



Crystal Lake, Burnsville, Minnesota Google Map

Aquatic Plant Surveys for Crystal Lake, Burnsville, Minnesota, 2011

Early Summer Survey: May 24, 2011
Late Summer Survey: August 30, 2011

Submitted to:
City of Burnsville



Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

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Aquatic Plant Surveys for Crystal Lake, Burnsville, Minnesota, 2011

Summary

Curlyleaf scouting and two full aquatic plant surveys were conducted on Crystal Lake in 2011. The 2011 early summer aquatic plant survey was conducted on May 24, 2011 and consisted of 25 transects with up to three depths sampled per transect. Aquatic plants (primarily curlyleaf pondweed) covered about 74% of the lake bottom (208 out of 280 acres)(Figures 1 and 2). There was very little nuisance growth of curlyleaf pondweed after harvesting was completed in 2011. Curlyleaf pondweed grew out to a water depth of 12 feet. Twelve submerged plant species were identified in Crystal Lake with curlyleaf pondweed being the most common plant (Table I).

The 2011 late summer aquatic plant survey was conducted on August 30, 2011 and consisted of 25 transects with three depths sampled per transect. By this time in the late summer, curlyleaf pondweed had died back and native aquatic plants covered about 57% of the lake bottom (160 out of 280 acres). Eighteen floatingleaf or submerged plant species were identified in Crystal Lake with coontail being the most common (Table I). Waterlilies were abundant in the fertile bays. Plants grew out to a water depth of about 11 feet.

Eurasian watermilfoil was found at 15 locations in Crystal Lake in 2011 and had about the same distribution as was found in 2010. Milfoil increased in abundance in 2006 compared to previous surveys but has stabilized in distribution the last few years (Table 1). Based on previous growth patterns, as long as plant community conditions remain intact, Eurasian watermilfoil has a low probability of increasing to nuisance conditions.



Figure 1. Coontail and northern milfoil were abundant in some areas in August 2011.

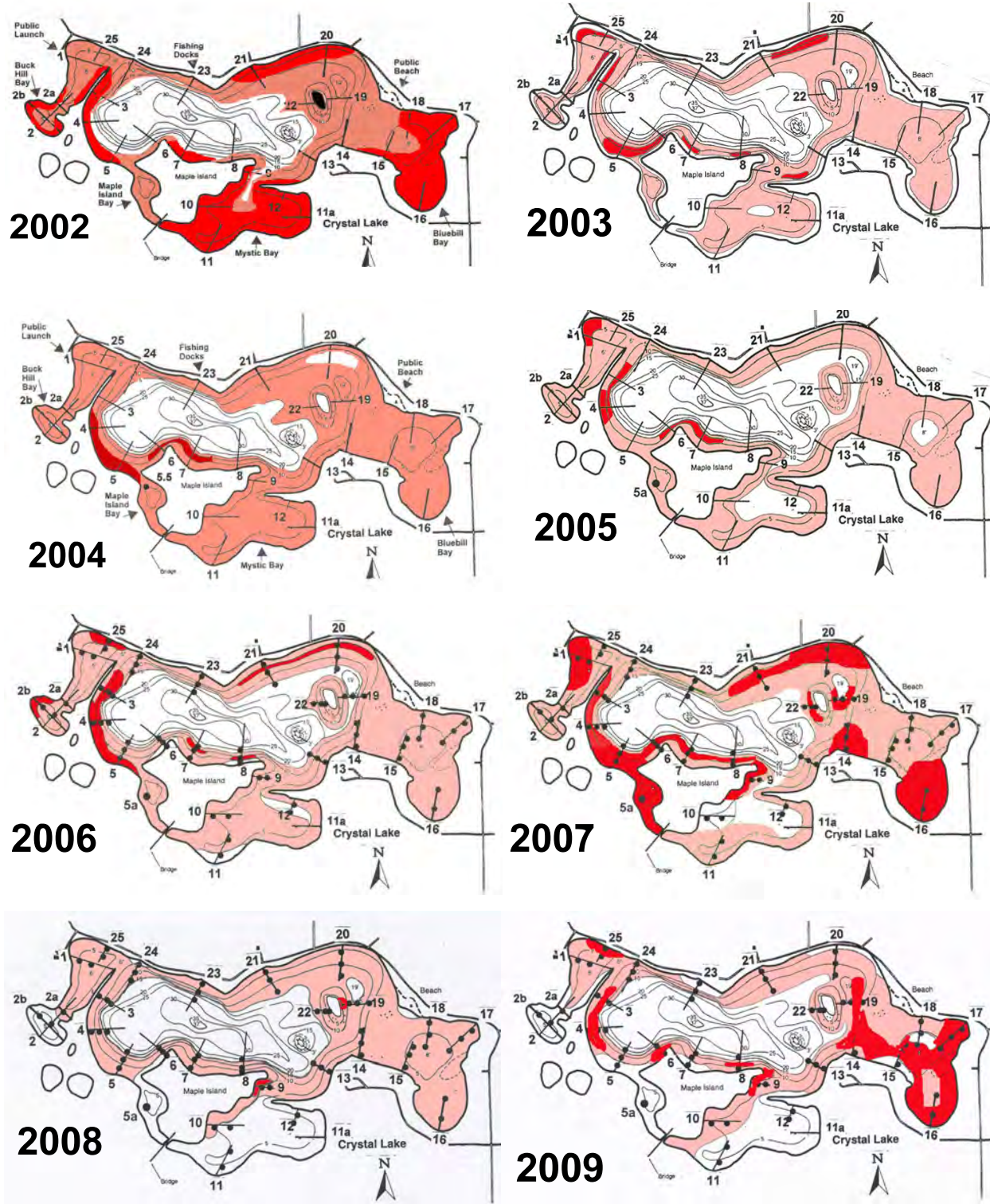


Figure 2. Curlyleaf pondweed coverage in 2002 through 2011. Curlyleaf coverage is shown in pink and nuisance growth is shown in red. Coverage in 2002 is prior to any curlyleaf control program. Coverage from 2003 to 2006 represents nuisance coverage after harvesting was completed. Coverage in 2007 and 2011 represents nuisance coverage prior to harvesting and coverage in 2008 and 2009 represents coverage during the harvesting operation. The harvesters have reduced the area of nuisance coverage but some areas in Crystal Lake exhibit heavy growth on a somewhat consistent basis.

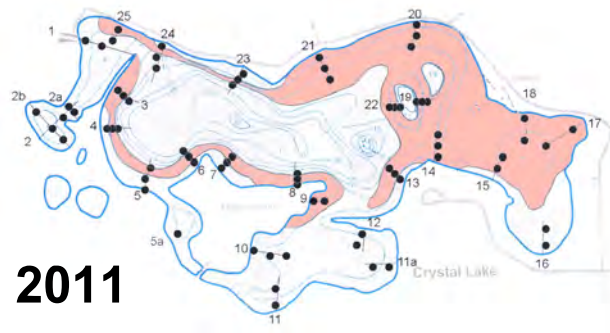
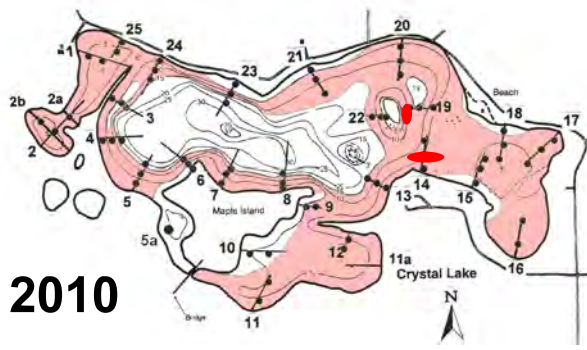


Figure 2. Concluded.

Summary of Crystal Lake Plant Surveys

Early Summer Aquatic Plant Summaries from 2002 - 2011

A comparison of plant occurrence and density for early summer plant surveys from 2002 through 2011 is shown in Table 1. Curlyleaf pondweed was the dominant plant followed by coontail. In 2011, coontail was the dominant native submerged plant. Occurrences of other aquatic plants are scarce in early summer.

Table 1. Early summer Crystal Lake aquatic plant comparisons for 2002 through 2011 for submerged and floatingleaf species. Surveys were conducted in May or June. Density is on a scale from 1 to 5 with 5 being the densest. Yellow shading indicates years of harvesting.

	2002 (65 stations)		2003 (63 stations)		2004 (73 stations)		2005 (68 stations)		2006 (68 stations)		2007 (69 stations)		2008 (68 stations)		2009 (67 stations)		2010 (68 stations)		2011 (64 stations)	
	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density
White waterlily (<i>Nymphaea</i> sp)	5	1.7	6	1.6	15	1.6	12	1.4	8	1.0	6	1.0	9	1.5	9	1.7	4	1	8	1.0
Coontail (<i>Ceratophyllum demersum</i>)	22	1.6	27	1.7	22	2.4	41	1.9	34	1.6	38	2.2	69	2.0	54	2.0	54	2.1	48	1.8
Chara (<i>Chara</i> sp)	--	--	--	--	--	--	--	--	--	--	6	1.3	1	1.5	3	1.5	3	1.5	6	1.1
Elodea (<i>Elodea canadensis</i>)	--	--	--	--	--	--	--	--	--	--	--	--	3	0.5	--	--	3	1	5	0.8
Star duckweed (<i>Lemna trisulca</i>)	--	--	--	--	--	--	--	--	1	0.3	1	0.3	1	1.0	3	1.0	3	1	9	0.8
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	6	1.1	10	1.3	--	--	7	1.1	4	0.3	14	1.0	16	1.0	25	1.4	26	1.3	16	0.9
Hybrid watermilfoil (<i>M. sp</i>)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	2.3	--	--
Eurasian watermilfoil (<i>M. spicatum</i>)	--	--	--	--	1	1.0	1	0.3	10	1.0	17	1.4	12	0.9	7	1.3	31	1.9	2	1.0
Naiads (<i>Najas flexilis</i>)	--	--	--	--	--	--	--	--	--	--	--	--	3	0.8	--	--	--	--	--	--
Cabbage (<i>Potamogeton amplifolius</i>)	5	1.0	5	1.0	1	0.5	3	0.8	--	--	--	--	1	1.0	--	--	3	0.8	2	1.0
Curlyleaf pondweed (<i>P. crispus</i>)	94	3.0	87	3.1	89	2.9	94	2.7	92	3.2	86	3.4	84	2.5	79	2.8	82	2.2	61	1.6
Illinois pondweed (<i>P. illinoensis</i>)	5	2.0	2	2.5	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	--	--
Floatingleaf pondweed (<i>P. natans</i>)	2	2.0	2	1.0	--	--	1	1.0	--	--	--	--	--	--	--	--	1	0.5	--	--
Whitestem pondweed (<i>P. praelongus</i>)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	1.0
Stringy pondweed (<i>P. pusillus</i>)	2	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	1	--	--
Claspingleaf pondweed (<i>P. richardsonii</i>)	6	1.4	6	1.0	3	0.5	1	1.0	3	1.0	6	1.3	1	1.0	4	0.8	6	1.3	--	--
Stringy pondweed (<i>S. sp</i>)	--	--	--	--	--	--	--	--	1	0.3	1	1.0	--	--	--	--	3	1	--	--
Flatstem pondweed (<i>P. zosteriformis</i>)	--	--	2	1.0	1	1.0	--	--	--	--	--	--	1	0.5	1	1.0	3	1	6	1.1
Buttercup (<i>Ranunculus</i> sp)	--	--	3	1.0	--	--	--	--	--	--	--	--	--	--	--	--	6	2.3	5	1.5
Bladderwort (<i>Utricularis</i> sp)	--	--	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	--	--	--	--
Water stargrass (<i>Zosterella dubia</i>)	--	--	--	--	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	2	1.0
filamentous algae	14	2.8	16	1.4	16	1.6	43	1.7	28	1.9	23	2.1	18	2.1	1	1.0	32	2.2	13	1.9
Number of plant species	9		10		7		8		8		10		14		8		15		13	

Late Summer Aquatic Plant Summaries from 1997-2011

A comparison of plant occurrence for late summer surveys from 1997 through 2011 is shown in Table 2. In all fifteen years of the surveys, coontail has been the dominant plant and either water celery or northern watermilfoil have been the second most common submerged plant. The distribution of plants have been relatively stable, but abundance has varied from 1997 - 2011.

Table 2. Later summer Crystal Lake aquatic plant comparisons for 1997 through 2011 for submerged and floatingleaf species. Surveys were conducted in July, August, or September. Yellow shading indicates years of harvesting.

	Late Summer Aquatic Plant Surveys														
	Percent Occurrence														
	1997 (46 stat)	1998 (50 stat)	1999 (50 stat)	2000 (50 stat)	2001 (50 stat)	2002 (52 stat)	2003 (50 stat)	2004 (50 stat)	2005 (54 stat)	2006 (54 stat)	2007 (69 stat)	2008 (50 stat)	2009 (50 stat)	2010 (50 stat)	2011 (65 stat)
Marsh marigold (<i>Bidens beckii</i>)	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--
Coontail (<i>Ceratophyllum demersum</i>)	74	78	92	90	78	92	82	84	65	85	90	66	88	90	69
Chara (<i>Chara sp</i>)	7	10	18	--	4	2	--	--	--	6	6	--	--	6	17
Elodea (<i>Elodea canadensis</i>)	--	2	--	--	--	--	--	--	--	--	--	--	6	--	--
Duckweed (<i>Lemna sp</i>)	--	--	--	--	--	--	--	--	--	--	--	--	8	--	--
Star duckweed (<i>Lemna trisulca</i>)	9	--	8	--	--	--	8	4	2	--	--	--	12	10	5
Northern watermilfoil (<i>Myriophyllum exalbescens</i>)	9	16	6	9	18	15	16	38	11	6	38	38	48	56	15
Watermilfoil (<i>M. sp</i>)	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
Eurasian watermilfoil (<i>M. spicatum</i>)	--	--	--	--	2	--	--	--	6	15	16	16	20	12	15
Naiads (<i>Najas sp</i>)	17	8	14	2	2	--	2	4	4	20	12	4	6	8	5
Nitella (<i>Nitella sp</i>)	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Spatterdock (<i>Nuphar sp.</i>)	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--
Water waterlily (<i>Nymphaea sp</i>)	9	14	18	12	18	25	24	24	24	20	22	8	18	18	14
Cabbage (<i>Potamogeton amplifolius</i>)	9	26	14	6	12	10	4	4	--	2	4	--	4	4	3
Curlyleaf pondweed (<i>P. crispus</i>)	--	--	6	6	10	4	34	22	9	2	2	2	8	2	2
Illinois pondweed (<i>P. illinoensis</i>)	--	--	2	2	8	12	16	14	2	2	2	--	--	8	6
Floatingleaf pondweed (<i>P. natans</i>)	--	--	--	--	2	--	2	2	--	--	--	--	2	4	3
Whitestem pondweed (<i>P. praelongus</i>)	--	--	--	--	--	--	--	--	--	--	--	2	8	--	--
Claspingleaf pondweed (<i>P. richardsonii</i>)	7	8	14	15	16	17	20	8	2	6	2	6	4	12	12
Robbins pondweed (<i>P. Robbinsii</i>)	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stringy pondweed (<i>Potamogeton sp</i>)	9	6	2	--	10	2	--	4	--	7	--	--	--	--	3
Flatstem pondweed (<i>P. zosteriformis</i>)	--	12	26	6	4	23	4	8	--	--	8	4	20	14	6
Buttercup (<i>Ranunculus sp</i>)	--	2	--	--	--	--	--	--	--	--	--	--	--	--	2
Sago pondweed (<i>Stuckenia pectinata</i>)	--	4	4	2	2	2	2	6	4	6	4	--	--	--	2
Bladderwort (<i>Utricularia sp</i>)	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Water celery (<i>Vallisneria americana</i>)	28	44	50	31	42	35	34	50	20	37	26	30	16	24	25
Water stargrass (<i>Zosterella dubia</i>)	9	2	4	17	2	25	10	20	2	6	--	6	--	10	18
Number of species	13	15	15	12	16	14	14	14	12	14	11	12	15	15	18

Water Quality Summary from 1973 - 2011

Water quality has fluctuated in Crystal Lake from 1973 - 2011 (Table 3 and Figures 3 and 4). In 2011, water clarity was good and the seasonal phosphorus concentration was the lowest on record (Table 3 and Figures 3 and 4). Phosphorus has been decreasing since 2008 and if phosphorus remains low, clarity should remain good as well.

Table 3. Water quality data for Crystal Lake. Secchi disc data for 1973 - 1992 are from the MPCA Citizen Lake Monitoring Program. Data from 1994 - 2011 are from the CAMP program.

	Secchi Disc			Total Phosphorus (ppb)	Chlorophyll a (ppb)	Fish Surveys (MnDNR) (#/trapnet)		
	June - Sept Avg		May - Sept Avg			Bluegill	Black Bullhead	Hybrid and Pumpkinseed
	ft	m	m					
1973	7.4	2.26						
1974	4.0	1.22						
1975	3.6	1.10				225	30	1
1976	6.1	1.86						
1977	6.2	1.89						
1978	5.0	1.52						
1979	11.3	3.45						
1980	8.4	2.56	2.0 (2 samples)	45 (2 samples)	22 (2 samples)	16	26	11
1981	5.0	1.52						
1982	5.9	1.80						
1983	6.9	2.10	2.2	38	19			
1984	7.3	2.23						
1985	8.5	2.59				65	51	23
1986	7.2	2.20						
1987	5.4	1.65						
1988	5.8	1.77						
1989	8.1	2.45	2.5	30	14			
1990	6.0	1.83				54	19	34
1991	6.3	1.92						
1992	7.5	2.29						
1993	--	--						
1994*	5.9	1.78	1.9	34	15			
1995	4.6	1.40	1.5	45	32	202	5	62
1996	5.6	1.70	1.7	68	24			
1997	7.3	2.2	2.2	38	22			
1998	5.9	1.8	1.8	43	40			
1999	6.9	2.1	2.1	35	15			
2000	3.3	0.99	1.3	54	37	46	11	11
2001	6.5	1.97	2.0	29	19			
2002	6.6	2.00	2.2	37	16			
2003	4.0	1.22	1.5	52	27			
2004	5.7	1.72	1.9	39	18			
2005	4.4	1.33	1.6	39	25	485	4	17
2006	5.2	1.57	1.9	45	35			
2007	5.5	1.67	2.0	38	21			
2008	5.0	1.5	1.8	34	22			
2009	6.2	1.9	2.1	32	15			
2010	4.0	1.2	1.8	31	23			
2011	6.8	2.1	2.1	23	12			

* 1994 - 2011 are CAMP data

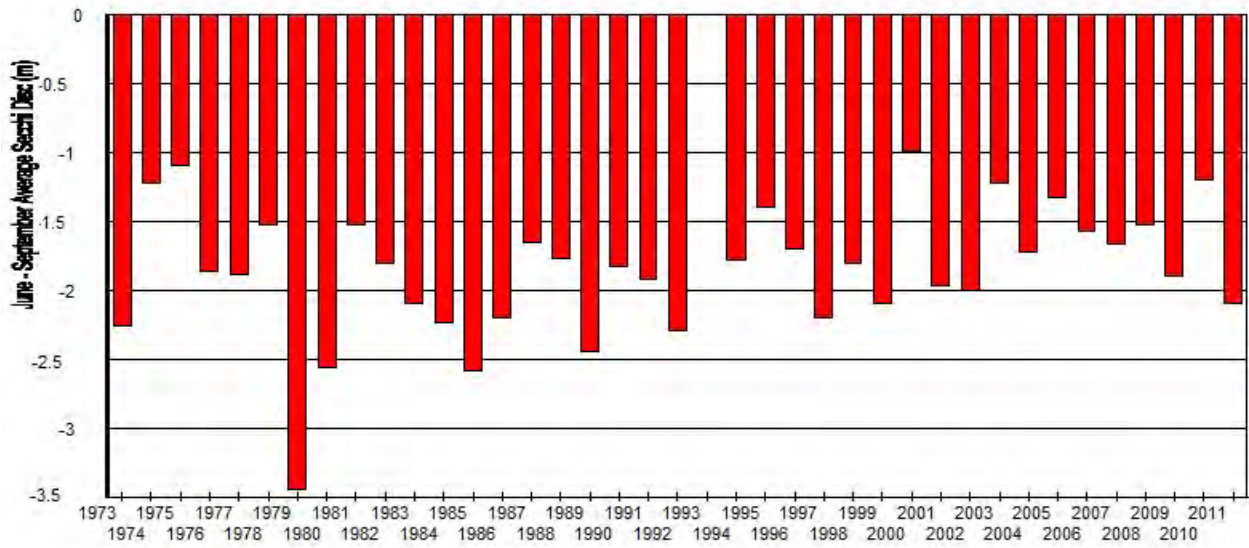


Figure 3. Water clarity data from 1973 through 2011 for Crystal Lake (June - September).

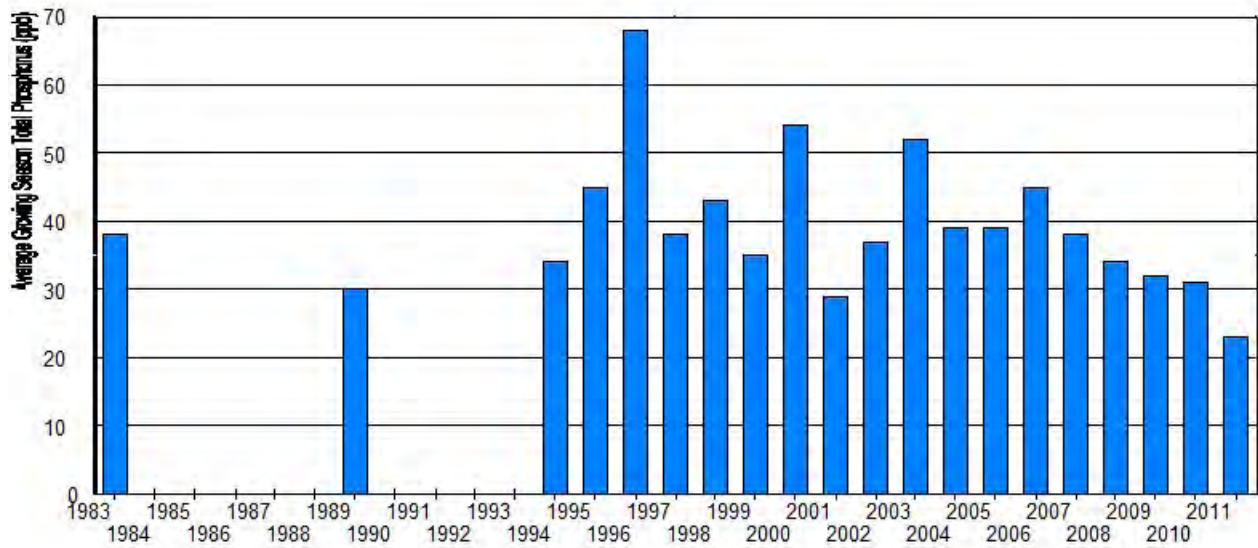


Figure 4. Total phosphorus data from 1983 through 2011, with several missing years.

Aquatic Plant Surveys for Crystal Lake, Burnsville, Minnesota, 2011

Introduction

Crystal Lake (ID # 19-0027) is a 280 acre lake with 208 littoral acres (water depths less than 15 feet deep) and is located in the City of Burnsville, Dakota County.

A curlyleaf pondweed assessment and two aquatic plant surveys were conducted on Crystal Lake in 2011. Early season curlyleaf pondweed assessments took place on May 10, 2010 in order to direct harvesting activities. The first plant survey occurred on May 24, 2011 and the second survey was on August 30, 2011. The objective of the surveys was to characterize the aquatic plant community. The emphasis of the early summer survey was to delineate curlyleaf pondweed and the emphasis of the late summer survey was to check the distribution of Eurasian watermilfoil (EWM). EWM was first detected in Crystal Lake in 1991 (referenced in the MnDNR Lake Finder site).

Methods

Several techniques were used to characterize aquatic plants in Crystal Lake. We used 25 line transects with several passing through previously known milfoil areas delineated by the MnDNR in 1995 (Figure 1). The same transects have been used from 1997 through 2010. A recording sonar (Lowrance X-16) was used to determine the depths of plant colonization. Three depths (0-5 feet, 6-10 feet, and 11-15 feet) on a transect in early summer were sampled with a rake to characterize species presence and it's density. Two depth ranges (0-5 ft and 6-10 ft) were sampled in late summer.

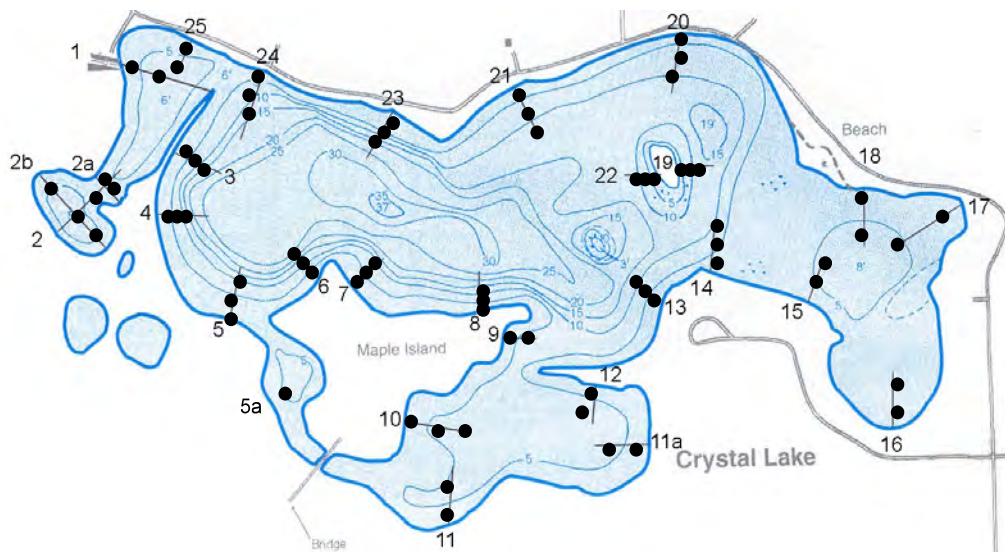
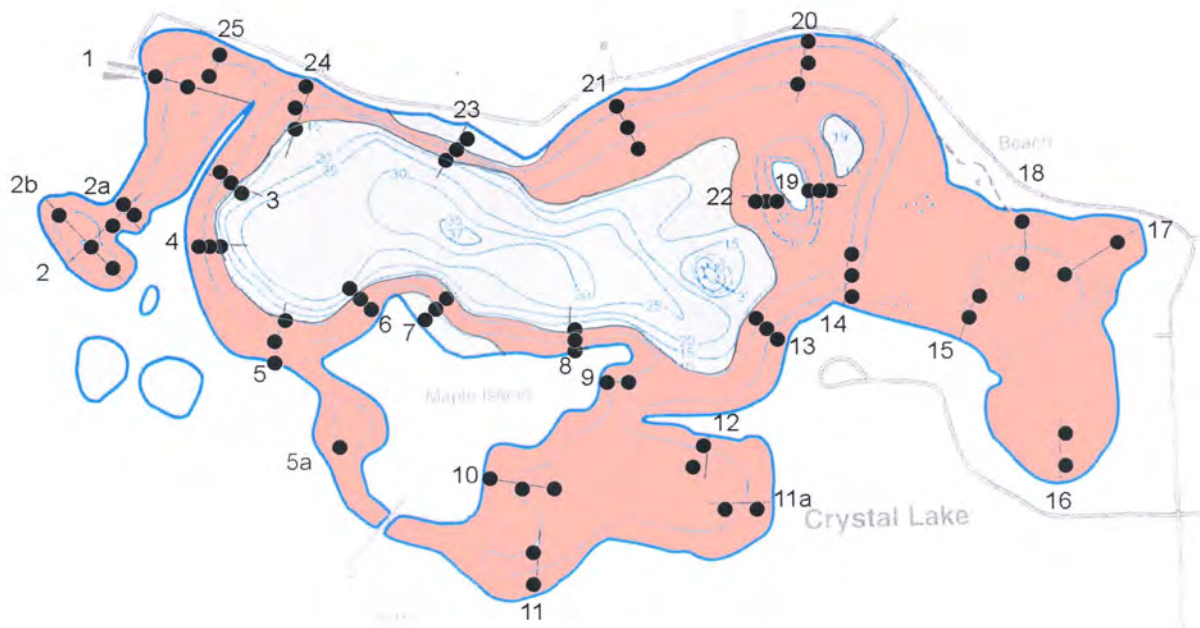


Figure 1. Transect map for aquatic plant surveys conducted on Crystal Lake, from 1997-2011.

Results of the Early Summer Survey May 24, 2011

Results from the May 24, 2011 aquatic plant survey found curlyleaf pondweed was the dominant submerged aquatic plant with coontail also very common. Plants grew out to a depth of 12 feet and covered about 74% of the lake bottom (208 out of 280 acres)(Figure 2).

Twelve species of submerged aquatic plants and one water lily species were identified (Table 1). The most common submerged plant found in Crystal Lake was curlyleaf pondweed, followed by coontail (Table 1). Curlyleaf and coontail were common at all three depths. Northern watermilfoil, closely resembling Eurasian watermilfoil, was found in ten sample locations, Eurasian watermilfoil was found at 1 location. The occurrence and density for individual transects in 2011 are shown in Table 1.



Legend

 Plants present.

Figure 2. Aquatic plant coverage for Crystal Lake on May 24, 2011. Shading indicates the coverage of all aquatic plants present.

Table 1. Crystal Lake aquatic plant occurrences and densities for the May 24, 2011 survey based on 25 transects and 3 depths, for a total of 64 stations. Density ratings are 1-5 with 1 being low and 5 being most dense. Transect 5A was not used in the analysis.

	Depth 0 - 5 feet (n=25)			Depth 6 - 10 feet (n=25)			Depth 11 - 15 feet (n=14)			All Stations (n=64)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
White waterlily (<i>Nymphaea</i> sp)	5	20	1.0	--	--	--	--	--	--	5	8	1.0
Coontail (<i>Ceratophyllum demersum</i>)	14	56	2.0	14	56	1.7	3	21	1.7	31	48	1.8
Chara (<i>Chara</i> sp)	4	16	1.0	1	4	0.5	--	--	--	4	6	1.1
Elodea (<i>Elodea canadensis</i>)	1	4	1.0	1	4	1.0	1	7	0.5	3	5	0.8
Star duckweed (<i>Lemna trisulca</i>)	4	16	0.9	1	4	0.5	1	7	0.5	6	9	0.8
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	5	20	1.0	5	20	0.9	--	--	--	10	16	0.9
Eurasian watermilfoil (<i>M. spicatum</i>)	1	4	1.0	--	--	--	--	--	--	1	2	1.0
Cabbage (<i>Potamogeton amplifolius</i>)	1	4	1.0	--	--	--	--	--	--	1	2	1.0
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	9	36	1.1	18	72	1.9	12	86	1.4	39	61	1.6
Whitestem pondweed (<i>P. praelongus</i>)	2	8	1.0	--	--	--	--	--	--	2	3	1.0
Flatstem pondweed (<i>P. zosteriformis</i>)	3	12	1.2	1	4	1.0	--	--	--	4	6	1.1
Buttercup (<i>Ranunculus</i> sp)	3	12	1.5	--	--	--	--	--	--	3	5	1.5
Water stargrass (<i>Zosterella dubia</i>)	1	4	1.0	--	--	--	--	--	--	1	2	1.0
Filamentous algae - benthic	5	20	2.0	3	12	1.7	--	--	--	8	13	1.9

Table 2. Individual transect data for Crystal Lake for May 24, 2011.

	T1		T2		T3			T4		T5		T5a		T6		
	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15
White waterlily	1		1													
Coontail	1	1	4	1.5		2		1.5	0.5	2		3	4	1	1	2
Chara																
Elodea			1													
Star duckweed																
Northern watermilfoil																
Eurasian watermilfoil																
Cabbage																
Curlyleaf pondweed					1	2			1.5		3				1	2
Whitestem pondweed								1								
Flatstem pondweed	2															
Buttercup																
Water stargrass																
Fila algae - benthic		1								3				4		

	T7			T8			T9		T10		T11		T12		T13			T14		
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
White waterlily									1		1									
Coontail							1	2	4	3	4	4	2	3		1	1	1	0.5	
Chara				2											0.5					
Elodea													1							
Star duckweed													1		0.5					
Northern watermilfoil		1					1			1				1						
Eurasian watermilfoil							1													
Cabbage				1																
Curlyleaf pondweed		1	2	1	2		1	1								1	1	1	1.5	2
Whitestem pondweed																				
Flatstem pondweed																				
Buttercup							0.5						2							
Water stargrass																				
Fila algae - benthic	1	2										2								

Table 2. Individual transect data for Crystal Lake for May 24, 2011.

	T15			T16		T17		T18			T19			T20			T21			
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	
White waterlily																				
Coontail				2				1				2	2	1						
Chara											1									
Elodea													0.5							
Star duckweed								1					0.5	1						
Northern watermilfoil	1					1	0.3											1		
Eurasian watermilfoil																				
Cabbage																				
Curlyleaf pondweed		2	1		3	1	1.5	1	3	2		2	1	2	2	1.5	1	2.5	1	
Whitestem pondweed																			1	
Flatstem pondweed	0.5																		1	
Buttercup						2														
Water stargrass																				
Fila algae - benthic				1																

	T22			T23			T24			T25	
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10
White waterlily										1	
Coontail					1					2	1
Chara							0.5	0.5			
Elodea											
Star duckweed											0.5
Northern watermilfoil								1		1	
Eurasian watermilfoil											
Cabbage											
Curlyleaf pondweed		3	1			1		1	1	1	
Whitestem pondweed											
Flatstem pondweed					1						
Buttercup											
Water stargrass	1										
Fila algae - benthic										1	



Figure 3. 2003: curlyleaf pondweed was topping out in the area around Transect 20 on June 1, 2003 (no harvesting). 2004: after harvesting, curlyleaf nuisance growth was greatly reduced. 2005: in the same area as in 2003 and 2004, harvesting was necessary to reduce nuisance curlyleaf pondweed growth. 2006: same area as the other photos, after harvesting. 2007: May 22, prior to harvesting. Curlyleaf grew rapidly in 2007. 2008: May 14, prior to harvesting. Curlyleaf was present, but several feet below the surface. 2009: May 31, during harvesting. Curlyleaf was present, but a lower densities then in previous years. 2010: May 28, before harvesting. Curlyleaf was present but at moderate densities.

Curlyleaf Pondweed Distribution in 2002 through 2011

Curlyleaf pondweed distribution has been similar in 2002 - 2011 in the early summer surveys except for the Mystic Bay location (Transects 10-12)(Figure 4). Nuisance curlyleaf was observed in Mystic Bay in 2002 and although present in 2003 to 2011 it has not been a nuisance. Nuisance coverage of curlyleaf pondweed was around 100 acres in 2002 and less than 30 acres after harvesting from 2003 through 2011.

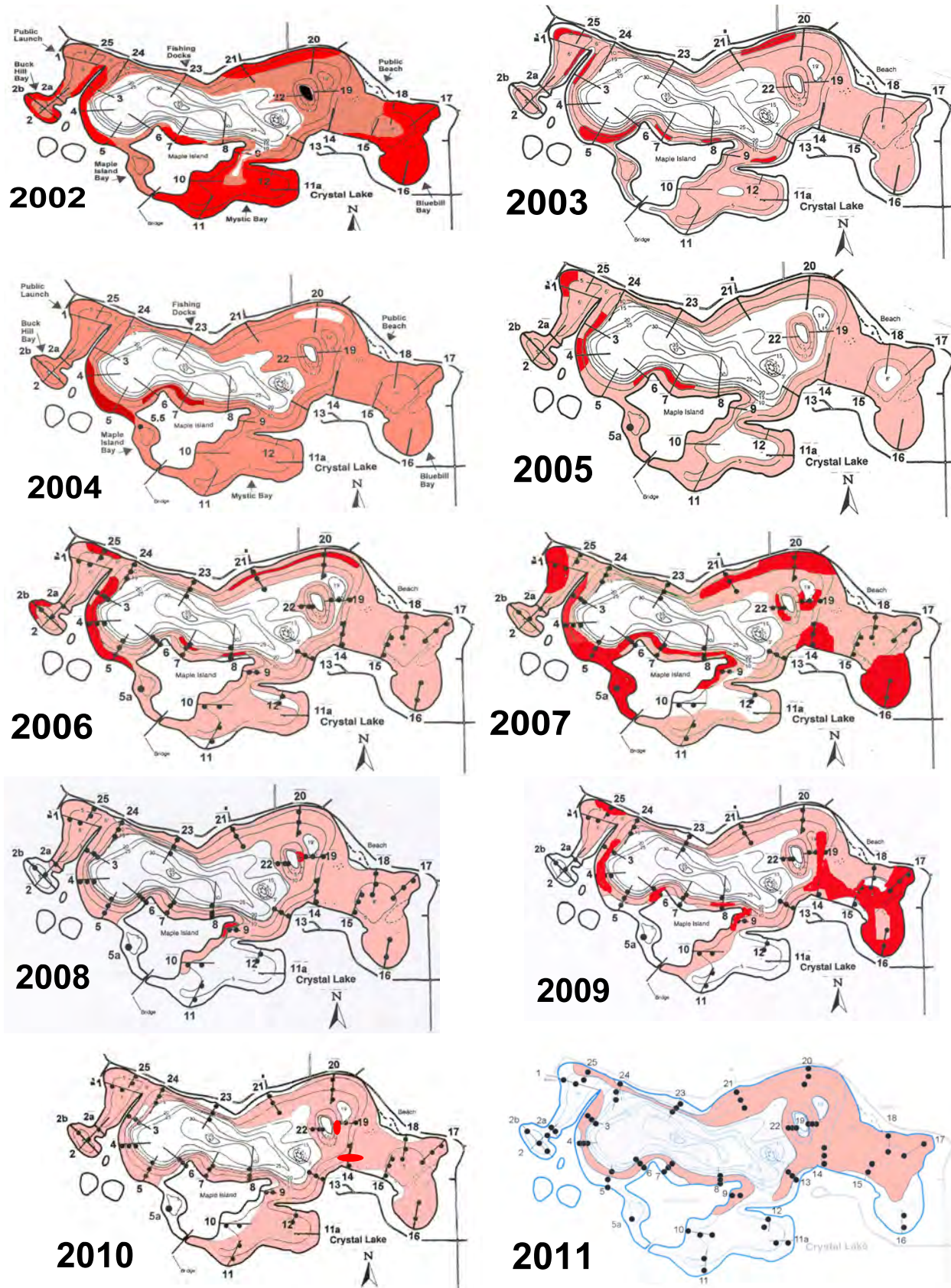


Figure 4. Curlyleaf pondweed coverage in 2002 through 2011.

Results of the Late Summer Survey August 30, 2011

In the late summer survey of August 30, 2011, curlyleaf pondweed dramatically declined compared to the May survey results. Native plants grew out to a depth of 11 feet and covered about 57% of the lake bottom (160 out of 280 acres)(Figure 5). Plant coverage in the summer of 2011 was similar to coverage in previous years.

Seventeen species of submerged aquatic plants and one species of a water lily were identified. The most common submerged plant found in Crystal Lake in August was coontail, followed by water celery (Table 3). Coontail was dominant at all water depths showing up in 45 out of 65 sample stations. Northern watermilfoil was found in 10 sample locations and Eurasian watermilfoil was found at 10 stations. The occurrence and density for individual transects in 2011 are shown in Table 4.

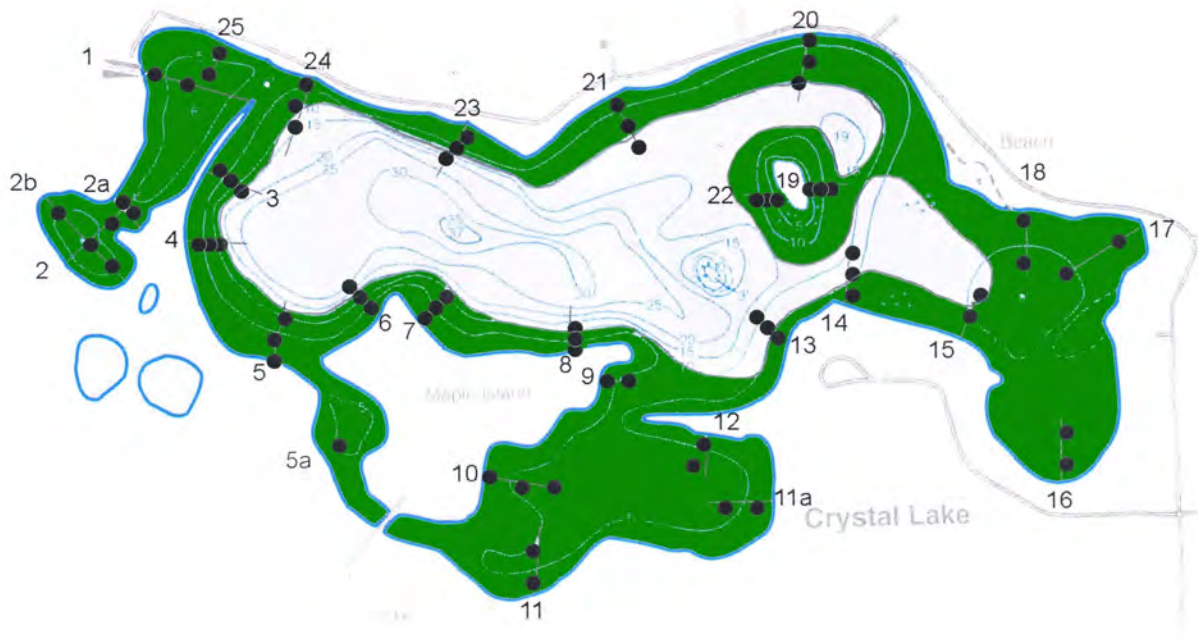


Figure 5. Aquatic plant coverage for Crystal Lake on August 30, 2011. Shaded area represents native aquatic plant coverage.

Table 3. Crystal Lake aquatic plant occurrences and densities for the August 30, 2011 survey based on 25 transects and 3 depths, for a total of 65 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0 - 5 feet (n=25)			Depth 6 - 10 feet (n=25)			Depth 11 - 15 feet (n=15)			All Stations (n=65)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
White waterlily (<i>Nymphaea</i> sp)	7	28	2.9	2	8	1.8	--	--	--	9	14	2.6
Chara (<i>Chara</i> sp)	8	32	2.3	3	12	1.2	--	--	--	11	17	2.0
Coontail (<i>Ceratophyllum demersum</i>)	18	72	2.4	22	88	2.3	5	33	2.2	45	69	2.5
Star duckweed (<i>Lemna trisulca</i>)	2	8	1.0	1	4	1.0	--	--	--	3	5	1.0
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	7	28	1.0	3	12	0.7	--	--	--	10	15	1.2
Eurasian watermilfoil (<i>M. spicatum</i>)	6	24	1.3	3	12	1.2	1	7	1.0	10	15	1.2
Naiads (<i>Najas flexilis</i>)	3	4	1.0	--	--	--	--	--	--	3	5	1.0
Cabbage (<i>Potamogeton amplifolius</i>)	2	8	0.8	--	--	--	--	--	--	2	3	0.8
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	--	--	--	1	4	1.0	--	--	--	1	2	1.0
Illinois pondweed (<i>P. illinoensis</i>)	4	16	1.0	--	--	--	--	--	--	4	6	1.0
Floatingleaf pondweed (<i>P. natans</i>)	1	4	1.0	1	4	3.0	--	--	--	2	3	2.0
Claspingleaf pondweed (<i>P. Richardsonii</i>)	7	28	1.1	1	4	0.5	--	--	--	8	12	1.1
Stringy pondweed (<i>P. sp</i>)	--	--	--	2	8	0.5	--	--	--	2	3	0.5
Flatstem pondweed (<i>P. zosteriformis</i>)	2	8	1.5	2	8	2.3	--	--	--	4	6	1.9
Buttercup (<i>Ranunculus</i> sp)	1	4	0.5	--	--	--	--	--	--	1	2	0.5
Sago pondweed (<i>Stuckenia pectinata</i>)	1	4	0.5	--	--	--	--	--	--	1	2	0.5
Water celery (<i>Vallisneria americana</i>)	15	60	1.8	1	4	0.5	--	--	--	16	25	1.7
Water stargrass (<i>Zosterella dubia</i>)	8	32	1.3	4	16	0.9	--	--	--	12	18	1.2
Filamentous algae - benthic	--	--	--	1	4	0.5	--	--	--	1	2	0.5
Filamentous algae - floating	1	4	2.0	2	8	3.0	--	--	--	3	5	2.7

Table 4. Individual transect data for Crystal Lake for August 30, 2011.

	T1		T2		T3			T4			T5		
	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
White waterlily			3								3	1.5	
Chara													
Coontail	1	3	4	4	0.5	3	2	2	3	3	3	3	3
Star duckweed	1							1					
Northern watermilfoil								1			1	0.5	
Eurasian watermilfoil			2										
Naiads													
Cabbage			1										
Curlyleaf pondweed													
Illinois pondweed	1												
Floatingleaf pondweed			1	3									
Claspingleaf pondweed					1								
Stringy pondweed													
Flatstem pondweed													
Buttercup					0.5								
Sago pondweed					0.5								
Water celery	2												
Water stargrass	1				1.5								
Fila algae - benthic													
Fila algae - floating													

	T6			T7			T8			T9		T10	
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	0 - 5	6 - 10
White waterlily										2		3	
Chara				3			1.5						
Coontail		3	1		0.8			3.5		4	4	3	4
Star duckweed													
Northern watermilfoil										1			
Eurasian watermilfoil	2	2			0.5	1	0.5			1			
Naiads				1									
Cabbage							0.5						
Curlyleaf pondweed													
Illinois pondweed													
Floatingleaf pondweed													
Claspingleaf pondweed							1						
Stringy pondweed								0.5					
Flatstem pondweed													
Buttercup													
Sago pondweed													
Water celery	2						1						
Water stargrass					0.5								
Fila algae - benthic													
Fila algae - floating													2

Table 4. Individual transect data for Crystal Lake for August 30, 2011.

	T11		T12		T13			T14			T15		
	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
White waterlily	2	2	5										
Chara								3					
Coontail	2	4	4	3	1			1				1	
Star duckweed												1	
Northern watermilfoil								1					
Eurasian watermilfoil			1										
Naiads											1		
Cabbage													
Curlyleaf pondweed												1	
Illinois pondweed	1		1										
Floatingleaf pondweed													
Claspingleaf pondweed								1					
Stringy pondweed													
Flatstem pondweed													
Buttercup													
Sago pondweed													
Water celery					2			1			1		
Water stargrass					1						3		
Fila algae - benthic													
Fila algae - floating		4											

	T16		T17		T18		T19			T20		
	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
White waterlily												
Chara					1		1					
Coontail	3	4	2	3	2	0.5	1	2.5	2		1	
Star duckweed												
Northern watermilfoil										4		
Eurasian watermilfoil												
Naiads												
Cabbage												
Curlyleaf pondweed												
Illinois pondweed							1					
Floatingleaf pondweed												
Claspingleaf pondweed												
Stringy pondweed												
Flatstem pondweed										2		
Buttercup												
Sago pondweed												
Water celery			3		3		2			2		
Water stargrass							1	0.5				
Fila algae - benthic						0.5						
Fila algae - floating	2											

Table 4. Individual transect data for Crystal Lake for August 30, 2011.

	T21			T22			T23			T24			T25	
	0 - 5	6 - 10	11 -15	0 - 5	6 - 10	11 -15	0 - 5	6 - 10	11 -15	0 - 5	6 - 10	11 -15	0 - 5	6 - 10
White waterlily													2	
Chara		1		3	1.5		1	1		3				
Coontail	2	0.5		4	2.5						1		3	2.5
Star duckweed														
Northern watermilfoil	1	0.5											1	1
Eurasian watermilfoil							1	1						
Naiads							1							
Cabbage														
Curlyleaf pondweed														
Illinois pondweed														
Floatingleaf pondweed														
Claspingleaf pondweed	1			1	0.5		2			1				
Stringy pondweed														0.5
Flatstem pondweed											4		1	0.5
Buttercup														
Sago pondweed														
Water celery	3			1	0.5		1			2			1	
Water stargrass	1			1	0.5		1	2						
Fila algae - benthic														
Fila algae - floating														

Comparison of Early Summer to Late Summer Aquatic Plant Occurrences

The major shift in the aquatic plant community from May to August of 2011 was the decline of curlyleaf pondweed (Table 5). Coontail was not observed in water deeper than 11 feet in August, 2011.

Table 5. Crystal Lake aquatic plant occurrences for early and late season plant surveys in 2011.

	May 24, 2011	August 30, 2011
	# of Occurrence (out of 64)	# of Occurrence (out of 65)
White waterlily	8	14
Coontail	48	69
Chara	6	17
Elodea	5	--
Star duckweed	9	5
Northern watermilfoil	16	15
Watermilfoil	--	--
Eurasian watermilfoil	2	15
Naiads	--	5
Cabbage	2	3
Curlyleaf pondweed	61	2
Illinois pondweed	--	6
Floatingleaf pondweed	--	3
Claspingleaf pondweed	--	12
Stringy pondweed	--	3
Whitestem pondweed	3	--
Flatstem pondweed	6	6
Buttercup	5	2
Sago pondweed	--	2
Water celery	--	25
Water stargrass	2	18
Filamentous algae	13	6

Summary of Crystal Lake Plant Surveys

Early Summer Aquatic Plant Summaries from 2002 - 2011

A comparison of plant occurrence and density for early summer plant surveys from 2002 through 2011 is shown in Table 6. Curlyleaf pondweed was the dominant plant followed by coontail. In 2011, coontail was the dominant native submerged plant. Occurrences of other aquatic plants are scarce in early summer.

Table 6. Early summer Crystal Lake aquatic plant comparisons for 2002 through 2011 for submerged and floatingleaf species. Surveys were conducted in May or June. Density is on a scale from 1 to 5 with 5 being the densest. Yellow shading indicates years of harvesting.

	2002 (65 stations)		2003 (63 stations)		2004 (73 stations)		2005 (68 stations)		2006 (68 stations)		2007 (69 stations)		2008 (68 stations)		2009 (67 stations)		2010 (68 stations)		2011 (64 stations)	
	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density	% Occur	Density
White waterlily (<i>Nymphaea</i> sp)	5	1.7	6	1.6	15	1.6	12	1.4	8	1.0	6	1.0	9	1.5	9	1.7	4	1	8	1.0
Coontail (<i>Ceratophyllum demersum</i>)	22	1.6	27	1.7	22	2.4	41	1.9	34	1.6	38	2.2	69	2.0	54	2.0	54	2.1	48	1.8
Chara (<i>Chara</i> sp)	--	--	--	--	--	--	--	--	--	--	6	1.3	1	1.5	3	1.5	3	1.5	6	1.1
Elodea (<i>Elodea canadensis</i>)	--	--	--	--	--	--	--	--	--	--	--	--	3	0.5	--	--	3	1	5	0.8
Star duckweed (<i>Lemna trisulca</i>)	--	--	--	--	--	--	--	--	1	0.3	1	0.3	1	1.0	3	1.0	3	1	9	0.8
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	6	1.1	10	1.3	--	--	7	1.1	4	0.3	14	1.0	16	1.0	25	1.4	26	1.3	16	0.9
Hybrid watermilfoil (<i>M. sp</i>)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	2.3	--	--
Eurasian watermilfoil (<i>M. spicatum</i>)	--	--	--	--	1	1.0	1	0.3	10	1.0	17	1.4	12	0.9	7	1.3	31	1.9	2	1.0
Naiads (<i>Najas flexilis</i>)	--	--	--	--	--	--	--	--	--	--	--	--	3	0.8	--	--	--	--	--	--
Cabbage (<i>Potamogeton amplifolius</i>)	5	1.0	5	1.0	1	0.5	3	0.8	--	--	--	--	1	1.0	--	--	3	0.8	2	1.0
Curlyleaf pondweed (<i>P. crispus</i>)	94	3.0	87	3.1	89	2.9	94	2.7	92	3.2	86	3.4	84	2.5	79	2.8	82	2.2	61	1.6
Illinois pondweed (<i>P. Illinoensis</i>)	5	2.0	2	2.5	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	--	--
Floatingleaf pondweed (<i>P. natans</i>)	2	2.0	2	1.0	--	--	1	1.0	--	--	--	--	--	--	--	--	1	0.5	--	--
Whitestem pondweed (<i>P. praelongus</i>)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	1.0
Stringy pondweed (<i>P. pusillus</i>)	2	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	1	--	--
Claspingleaf pondweed (<i>P. richardsonii</i>)	6	1.4	6	1.0	3	0.5	1	1.0	3	1.0	6	1.3	1	1.0	4	0.8	6	1.3	--	--
Stringy pondweed (<i>S. sp</i>)	--	--	--	--	--	--	--	--	1	0.3	1	1.0	--	--	--	--	3	1	--	--
Flatstem pondweed (<i>P. zosteriformis</i>)	--	--	2	1.0	1	1.0	--	--	--	--	--	--	1	0.5	1	1.0	3	1	6	1.1
Buttercup (<i>Ranunculus</i> sp)	--	--	3	1.0	--	--	--	--	--	--	--	--	--	--	--	--	6	2.3	5	1.5
Bladderwort (<i>Utricularis</i> sp)	--	--	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	--	--	--	--
Water stargrass (<i>Zosterella dubia</i>)	--	--	--	--	--	--	--	--	--	--	--	--	1	1.0	--	--	--	--	2	1.0
filamentous algae	14	2.8	16	1.4	16	1.6	43	1.7	28	1.9	23	2.1	18	2.1	1	1.0	32	2.2	13	1.9
Number of plant species	9		10		7		8		8		10		14		8		15		13	

Late Summer Aquatic Plant Summaries from 1997-2011

A comparison of plant occurrence for late summer surveys from 1997 through 2011 is shown in Table 7. In all fifteen years of the surveys, coontail has been the dominant plant and either water celery or northern watermilfoil have been the second most common submerged plant. The distribution of plants have been relatively stable, but abundance has varied from 1997 - 2011.

Table 7. Later summer Crystal Lake aquatic plant comparisons for 1997 through 2011 for submerged and floatingleaf species. Surveys were conducted in July, August, or September. Yellow shading indicates years of harvesting.

	Late Summer Aquatic Plant Surveys														
	Percent Occurrence														
	1997 (46 stat)	1998 (50 stat)	1999 (50 stat)	2000 (50 stat)	2001 (50 stat)	2002 (52 stat)	2003 (50 stat)	2004 (50 stat)	2005 (54 stat)	2006 (54 stat)	2007 (69 stat)	2008 (50 stat)	2009 (50 stat)	2010 (50 stat)	2011 (65 stat)
Marsh marigold (<i>Bidens beckii</i>)	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--
Coontail (<i>Ceratophyllum demersum</i>)	74	78	92	90	78	92	82	84	65	85	90	66	88	90	69
Chara (<i>Chara sp</i>)	7	10	18	--	4	2	--	--	--	6	6	--	--	6	17
Elodea (<i>Elodea canadensis</i>)	--	2	--	--	--	--	--	--	--	--	--	--	6	--	--
Duckweed (<i>Lemna sp</i>)	--	--	--	--	--	--	--	--	--	--	--	--	8	--	--
Star duckweed (<i>Lemna trisulca</i>)	9	--	8	--	--	--	8	4	2	--	--	--	12	10	5
Northern watermilfoil (<i>Myriophyllum exalbescens</i>)	9	16	6	9	18	15	16	38	11	6	38	38	48	56	15
Watermilfoil (<i>M. sp</i>)	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
Eurasian watermilfoil (<i>M. spicatum</i>)	--	--	--	--	2	--	--	--	6	15	16	16	20	12	15
Naiads (<i>Najas sp</i>)	17	8	14	2	2	--	2	4	4	20	12	4	6	8	5
Nitella (<i>Nitella sp</i>)	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Spatterdock (<i>Nuphar sp.</i>)	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--
Water waterlily (<i>Nymphaea sp</i>)	9	14	18	12	18	25	24	24	24	20	22	8	18	18	14
Cabbage (<i>Potamogeton amplifolius</i>)	9	26	14	6	12	10	4	4	--	2	4	--	4	4	3
Curlyleaf pondweed (<i>P. crispus</i>)	--	--	6	6	10	4	34	22	9	2	2	2	8	2	2
Illinois pondweed (<i>P. illinoensis</i>)	--	--	2	2	8	12	16	14	2	2	2	--	--	8	6
Floatingleaf pondweed (<i>P. natans</i>)	--	--	--	--	2	--	2	2	--	--	--	--	2	4	3
Whitestem pondweed (<i>P. praelongus</i>)	--	--	--	--	--	--	--	--	--	--	--	2	8	--	--
Claspingleaf pondweed (<i>P. richardsonii</i>)	7	8	14	15	16	17	20	8	2	6	2	6	4	12	12
Robbins pondweed (<i>P. Robbinsii</i>)	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stringy pondweed (<i>Potamogeton sp</i>)	9	6	2	--	10	2	--	4	--	7	--	--	--	--	3
Flatstem pondweed (<i>P. zosteriformis</i>)	--	12	26	6	4	23	4	8	--	--	8	4	20	14	6
Buttercup (<i>Ranunculus sp</i>)	--	2	--	--	--	--	--	--	--	--	--	--	--	--	2
Sago pondweed (<i>Stuckenia pectinata</i>)	--	4	4	2	2	2	2	6	4	6	4	--	--	--	2
Bladderwort (<i>Utricularia sp</i>)	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Water celery (<i>Vallisneria americana</i>)	28	44	50	31	42	35	34	50	20	37	26	30	16	24	25
Water stargrass (<i>Zosterella dubia</i>)	9	2	4	17	2	25	10	20	2	6	--	6	--	10	18
Number of species	13	15	15	12	16	14	14	14	12	14	11	12	15	15	18

Eurasian Watermilfoil Distribution From 1995 to 2011

Eurasian watermilfoil was first observed in Crystal Lake in 1991 (source: MnDNR). Six areas with Eurasian watermilfoil were treated in 1995 (Figure 7). In 1996 only one area was treated by the boat landing. No Eurasian watermilfoil was observed in Crystal Lake from 1997 through 2000. However, in 2001 Eurasian watermilfoil was found in one location, in the far edge of a bay by the boat landing. No Eurasian watermilfoil was found in the 2002 or 2003 surveys, but milfoil has been found on the west side of the lake from 2004 through 2011. Plant surveys from 1997 through 2011 have been conducted by Blue Water Science. In most years, northern watermilfoil is more common than Eurasian watermilfoil.



Figure 6a. 2007: Eurasian watermilfoil was present in Crystal Lake in 2007, but it was either scattered or found in clumps in shallow water (about 3 to 4 feet deep).



Figure 6b. 2008: Eurasian watermilfoil was present in Crystal Lake in 2008 in shallow water (about 3 to 4 feet deep). Eurasian watermilfoil grew to the surface in only a few small areas.



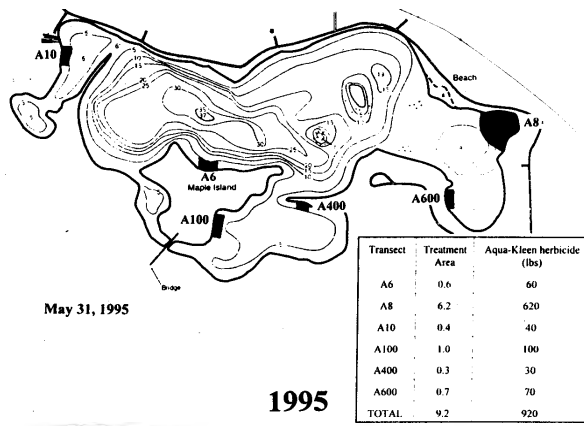
Figure 6c. 2009: Eurasian watermilfoil was present in Crystal Lake in 2009 in shallow water (less than 5 feet deep).



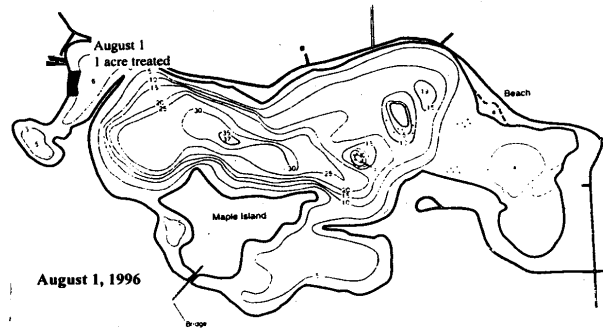
Figure 6d. 2010: Eurasian watermilfoil was present in Crystal Lake in 2010. Eurasian watermilfoil was more common in the early summer than in the late summer survey.



Figure 6e. 2011: Northern watermilfoil was present in Crystal Lake in 2011.



1995



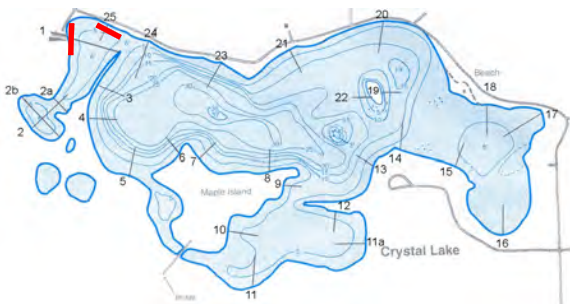
1996



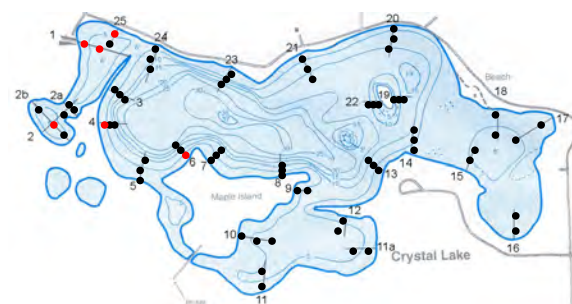
2001



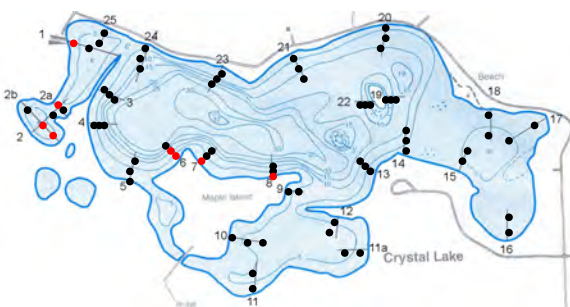
2004



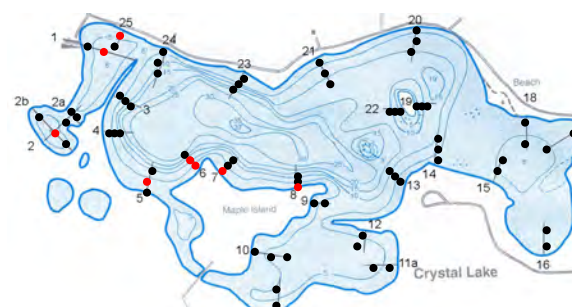
2005



2006

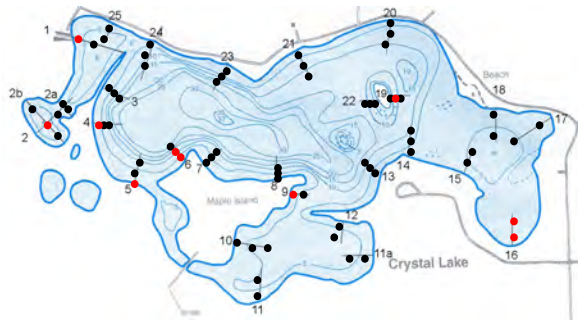


2007

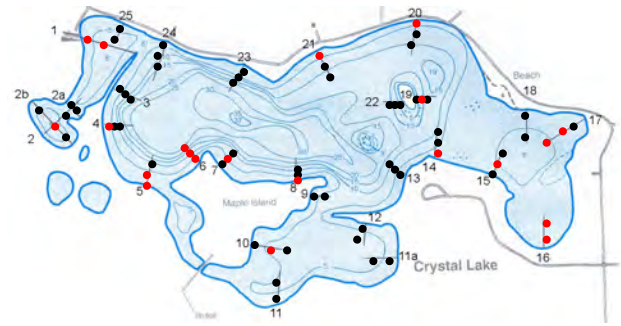


2008

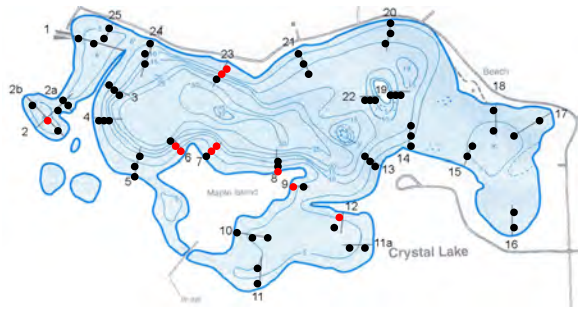
Figure 7. Eurasian watermilfoil was discovered in Crystal Lake in 1991. In 1995, 9.2 acres were treated. In 1996, one acre of milfoil was treated. Milfoil was not detected in surveys in 1997 through 2000. In 2001 it was found at one location. Milfoil was not observed in 2002 and 2003. It was found in one spot in 2004 and was treated. Milfoil was found at three stations in 2005, in six locations in 2006, in eight locations in 2007 and 2008, ten locations in 2009, and 20 locations in 2010 in the Blue Water Science Surveys.



2009



2010



2011

Figure 7. Eurasian watermilfoil was discovered in Crystal Lake in 1991. In 1995, 9.2 acres were treated. In 1996, one acre of milfoil was treated. Milfoil was not detected in surveys in 1997 through 2000. In 2001 it was found at one location. Milfoil was not observed in 2002 and 2003. It was found in one spot in 2004 and was treated. Milfoil was found at three stations in 2005, in six locations in 2006, in eight locations in 2007 and 2008, ten locations in 2009, 20 locations in 2010, and ten locations in 2011 in the Blue Water Science Surveys.

Native Plant Distribution in 2002 through 2011

Native aquatic plant distribution has remained relatively consistent from 2002 through 2011. In the late summer surveys, coontail was the dominant plant in water out to about 9-feet deep. Native plants cover about 57% of the lake bottom or roughly 160 out of 280 lake acres.

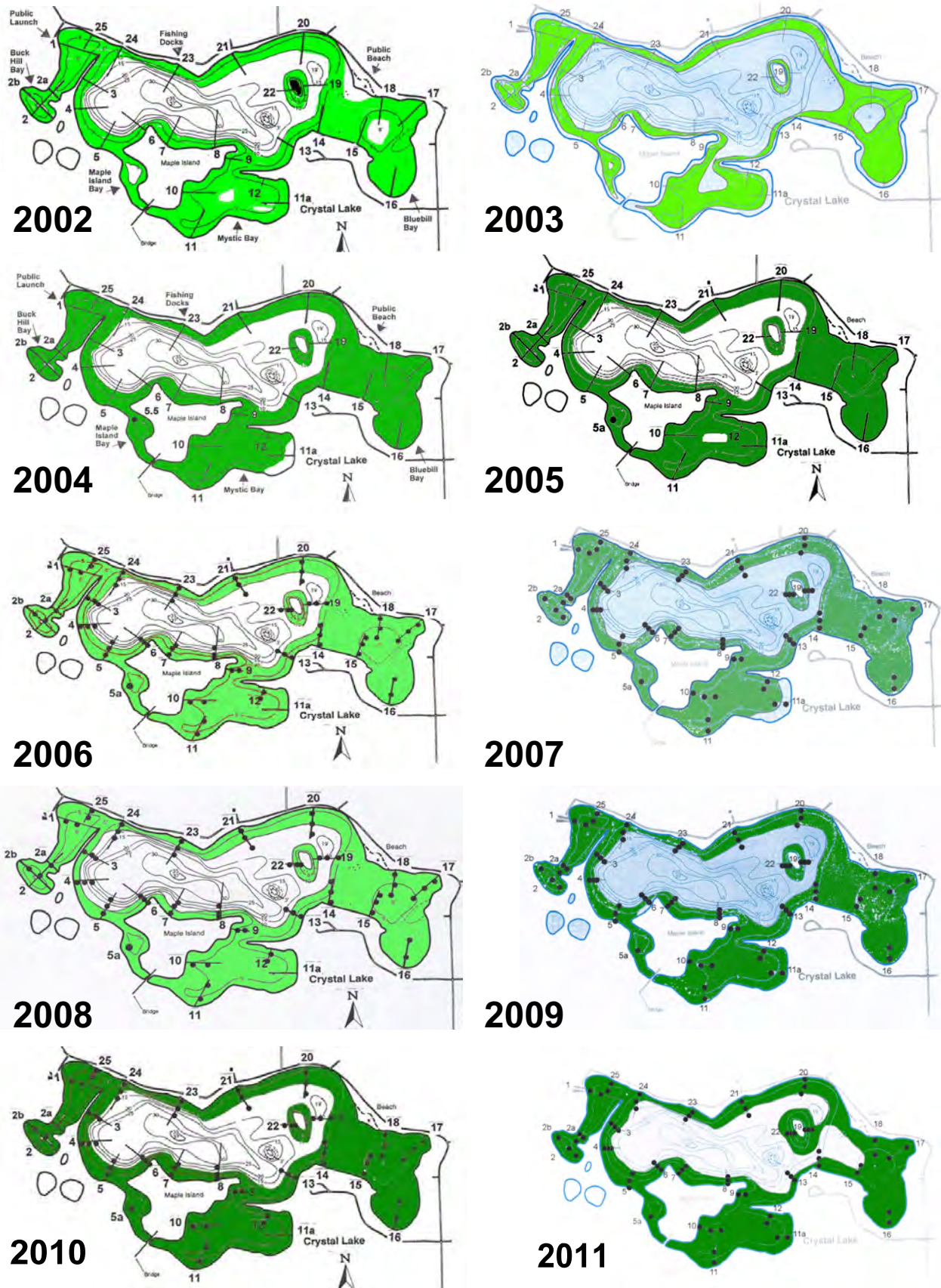


Figure 8. Native aquatic plant coverage in 2002 through 2011.

Crystal Lake - Curlyleaf Pondweed Density Summary: 2002 - 2011

Transect	Depth	2002	2003	2004 May 30	2005 June 27	2006 May 26	2007 May 22	2008 May 30	2009 May 31	2010 May 28	2011 May 24	Average	% Red	Predicted growth based on lake soils
1	S	2	0.5	4	4	1	4.5	3	3	2	0	2.4	30	
	M	1	2.5	2.75	2.5	4.3	4.5	0.8	0.5	2	0	2.1	20	
2	S	1	2	1	2	3	0	0	0	3	0	1.2	0	
	M	3	1	0	1	3	0.5	0	0	0.5	0	0.9	0	Light
3	S	3	3	2	3	3.7	0	1	1	1	1	1.9	0	
	M	4	4	4	5	5	5	3.5	5	0	2	3.8	70	
	D	X	2	3	2	4.3	4	1	3	1	0	2.3	22	
4	S	1	1	5	5	5	1	2	4	2	0	2.6	40	
	M	4	2	4	5	4.5	3	2.5	4	4	1.5	3.5	60	
	D	1	1	3	2	4	4	1	2	1	X	2.1	22	
5	S	0	3.5	5	2	4	5	2	0	2	0	2.4	30	
	M	3	3.5	4	2.5	2	5	2	3	4	3	3.2	30	
	D	1	4	4	3.5	3	3	3	2	1	0	2.5	22	
6	S	0	0	4	3.5	0	4	0	4.5	0	X	1.8	33	
	M	2	5	5	5	4	5	1.5	4.5	1	1	3.4	60	
	D	1	4	3	2	2	4.5	2	1	4	2	2.6	30	
7	S	5	3	4.5	3	3	2	0.5	0	0.5	0	2.2	20	
	M	4.5	5	5	5	5	4.5	3	2	0.5	1	3.6	60	
	D	4	3	4	2	3	0	2	2	2	2	2.4	20	
8	S	2	0	4.5	3	0.5	0	0.5	1	1	1	1.4	10	
	M	4	4.5	4	4	4.5	5	4	4	1	2	3.7	80	
	D	2	1.5	2	1	4	4	2	2	1	0	2.0	20	
9	S	5	2.5	4.5	1.5	4	5	5	4.5	0	1	3.3	60	
	M	4.5	1.5	1	2	3	2.5	3.8	1	0.5	1	2.1	10	
	D	2	X	X	X	X	X	X	0	X	X	1.0	0	
10	S	3	1	0	3	1.5	0	1	2	0	0	1.2	0	
	M	3	1	0.5	0	3	0	0	0	0	0	0.8	0	Light
11	S	0.5	1	1	0	0	1	0	0	1	0	0.5	0	
	M	5	3	0	0	3	0.5	0	0	1	0	1.3	10	
12	S	1	0.5	1	0	3	0.5	0	0	1	0	0.7	0	
	M	2	1	0	0.5	0	0	0	0	1	0	0.5	0	
13	S	2	3	1.5	1	2	2	0.5	2	2	0	1.6	0	
	M	3	4	4	3	3.5	3.5	4	2	3	1	3.1	30	
	D	3	2.5	3	1	3	3	2	3.5	0.5	1	2.3	0	
14	S	5	3	1.5	4	4	5	2	3	2	1	3.1	40	
	M	4.5	5	3	3.5	4	5	3	4	4.5	1.5	3.8	60	
	D	X	3	4	3	4	4	1	4	4	2	3.2	44	
15	S	4	2.5	2	3	4	4	2	0	0	0	2.2	30	
	M	4	5	3.5	3	3	3.5	3	4	3.3	2	3.4	30	
16	D	X	3.5	3	3	3.5	4	4	4.5	4	1	3.4	44	
	S	5	5	X	1	4	5	4	5	1	0	3.3	67	
17	M	4.5	4.5	2	1	3	5	2	2	3	3	3.0	30	Moderate
	S	4	4	1	2	2	4	3	4.5	2	1	2.8	40	
18	M	4	4	2	4	3	4.3	4	4.5	2	1.5	3.3	60	
	D	X	X	4	3	X	2	4	4.5	2.5	X	3.3	50	
	S	1	2	2	1	2	0	2	1	0	1	1.2	0	
19	M	2.5	4.5	4	3.5	2	3	3	0	3	3	2.9	20	
	D	X	X	3.5	3	3	2	4	4.5	2	2	3.0	25	
	S	1.5	2	1	2	0.5	1	0	0.5	5	0	1.4	10	
20	M	4.5	5	3	3	4	4.5	4.5	5	4	2	4.0	70	
	D	3	X	3.5	2	3	3	4	4	4	1	3.1	33	
21	S	5	X	2	3	5	5	2	0	1	2	2.8	33	
	M	4.5	5	4	4	4	4.8	4	3.5	4.3	2	4.0	80	Heavy
	D	4	3	4	2	4	2	3	3	4	1.5	3.1	40	
22	S	5	2	1	3	3	4	4	1	0	1	2.4	30	
	M	4.5	3.5	2.5	4	4.5	5	4	3.5	3	2.5	3.7	50	
	D	3	X	2	3	4	3.3	3	2	4	1	2.8	22	
23	S	3	X	1.5	1	1	3.5	1	0	0	0	1.2	0	
	M	2	3	5	4	4	5	4	3.5	2.3	3	3.6	50	
	D	2	X	3.5	2	4	4	2	2	2	1	2.5	22	
24	S	1	2	1.5	1	1	1	1	0	0	0	0.9	0	
	M	3	2	2.5	4	3	1	3	1	1	0	2.1	10	
	D	2	4	2	2	2	4	1	2	3	1	2.3	20	
25	S	2	2	1	2	1	0	0	1	1	0	1.0	0	
	M	4	5	2	3	3	1	1.5	2	1	1	2.4	20	
	D	3	4	2	1	2	3	2	2	2	1	2.2	10	
26	S	2	2.5	4.5	2.5	5	2.5	4	4.5	1	1	3.0	40	
	M	2.5	4	4	3	4	3	0.5	1	0	0	2.2	30	
	D	X	X	3	X	X	X	X	X	X	X	3.0	0	
Number of Reds		24	20	23	13	27	31	15	19	12	0			
Avg CLP Density		3.0	3.1	2.9	2.7	3.2	3.4	2.5	2.8	2.2	1.6			

Depth Zones: S = 0 - 5 feet M = 6 - 10 feet D = 11 - 15 feet

Crystal Lake - Eurasian Watermilfoil Density Summary: 1995-2011

Transect	Depth	1995	1998	1999	2000	2001	2002	2003	2004 Aug 22	2005 Aug 22	2006 Aug 21	2007 July 12/19	2008 Aug 30	2009 Aug 12	2010 Aug 2	2011 Aug 30	Average	% Red	Predicted growth based on lake soils
1	S	T	0	0	0	0	0	0	0	1	1	3.5	5	1	0	0	0.8	8	Moderate
	M		0	0	0	0	0	0	0	0	0.7	0	3	0	1	0	0.3	0	
2	S		0	0	0	T	0	0	T	1	1	3	1	1	0	2	0.8	0	
	M		0	0	0	0	0	0	0	0	0	1	2	0	0	0	0.2	0	
3	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
4	S		0	0	0	0	0	0	0	0	1	0	0	1	0	0	0.1	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
5	S		0	0	0	0	0	0	0	0	0	0	4.5	2	0	0	0.5	8	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
6	S		0	0	0	0	0	0	0	0	0	1	0	2.5	0	2	0.4	0	
	M		0	0	0	0	0	0	0	0	0	0.2	1	0.5	1	2	0.3	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
7	S	T	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0.1	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0		
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	1	0.1		
8	S		0	0	0	0	0	0	0	0	0	1	0	0	0	0.5	0.1	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
9	S		0	0	0	0	0	0	0	0	0	0	2	2	0	1	0.4	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	X	0.0	0	
10	S	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	Light
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
11	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
12	S	T	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
13	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
14	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
15	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
16	S	T	0	0	0	0	0	0	0	0	0	0	0	1.5	2	0	0.3	0	Moderate
	M		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.1	0	
17	S	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	X	0.0	0	
18	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	X	0.0	0	
19	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
20	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	Moderate
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
21	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
22	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
23	S		0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.1	0	
	M		0	0	0	0	0	0	0	0	0.5	0	0	0	0	1	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
24	S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	
	M		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	0	0.0	0	
25	S		0	0	0	0	0	0	0	2	0.5	1	2	0	0	0	0.4	0	
	M		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0.1	0	
	D		0	0	0	0	0	0	0	0	0	0	0	0	X	X	0.0	0	
Number of Reds			0	0	0	0	0	0	0	0	0	0	2	0	0	0			
Avg EWM Density		X	0	0	0	0	0	0	0	0.8	0.8	1.5	2.4	1.4	1.2	1.2			

Depth Zones: S = 0 - 5 feet M = 6 - 10 feet D = 11 - 15 feet

Water Quality Summary from 1973 - 2011

Water quality has fluctuated in Crystal Lake from 1973 - 2011 (Table 8 and Figures 9 and 10). In 2011, water clarity was good and the seasonal phosphorus concentration was the lowest on record (Table 8 and Figures 9 and 10). Phosphorus has been decreasing since 2008 and if phosphorus remains low, clarity should remain good as well.

Table 8. Water quality data for Crystal Lake. Secchi disc data for 1973 - 1992 are from the MPCA Citizen Lake Monitoring Program. Data from 1994 - 2011 are from the CAMP program.

	Secchi Disc			Total Phosphorus (ppb)	Chlorophyll a (ppb)	Fish Surveys (MnDNR) (#/trapnet)		
	June - Sept Avg		May - Sept Avg			Bluegill	Black Bullhead	Hybrid and Pumpkinseed
	ft	m	m					
1973	7.4	2.26						
1974	4.0	1.22						
1975	3.6	1.10				225	30	1
1976	6.1	1.86						
1977	6.2	1.89						
1978	5.0	1.52						
1979	11.3	3.45						
1980	8.4	2.56	2.0 (2 samples)	45 (2 samples)	22 (2 samples)	16	26	11
1981	5.0	1.52						
1982	5.9	1.80						
1983	6.9	2.10	2.2	38	19			
1984	7.3	2.23						
1985	8.5	2.59				65	51	23
1986	7.2	2.20						
1987	5.4	1.65						
1988	5.8	1.77						
1989	8.1	2.45	2.5	30	14			
1990	6.0	1.83				54	19	34
1991	6.3	1.92						
1992	7.5	2.29						
1993	--	--						
1994*	5.9	1.78	1.9	34	15			
1995	4.6	1.40	1.5	45	32	202	5	62
1996	5.6	1.70	1.7	68	24			
1997	7.3	2.2	2.2	38	22			
1998	5.9	1.8	1.8	43	40			
1999	6.9	2.1	2.1	35	15			
2000	3.3	0.99	1.3	54	37	46	11	11
2001	6.5	1.97	2.0	29	19			
2002	6.6	2.00	2.2	37	16			
2003	4.0	1.22	1.5	52	27			
2004	5.7	1.72	1.9	39	18			
2005	4.4	1.33	1.6	39	25	485	4	17
2006	5.2	1.57	1.9	45	35			
2007	5.5	1.67	2.0	38	21			
2008	5.0	1.5	1.8	34	22			
2009	6.2	1.9	2.1	32	15			
2010	4.0	1.2	1.8	31	23			
2011	6.8	2.1	2.1	23	12			

* 1994 - 2011 are CAMP data

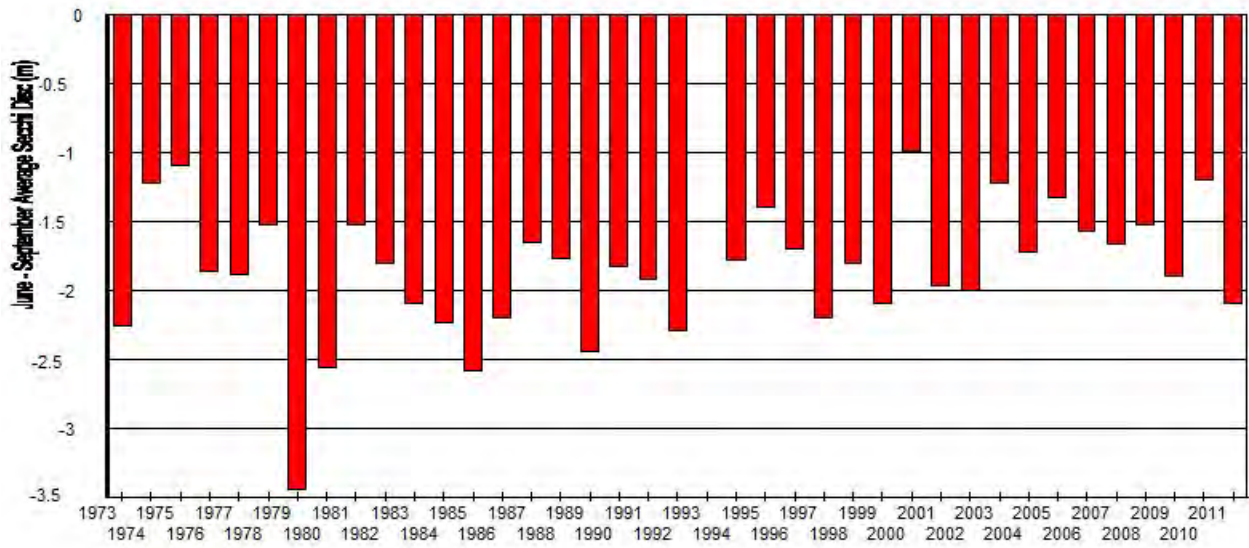


Figure 9. Water clarity data from 1973 through 2011 for Crystal Lake (June - September).

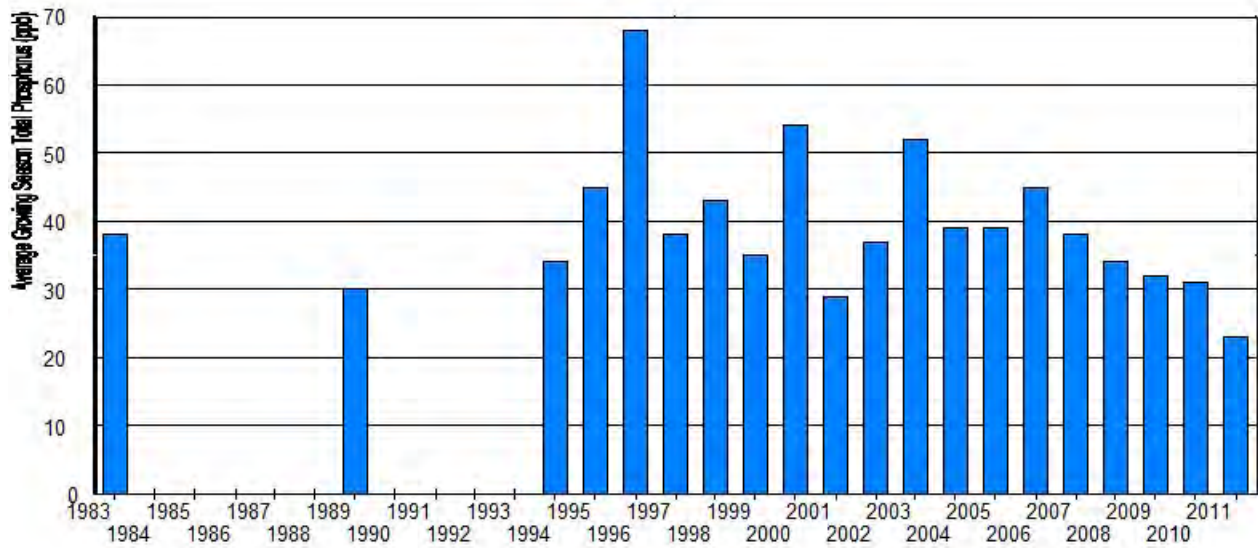
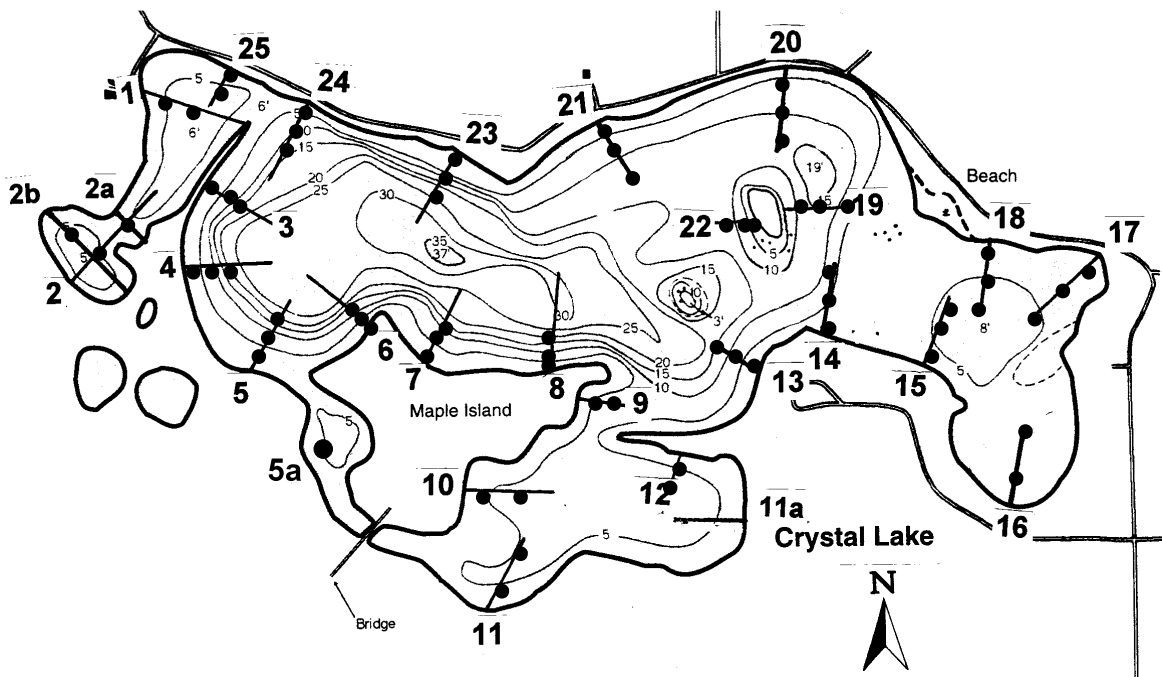


Figure 10. Total phosphorus data from 1983 through 2011, with several missing years.

Appendix A



Description for the transect locations

Transect Number	Description of Transect Target
1*	Come in just left of boat landing.
2	Head into bay.
3	About halfway down the peninsula, right of sand beach.
4	East end of the bay, right of 1 st house.
5	Two big trees in front of gray house with beach, right of inlet.
6	Between 1 st and 2 nd house on the end of point.
7*	2 nd house back from point, beige house.
8	Brown boat house.
9	Red fire hydrant and a brown shed.
10*	Right of big willow tree, beige house.
11	Huge house, huge roof, next to boulder landscaped area.
12*	About midway on the peninsula.
13	Brown house with rock wall. Brown playhouse near shore.
14	Small sand beach in front of brown house.
15	Between brown house and 3-story narrow house.
16	Tan house with boat house on shore.
17*	Beige house at end of bay.
18	2 nd house (brown) from swimming beach.
19	On island.
20	White house with brick chimney, 2 nd story deck.
21	Willow with white house behind.
22	On island.
23	Left of willow trees, key stone wall.
24	West (left) of fishing pier, natural shoreline.
25	East (right) of cement outlet.

* EWM was found in 1995.

Aquatic plants can be variable from year to year. A 10-year span for the same transect (9) is shown in Figure 1. Lilies were abundant in 1998 and were absent in 2002 and have not come back through 2008.



Figure 1. Plant conditions at Transect 9. Water lilies are abundant in 1998 but not in 2002, 2008, and 2010.



The last “cabin” on Crystal Lake was upgraded to a larger dwelling from 2004 to 2005.