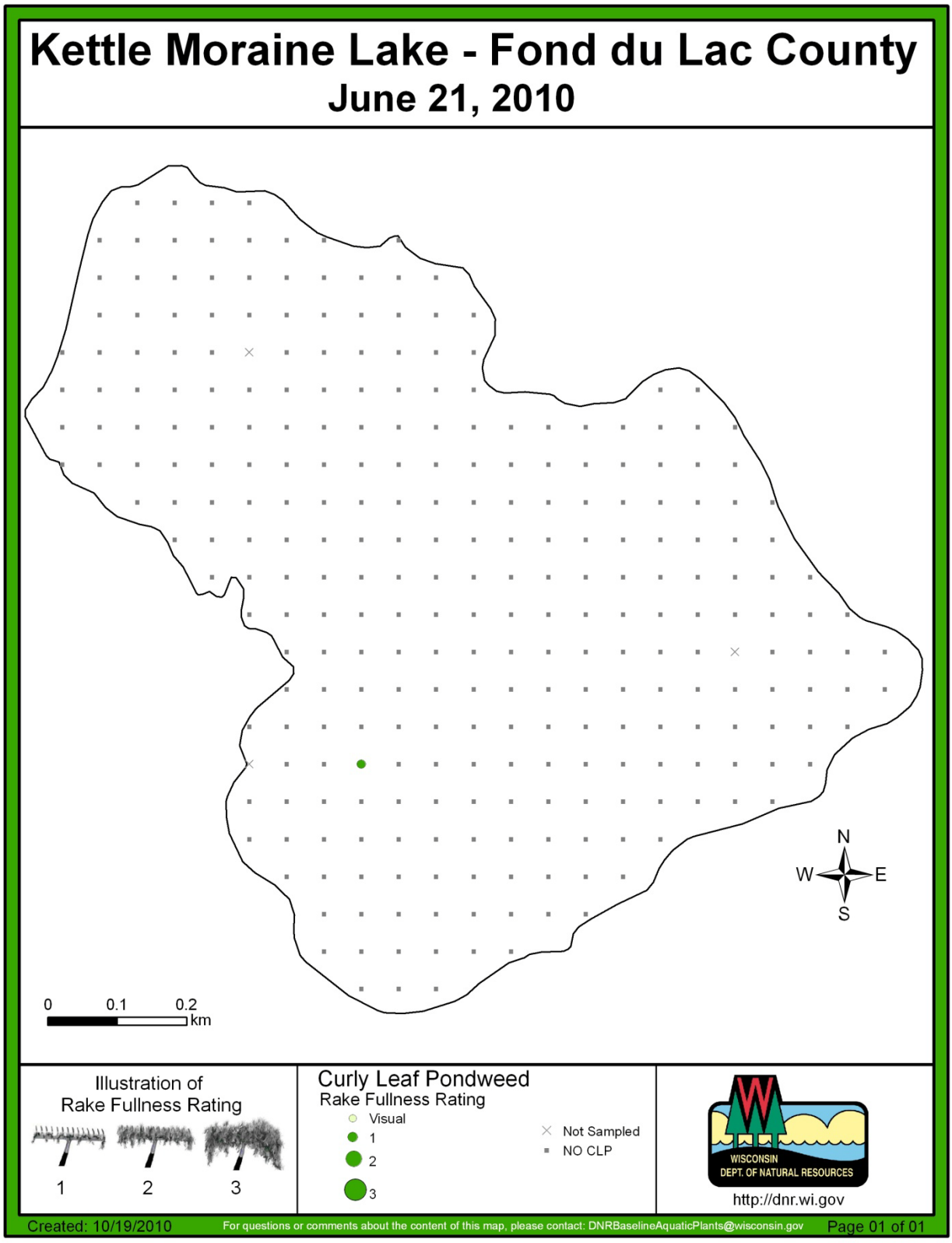


Figure 3. A map of the approximate location of curly-leaf pondweed.

Please note that while this study conforms to statewide protocol and standards for baseline data collection, it may not be suitable for management purposes. For information as to whether this survey meets requirements for management plans or permitting requirements, please contact your local DNR lake manager.

Figure 3. Eurasian watermilfoil distribution on Kettle Moraine Lake on October 6, 2010.

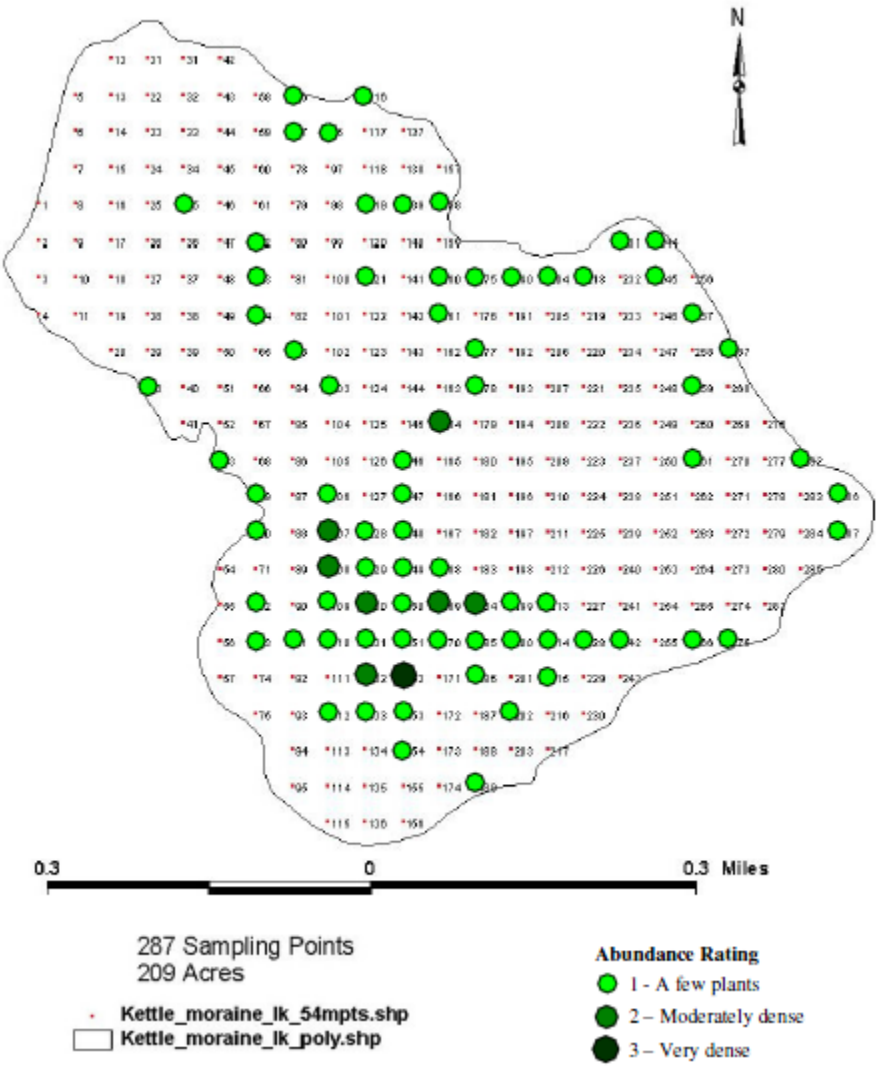
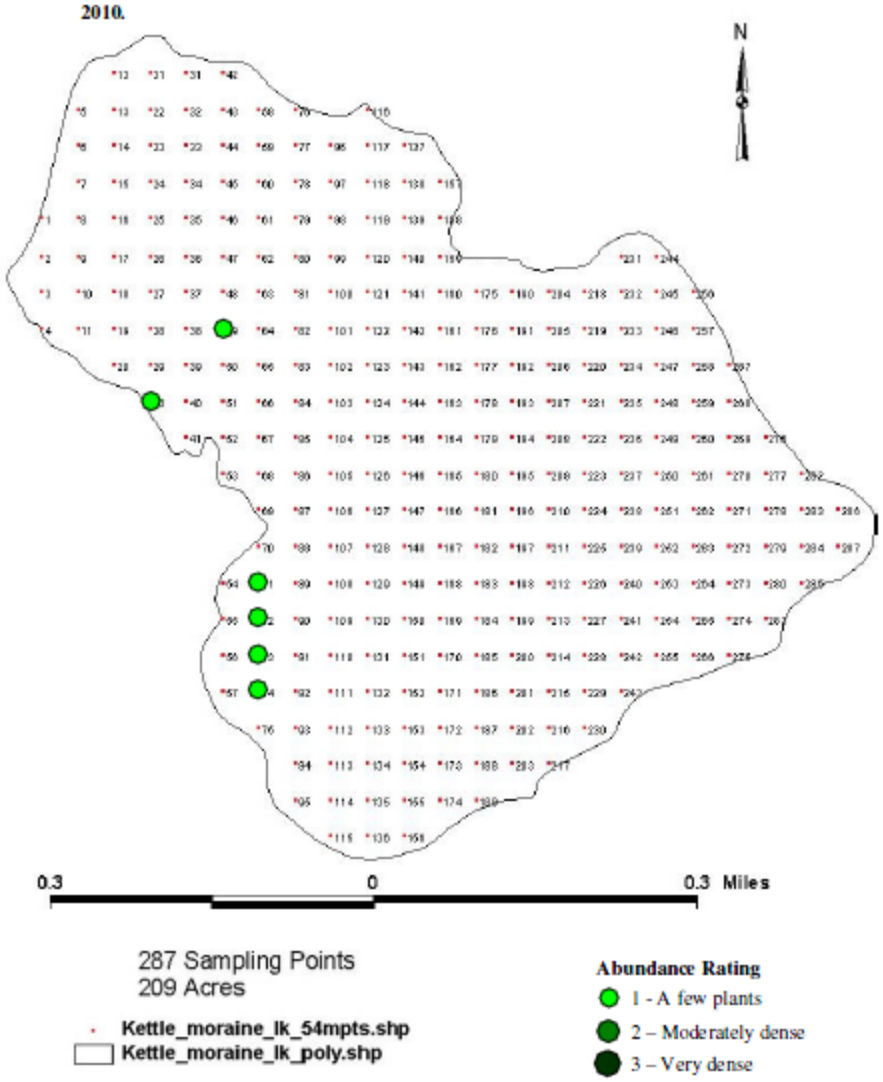


Figure 4. Curly-leaf pondweed distribution on Kettle Moraine Lake on October 6, 2010.



2011

Overview

Kettle Moraine Lake was treated on May 10, 2011 with a liquid formulation of 2,4-D at a lake wide target application rate of 250 ug/L ae (2.5 mg/L ae) to control Eurasian milfoil. The lake was treated with a liquid formulation of endothall at a target concentration of 1000 ug/L ai (2129 ug/L ae) in specific target areas to control curly-leaf pondweed. Water sample sites were established at 4 sites to monitor herbicide concentration and exposure times (Figure 1).

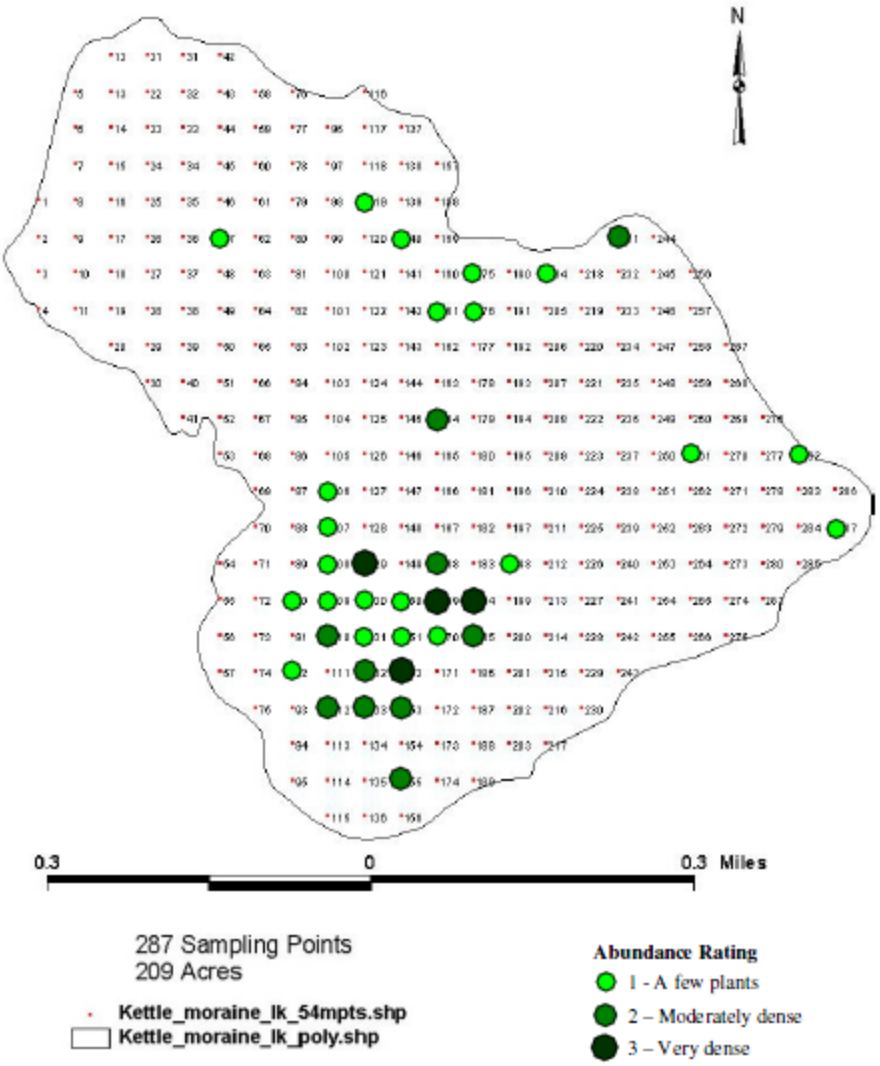
Water samples were collected using an integrated water sampler which collects a water sample from the entire water column. Water samples were collected at intervals of approximately 1, 3, 7, 14, 21, 28, and 35 days after treatment (DAT). Samples were taken to shore after completion of each sample interval, and 3 drops of muriatic acid were added to each sample bottle to fix the herbicide and prevent degradation. Samples were then stored in a refrigerator, until shipped to the ERDC laboratory in Gainesville, FL for analysis of 2,4-D and endothall.

Peak 2,4-D concentrations ranged from 258 to 354 ug/L ae (Figure 2). The mean 2,4-D concentration from 0 to 7 DAT was 277 ug/L ae compared to the lake wide target concentration of 250 ug/L ae (Figure 3). The mean concentration for all locations was less than the irrigation standard of 100 ug/L ae by 28 DAT.

Peak lake wide endothall concentrations ranged from 58 to 86 ug/L ae (Figure 4). The mean endothall concentration from 0 to 7 DAT was 52 ug/L (Figure 5).

Applying 2,4-D in combination may provide improved control of Eurasian watermilfoil compared to individual products applied alone (Figure 6).

Eurasian watermilfoil distribution on Kettle Moraine Lake on May 10, 2011.



Curly-leaf pondweed distribution on Kettle Moraine Lake on May 10, 2011.

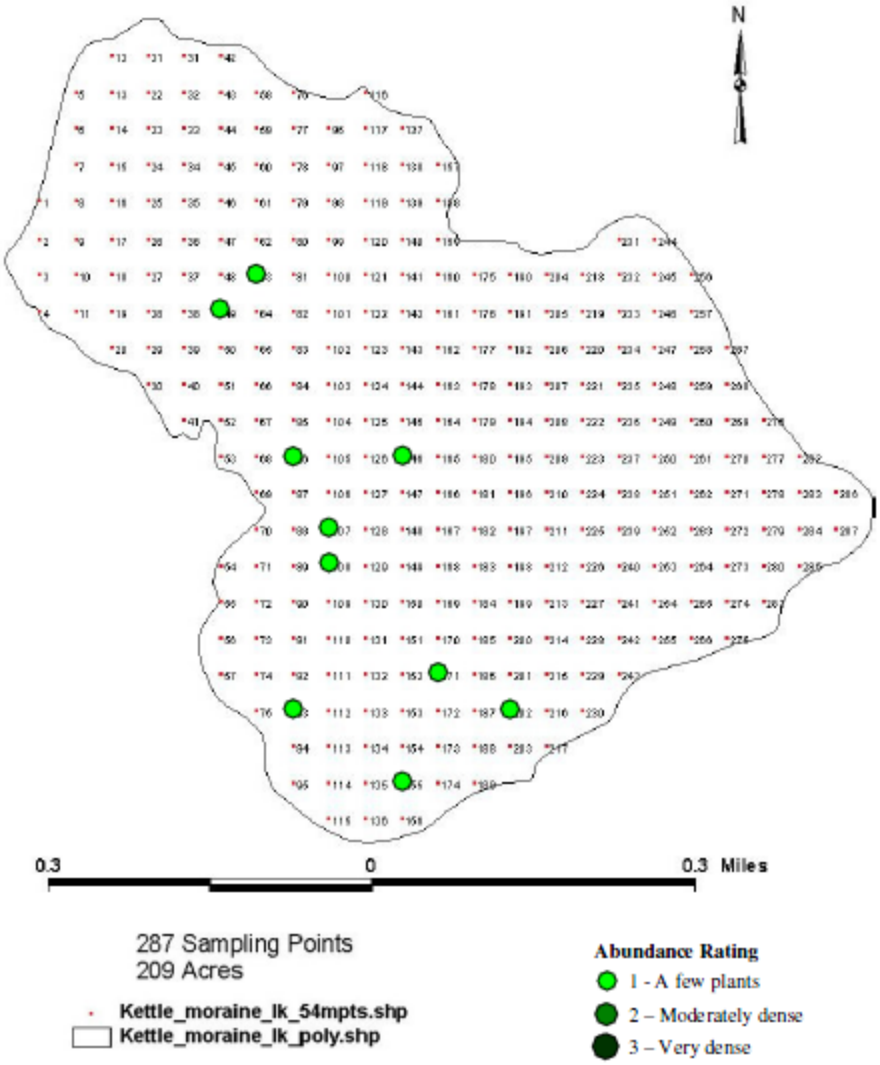


Figure 1. Kettle Moraine 2,4-D and Endothall Sample Locations, 2011

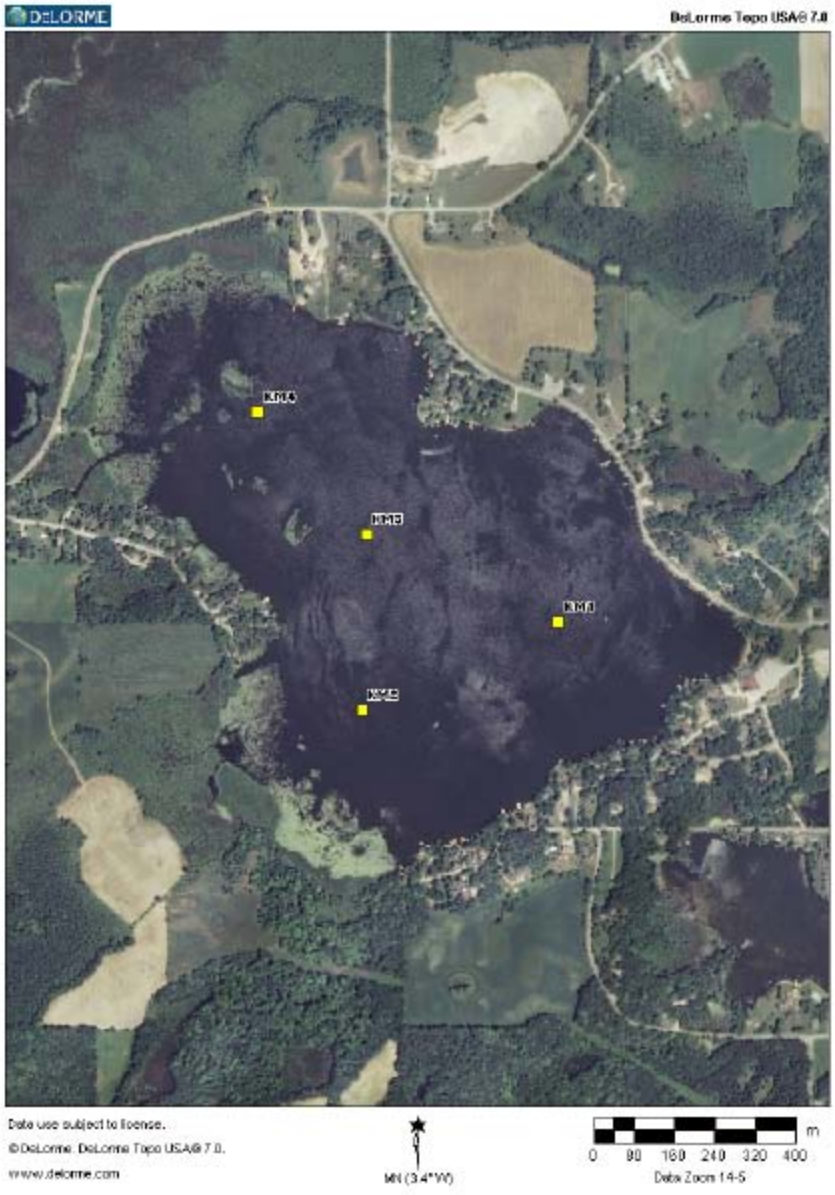


Figure 2

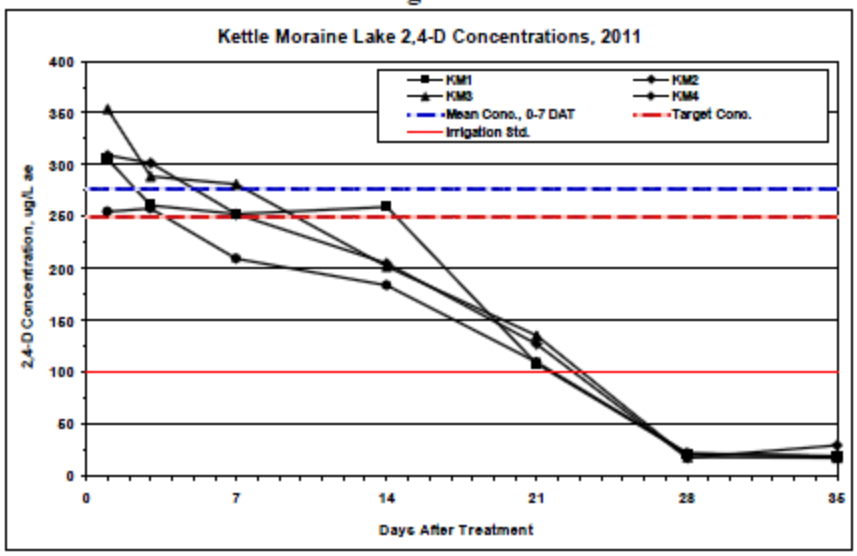


Figure 3

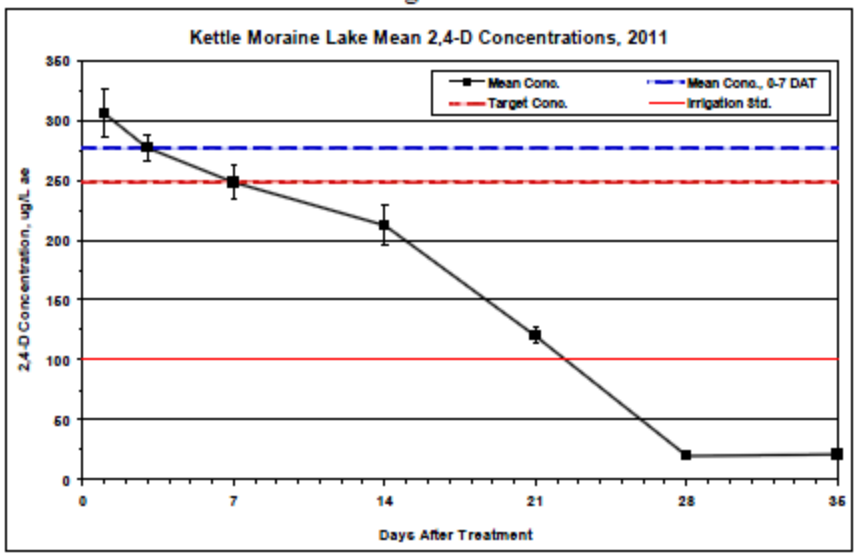


Figure 4

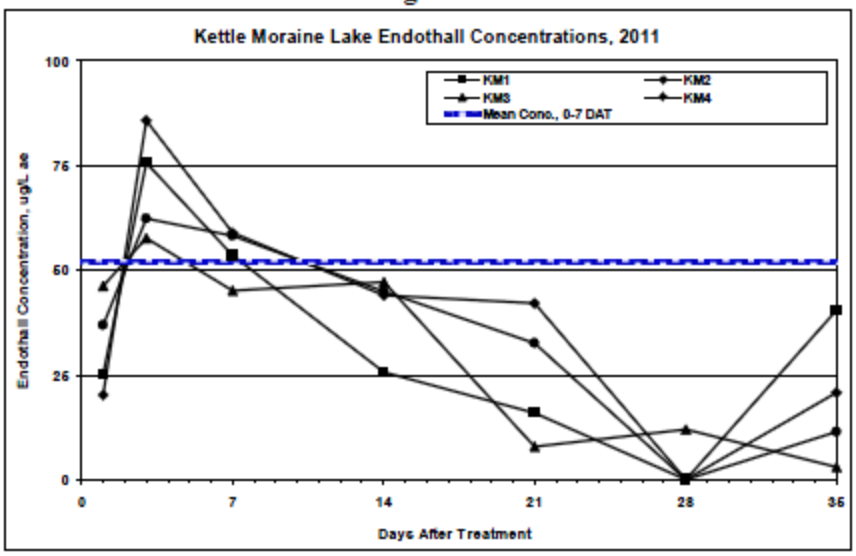


Figure 5

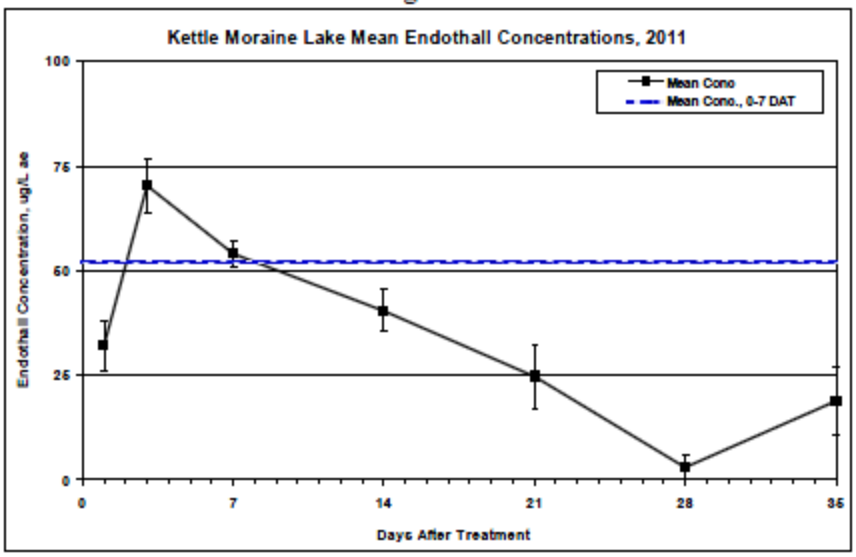
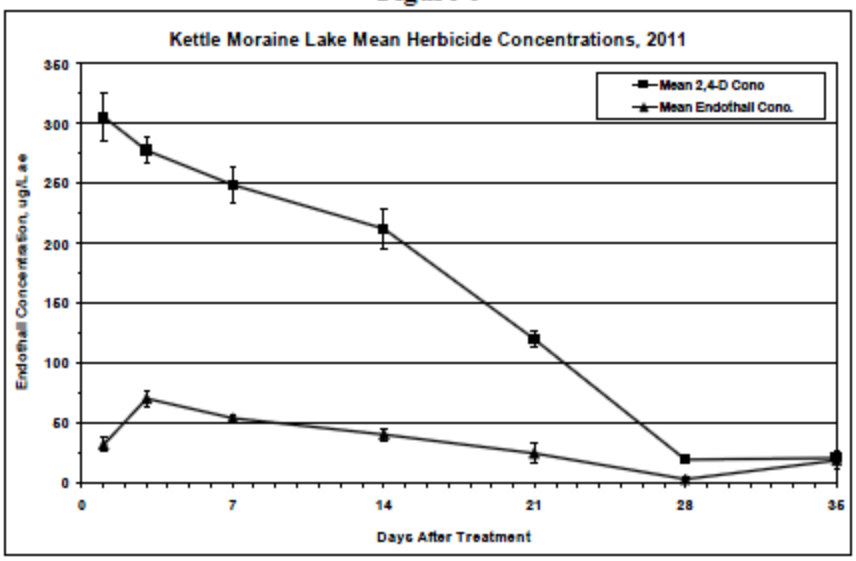


Figure 6



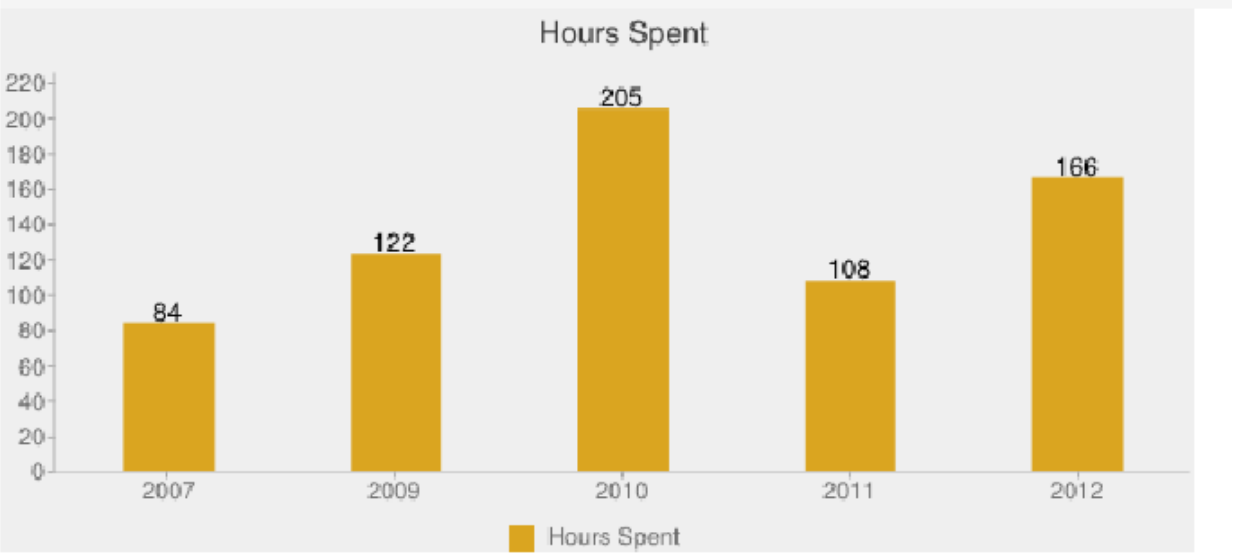
Chemical Treatment:

Kettle Moraine Lake was treated on May 10, 2011 with a liquid formulation of 2,4-D at a lake wide target application rate of 250 ug/L ae (2.5 mg/L ae) to control Eurasian milfoil. The lake was treated with a liquid formulation of endothall at a target concentration of 1000 ug/L ai (2129 ug/L ae) in specific target areas to control curly-leaf pondweed.

Non-Chemical Treatments:

- Lake property owners conduct raking along shoreline
- Conduct visual lake inspections
- Secchi readings
- Water samples and chemical dispersion measurements
- Dissolved oxygen readings post AIS chemical treatment

- CBCW


Hours Spent
220
200
180
160
140
120
100
80
60
40
20
0
84
122
205
108
166
2007
2009
2010
2011
2012
Hours Spent

Wisconsin Department of Natural Resources

Lake Water Quality 2011 Annual Report

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE

Site Name	Storet #
Kettle Moraine Lake - Deep Hole	203059

Date	SD (ft)	SD (m)	Hit Bottom	CHL	TP	TSI (SD)	TSI (CHL)	TSI (TP)	Lake Level	Clarity	Color	Perception
05/28/2011	7.5	2.3	NO			48			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
06/05/2011	8	2.4	NO			47			HIGH	CLEAR	BROWN	2-Very minor aesthetic problems
06/12/2011	8.5	2.6	NO			46			HIGH	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
06/20/2011	7	2.1	NO			49			NORMAL	CLEAR	BROWN	1-Beautiful, could not be nicer
07/02/2011	8.5	2.6	NO			46			NORMAL	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
07/10/2011	8	2.4	NO			47			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
07/24/2011	8	2.4	NO			47			NORMAL	CLEAR	BROWN	2-Very minor aesthetic problems
08/06/2011	7	2.1	NO			49			LOW	CLEAR	BROWN	2-Very minor aesthetic problems
08/13/2011	7.5	2.3	NO			48			LOW	MURKY	BROWN	2-Very minor aesthetic problems
08/21/2011	7.5	2.3	NO			48			LOW	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
08/28/2011	8	2.4	NO			47			LOW	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)

Date	Data Collectors	Project
05/28/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/05/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/12/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/20/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/02/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/10/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/24/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/06/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/13/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/21/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/28/2011	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole

SD = Secchi depth measured in feet converted to meters; Chl = Chlorophyll a in micrograms per liter(ug/l); TP = Total phosphorus in ug/l, surface sample only; TSI(SD), TSI(CHL), TSI(TP) = Trophic state index based on SD, CHL, TP respectively; Depth measured in feet.

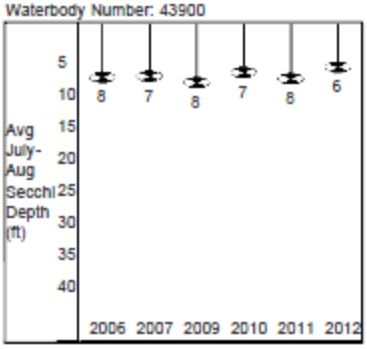
Wisconsin Department of Natural Resources **Wisconsin Lakes Partnership**

Report Generated: 01/14/2013

Wisconsin Department of Natural Resources

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2006	7.5	7.5	7.5	6
2007	7.4	7	7.5	5
2009	8.3	6.5	9.5	8
2010	6.8	6.5	7.5	6
2011	7.8	7	8.5	7
2012	6	5	7	6

Report Generated: 01/14/2013

2011 Dissolved Oxygen Measurements

Kettle Moraine Lake Herbicide Residual Sampling Data				
Sample Interval		1DAT	**Date**	5/11/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	6:47	14.7c	9.08
KM2	Integrated	6:38	15.5c	9.3
KM3	Integrated	6:27	15.2c	9.15
KM4	Integrated	6:21	15.3c	9.08

Sample Interval		3DAT	**Date**	5/13/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	14:50	15.1c	7.31
KM2	Integrated	14:38	14.7c	7.48
KM3	Integrated	14:30	15.1c	8.24
KM4	Integrated	14:25	15c	8.7

Sample Interval		7DAT	**Date**	5/16/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	14:50	13.4c	7.73
KM2	Integrated	14:20	13.5c	8.99
KM3	Integrated	14:05	14.3c	8.33
KM4	Integrated	14:00	14.3c	8.55

Sample Interval		14DAT	**Date**	5/23/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	6:00	19.2c	8.42
KM2	Integrated	5:48	19.2c	8.72
KM3	Integrated	5:35	18.8c	8.24
KM4	Integrated	5:20	19.6c	8.7

Sample Interval		21DAT	**Date**	5/30/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	6:15	18.4c	8.95
KM2	Integrated	6:06	18.8c	9.39
KM3	Integrated	5:42	20.1c	9.58
KM4	Integrated	5:35	20.7c	9.62

Sample Interval		28DAT	**Date**	6/6/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	17:35	23.0c	8.8
KM2	Integrated	17:30	24.7c	9.3
KM3	Integrated	17:25	24.2c	9

KM4	Integrated	17:15	25.1c	9.7

Sample Interval		35DAT	**Date**	6/12/2011
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	17:00	19.8c	6
KM2	Integrated	16:52	18.7c	6.9
KM3	Integrated	16:45	19.8c	6.1
KM4	Integrated	16:40	19.5c	7.35

2011 Results:

This summer you requested information regarding an aquatic plant survey that staff from the Research Bureau of the Department of Natural Resources conducted on June 20, 2011 on Kettle Moraine Lake in Fond du Lac County, WI. The plant survey was conducted as part of a statewide Eurasian water milfoil monitoring project. This data will be used by the Department to understand the variation in milfoil growth among lakes across the state, how aquatic plant populations respond to management regimes, and how plant communities change over time. Kettle Moraine Lake is one of the lakes chosen for this project because it meets certain criteria (size, region, nutrient levels, presence of milfoil, timing of milfoil establishment, etc.) for this study.

Importance of Aquatic Plants

Aquatic plants form the foundation of healthy lake ecosystems. They not only protect water quality, but also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and prevent shoreline erosion by reducing the effect of waves and currents. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants such as Eurasian water milfoil and curly-leaf pondweed. Native aquatic plants also provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. By leaving or restoring a natural buffer area of emergent vegetation along the shoreline, property owners can reduce erosion, help maintain water quality, and provide habitat and travel corridors for wildlife.

Invasive Aquatic Plant Species

Invasive aquatic species are a huge threat to Wisconsin lakes both ecologically and economically. Ecological impacts of introduced invasive species can range in severity depending on differing ecosystem variables. Specific impacts are difficult to predict. Invasive

plants are problematic because they can grow to nuisance levels. These dense populations of non-native plants often have a negative impact on native plant communities because they are able to out-compete them for available resources needed for survival. Changes in the native plant community have far-reaching effects on fish, birds and invertebrates that need native plants to survive. Nuisance levels of non-native aquatic plants may also inhibit recreational activities (such as fishing, swimming, boating, etc.), decrease aesthetic value, and negatively effect water quality. Some industries such as sport and commercial fishing and raw water users (power companies and utilities), are also negatively affected by invasive species. It is important that everyone utilizing Wisconsin's lake resources do their part to help prevent and stop the spread of aquatic invasive species.

Point-Intercept Sampling Method

Based on area and depth specific to Kettle Moraine Lake, we mapped a 287-point sampling grid over the entire lake surface. Using a GPS, we navigated by boat to each of the pre-determined grid points. At each point we used a two-sided rake to sample approximately 1 foot along the bottom. After pulling the plants to the surface, the overall rake as well as individual species on the rake were assigned a fullness rating of 1, 2 or 3 to estimate density of plant growth (see Figure 1 for descriptions of rake fullness ratings). We also recorded visual sightings of species within six feet of the sample point, as well as any additional species seen in the lake during a general boat survey. For more detailed information on the point-intercept sampling method and how data were collected please visit: http://dnr.wi.gov/org/es/science/publications/PUB-SS-1068-2010.pdf

Species frequencies of occurrence reflect the percentage of times a species was found out of the total number of points sampled. Littoral frequency of occurrence (given in Table 1) indicates how often a species was found considering only areas of the lake that are capable of supporting plant growth (known as the "littoral area"). The maximum depth of plant growth is the deepest depth at which plants were found in the lake. Species richness is a count of the total number of different plant species found in a lake. The Floristic Quality Index (FQI) is a metric that evaluates the closeness of the flora in a lake to that of an undisturbed condition. The higher a FQI value, the closer that plant community is to an undisturbed ecosystem. Statewide and ecoregion averages are calculated from a subset of approximately 250 lakes across Wisconsin.

Table 1: Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is detected in a lake divided by the total number of points in a lake at which the growth of plants is possible. Voucher specimens have been sent to the UW-Stevens Point Herbarium, therefore all species identifications are subject to change pending verification.

Common Name	Scientific Name	Growth Form (Floating, free floating, submerged, emergent)	% Frequency of Occurrence
Waterweed	*Elodea* spp.	Submerged	82.18
Muskgrasses	*Chara* sp.	Submerged	44.73
Southern naiad	*Najas guadalupensis*	Submerged	41.82
Coontail	*Ceratophyllum demersum*	Submerged	38.55
Pondweed hybrid	*Potamogeton x scoliophyllus*	Submerged	20.73
Watershield	*Brasenia schreberi*	Floating	6.18
Illinois pondweed	*Potamogeton illinoensis*	Submerged	4.73
White water lily	*Nymphaea odorata*	Floating	4.00
Sago pondweed	*Stuckenia pectinata*	Submerged	4.00
Creeping bladderwort	*Utricularia gibba*	Free floating	3.64
Wild celery	*Vallisneria americana*	Submerged	2.91
Curly-leaf pondweed*	*Potamogeton crispus**	Submerged	1.09
Water star-grass	*Heteranthera dubia*	Submerged	1.09
Spatterdock	*Nuphar variegata*	Floating	0.73
Pickerelweed	*Pontederia cordata*	Emergent	0.36
White-stem pondweed	*Potamogeton praelongus*	Submerged	0.36
Swamp loosestrife	*Decodon verticillatus*	Emergent	General Survey
Three-square bulrush	*Schoenoplectus pungens*	Emergent	General Survey
Cattail	*Typha* sp.	Emergent	Boat Survey
Small duckweed	*Lemna minor*	Free floating	Boat Survey
Large duckweed	*Spirodela polyrhiza*	Free floating	Boat Survey
Yellow iris*	*Iris pseudacorus**	Emergent	Boat Survey
Blue flag	*Iris* sp.	Emergent	Boat Survey
Common bladderwort	*Utricularia vulgaris*	Free floating	Boat Survey
Freshwater sponge		Submerged	4.36
Filamentous algae		Submerged	43.64

***** = species non-native and potentially invasive in WI

Survey Summary

	LAKE	STATEWIDE AVERAGE	SWTP ECOREGION AVERAGE
Littoral Frequency of Occurrence (%)	97.5	74.3	79.0
Maximum Depth of Plant Growth (feet)	17.5	15.3	15.4
Species Richness	16	16.8	15.0
Floristic Quality Index (FQI)	22.7	24.1	20.0

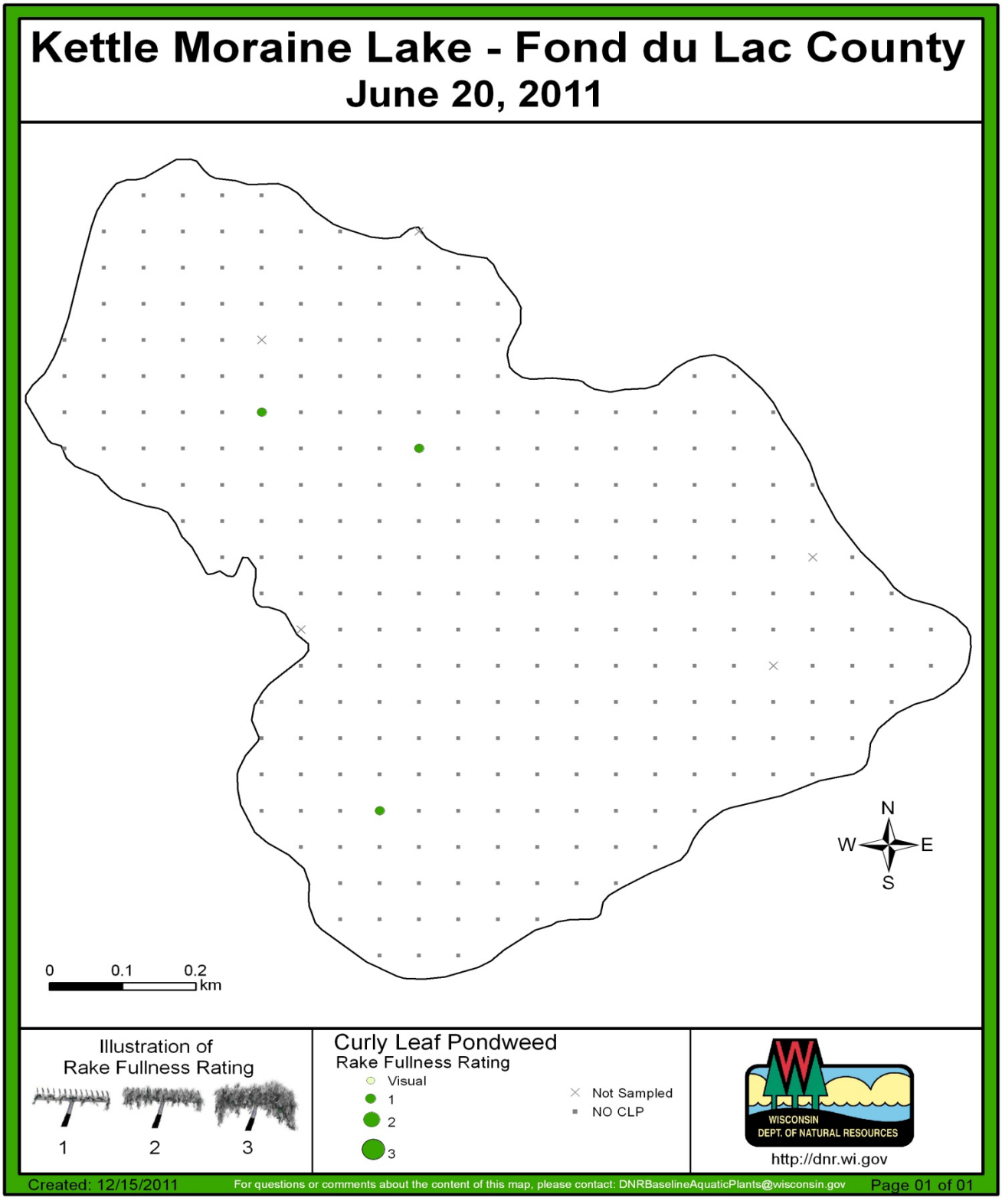
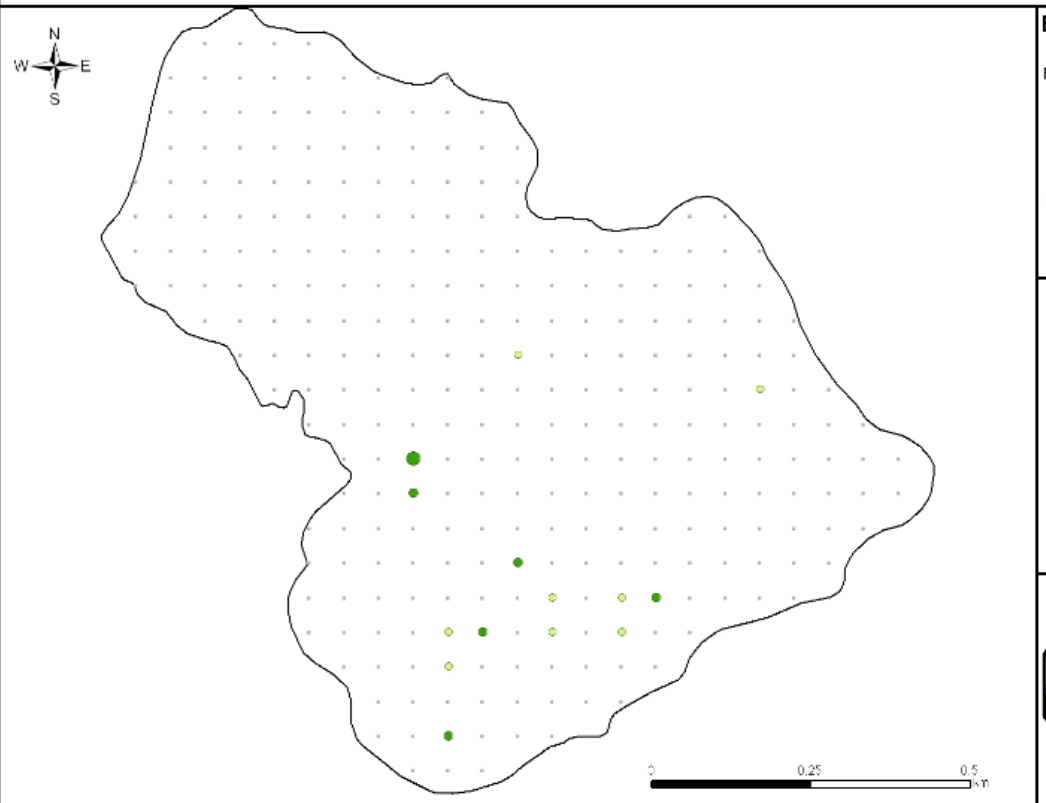


Figure 4: A map of the approximate location of Curly Leaf Pondweed.

Kettle Moraine - Fond du Lac Co.
09/15/2011



Eurasian Water Milfoil
Rake Fullness Rating
- Visual
- 1
- 2
- 3
- No EWM
- Not Sampled

Illustration of Rake Fullness Rating

http://dnr.wi.gov

Created: 9-23-2011

For questions or comments about the content of this map, please contact: DNRBaselineAquaticPlants@wisconsin.gov

2012

Overview

On 20 April 2012, 37 acres of Kettle Moraine Lake were treated with a liquid formulation of 2,4-D at a lake wide target application rate of 300 ug/L ae (3 mg/L ae) to control Eurasian milfoil. On 27 April, 30.4 acres were treated with a liquid formulation of endothall at a target concentration of 3000 ug/L ai (2129 ug/L ae) to control curly-leaf pondweed. On 7 May, an additional 30.1 acres were treated with a liquid formulation of endothall at a target concentration 900 ug/L ai (639 ug/L ae). to control curly-leaf pondweed. The lake wide application rates for the two endothall treatments was 267 ug/L ai (189 ug/L ae) and 84 ug/L ai (60 mg/L ae) respectively. Water sample sites were established at 3 sites to monitor herbicide concentration and exposure times including 2 sites (KM2 and KM3) in treatment target areas and one site (KM1) in the untreated deep area in south east part of the lake.

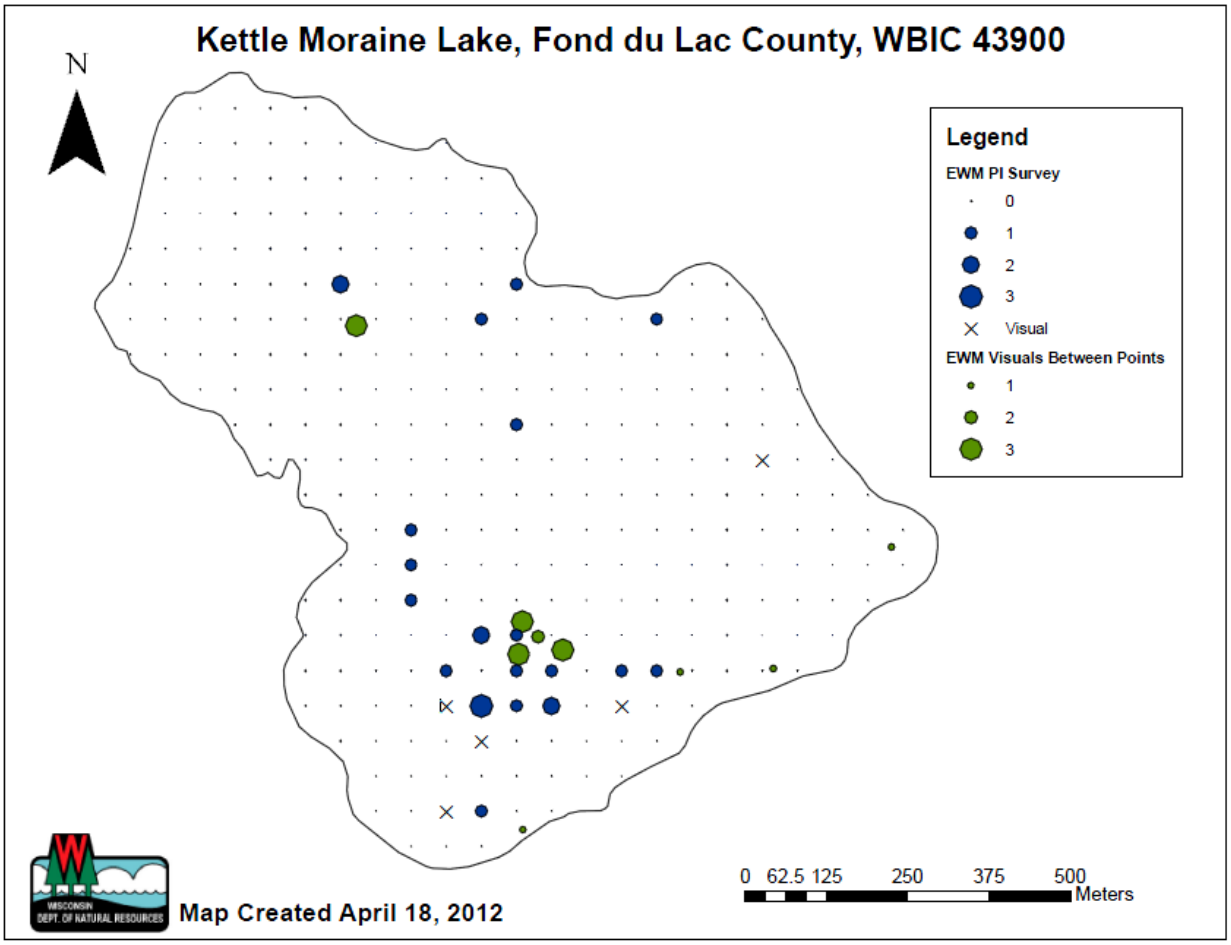
Water samples were collected using an integrated water sampler which collects a water sample from the entire water column. The water sample plan was designed based on one treatment date so that each sample would be analyzed for both 2,4-D and endothall. Water samples were therefore collected at intervals of approximately 1, 3, 5, 7, 14, 21, and 28 days after the 2,4-D treatment (DAT). Water samples were collected at intervals of approximately 0, 7, 14, and 21 DAT after the first endothall treatment. Water samples were collected at intervals of approximately 4 and 11 DAT of the second first treatment. Samples were taken to shore after completion of each sample interval, and 3 drops of muriatic acid were added to each sample bottle to fix the herbicide and prevent degradation. Samples were then stored in a refrigerator, until shipped to the ERDC laboratory in Gainesville, FL for analysis of 2,4-D and endothall.

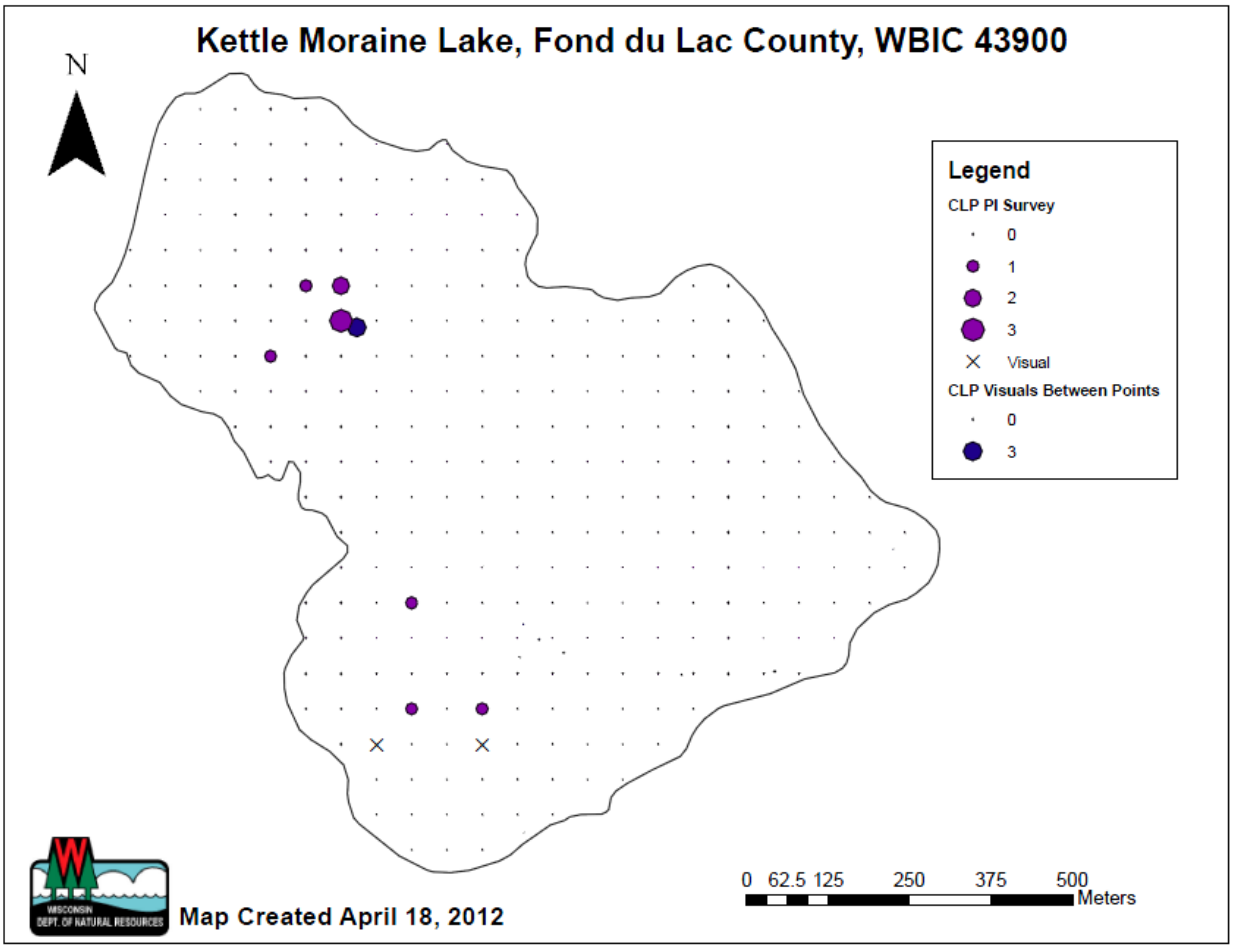
Peak 2,4-D concentrations ranged from 240 to 371 ug/L ae (Figure 2). The mean 2,4-D concentration from 0 to 7 DAT was 215 ug/L ae compared to the lake wide target concentration of 300 ug/L ae (Figure 3). The mean concentration for all three location was less than the irrigation standard of 100 ug/L ae by 21 DAT. The highest concentration was measured in the untreated KM1 site 1 DAT indicating that the herbicide rapidly dissipated out of the target areas. Concentrations of 2,4-D were similar at all sites by 5 DAT.

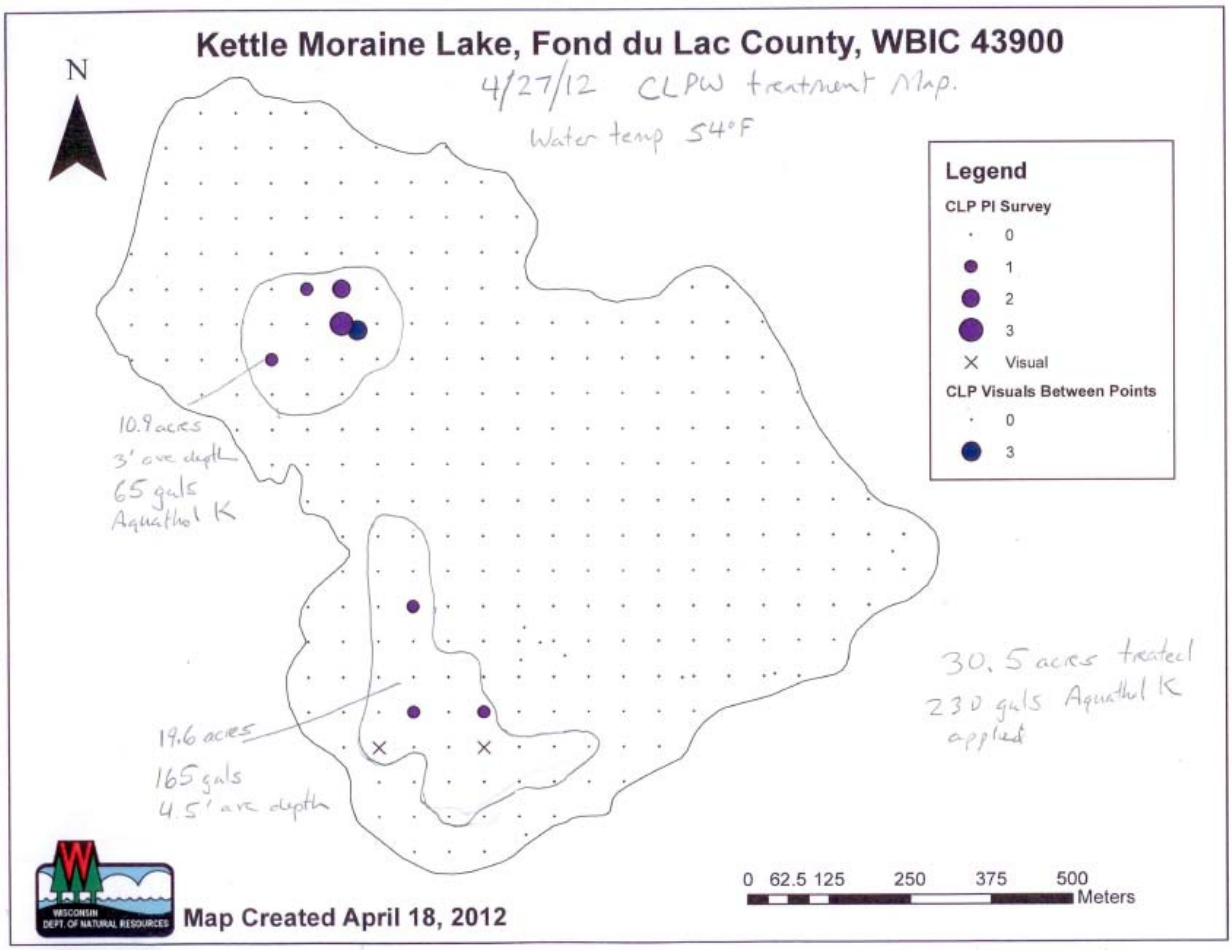
Peak endothall concentrations ranged from 154 to 373 ug/L ae compared to the target application rate of 2129 ug/L ae (Figure 4). The mean concentration from 0 to 7 DAT was 148 ug/L ae compared to the lake wide target concentration of 267 ug/L ae (Figure 5). Because the first endothall treatment was delayed 7 days, not enough samples were collected with the first 7 days to quantify the dissipation from target sites. Based on the 2,4-D data collected here, and based on data from numerous other lakes, dissipation of endothall was likely rapid becoming a whole lake treatment within a couple days.

Endothall and 2,4-D have been used in combination using lower application rates or possibly to control more difficult target species such as hybrid milfoil (Figure 6). The data to date is unclear whether the combination has an additive effect or possibly a synergistic effect. For additional data refer to the Half Moon Lake summary for the 2009 herbicide treatment and the Half Moon Lake summary from 2010 and 2012. Since the first endothall treatment occurred 7 days after the 2,4-D

treatment the impact of the combination of the two herbicides on Eurasian watermilfoil and curly-leaf pondweed is unclear. They were present in combination at significant concentrations.


Kettle Moraine Lake, Fond du Lac County, WBIC 43900
N
Legend
EWM PI Survey
0
1
2
3
Visual
EWM Visuals Between Points
1
2
3
0 62.5 125 250 375 500
Meters
WISCONSIN DEPT. OF NATURAL RESOURCES
Map Created April 18, 2012


Kettle Moraine Lake, Fond du Lac County, WBIC 43900
N
Legend
CLP PI Survey
0
1
2
3
Visual
CLP Visuals Between Points
0
3
0 62.5 125 250 375 500
Meters
WISCONSIN DEPT. OF NATURAL RESOURCES
Map Created April 18, 2012


Kettle Moraine Lake, Fond du Lac County, WBIC 43900
4/27/12 CLPW treatment Map.
Water temp 54°F
N
Legend
CLP PI Survey
0
1
2
3
Visual
CLP Visuals Between Points
0
3
10.9 acres
3' ave. depth
65 gals
Aquathol K
19.6 acres
165 gals
4.5' ave depth
30.5 acres treated
230 gals Aquathol K
applied
0 62.5 125 250 375 500
Meters
WISCONSIN
DEPT. OF NATURAL RESOURCES
Map Created April 18, 2012

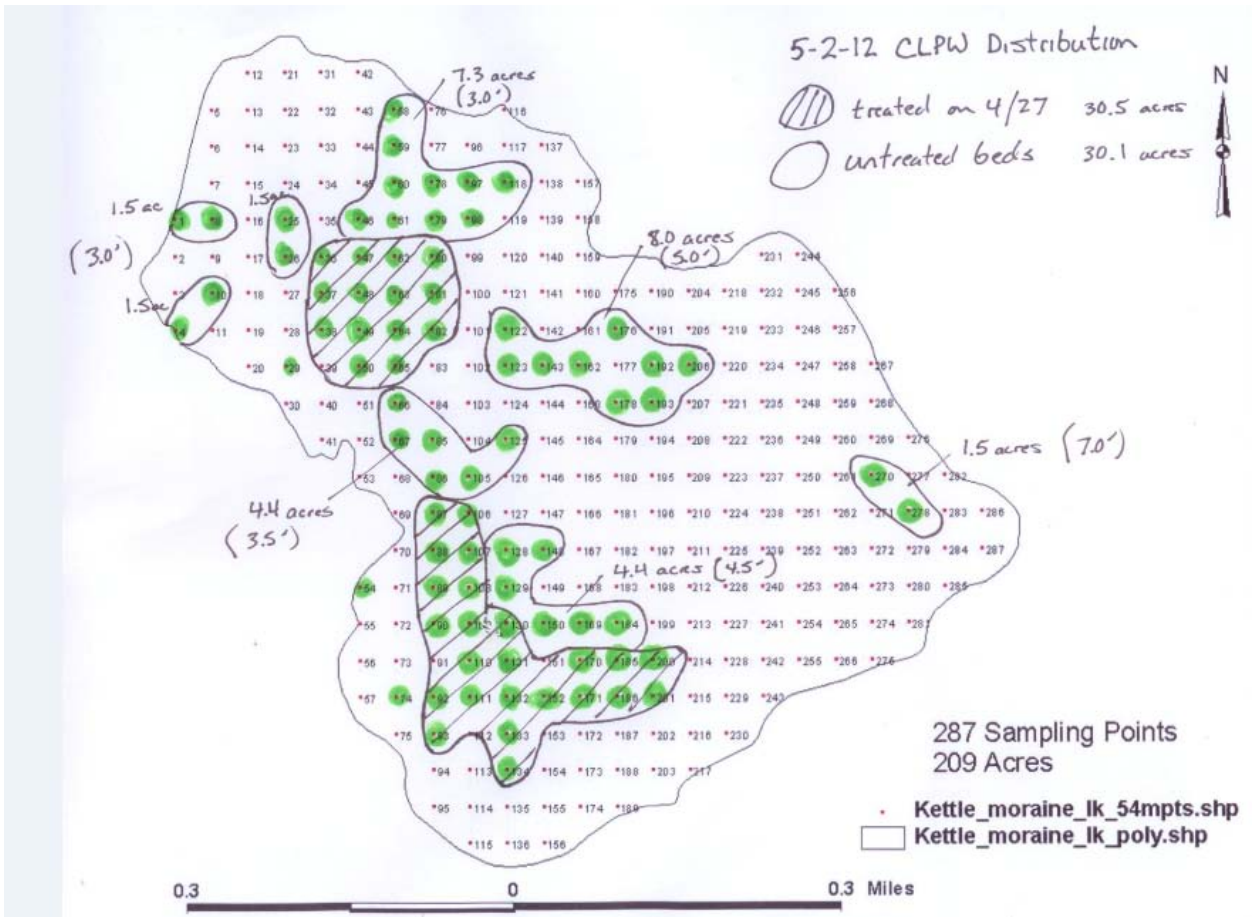

5-2-12 CLPW Distribution
treated on 4/27 30.5 acres
untreated beds 30.1 acres
N
7.3 acres (3.0')
8.0 acres (5.0')
1.5 ac (3.0')
1.5 acres (7.0')
4.4 acres (3.5')
4.4 acres (4.5')
287 Sampling Points
209 Acres
Kettle_moraine_lk_54mpts.shp
Kettle_moraine_lk_poly.shp
0.3 0 0.3 Miles

Figure 1. Kettle Moraine 2,4-D and Endothall Sample Locations, 2012

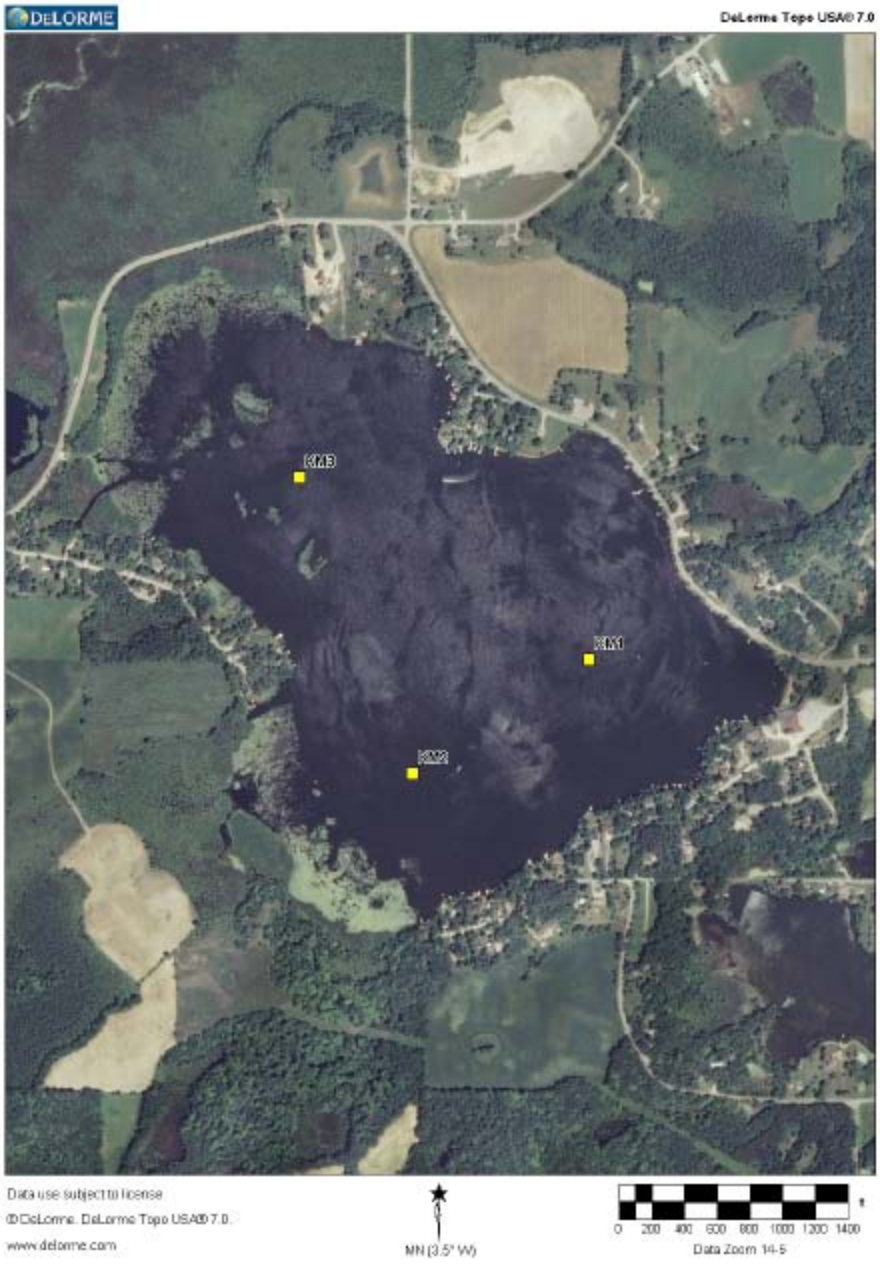


Figure 2

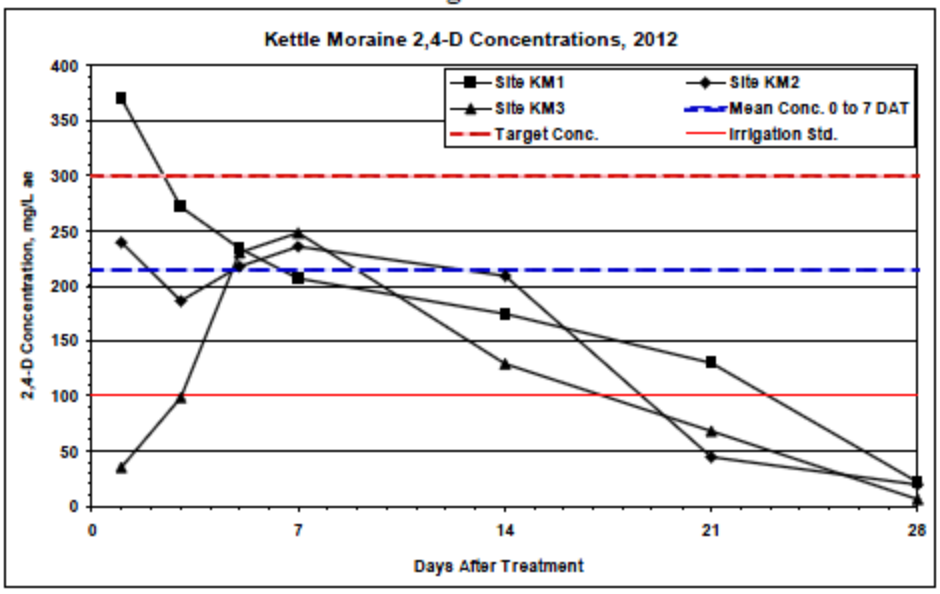


Figure 3

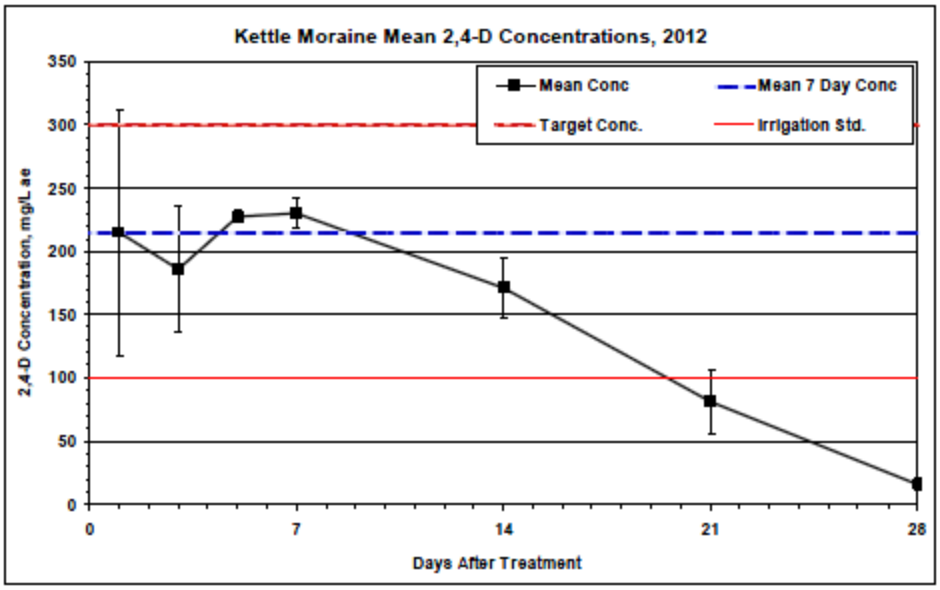


Figure 4

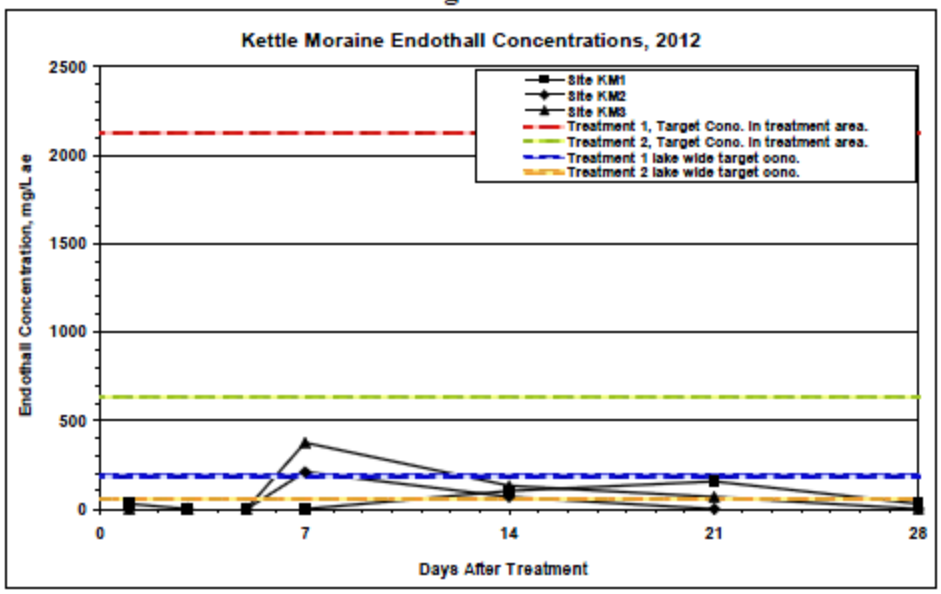


Figure 5

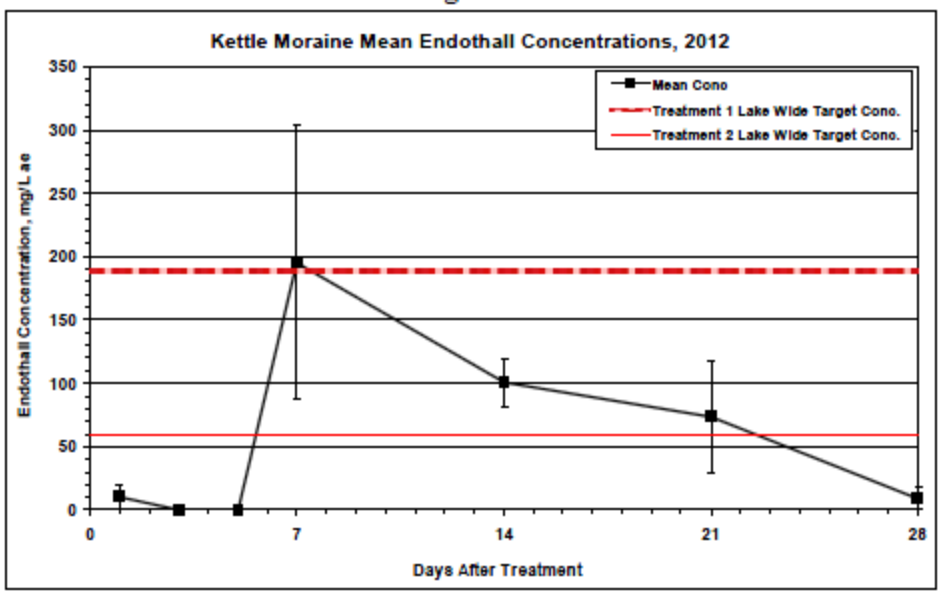
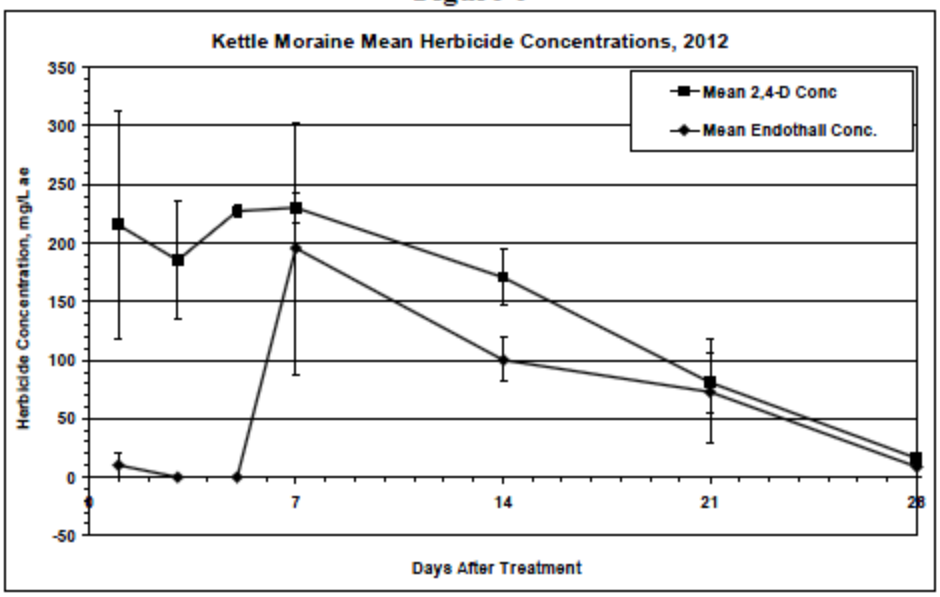


Figure 6

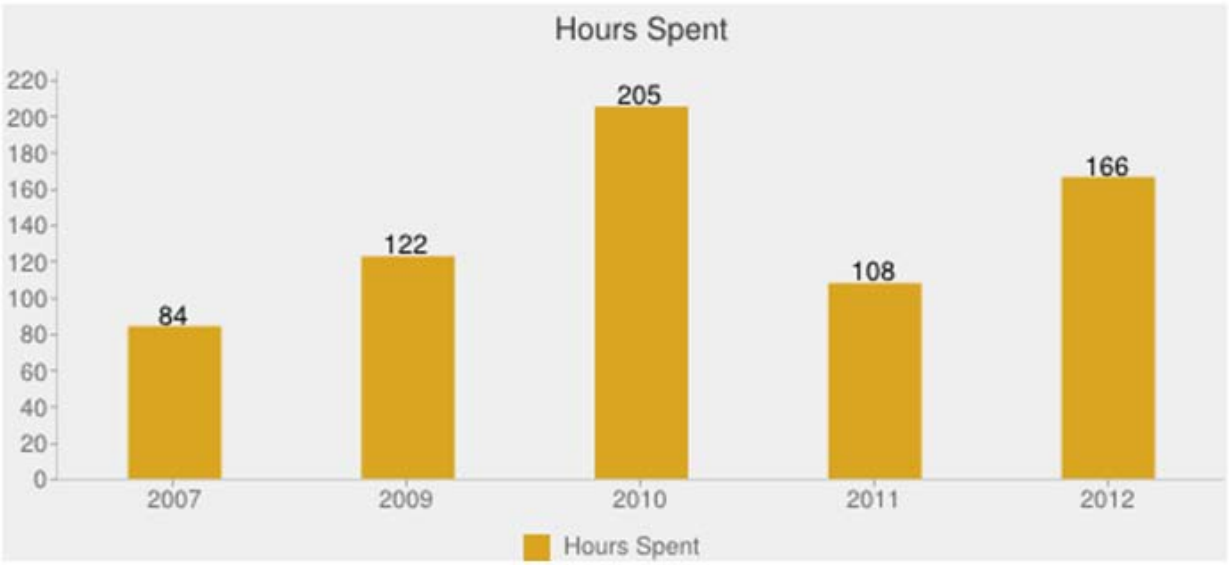


Chemical Treatment

On 20 April 2012, 37 acres of Kettle Moraine Lake were treated with a liquid formulation of 2,4-D at a lake wide target application rate of 300 ug/L ae (3 mg/L ae) to control Eurasian milfoil. On 27 April, 30.4 acres were treated with a liquid formulation of endothall at a target concentration of 3000 ug/L ai (2129 ug/L ae) to control curly-leaf pondweed. On 7 May, an additional 30.1 acres were treated with a liquid formulation of endothall at a target concentration 900 ug/L ai (639 ug/L ae). to control curly-leaf pondweed. The lake wide application rates for the two endothall treatments was 267 ug/L ai (189 ug/L ae) and 84 ug/L ai (60 mg/L ae) respectively.

Non-Chemical Treatments:

- Lake property owners conduct raking along shoreline
- Conduct visual lake inspections
- Secchi readings
- Water samples and chemical dispersion measurements
- Dissolved oxygen readings post AIS chemical treatment
- CBCW


Hours Spent
220
200
180
160
140
120
100
80
60
40
20
0
84
122
205
108
166
2007
2009
2010
2011
2012
Hours Spent

Water Quality Management:

Lake Water Quality 2012 Annual Report

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE

Site Name	Storet #
Kettle Moraine Lake - Deep Hole	203059

Date	SD (ft)	SD (m)	Hit Bottom	CHL	TP	TSI (SD)	TSI (CHL)	TSI (TP)	Lake Level	Clarity	Color	Perception
04/29/2012	10	3	NO			44			HIGH	CLEAR	BROWN	1-Beautiful, could not be nicer
05/06/2012	9.5	2.9	NO			45			HIGH	CLEAR	BROWN	1-Beautiful, could not be nicer
05/13/2012	10	3	NO			44			HIGH	CLEAR	BROWN	1-Beautiful, could not be nicer
05/20/2012	9	2.7	NO			45			HIGH	MURKY	GREEN	3-Enjoyment somewhat impaired (algae)
06/09/2012	8	2.4	NO			47			NORMAL	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
06/16/2012	7	2.1	NO			49			LOW	CLEAR	BROWN	2-Very minor aesthetic problems
06/24/2012	6	1.8	NO			51			LOW	CLEAR	BROWN	2-Very minor aesthetic problems
07/08/2012	7	2.1	NO			49			LOW	CLEAR	BROWN	3-Enjoyment somewhat impaired (algae)
07/15/2012	5	1.5	NO			54			LOW	CLEAR	BROWN	3-Enjoyment somewhat impaired (algae)
07/28/2012	5	1.5	NO			54			LOW	CLEAR	BROWN	2-Very minor aesthetic problems
08/05/2012	6	1.8	NO			51			LOW	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
08/12/2012	6	1.8	NO			51			LOW	MURKY	BROWN	3-Enjoyment somewhat impaired (algae)
08/19/2012	7	2.1	NO			49			LOW	CLEAR	BROWN	2-Very minor aesthetic problems

Date	Data Collectors	Project
04/29/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
05/06/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
05/13/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
05/20/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/09/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/16/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
06/24/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/08/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/15/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
07/28/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/05/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/12/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole
08/19/2012	Cindy Katt	Citizen Lake Monitoring - Water Quality - Kettle Moraine Lake (43900)- Deep Hole

SD = Secchi depth measured in feet converted to meters; Chl = Chlorophyll a in micrograms per liter(ug/l); TP = Total phosphorus in ug/l, surface sample only; TSI(SD), TSI(CHL), TSI(TP) = Trophic state index based on SD, CHL, TP respectively; Depth measured in feet.

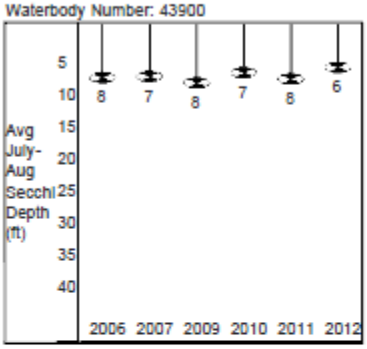
Wisconsin Department of Natural Resources **Wisconsin Lakes Partnership**

Secchi Readings:

Wisconsin Department of Natural Resources

Kettle Moraine Lake
Fond du Lac County
Waterbody Number: 43900

Lake Type: SEEPAGE
DNR Region: NE
GEO Region:SE



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2006	7.5	7.5	7.5	6
2007	7.4	7	7.5	5
2009	8.3	6.5	9.5	8
2010	6.8	6.5	7.5	6
2011	7.8	7	8.5	7
2012	6	5	7	6

Report Generated: 04/23/2013

dnr.wi.gov

2012 Dissolved Oxygen Measurements

Kettle Moraine Lake Herbicide Residual Sampling Data				
Sample Interval	1DAT	**Date**	4/21/2012	
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	6:37	9.9c	10.95
KM2	Integrated	6:27	11.9c	11.37
KM3	Integrated	6:11	12.7c	11.55

[redacted]

Sample Interval		3DAT	Date	4/23/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	6:00	15.1c	10.83
KM2	Integrated	6:14	14.7c	11.43
KM3	Integrated	6:19	15.1c	11.96

Sample Interval		7DAT	Date	4/25/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	13:32	11.8c	10.23
KM2	Integrated	13:24	11.8c	10.35
KM3	Integrated	13:13	12.2c	11.18

Sample Interval		14DAT	Date	4/29/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	14:23	11.3c	10.22
KM2	Integrated	14:14	11.4c	10.97
KM3	Integrated	14:00	11.5c	10.82

Sample Interval		21DAT	Date	5/6/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	8:17	14.8c	9.1
KM2	Integrated	8:11	14.6c	8.88
KM3	Integrated	7:51	14.6c	12.3

Sample Interval		28DAT	Date	5/13/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	16:38	17.6c	10
KM2	Integrated	16:26	18.9c	10.6
KM3	Integrated	16:16	19.8c	13.2

Sample Interval		35DAT	Date	5/20/2012
Site	**Sample Depth**	**Time**	**Water Temp**	**Dissolved Oxygen**
KM1	Integrated	13:20	21.2c	7.8

KM2	Integrated	13:11	21.5c	8.37
KM3	Integrated	12:56	22.3c	7.6

2012 Results:

This summer you requested information regarding an aquatic plant survey that staff from the Research Bureau of the Department of Natural Resources conducted on June 20, 2012 on Lake Kettle Moraine in Fond du Lac County, WI. The plant survey was conducted as part of a statewide Eurasian water milfoil monitoring project. This data will be used by the Department to understand the variation in milfoil growth among lakes across the state, how aquatic plant populations respond to management regimes, and how plant communities change over time. Lake Kettle Moraine is one of the lakes chosen for this project because it meets certain criteria (size, region, nutrient levels, presence of milfoil, timing of milfoil establishment, etc.) for this study.

Importance of Aquatic Plants

Aquatic plants form the foundation of healthy lake ecosystems. They not only protect water quality, but also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and prevent shoreline erosion by reducing the effect of waves and currents. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants such as Eurasian water milfoil and curly-leaf pondweed. Native aquatic plants also provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. By leaving or restoring a natural buffer area of emergent vegetation along the shoreline, property owners can reduce erosion, help maintain water quality, and provide habitat and travel corridors for wildlife.

Invasive Aquatic Plant Species

Invasive aquatic species are a huge threat to Wisconsin lakes both ecologically and economically. Ecological impacts of introduced invasive species can range in severity depending on differing ecosystem variables. Specific impacts are difficult to predict. Invasive plants are problematic because they can grow to nuisance levels. These dense populations of non-native plants often have a negative impact on native plant communities because they are able to out-compete them for available resources needed for survival. Changes in the native plant community have far-reaching effects on fish, birds and invertebrates that need native plants to survive. Nuisance levels of non-native aquatic plants may also inhibit recreational activities (such as fishing, swimming, boating, etc.), decrease aesthetic value, and negatively effect water quality. Some industries such as sport and commercial fishing and raw water users (power

companies and utilities), are also negatively affected by invasive species. It is important that everyone utilizing Wisconsin's lake resources do their part to help prevent and stop the spread of aquatic invasive species.

Point-Intercept Sampling Method

Based on area and depth specific to Lake Kettle Moraine, we mapped a 287-point sampling grid over the entire lake surface. Using a GPS, we navigated by boat to each of the pre-determined grid points. At each point we used a two-sided rake to sample approximately 1 foot along the bottom. After pulling the plants to the surface, the overall rake as well as individual species on the rake were assigned a fullness rating of 1, 2 or 3 to estimate density of plant growth (see Figure 1 for descriptions of rake fullness ratings). We also recorded visual sightings of species within six feet of the sample point, as well as any additional species seen in the lake during a general boat survey. For more detailed information on the point-intercept sampling method and how data were collected please visit: http://dnr.wi.gov/org/es/science/publications/PUB-SS-1068-2010.pdf

Species frequencies of occurrence reflect the percentage of times a species was found out of the total number of points sampled. Littoral frequency of occurrence (given in Table 1) indicates how often a species was found considering only areas of the lake that are capable of supporting plant growth (known as the "littoral area"). The maximum depth of plant growth is the deepest depth at which plants were found in the lake. Species richness is a count of the total number of different plant species found in a lake. The Floristic Quality Index (FQI) is a metric that evaluates the closeness of the flora in a lake to that of an undisturbed condition. The higher a FQI value, the closer that plant community is to an undisturbed ecosystem. Statewide and ecoregion averages are calculated from a subset of approximately 250 lakes across Wisconsin.

Table 1: Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is detected in a lake divided by the total number of points in a lake at which the growth of plants is possible. Voucher specimens have been sent to the UW-Stevens Point Herbarium, therefore all species identifications are subject to change pending verification.

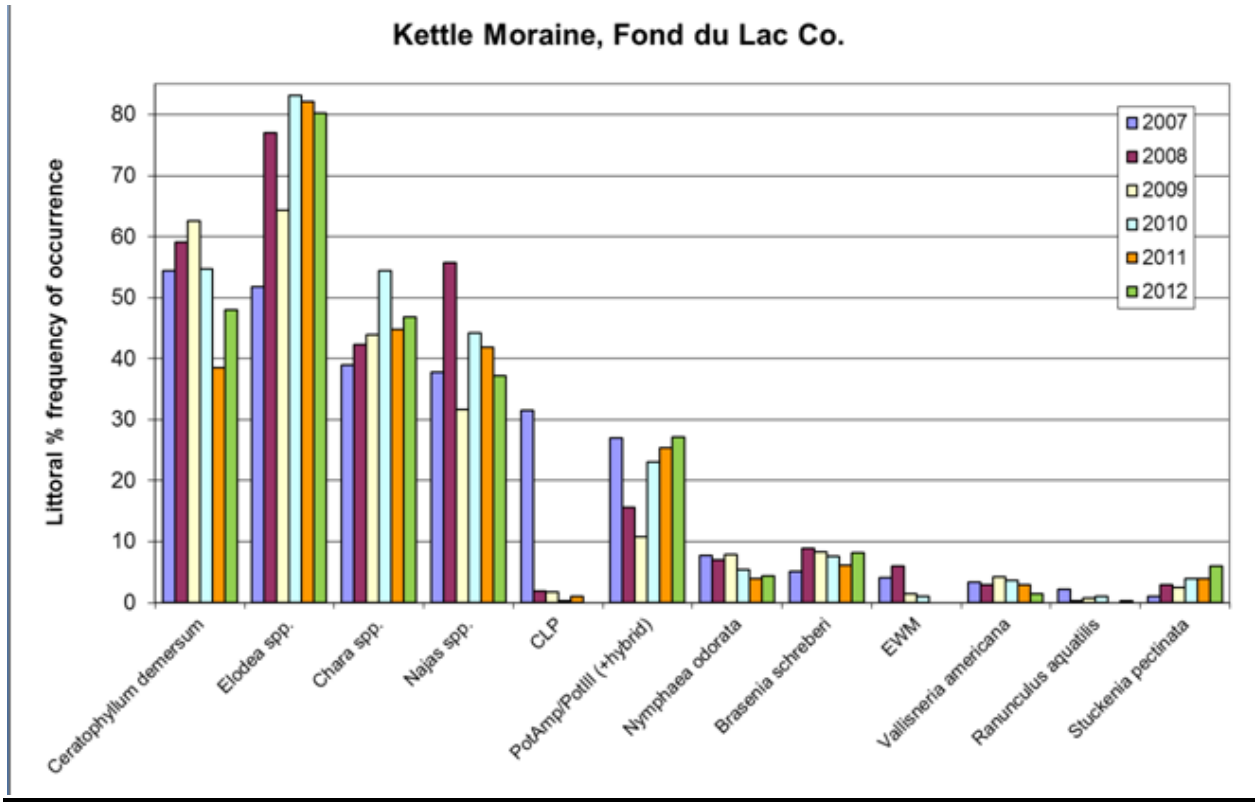
Common Name	**Scientific Name**	**Growth Form (Floating, free floating, submerged, emergent)**	**% Frequency of Occurrence**
Waterweed	*Elodea* spp.	Submerged	80.3
Coontail	*Ceratophyllum demersum*	Submerged	48.0
Muskgrasses	*Chara* sp.	Submerged	46.8
Southern naiad	*Najas guadalupensis*	Submerged	37.2
Illinois + Large leaf pondweed hybrid	*Potamogeton X scoliophyllus*	Submerged	20.4
Watershield	*Brasenia schreberi*	Floating	8.2
Sago pondweed	*Stuckenia pectinata*	Submerged	5.9
White water lily	*Nymphaea odorata*	Floating	4.5
Large-leaf pondweed	*Potamogeton amplifolius*	Submerged	4.1
Creeping bladderwort	*Utricularia gibba*	Free floating	4.1
Illinois pondweed	*Potamogeton illinoensis*	Submerged	2.6
Nitella	*Nitella* sp.	Submerged	2.2
Water star-grass	*Heteranthera dubia*	Submerged	1.9
Wild celery	*Vallisneria americana*	Submerged	1.5
Spatterdock	*Nuphar variegata*	Floating	0.4
Floating-leaf pondweed	*Potamogeton natans*	Floating	0.4
White water crowfoot	*Ranunculus aquatilis*	Submerged	0.4
Large duckweed	*Spirodela polyrhiza*	Free floating	0.4
Small duckweed	*Lemna minor*	Free floating	Visual
Pickerelweed	*Pontederia cordata*	Emergent	Visual
Long-leaf pondweed	*Potamogeton nodosus*	Submerged	Visual

Softstem bulrush	*Schoenoplectus tabernaemontani*	Emergent	Visual
Common bladderwort	*Utricularia vulgaris*	Free floating	Boat Survey
Swamp loosestrife	*Decodon verticillatus*	Emergent	Boat Survey
Freshwater sponge		Submerged	0.7
Filamentous algae		Submerged	61.0

***** = species non-native and potentially invasive in WI

Survey Summary

	LAKE	**STATEWIDE AVERAGE**	**SWTP ECOREGION AVERAGE**
Littoral Frequency of Occurrence (%)	95.5	74.3	79.0
Maximum Depth of Plant Growth (feet)	14.0	15.3	15.4
Species Richness	22	16.8	15.0
Floristic Quality Index (FQI)	24.5	24.1	20.0



Key Learnings:

- Summer DNR PI surveys for CLP and EWM often changed dramatically from what were seen between the late fall and spring pre-treatment surveys.
- Given the limited depth in Kettle Moraine Lake the water temperatures can increase quickly necessitating quick response with AIS chemical treatments (this emphasizes the need to have pre-treatment surveys completed and chemical treatment permits issued early in the season).
- In 2012, water temperatures rose quickly and the chemical applicators observed that there was a significant difference between the pre-treatment PI survey that had been conducted several weeks prior and what was seen on the day of treatment (AIS concentrations can change rapidly in the spring).
- Full lake treatments for CLP and EWM provided the greatest benefit in terms of reducing areas and thickness of AIS species.
- AIS treatment effectiveness improved dramatically as a result of DNR biologists' recommendations.
- AIS chemical treatment effectiveness improved when water samples were taken and dispersion rates began being monitored.

- AIS treatment efficacy showed dramatic improvement when the DNR began conducting summer and fall PI surveys and having their DNR biologists use this information to determine the chemical treatment plans.
- Separating the responsibilities for chemical treatment applications from the PI surveys and chemical treatment requests has improved accountability.

Recommendations:

- Dividing the responsibilities for evaluating AIS treatment effectiveness and chemical applications is essential to long-term AIS effectiveness on Kettle Moraine Lake.
- Full-lake treatments that meet targeted dispersion rates provide the best results.
- EWM must be monitored and treated on an annual basis. When EWM concentrations were not treated in their entirety the EWM populations returned to levels similar to what they had been prior to treatment.
- CBCW needs to be an essential part of a non-chemical treatment plan.
- Kettle Moraine Lake has limited financial resources to support full-lake treatments and it is essential that the DNR continue to financially support KML's AIS treatment efforts.