Kimball Lake (photo by the Mitchells)

Lake Management Plan for Kimball Lakes, Washburn County, Wisconsin

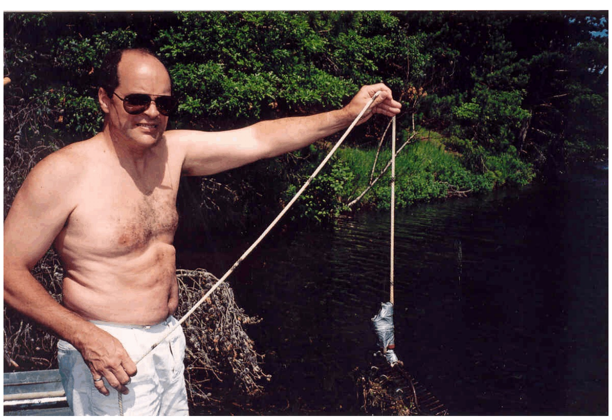
Revised November 2005

Prepared by Steve McComas, Blue Water Science
with contributions from Wisconsin Department of Natural Resources and the Kimball Lakes Association

Funded in part by the Wisconsin Lake Management Planning Grants Program

ACKNOWLEDGMENTS

Members of the Kimball Lake Association and many others contributed in various ways to the work effort on the projects that formed the basis for this Management Plan. Some of the volunteers are shown below:



Lake Management Plan for
Kimball Lake, Washburn County, Wisconsin

Table of Contents

Kimball Lakes Report

WASHBURN COUNTY, WISCONSIN

Summary of the Lake Management Study

Field Work: 2004 **Report: Autumn 2005**

Kimball Lakes Management Program Formulated

Kimball Lake, Washburn County, Wisconsin

Natural Conditions Rated as Good

PROTECTION PROJECTS WILL SUSTAIN GOOD WATER QUALITY

The Kimball Lakes consist of three lake basins located in Washburn County, Wisconsin. Upper and Lower Kimball are shallow basins and Middle Kimball is the deepest of the three with a maximum depth of 77 feet. A summary of lake statistics is shown in the column on the right.

A lake study was conducted in 2004 with two primary objectives.

* To characterize existing lake conditions and,
* To develop a lake management plan that protects, maintains, and enhances the Kimball Lakes water quality.

Results found that lake summer water clarity conditions of about 18 feet were slightly better than expected compared to reference lakes in the area (see page 3 for more information).

Phosphorus is typically the nutrient that has the biggest influence on algae growth. Phosphorus levels in Kimball Lakes were on the low side ranging from 11 to 21 parts per billion. This accounts for low algae growth and good water clarity that is found in the three Kimball Lakes basins.

Aquatic plants were also studied in 2004. Kimball Lakes had good diversity of plants with at least 26 plant species. Two common plants are fern pondweed and northern watermilfoil, both native species.

Results indicate that Kimball Lakes are in relatively good shape. This means less expensive protection projects rather than expensive restoration projects are the preferred approach as long as the Kimball Lakes retain good quality.

This special newsletter was prepared by Blue Water Science, St. Paul, Minnesota and is part of a lake management program conducted on Kimball Lakes. The program was funded by a grant from the Wisconsin DNR with volunteer assistance from the Kimball Lakes Association.

Kimball Lakes Statistics

Upper Kimball Lakes

- Lake size (acre): 44
- Mean depth (feet): 5
- Maximum depth (feet): 11
- Volume (acre-feet): 220
- Watershed area (acre): . . . . 543 (not including the lake)
- Watershed : Lake surface ratio 12:1
- Clarity in 2004 (feet): 11
- Lake phosphorus in 2004 (parts per billion) 21

Middle Kimball Lakes

- Lake size (acre): 98
- Mean depth (feet): 31
- Maximum depth (feet): 77
- Volume (acre-feet): 3,038
- Watershed area (acre)(direct): . . . . 408 (not including the lake)
- Watershed : Lake surface ratio 4:1
- Clarity in 2004 (feet): 18.4
- Lake phosphorus in 2004 (parts per billion) 11

Lower Kimball Lakes

- Lake size (acre): 129
- Mean depth (feet): 4
- Maximum depth (feet): 7
- Volume (acre-feet): 516
- Watershed area (acre)(direct): . . . . 363 (not including the lake)
- Watershed : Lake surface ratio 3:1
- Clarity in 2004 (feet): 6.0
- Lake phosphorus in 2004 (parts per billion) 15

Summary of Lake and Watershed Conditions

Geology and Soils
The Kimball Lakes are glacial lakes formed during the last retreat of the Wisconsin Valley glacial lobe starting about 10,000 years ago. The soils deposited by the glacier are primarily sands and loamy sands.

Watershed Characteristics
The watershed area draining to Kimball (not including the lake) is 1,314 acres. Land use is primarily forests and wetlands, with residential use accounting for a small percent of the total watershed area.

Water Inflows and Outflows
The water inflow to Kimball is from temporary streams and groundwater springs. The outflow is through Lower Kimball.

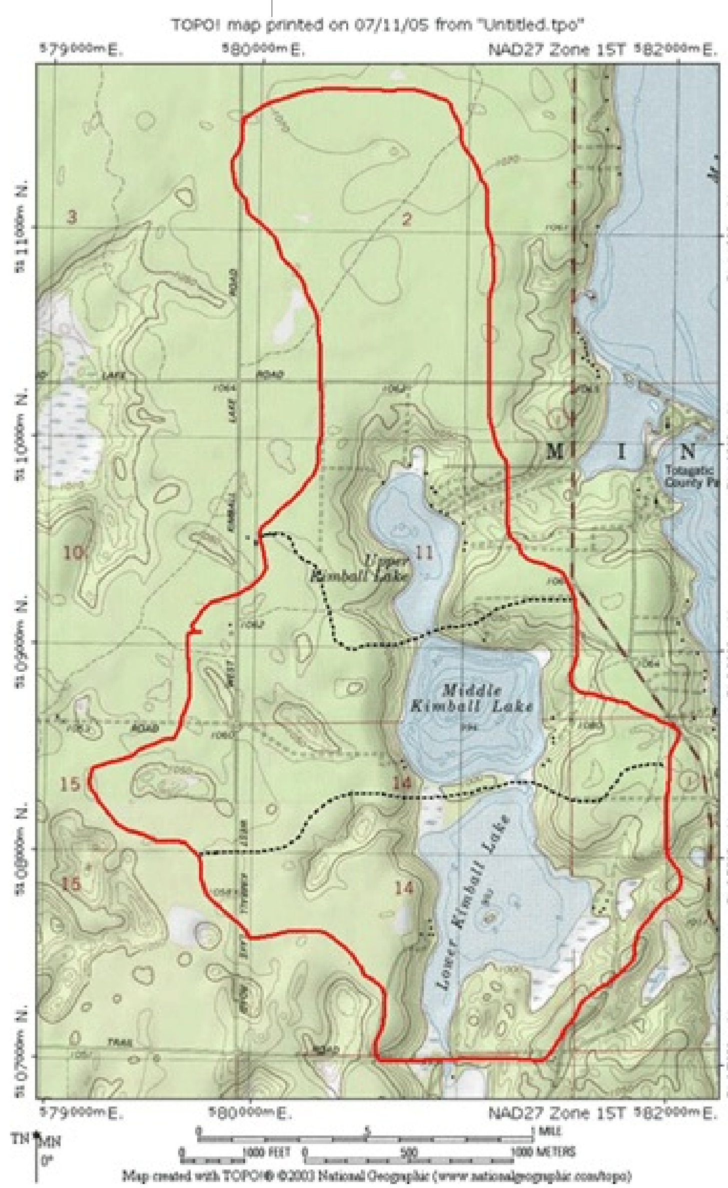
Lake Dissolved Oxygen & Temperature
Middle Kimball Lake thermally stratifies during the summer. This means that wind action will mix the upper lake water only during the summer. Oxygen concentrations may fall in the bottom water and become temporarily depleted in the bottom of the lake. Otherwise, the shallower Upper and Lower Kimball Lakes are mixed over the summer.

Lake Clarity
Lake water clarity in the Kimball Lakes is good. The summer average in Middle Kimball is 18 feet.

Lake Nutrients
Phosphorus concentrations in the Kimball Lakes are low when compared to other lakes in the Northern Lakes and Forest ecoregion. A growing season phosphorus average for 2004 for Kimball Lakes is 18 ppb. A predicted phosphorus concentration using ecoregion values is higher at about 24 ppb.

Lake Algae
Kimball Lakes has algae species that are common to lakes in this part of the state.

Lake Aquatic Plants
There is good coverage of submerged aquatic plants covering about 70% of the lake bottom (189 acres). Plants are beneficial as a filter for nutrients and as fish and wildlife habitat. Aquatic plant diversity is good with 26 submerged or floatingleaf plant species identified in Kimball Lakes.



The watershed drainage area to the Kimball Lakes is about 1,314 acres and is outlined in red.

What is a watershed?

A watershed is the land area around the lake that captures rainfall and where all the drainage and runoff goes into the lake. It is also called a drainage basin. If the watershed has pollution sources, then the pollution will be carried into the lake with runoff. It is important to reduce the source of pollution in the watershed because this in turn will reduce the amount of pollution that gets into the lake.

Lake Assessment

Water quality of Kimball is within range of lakes found in the Lakes and Forests Ecoregion. Water quality parameters consisted of transparency readings, phosphorus, and chlorophyll.

Lake water quality in Kimball is slightly better than what would be expected based on it's watershed size and the ecoregion setting.

Lake management efforts should be directed to protect the existing good water quality.

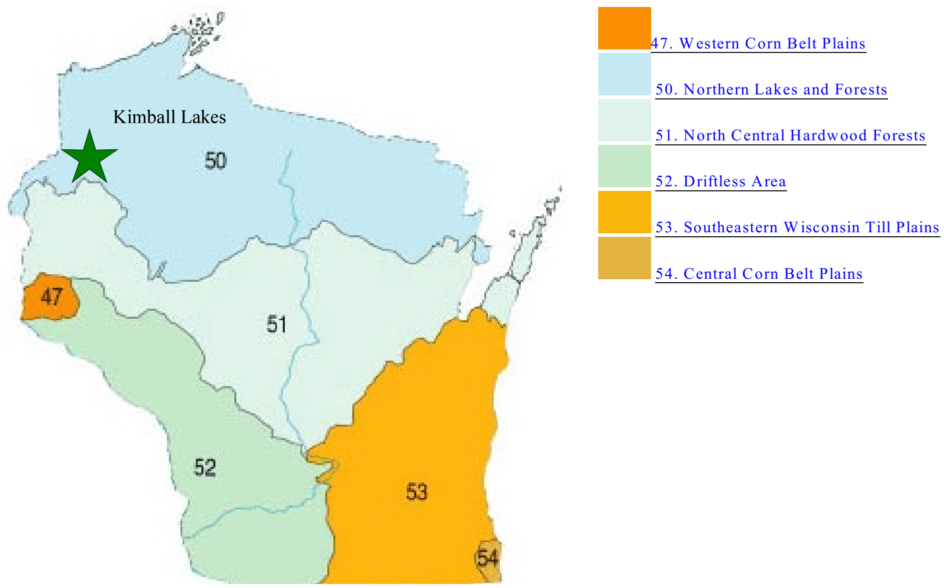
Native aquatic plants are diverse but two species present some navigational problems. In the shallow southwest bay, fern pondweed is found close to the surface or floating. In a channel along the west side, broadleaf pondweed grows to the surface and can restrict some types of navigation.

Ecoregions of Wisconsin

Revised April 2000

National Health and Environmental Effects Research Laboratory

U.S. Environmental Protection Agency

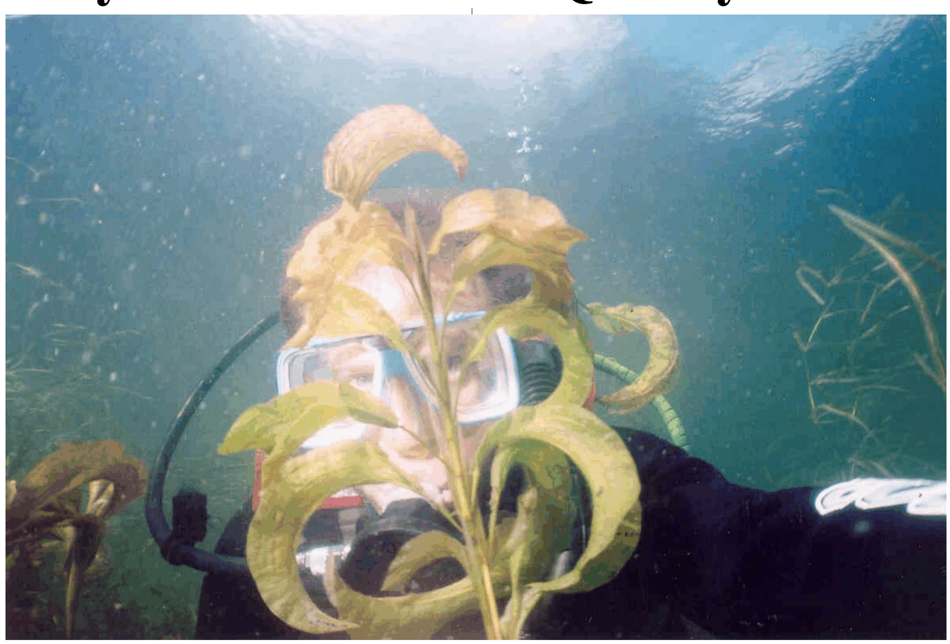


Kimball Lakes is located in the Northern Lakes and Forest Ecoregion. Lakes in this ecoregion have some of the best water quality n the state.

Aquatic Plants Are Key to Good Water Quality

Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently Kimball Lake has a high diversity (number of species) of aquatic plants with a total of 26 species identified in 2004. Common plants found in the Kimball Lakes include: fern pondweed, northern watermilfoil, chara, and needle spike rush.

In July and August of 2004, aquatic plant distribution was estimated to be at 189 acres. Of that coverage, less than 1 acre of plants grew to nuisance conditions where plants top out at the lake surface and would hinder navigation.



Here is a picture of broadleaf pondweed from Middle Kimball Lake. This is a desirable aquatic plant species. All three lakes have relatively good aquatic plant diversity and should promote good water clarity.

Recommended Lake Management Projects

1. Watershed projects - forests and roads
Maintain a photolog of typical forest and roadside areas to serve as a benchmark for future reference. Alert the County if excessive erosion is observed.

2. On-site system maintenance
On-site wastewater treatment systems operate satisfactorily when they are properly installed and maintained. Several activities can be implemented to assist in proper operation of the system. These activities include workshops, septic tank pumping campaigns, and ordinance implementation. However, much of the education can be conveyed through Lake Association newsletters.

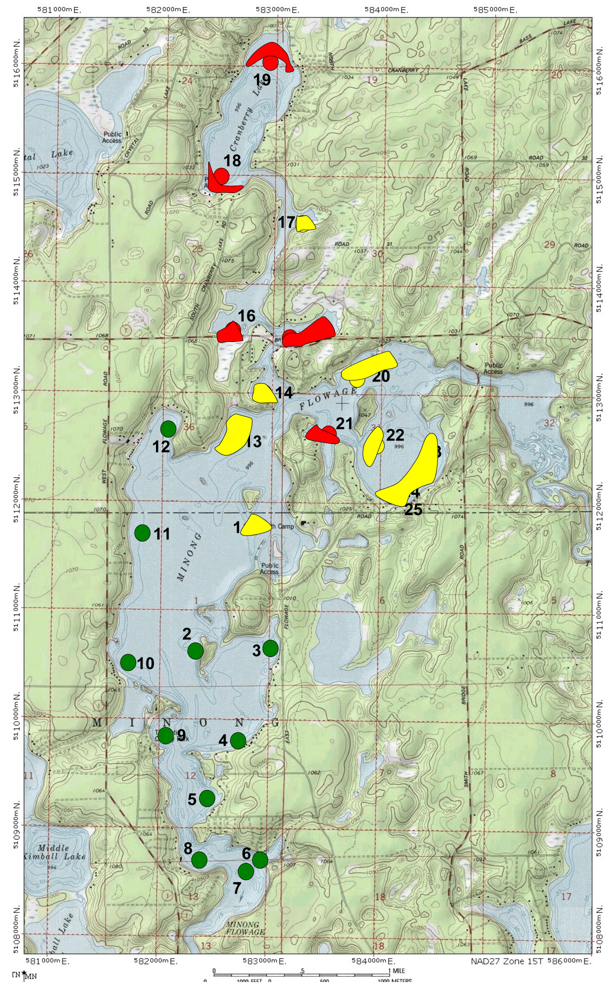
There is little evidence of failing onsite systems based on shoreland setback distances and the good water quality of the lakes. An option would be to contract with the County to randomly select 10% of the systems around the lake and conduct an onsite inspection and publish the results in a newsletter.

3. Aquascaping projects
Kimball Lakes has stretches of natural shoreline conditions but vegetative buffers and natural conditions could be improved along some of the developed parcels. The challenge is to protect the existing natural conditions and to enhance shorelands that lack native vegetative buffers. A volunteer lakescaping program should be implemented. Set up a Kimball Lakes Shoreland model describing how to design, install, and maintain a natural shoreland. Publish it in the lake's newsletter.

4. Aquatic plant projects
Based on the aquatic plant survey results from 2004, no exotic aquatic plants were found. However, Eurasian watermilfoil is present above in the Minong Flowage and below in Lake Nancy. The question is: what would milfoil do if it got into Kimball Lakes. A new technique of using lake sediment analysis to gage the potential for nuisance growth of Eurasian watermilfoil is available. A sediment survey could be conducted for the Kimball Lakes for a cost of $3,000.

5. Ongoing education program
The Lake Association's newsletter should be an ongoing instrument to provide lake protection information. Abundant material is available from the WDNR on the internet and from a variety of books, including the book "Lake and Pond Management Guidebook" written by Steve McComas. This material can be inserted into newsletters.

A variety of educational opportunities are available that go beyond newsletter articles. Lake fairs and demonstration projects could be useful for advancing lake information. A good time for special events is in conjunction with the annual meeting.



An example of a sediment survey used to determine the potential for nuisance milfoil growth. The north end of the flowage has higher nitrogen levels than the south end. Low water clarity may restrict nuisance milfoil growth in Minong Flowage to water depths of less than 6 or 7 feet. Areas that have the potential to support nuisance growth of Eurasian watermilfoil are shown in red shading. Nuisance key: green = low; yellow = medium; red = high potential.

6. Watershed and lake monitoring program
Ongoing lake testing should include: Secchi disk, total phosphorus, and chlorophyll a. Testing once per month from May through September is adequate to characterize lake conditions. Sampling twice per month would be better. An aquatic plant survey should be conducted every three to four years. The level of effort for a monitoring program depends on the availability of volunteers and funding levels.

In addition, winter dissolved oxygen levels could be collected to check for potential winterkill conditions caused by a lack of dissolved oxygen.

1. Introduction and Project Setting

The Kimball Lakes are composed of three lake basins, Upper, Middle, and Lower, and are located in Washburn County, Wisconsin (Figure 1). The Kimball Lakes characteristics are shown in Table 1.

The objectives of this study were to characterize existing lake conditions and to make recommendations to protect and improve the lake environment where feasible.

Table 1. Lake statistics (WDNR 1980).

	Kimball Lakes		
	Upper	Middle	Lower
Size (acres)	44	98	129
Mean depth (ft)	5	31	4
Maximum depth (ft)	11	77	6

Figure 1. Kimball Lake is located in Washburn County, Wisconsin.

2. Glaciers and Soils

Kimball Lake was formed approximately 10,000 years ago during the last glacial retreat of the Superior Lobe (Figure 2). The soils deposited by the Wisconsin Valley Lobe glacier were primarily sands and loamy-sands. Beneath these soils, at depths of about 50-350 feet, is Precambrian bedrock that is over one billion years old. The bedrock is referred to as the North American shield.

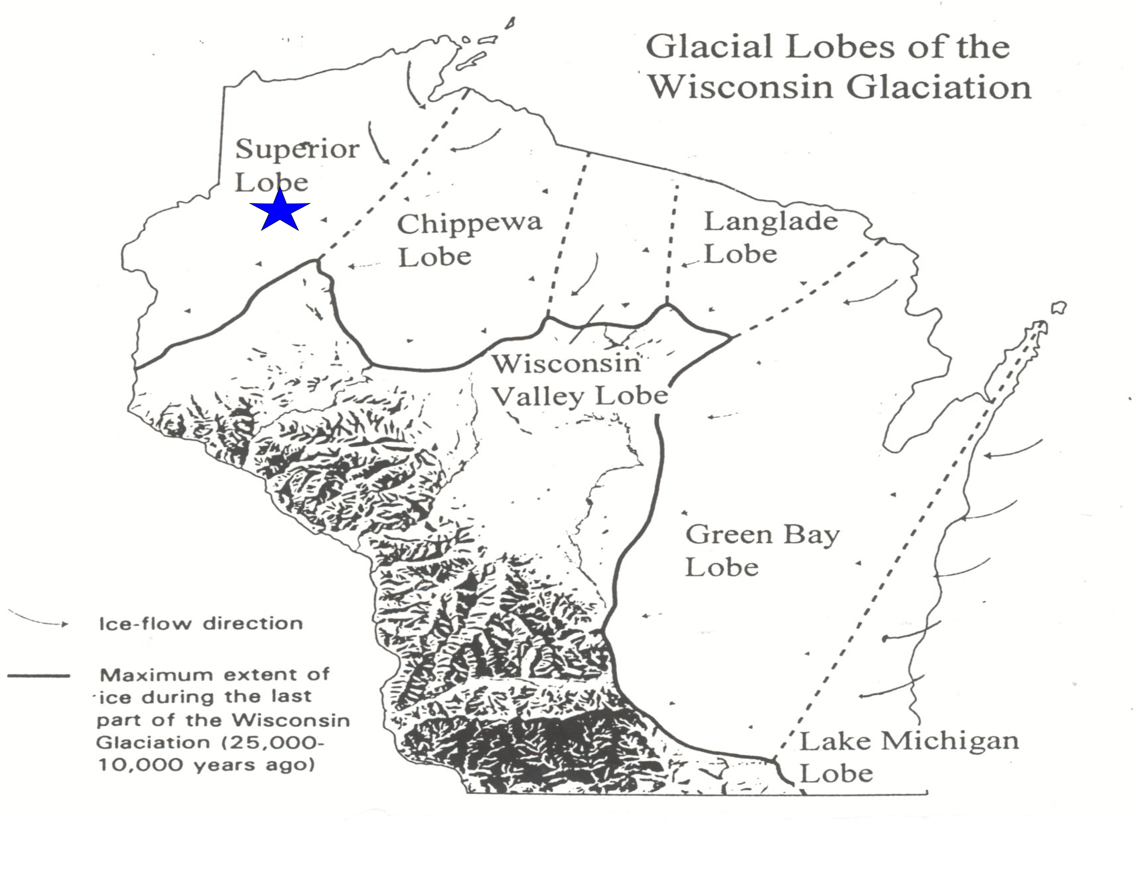


Figure 2. Glacial lobes of the Wisconsin glaciation. Kimball Lake is located in the Wisconsin Valley lobe.

Soil composition reflects the parent material that is present. Kimball Lake is located in an area dominated by forested sandy-loamy soils and adjacent to forested loamy soils (Figure 3).

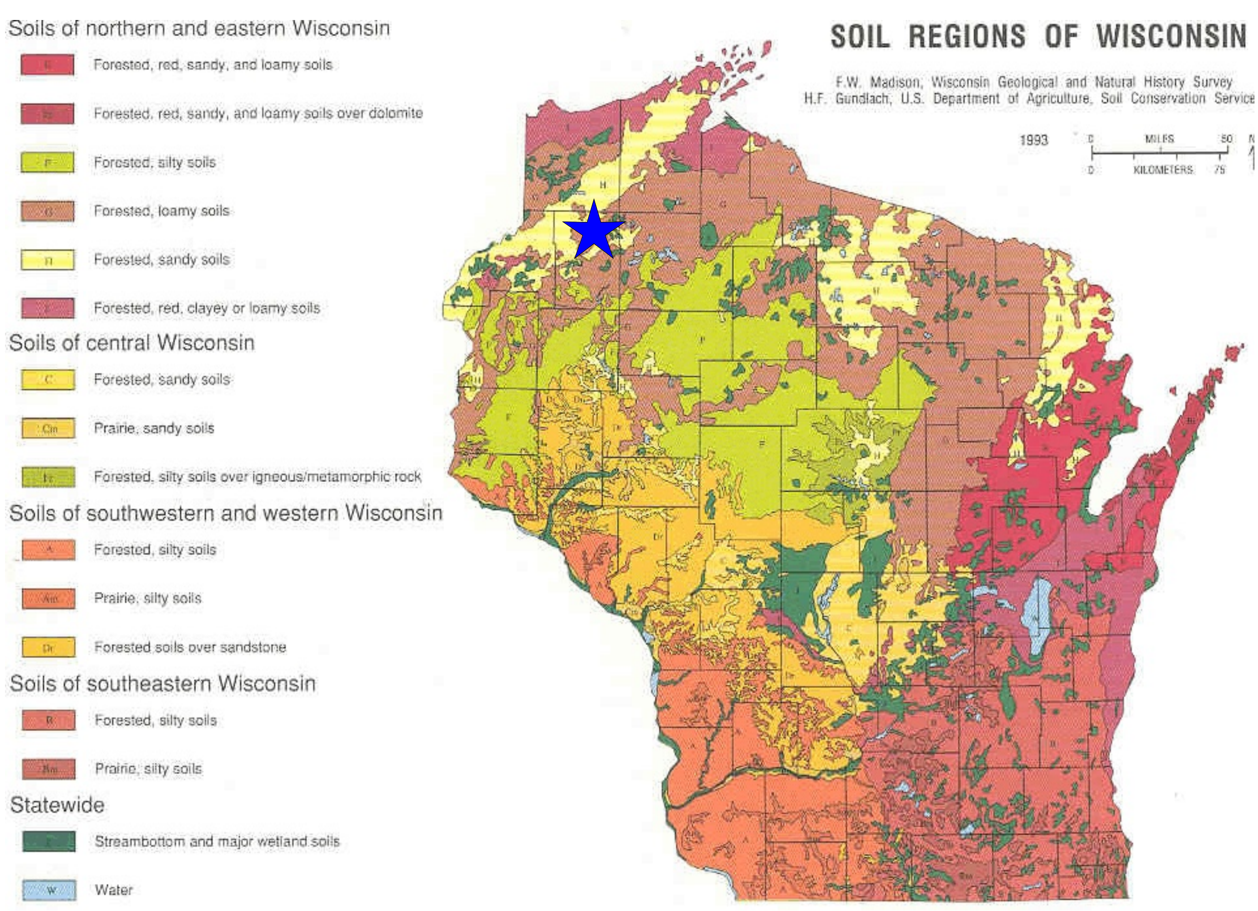


Figure 3. Kimball Lake is located within a soils group characterized as forested silty soils.

3. Watershed Features

3.1. Drainage Area and Land Use of Kimball Lake

Drainage area to all three Kimball Lakes is 1,314 acres (does not include lake areas) and is based on a USGS map. The drainage area delineation is shown in Figure 4.

Kimball Lakes and its watershed is located within Washburn County and forested and wetland areas are the dominant land condition.

The Kimball Lakes have good water clarity. To preserve good water quality in years to come, conservation measures in the watershed and on the lakeshore of Kimball Lake should be considered.

Project ideas are found on page 46.

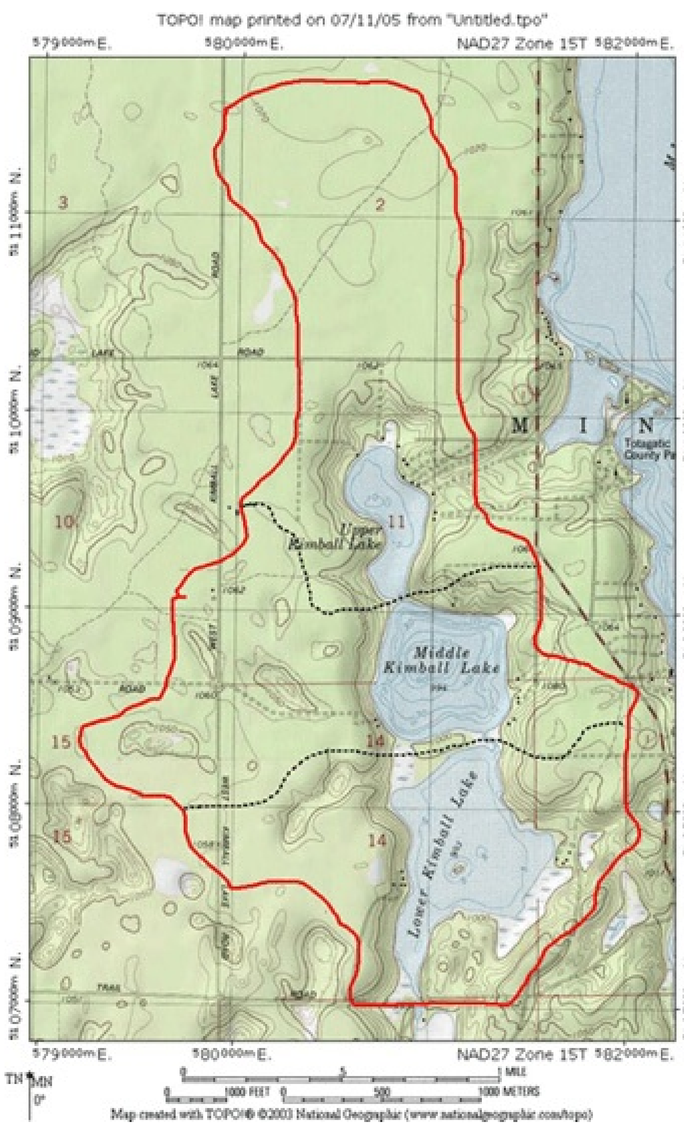


Figure 4. Drainage area to all three of the Kimball Lakes is 1,314 acres (does not include lake area).

3.2. Source of Water and Nutrients to Kimball Lake

Water: Source of water to the Kimball Lakes are from a combination of surface runoff, rainfall, and groundwater. The amount of water flowing into and out of Kimball Lake is estimated to be about 1.4 cubic feet per second. Flows were estimated based on runoff amounts listed for Washburn County in the Wisconsin Spreadsheet Lake Model (Table 2). Much of the inflow is through groundwater springs.

Table 2. Average annual water flow into Kimball Lake.

	Upper Kimball (44 ac)	Middle Kimball (98 ac)	Lower Kimball (129 ac)
Watershed area (not including the lake)(acre)	543	995*	1,456*
Average yearly runoff for Washburn County (feet)(from WDNR WILMS Model)	0.7	0.7	0.7
Total water inflow (acre-feet)	380	697	1,019

* includes watershed area from the lake(s) above.

The estimated 1,019 acre-feet of water flowing into Kimball Lake in one year would be enough water to fill a swimming pool the size of a football field to a depth of 1,000 feet. It would also be enough drinking water to supply a town of 12,000 for a year.

Although this is a lot of water coming into Kimball Lake, the volume of all three Kimball Lake basins is 3,800 acre-feet. If Kimball Lake completely dried up, it would take 3.7 years to fill.

Watershed Nutrients: The primary source of phosphorus from the watershed of Kimball Lake is from forested and wetland areas. There are no known land uses such as row crops or agricultural lands contributing excess phosphorus to Kimball Lake.

Figure 5. Outlet at Lower Kimball Lake. Outflow averages about 1.4 cubic feet per second.

3.3. Shoreland Inventory

The shoreland area encompasses three components: the upland fringe, the shoreline, and shallow water area by the shore. A photographic inventory of the Kimball Lakes shoreline was conducted on July 16 and August 13, 2004. The objectives of the survey were to characterize existing shoreland conditions which will serve as a benchmark for future comparisons.

For each photograph we looked at the shoreline and the upland condition. Our criteria for natural conditions were the presence of 50% native vegetation in the understory and at least 50% natural vegetation along the shoreline in a strip at least 15 feet deep. We evaluated shorelines and uplands at the 75% natural level as well (Figure 6 illustrates the methodology).

A summary of the inventory results is shown in Table 3. Based on our subjective criteria over 88% of the parcels in the Kimball Lakes shoreland area meet the natural ranking criteria for shorelines and upland areas. This is above average compared to other lakes found in the Northern Wisconsin data set. In the next five to ten years proactive volunteer native landscaping could improve the natural aspects of some of the parcels.

Table 3. Summary of shoreline buffer and upland conditions in the shoreland area of Kimball Lakes. Approximately 121 parcels were examined.

ID #	Natural Upland Condition		Natural Shoreline Condition		Shoreline Erosion		# of Lots	Undev. Lots	Shoreline Structure		
	>50%	>75%	>50%	>75%	No	Yes			No	Yes	
										riprap	wall
Upper Kimball	30 (94%)	27 (84%)	32 (100%)	31 (97%)	32 (100%)	0 (0%)	32 (100%)	10 (31%)	32 (100%)	0 (0%)	0 (0%)
Middle Kimball	29 (91%)	29 (91%)	31 (97%)	31 (97%)	32 (100%)	0 (0%)	32 (100%)	14 (44%)	31 (97%)	1 (3%)	0 (0%)
Lower Kimball	55 (96%)	51 (89%)	57 (100%)	53 (93%)	57 (100%)	0 (0%)	57 (100%)	22 (39%)	57 (100%)	0 (0%)	0 (0%)
Full Lake	114 (94%)	107 (88%)	120 (99%)	115 (95%)	121 (100%)	0 (0%)	121 (100%)	46 (38%)	120 (99%)	1 (1%)	0 (0%)

A comparison of the Kimball Lake's shoreland conditions to other lakes in Minnesota and Wisconsin is shown in Table 4 and in Figure 7.

Figure 6. [top] This parcel would rate as having a shoreline with a buffer greater than 50% of the lot width and an understory with greater than 50% natural cover.
[bottom] This parcel, from another lake, would not qualify as having a natural shoreline buffer greater than 50% of the lot width. Also the understory in the upland area would be rated as having less than 50% natural cover.

Table 4. Summary of shoreland inventories from Kimball Lakes and 36 other lakes in Minnesota and Wisconsin.

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition > 50% % (#)	Natural Upland Condition >75% % (#)	Natural Shoreline Condition > 50% % (#)	Natural Shoreline Condition >75% % (#)	Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
NORTHWOODS LAKES										
Ballard chain Vilas Co, WI	LF	7.23.99	110	--	98 (108)	96 (106)	96 (106)	95 (105)	--	0
Kimball Lakes Washburn Co, WI	LF	7.16-8.13.04	121	46 (38)	94 (114)	88 (107)	99 (120)	95 (115)	0 (0)	1 (1)
Pike Chain Price & Vilas Co, WI	LF	2001	722	380	92 (633)	87 (626)	95 (684)	91 (654)	--	5 (34)
Bear Oneida Co, WI	LF	6.8.99	115	6 (7)	93 (107)	78 (90)	84 (97)	77 (89)	1 (1)	8 (9)
Van Vliet Vilas Co, WI	LF	6.04	100	20 (20)	93 (93)	65 (65)	82 (82)	68 (68)	8 (8)	11 (11)
Muskellunge Vilas Co, WI	LF	8.7.04	129	8 (10)	81 (104	62 (80)	88 (114)	76 (98)	2 (2)	18 (23)
Big Bear Lake Burnett Co, WI	LF	9.11.02	87	13 (11)	82 (71)	62 (54)	86 (75)	76 (66)	0	9 (8)
Nancy Lake Washburn Co, WI	LF	9.21.00	217	19 (41)	77 (167)	65 (141)	80 (174)	72 (156)		5 (11)
Plum Lake Vilas Co, WI	LF	7.26.01	225	13 (30)	75 (169)	58 (130)	81 (182)	708(158)	--	9(4)
Big Bearskin Oneida Co, WI	LF	8.10.99	130	--	73 (95)	63 (82)	80 (104)	67 (87)	--	0
COUNTRY LAKES										
North Pipe Lake Polk Co, WI	CHF	8.03	80	45 (36)	100 (80)	96 (77)	94 (75)	91 (73)	0	1 (1)
Upper Turtle Lake Baron Co, WI	CHF	7.23-24.02	309	28 (85)	72 (224)	58 (178)	76 (234)	68 (209)	0	20 (63)
Lower Turtle Barron Co, WI	CHF	7.23.04	127	9 (12)	43 (54)	29 (37)	82 (104)	71 (90)	1 (1)	6 (8)
Pipe Lake Polk Co, WI	CHF	8.03	217	8 (17)	67 (144)	50 (108)	63 (137)	56 (121)	0	22 (48)
Little Pelican Otter Tail Co, MN	CHF	9.16.04	119	33% (39)	55% (65)	61% (51)	66% (79)	61% (73)	33 (39)	23 (27)
Comfort Chisago Co, MN	CHF	10.9-11.2.98	100	--	62 (62)	--	50 (50)	--	--	12 (12)
Lake Volney Le Sueur Co, MN	CHF	9.21.02	79	25 (20)	54 (43)	42 (33)	56 (44)	47 (37)	0	30 (24)
Rush Lake Chisago Co, MN	CHF	9.16.00	524	11 (58)	48 (253)	28 (147)	51 (267)	38 (201)	1 (3)	18 (92)
West Rush Lake, Chisago Co, MN	CHF	9.16.00	332	12 (40)	52 (171)	31 (103)	55 (184)	43 (142)	1 (2)	15 (50)
East Rush Lake, Chisago Co, MN	CHF	9.16.00	192	9 (18)	43 (82)	23 (44)	43 (83)	31 (59)	1 (1)	22 (42)
Fish Otter Tail Co, MN	CHF	9.16.04	95	21% (20)	38% (36)	36% (34)	43% (41)	36% (38)	48 (46)	7 (7)
Big Round Lake, Polk Co, WI	CHF	8.03	74	14 (10)	27 (20)	24 (18)	39 (29)	34 (25)	1 (1)	14 (10)
Bass Otter Tail Co, MN	CHF	9.16.04	22	0% (0)	6% (27)	3% (14)	41% (9)	41% (9)	68 (15)	2 (2)
Pelican Otter Tail Co, MN	CHF	9.16.04	881	14% (2)	21% (183)	14% (123)	21% (181)	16% (142)	2 (14)	80 (706)
Green Lake Kandiyohi Co, MN	CHF	9.19.01	721	1 (9)	20 (146)	12 (88)	19 (140)	14 (100)	0	62 (446)

Table 4. Concluded.

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition		Natural Shoreline Condition		Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
					> 50% % (#)	>75% % (#)	> 50% % (#)	>75% % (#)		
Diamond Lake Kandiyohi Co, MN	CHF	8.13 & 14.02	344	2 (7)	13 (44)	11 (39)	16 (56)	12 (42)	1 (5)	49 (168)
METROPOLITAN LAKES										
Ravine Lake Washington Co, MN	CHF	7.19.01	9	100 (9)	100 (9)	100 (9)	100 (9)	100 (9)	0	0
Pike Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	9	56 (5)	100 (9)	100 (9)	100(9)	100 (9)	0	0
Powers City of Woodbury, MN	CHF	1998	30	90 (27)	90 (27)	90 (27)	97 (29)	97 (29)	0	0
Lake Edward, City of Maple Grove, MN	CHF	9.30 - 10.12.99	34	12 (4)	91 (31)	88 (30)	76 (26)	71 (24)	6 (2)	3 (1)
Rice Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	137	33 (45)	71 (97)	64 (87)	81 (111)	74 (102)	0	19 (25)
Lee Lake Dakota Co, MN	CHF	5.31.02	30	37 (11)	73 (22)	50 (15)	77 (23)	67 (20)	0 (0)	10 (3)
Fish Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	170	7 (12)	74 (126)	44 (75)	57 (97)	41 (70)	1 (1)	20 (34)
Alimagnet Lake Dakota Co, MN	CHF	8.6.03	108	37 (40)	54 (58)	47 (51)	69 (75)	61 (66)	0	16 (17)
Eagle Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	90	14 (13)	64 (58)	52 (47)	47 (42)	41 (37)	0	35 (32)
Cedar Island Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	93	5 (5)	62 (58)	35 (33)	55 (51)	39 (36)	0	22 (21)
Orchard Lake Dakota Co, MN	CHF	9.17.01	109	4 (4)	47 (51)	30 (33)	53 (58)	32 (35)	0	54 (59)
Lac Lavon Dakota County, MN	CHF	9.9.03	110	7 (8)	54 (59)	44 (48)	42 (46)	30 (33)	0	8 (9)
Upper Prior Scott Co, MN	CHF	9.30 - 10.12.99	366	10 (37)	51 (187)	36 (132)	35 (128)	31 (113)	4 (15)	46 (168)
Weaver Lake, City of Maple Grove, MN	CHF	9.30 - 10.12.99	111	5 (5)	47 (52)	28 (31)	44 (49)	29 (32)	0	14 (16)
Lower Prior Scott Co, MN	CHF	9.24-30.99	691	10 (66)	36 (249)	24 (166)	22 (152)	17 (117)	5 (35)	54 (373)
Maple Grove Lake Summary, MN	CHF	9.30 - 10.12.99	644	14 (89)	67 (431)	48 (312)	60 (385)	48 (310)	1 (3)	20 (129)

* CHF = Central Hardwood Forest Ecoregion
** LF = Lake and Forests Ecoregion

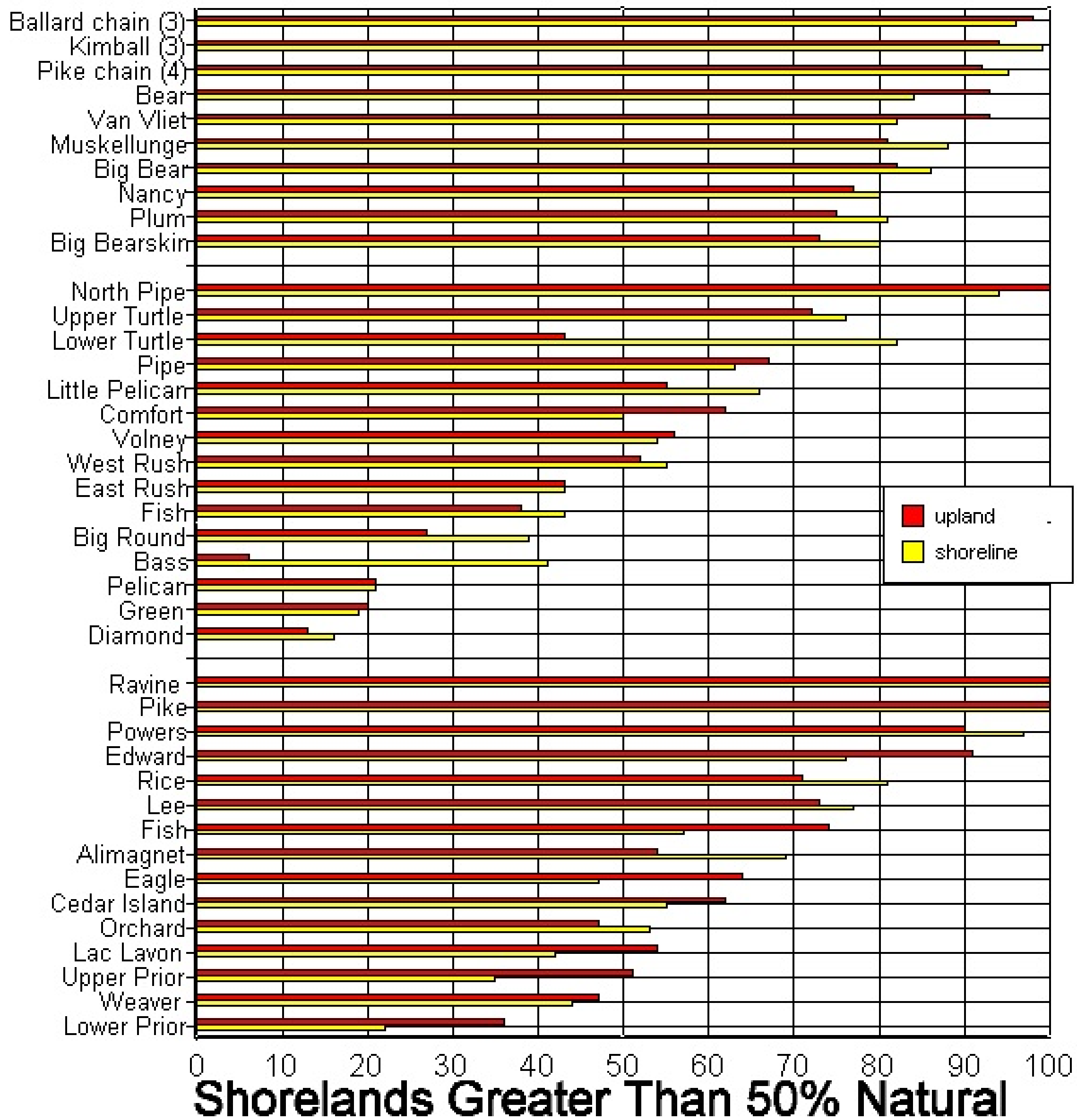


Figure 7. A summary of shoreland inventory results for lakes using an evaluation based on shoreland photographs. For each lake the percentage of shoreline and upland conditions with greater than 50% natural conditions is shown. The first tier of lakes are located in northern Wisconsin which are 4 to 5 hours from a major metropolitan area. The middle tier of lakes are about an hour's drive from the Twin Cities, and are considered to be "country" lakes. The lower tier of lakes are in the Twin City Metropolitan area and are categorized as urban lakes. Several lakes of the "urban" lakes have most of their shoreland owned by the city and there is a high percentage of natural conditions.

Kimball Lakes is considered a northwoods lake for this inventory. Natural shoreland conditions for Kimball Lakes are about average compared to the other northern Wisconsin lakes.

3.4. On-site Wastewater Treatment Systems

Onsite systems are likely in good condition based on the surrounding sandy soils and the setback of the cabins and homes. A conventional onsite system is shown in Figure 8. With proper maintenance (such as employing a proper pumping schedule) onsite systems are an excellent wastewater treatment option. The challenge is to maintain systems in good working condition.

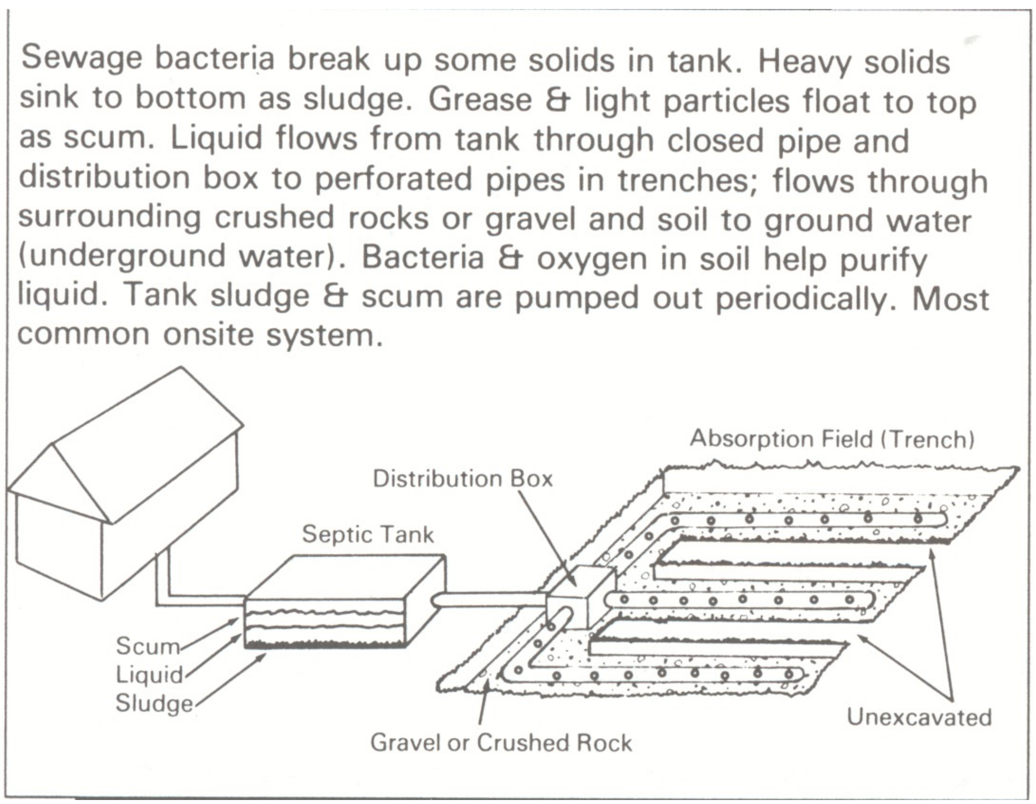


Figure 8. Typical onsite wastewater treatment system found in the Kimball Lakes watershed.

4. Lake Features

4.1. Lake Map and Lake Statistics

With all three basins combined, the Kimball Lakes are approximately 271 acres in size, with a watershed of 1,456 acres. The average depth of Upper, Middle, and Lower Kimball Lakes are 1.5, 9.4, and 1.2 meters (5, 31, 4 feet) respectively. The maximum depth of the three lakes are 3.3, 23.3, and 1.8 meters (11, 77, 6 feet) (Table 7). A lake contour map is shown in Figure 9. The Kimball Lakes are located in an area of Wisconsin that is dominated by forests and wetlands.

Figure 9. Kimball Lake, Washburn County, Wisconsin.

Table 5. Kimball Lake Characteristics

	Upper Kimball	Middle Kimball	Lower Kimball
Area (Lake):	44 acres (17.8 ha)	98 acres (39.7 ha)	129 acres (52.2 ha)
Mean depth:	5 feet (1.5 m)	31 feet (9.4 m)	4 feet (1.2 m)
Maximum depth:	11 feet (3.3 m)	77 feet (23.3 m)	6 feet (1.8 m)
Volume:	220 acre-feet (26.7 Ha-M)	3,038 acre-feet (373.2 Ha-M)	516 acre-feet (62.6 Ha-M)
Watershed area (not including lake area):	543 acres (220 ha)	408 acres (direct) 995 ac (total)	363 acres (direct) 1,456 ac (total)
Watershed: Lake surface ratio	12:1	4:1	3:1
Public accesses (#):	0	0	1
Inlets:	0	1	1

ha = hectares
m = meters
Ha-M = hectare-meters

Figure 10. Lower Kimball Lake from the public access.

4.2. Dissolved Oxygen and Temperature

Temperature profiles for Kimball Lake are shown in Figure 11.

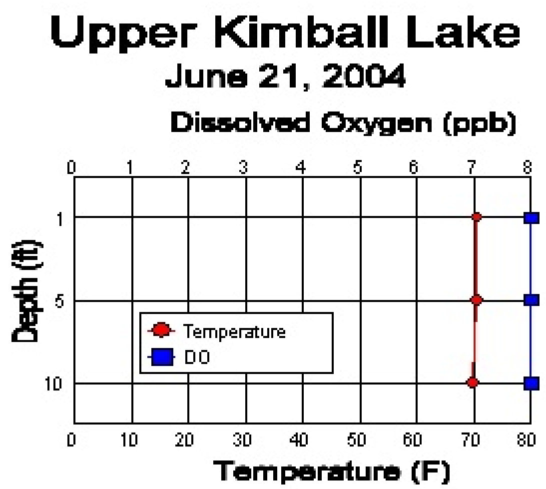
A profile for each of the three basins was obtained in June, 2004. By examining the profiles, one can learn a great deal about the condition of a lake and the habitat that is available for aquatic life.

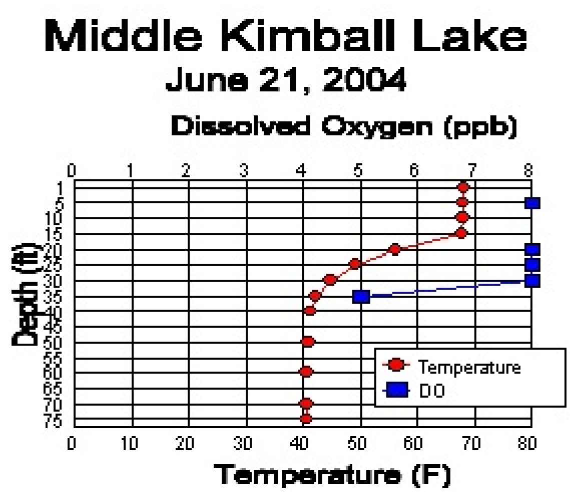
For example, the June profile shows that Middle Kimball Lake was thermally stratified. **Thermally stratified** means that the water column of the lake is segregated into different layers of water based on their temperature. Just as hot air rises because it is less dense than cold air, water near the surface that is warmed by the sun is less dense than the cooler water below it and it "floats" forming a layer called the *epilimnion*, or *mixed layer*. The water in the epilimnion is frequently mixed by the wind, so it is usually the same temperature and is saturated with oxygen.

Below this layer of warm, oxygenated surface water is a region called the *metalimnion*, or *thermocline* where water temperatures decrease precipitously with depth. Water in this layer is isolated from gas exchange with the atmosphere. The oxygen content of this layer usually declines with depth in a manner similar to the decrease in water temperature.

Below the thermocline is the layer of cold, dense water called the *hypolimnion*. This layer is completely cut off from exchange with the atmosphere and light levels are very low. So, once the lake stratifies in the summer, oxygen concentrations in the hypolimnion progressively decline due to the decomposition of plant and animal matter and respiration of benthic (bottom-dwelling) organisms.

Because Upper and Lower Kimball Lakes are relatively shallow, it appears these two basins probably don't stratify and can mix over the summer.





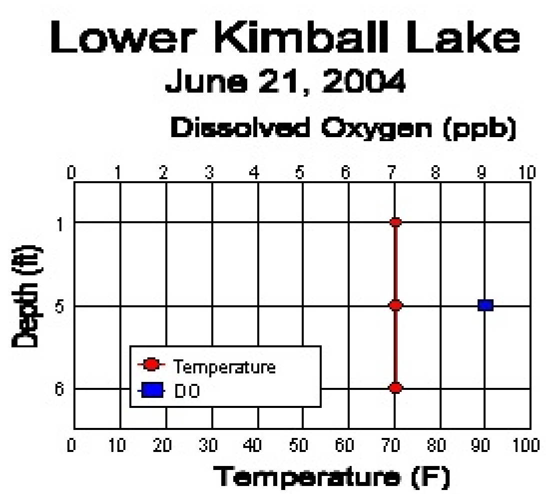


Figure 11. Dissolved oxygen (DO)/temperature profiles for June 21, 2004. Dissolved oxygen data are shown with squares and temperature with circles.

4.3. Lake Water Quality Summary

Water quality data have been collected over the years. A summary of water quality data for 2004 is shown in Table 6. Summer averages for Secchi disc transparencies are shown in Table 7.

All the summer water clarity data were collected in 1997 through 2004 as well as total phosphorus (TP), and chlorophyll a (Chl a) data collected in 2004 are shown in Tables 8, 9, and 10. Overall, the three water quality indicators (Secchi disc, total phosphorus, and chlorophyll a) in 2004 indicate Kimball is in good shape. Good is defined as water quality being comparable to relatively unimpacted lakes in the area.

Table 6. Summary for 2004 (May - September)

	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
Upper Kimball	11.0 (visible on bottom)	21	17
Middle Kimball	18.4	11	1.4
Lower Kimball	6.0 (visible on bottom)	15	3.5

Table 7. Water quality (based on the Secchi disc transparency).

	Secchi Disc Transparency		
	Upper Kimball	Middle Kimball	Lower Kimball
1998	9.5	19.3	6.0*
1999	11.4*	17.9	6.0*
2000	10.8*	19.1	7.0*
2001	11.1*	19.3	7.0*
2002	11.5*	19.0	6.0*
2003	12.0*	16.9	6.5*
2004	11.0*	18.4	6.0*

* Secchi disc visible on lake bottom.

Table 8. Summary of water quality data for Upper Kimball Lake collected through the Citizen Self-Help Monitoring Program.

UPPER KIMBALL LAKE	
Date	**Secchi Disc (ft)**
1997	
9.11	10
9.18	10
9.25	10
Sept Avg	***10***
1998	
5.25	9.5
6.15	9.5
7.2	9.5
7.19	9.5
7.31	9.5
8.9	9.5
8.23	9.5
9.4	9.5
9.18	9.5
May - Sept Avg	***9.5***
1999	
5.15	11.5
5.27	11.5
6.4	11.5
6.18	11.5
7.17	11.5
8.14	10
8.21	11.5
9.6	11.5
9.17	11.5
May - Sept Avg	***11.4***
2000	
5.20	10.5
6.8	10.5
6.25	11
7.9	11
7.16	10.5
7.25	11
8.1	11
8.12	11
8.27	11
9.8	10.5
9.18	11
9.24	11
9.29	10
May - Sept Avg	***10.8***

UPPER KIMBALL LAKE	
Date	**Secchi Disc (ft)**
2001	
5.18	11
6.8	11
6.15	10.5
6.28	11
7.7	11
7.13	11.5
7.29	11
8.10	11.5
8.16	11
8.31	11.5
9.12	11.5
9.28	11
May - Sept Avg	***11.1***
2002	
5.16	11.5
5.27	11.5
6.9	11.5
6.14	11.5
6.28	11.5
7.11	11.5
7.26	11.5
8.1	11.5
8.11	11.5
8.24	11.5
9.8	11.5
9.30	11.5
May - Sept Avg	***11.5***
2003	
5.23	12
6.18	12
7.3	12
8.14	12
9.5	12
May-Sept Avg	***12***

Table 8. Concluded.

UPPER KIMBALL LAKE		
Date	**Secchi Disc (ft)**	**TP - top (ppb)**
2004		
5.6	11	
5.18	11	
5.24	11	20
6.4	11	
6.14	11	
6.21	11	21
7.1	11	
7.12	11	
7.22	11	22
8.1	11	
8.13	11	
8.23	11	20
9.1	11	
9.11	11	
9.26	11	
May-Sept Avg	***11***	***21***

**** listed as 54 µg/l in data base. We have assumed it is 5.4 µg/l.***

Table 9. Middle Kimball Lake water quality data.

MIDDLE KIMBALL LAKE	
Date	**Secchi Disc (ft)**
1997	
9.11	21.25
9.18	21.25
9.25	21
Sept Avg	***21.2***
1998	
5.25	17.75
6.15	16
7.2	21.75
7.19	20
7.31	19.5
8.9	20.5
8.23	21.5
9.4	21.5
9.18	21
May - Sept Avg	***19.3***
1999	
5.15	15.5
5.27	17
6.4	18
6.18	15.5
7.8	18
7.17	18.25
8.14	18
8.21	20
9.6	19.75
9.17	19
May - Sept Avg	***17.9***
2000	
5.20	22.75
6.8	19
6.25	19.5
7.9	16.5
7.16	17.75
7.25	16.75
8.1	18.75
8.12	17.5
8.27	18
9.8	18.75
9.18	18.75
9.24	18.5
9.29	17.5
May - Sept Avg	***19.1***

MIDDLE KIMBALL LAKE	
Date	**Secchi Disc (ft)**
2001	
5.18	16.25
6.8	19.5
6.15	20
6.28	22.5
7.7	19.5
7.13	21
7.29	18.5
8.10	18.5
8.16	20
8.31	18.75
9.12	19.5
9.28	22
May - Sept Avg	***19.3***
2002	
5.16	15
5.27	19
6.9	19.5
6.14	18.5
6.28	19.5
7.11	18.75
7.26	19.5
8.1	19.5
8.11	20
8.24	19.75
9.8	20
9.30	20
May - Sept Avg	***19.0***
2003	
5.12	12.5
5.23	17.5
5.29	18
6.13	18
6.18	18.5
6.28	19.5
7.3	19.5
7.13	19.5
7.23	20.5
8.4	20
9.11	10
9.17	10
9.25	10
May - Sept Avg	***16.9***

Table 9. Concluded.

MIDDLE KIMBALL LAKE		
Date	**Secchi Disc (ft)**	**TP - top (ppb)**
2004		
5.6	12	
5.18	19	
5.28	19.5	
6.4	19.5	
6.14	20	
6.21	19	11
7.1	20	
7.12	20.5	
7.22	20.5	12
8.1	21	
8.13	20.5	
8.23	20.5	9
9.1	20.5	
9.11	21	
9.26	22	
May - Sept Avg	18.4	11

Table 10. Lower Kimball Lake water quality data.

LOWER KIMBALL LAKE	
Date	**Secchi Disc (ft)**
1997	
9.11	6
9.18	6
9.25	6
Sept Avg	***6***
1998	
5.25	6
6.15	6
7.2	6
7.19	6
7.31	6
8.9	6
8.23	6
9.4	6
9.18	6
May - Sept Avg	***6***
1999	
5.15	6
5.27	6
6.4	6
6.18	6
7.17	6
8.14	--
8.21	6
9.6	6
9.17	6
May - Sept Avg	***6.0***
2000	
5.20	7
6.8	7
6.25	7
7.9	7
7.16	7
7.25	7
8.1	7
8.12	7
8.27	7
9.8	7
9.18	7
9.24	7
9.29	7
May - Sept Avg	***7***

LOWER KIMBALL LAKE	
Date	**Secchi Disc (ft)**
2001	
5.18	7
6.8	7
6.15	7
6.28	7
7.7	7
7.13	7
7.29	7
8.10	7
8.16	7
8.31	7
9.12	7
9.28	7
May - Sept Avg	***7***
2002	
5.16	6
5.27	6
6.9	6
6.14	6
6.28	6
7.11	6
7.26	6
8.1	6
8.11	6
8.24	6
9.8	6
9.30	6
May - Sept Avg	***6***
2003	
5.23	6.5
6.18	6.5
7.3	6.5
8.14	6.5
9.5	6.5
May - Sept Avg	***6.5***

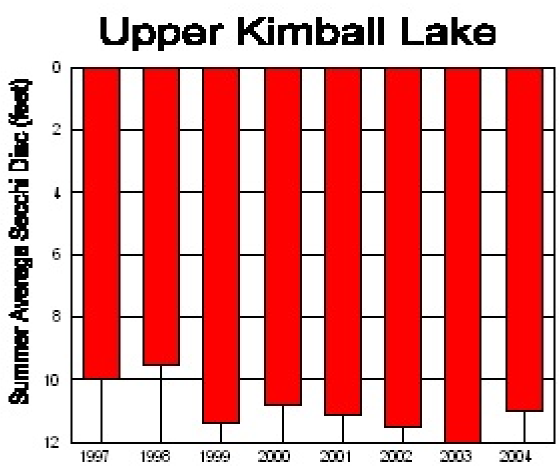
Table 10. Concluded.

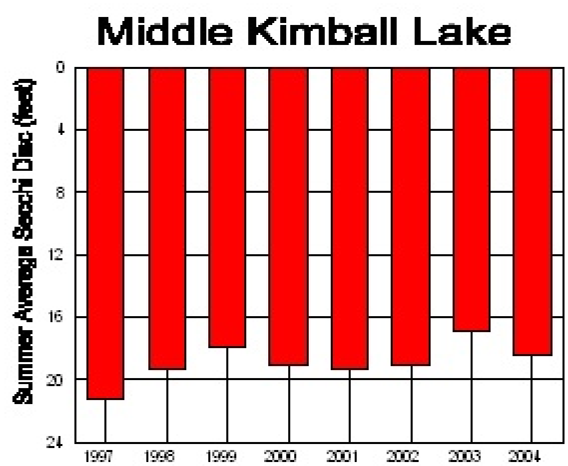
LOWER KIMBALL LAKE		
Date	**Secchi Disc (ft)**	**TP - top (ppb)**
2004		
5.6	6	
5.18	6	
5.28	6	
6.4	6	
6.14	6	
6.21	6	15
7.1	6	
7.12	6	
7.22	6	17
8.1	6	
8.13	6	
8.23	6	14
9.1	6	
9.11	6	
9.26	6	
May - Sept Avg	***6.0***	***15***

4.3.1. Secchi Disc Transparency

Water clarity is commonly measured with a Secchi disc. A typical seasonal pattern in lakes shows good clarity in May and June with a drop off in July and August. The lower water clarity in late summer is usually due to algae growth. This pattern is also found in Kimball.

Water clarity summer averages from 1997 through 2004 are shown in Figure 12. Clarity has been good for all three lakes since 1997 when seasonal records started being taken.





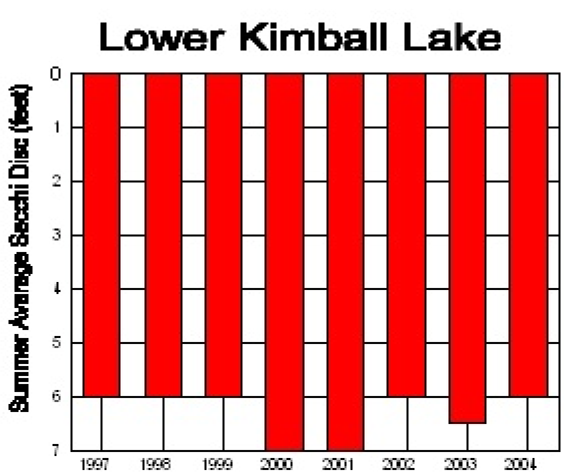


Figure 12. Secchi disc data for the Kimball Lakes. Middle Kimball shows excellent clarity since 1997. For the shallower Upper and Lower Kimball Lakes, Secchi disc readings were almost always on the lake bottom.

4.3.2. Total Phosphorus

Phosphorus is the nutrient more often associated with stimulating nuisance algae growth. Typical sources of phosphorus are from rainfall, watershed runoff, and the lake sediments. Lake phosphorus concentrations for the summer of 2004 are shown in Figure 13. Phosphorus concentrations in the Kimball Lakes are fairly low. A seasonal average of around 20 parts per billion (ppb) or less will result in low algae growth and good clarity.

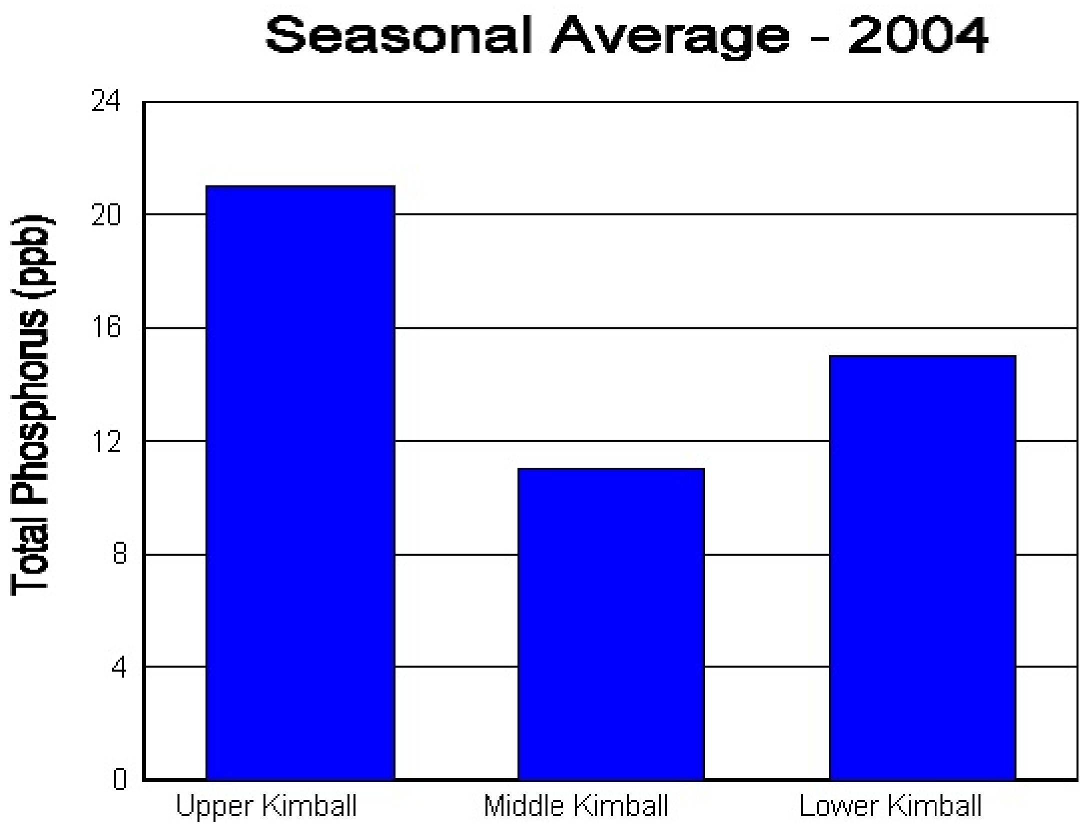


Figure 13. Seasonal average total phosphorus for Kimball Lakes in 2004.

4.3.3. Chlorophyll (a measure of algae)

Algae are small green plants, often consisting of single cells or grouped together in filaments (strings of cells). If algae are too abundant, the resulting algae blooms create greenish turbid water. Low amounts of algae in the lake will result in clear water. The amount of algae can be characterized by measuring the chlorophyll content in lake water. Chlorophyll results in 2004 are shown in Figure 14. Chlorophyll concentrations are low.

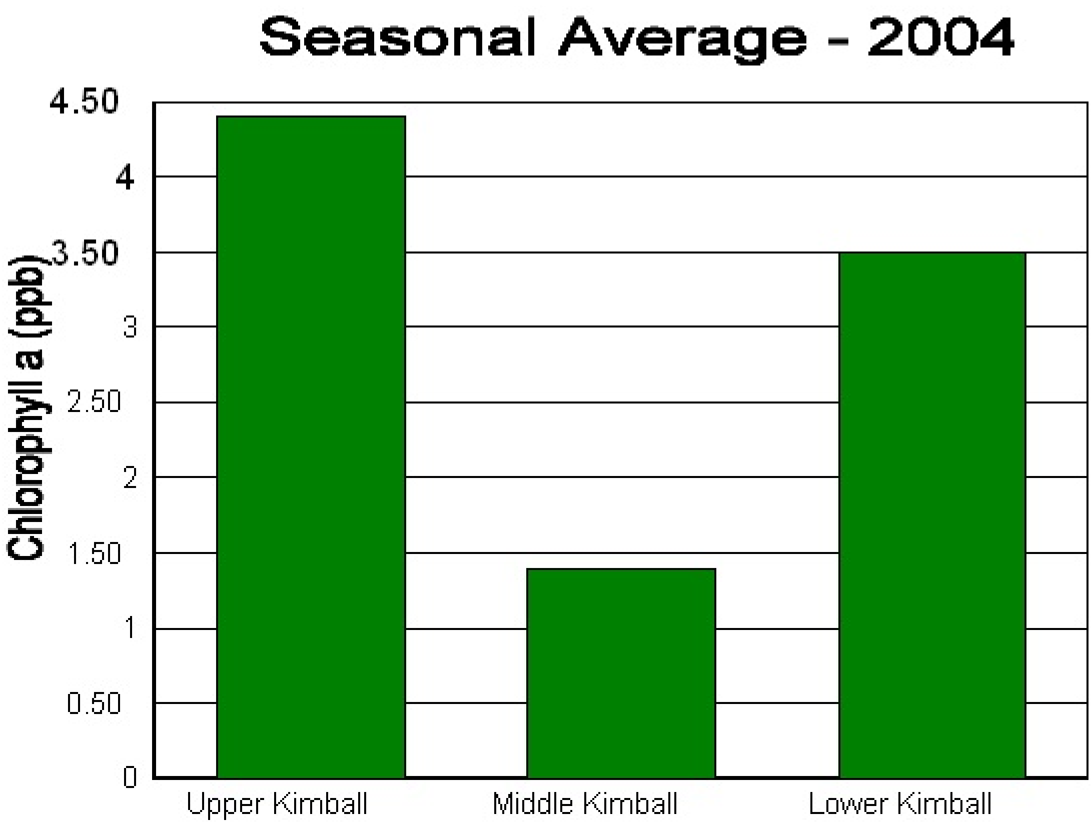


Figure 14. Seasonal average chlorophyll concentrations for Kimball Lakes in 2004.

4.4. Algae

In mid to late summer, algae numbers increase and reduce transparency slightly in the Kimball Lakes. The dominant late summer algal species in the Kimball Lakes in 2004 consist of dinoflagellates and desmids (Figure 15).

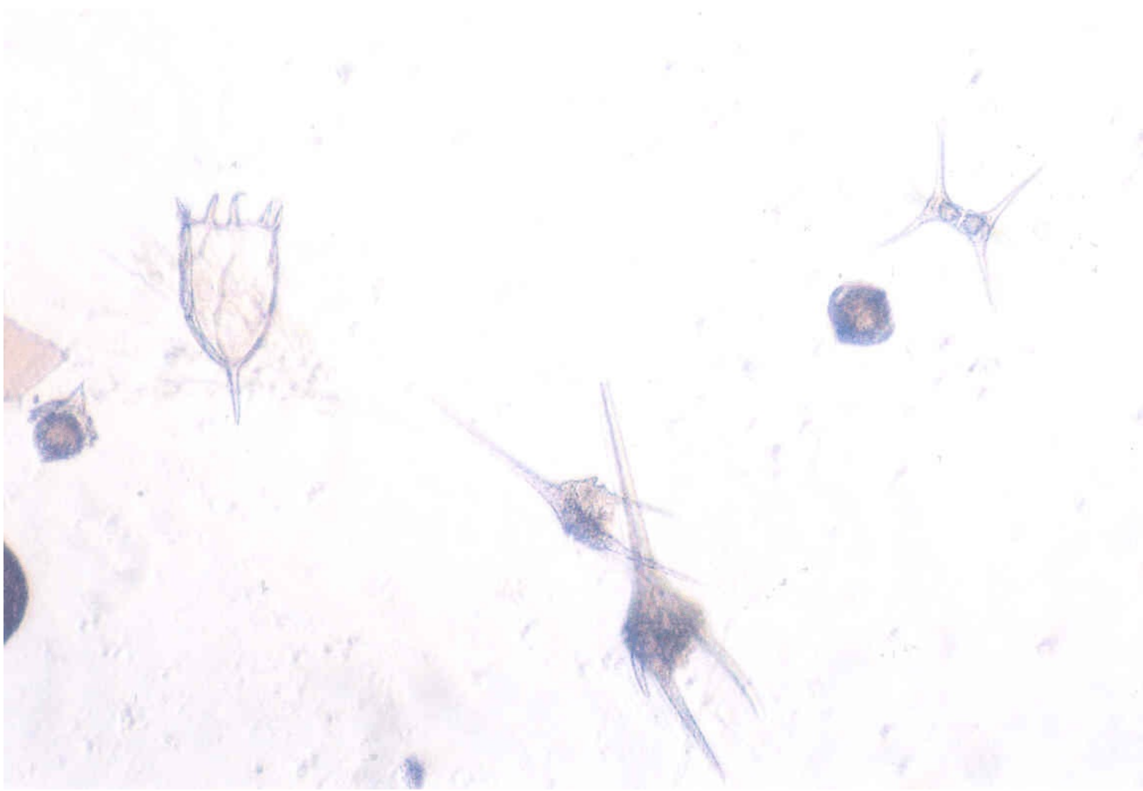


Figure 15. Rotifers (left), dinoflagellates (center) and desmids (right) are shown above.

4.5. Zooplankton

Zooplankton are small crustaceans that can feed on algae. A variety of different zooplankton are commonly found in lakes. An example of a large-sized zooplankton species from Kimball Lake is shown in Figure 16. The zooplankton community in the Kimball Lakes are typical for lakes in Northern Wisconsin. In the photo, the image is magnified 150 times.

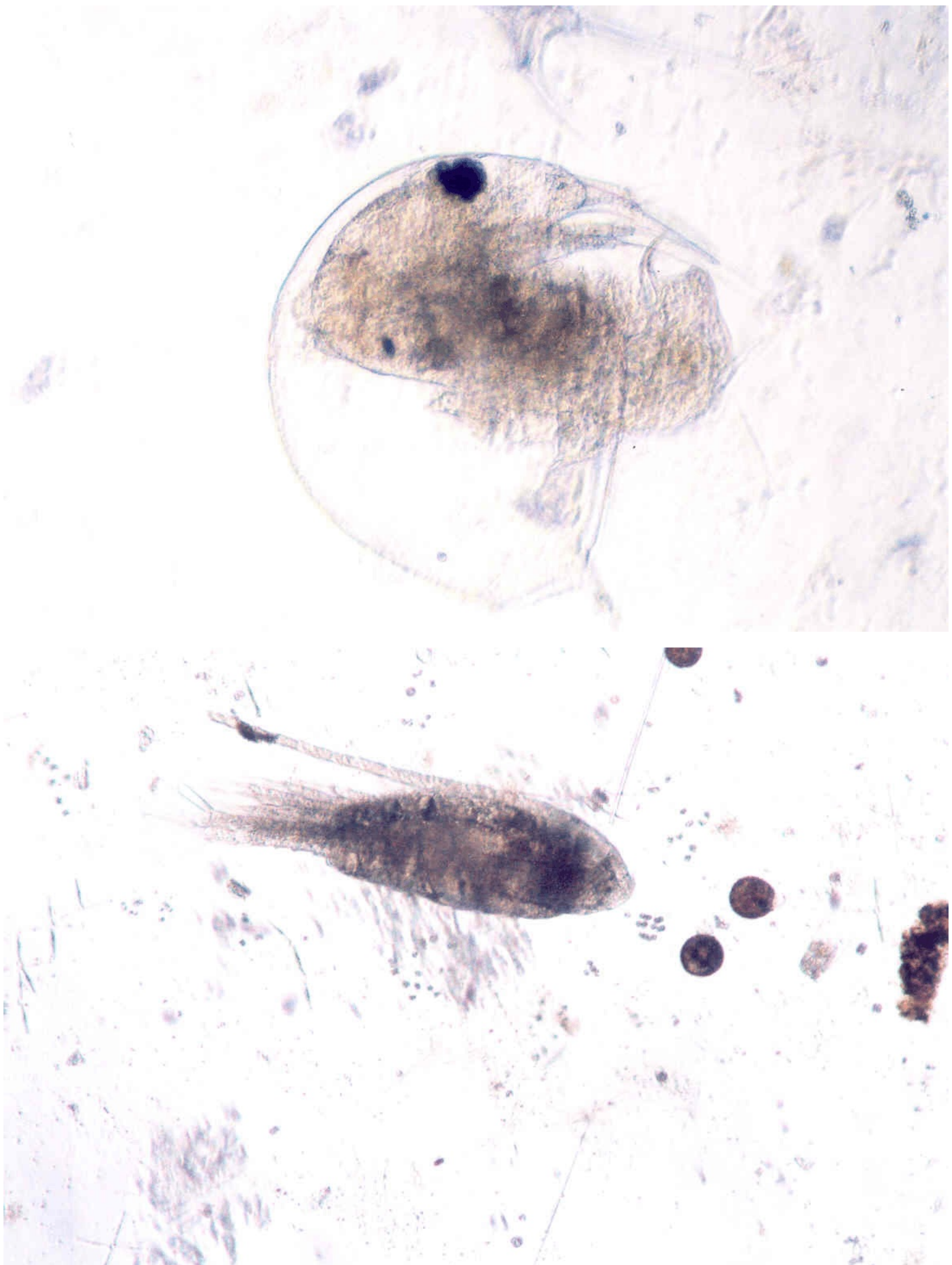


Figure 16. The crustacean at the top of the picture is a *Bosmina*, a cladoceran zooplankton that feeds on algae (June 5, 2004). The crustacean in the lower part of the photo is a copepod zooplankton.

Zooplankton in Kimball Lake were sampled on two dates in 2004 and results are shown in Table 11. Bosmina were dominant in June and declined in July. This is a common pattern in many lakes.

Table 11. Zooplankton counts.

	Middle Kimball	Middle Kimball	Lower Kimball
Date	**6.19.04**	**7.16.04**	**7.16.04**
Depth (ft)	**20**	**20**	**5**
Big Daphnids	0	1	2
Little Daphnids	15	3	0
Ceriodaphnia	0	0	0
Bosmina	0	0	0
Chydorus	0	0	20
Cladoceran	**15**	**4**	**20**
Calonoids	1	3	5
Cyclopoids	3	4	0
Nauplii	6	5	5
Copepods	**10**	**12**	**10**
Rotifers	**2**	**2**	**9**
Total	**27**	**18**	**41**

4.6. Aquatic plant status

Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently Kimball Lake has a high diversity (number of species) of aquatic plants with a total of 26 species identified in 2004. Common plants found in the Kimball Lakes include: fern pondweed, northern watermilfoil, chara, and needle spike rush.

In July and August of 2004, aquatic plant distribution was estimated to be at 188 acres (Figure 17). Of that coverage, less than 1 acre of plants grew to nuisance conditions where plants top out at the lake surface and would hinder navigation.

Filamentous algae was present at one end of the Upper Kimball Lake.

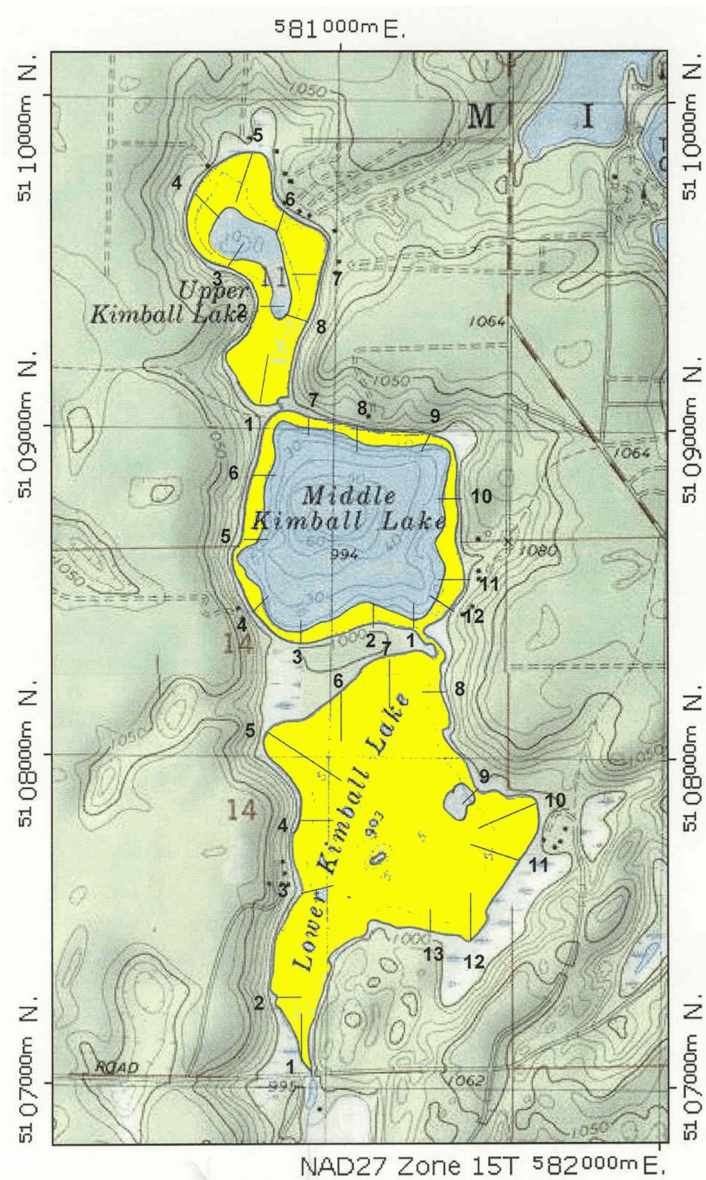


Figure 17. Aquatic plant coverage in the Kimball Lake on July and August, 2004 is shown in yellow.

A summary of aquatic plant statistics is shown in Table 12.

Line drawings of common Kimball Lake aquatic plants are shown on page 32.

Table 12. Summer aquatic plant survey summary.

	All Stations		
	Upper Kimball	**Middle Kimball**	**Lower Kimball**
Aquatic plant coverage (acres and percent coverage)	35 (80%)	28 (28%)	126 (97%)
Number of floatingleaf and submerged aquatic plant species found	14	19	15
Common plant species	fern pondweed, elodea	northern watermilfoil	fern pondweed, white lilies
Rarest plant	5 species occur at 1 station out of 17 stations	whitestem pondweed	claspingleaf pondweed
Maximum depth of plant growth (feet)	11	12	7
Maximum depth of the lake (feet)	11	77	7

Figure 18. Lake resident volunteers helped with the aquatic plant survey.

Table 13. Kimball Lakes aquatic plant occurrences for the July 16, 2004. Density ratings are 1-5 with 1 being low and 5 being most dense.

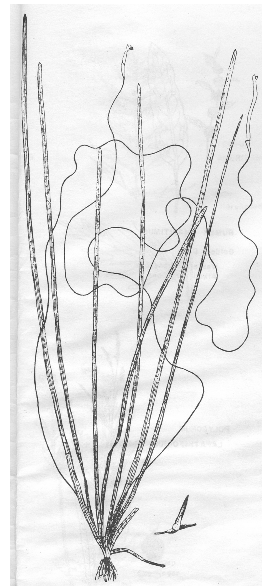
	Upper Kimball 17 stations		**Middle Kimball** 36 stations		**Lower Kimball** 26 stations	
	Occur	% occur	Occur	% occur	Occur	% occur
Watershield (*Brasenia Schreberi*)	1	6	0	--	4	15
Spatterdock (*Nuphar variegatum*)	0	--	0	--	7	27
White lilies (*Nymphaea tuberosa*)	0	--	0	--	10	38
Marigold (*Bidens beckii*)	0	--	3	8	0	--
Coontail (*Ceratophyllum demersum*)	1	6	4	11	0	--
Chara (*Chara sp*)	2	12	18	50	5	19
Needle spike rush (*Eleocharis sp*)	1	6	18	50	9	35
Elodea (*Elodea canadensis*)	7	41	15	42	3	12
Quillwort (*Isoetes sp*)	1	6	0	--	0	--
Northern watermilfoil (*Myriophyllum sibiricum*)	7	41	24	67	0	--
Dwarf watermilfoil (*M. sp*)	4	24	0	--	0	--
Naiads (*Najas sp*)	0	--	3	8	7	27
Cabbage (*Potamogeton amplifolius*)	0	--	13	36	1	4
Variable pondweed (*P. gramineus*)	0	--	5	14	3	12
Illinois pondweed (*P. illinoensis*)	3	18	7	19	0	--
Floatingleaf pondweed (*P. natans*)	0	--	0	--	2	8
Whitestem pondweed (*P. praelongus*)	0	--	1	3	0	--
Claspingleaf pondweed (*P. richardsonii*)	0	--	3	8	1	4
Fern pondweed (*P. robbinsii*)	13	76	13	36	12	46
Stringy pondweed (P. sp)	0	--	2	6	4	15
Flatstem pondweed (*P. zosteriformis*)	0	--	8	22	0	--
Water smartweed (*Polygonum amphibium*)	3	18	0	--	0	--
Buttercup (*Ranunculus sp*)	1	6	2	6	0	--
Rosette (*Sagittaria sp*)	3	18	2	6	7	27
Water celery (*Vallisneria americana*)	6	35	5	14	8	31
Unknown flatstem	0	--	3	8	0	--

Common Plants in Kimball Lake

Fern Pondweed

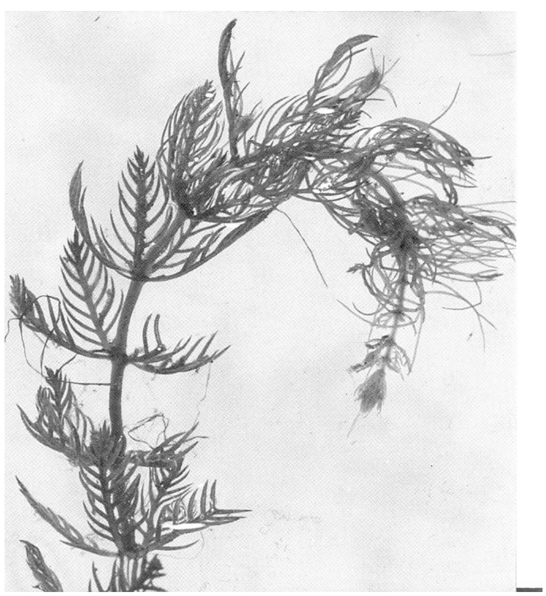
Fern pondweed (*Potamogeton robbinsii*) is found in all water depths.

Water celery



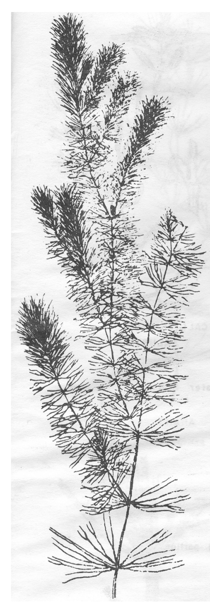
Water celery (*Vallisneria americana*) is found in water depths to 6 feet.

Northern watermilfoil



Northern watermilfoil (*Myriophyllum sibiricum*) is found in water depths to 10 feet.

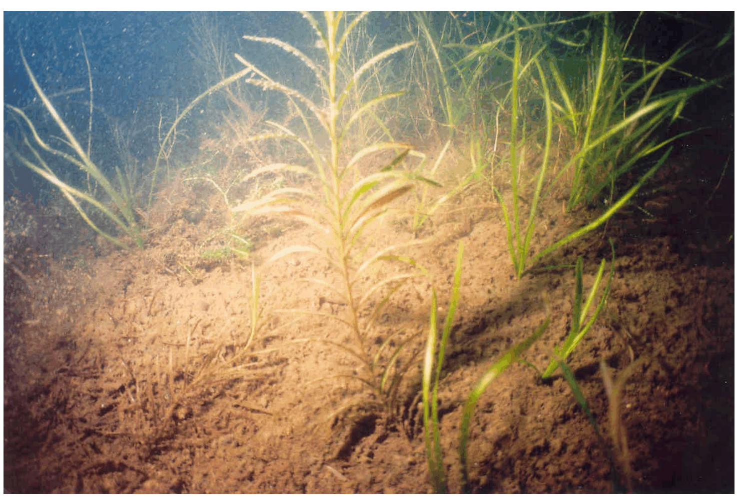
Coontail



Coontail (*Ceratophyllum demersum*) is dominant in all water depths.

A Sampling of Aquatic Plants from Kimball Lake in 2004

Photographs by Steve McComas



Aquatic Plant Survey Results: Results of aquatic plant surveys for Upper, Middle, and Lower Kimball Lakes are presented in Tables 14 - 19.

Table 14. Upper Kimball Lake aquatic plant occurrences and densities for the August 13, 2004 survey based on 8 transects and 3 depths, for a total of 17 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0-4 feet (n=8)			Depth 5-8 feet (n=8)			Depth 9-12 feet (n=1)			All Stations (n=17)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
Watershield (*Brasenia Schreberi*)	1	13	2.0	--	--	--	--	--	--	1	6	2.0
Coontail (*Ceratophyllum demersum*)	--	--	--	--	--	--	1	100	4.0	1	6	4.0
Chara (*Chara sp*)	1	13	2.0	1	13	0.3	--	--	--	2	12	1.2
Needle spike rush (*Eleocharis sp*)	--	--	--	1	13	3.0	--	--	--	1	6	3.0
Elodea (*Elodea canadensis*)	2	25	0.8	4	50	1.3	1	100	1.0	7	41	1.1
Quillwort (*Isoetes sp*)	1	13	1.0	--	--	--	--	--	--	1	6	1.0
Northern watermilfoil (*Myriophyllum sibiricum*)	3	38	1.0	4	50	1.0	--	--	--	7	41	1.0
Dwarf watermilfoil (*M. tenellum*)	3	38	2.0	1	13	0.5	--	--	--	4	24	1.6
Water smartweed (*Polygonum amphibium*)	2	25	1.0	1	13	1.0	--	--	--	3	18	1.0
Illinois pondweed (*Potamogeton illinoensis*)	--	--	--	3	38	1.0	--	--	--	3	18	1.0
Fern pondweed (*P. robbinsii*)	5	63	1.6	7	88	2.6	1	100	2.0	13	76	2.2
Rosette (*Sagittaria sp*)	3	38	1.1	--	--	--	--	--	--	3	18	1.1
Buttercup (*Ranunculus sp*)	--	--	--	1	13	0.5	--	--	--	1	6	0.5
Water celery (*Vallisneria americana*)	3	38	1.0	3	38	1.0	--	--	--	6	35	1.0

Table 15. Individual transect data for Upper Kimball Lake on August 13, 2004.

	T1		T2		T3		T4		
	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	9-12
Watershield	2								
Coontail									4
Chara			2						
Needle spike rush				3					
Elodea				1		2			1
Quillwort									
Northern watermilfoil	1				1			1.5	
Dwarf watermilfoil					1		2	0.5	
Water smartweed			1					1	
Illinois pondweed				1		1			
Fern pondweed	3	2		2	1	4			2
Rosette	0.5								
Buttercup								0.5	
Water celery					1	1			

	T5		T6		T7		T8	
	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8
Watershield								
Coontail								
Chara		0.3						
Needle spike rush								
Elodea	1			1			0.5	1
Quillwort							1	
Northern watermilfoil	1	1		0.5		1		
Dwarf watermilfoil					3			
Water smartweed			1					
Illinois pondweed						1		
Fern pondweed	1	2	2	3	1	2		3.5
Rosette					1		2	
Buttercup								
Water celery			1	1	1	1		

Table 16. Middle Kimball Lake aquatic plant occurrences and densities for the July 16, 2004 survey based on 12 transects and 3 depths, for a total of 36 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0-4 feet (n=12)			Depth 5-8 feet (n=12)			Depth 9-12 feet (n=12)			All Stations (n=36)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
Marigold (*Bidens beckii*)	--	--	--	--	--	--	3	25	1.3	3	8	1.3
Coontail (*Ceratophyllum demersum*)	--	--	--	2	17	1.0	2	17	1.0	4	11	1.0
Chara (*Chara sp*)	4	33	0.9	5	42	1.8	--	--	--	18	50	0.7
Needle spike rush (*Eleocharis sp*)	10	83	2.8	7	58	2.7	1	8	2.0	18	50	2.7
Elodea (*Elodea canadensis*)	1	8	1.0	4	33	1.1	10	83	1.7	15	42	1.5
Northern watermilfoil (*Myriophyllum sibiricum*)	6	50	0.9	7	58	1.1	11	92	1.6	24	67	1.3
Naiads (*Najas sp*)	1	8	0.5	1	8	2.0	--	--	--	3	8	0.8
Cabbage (*Potamogeton amplifolius*)	2	17	1.3	5	42	1.1	6	50	0.9	13	36	1.0
Variable pondweed (*P. gramineus*)	2	17	1.0	2	17	1.5	1	8	1.0	5	14	1.2
Illinois pondweed (*P. illinoensis*)	--	--	--	2	17	1.0	5	42	1.4	7	19	1.3
Whitestem pondweed (*P. praelongus*)	--	--	--	--	--	--	1	8	1.0	1	3	1.0
Claspingleaf pondweed (*P. richardsonii*)	--	--	--	2	17	1.0	1	8	1.0	3	8	1.0
Fern pondweed (*P. robbinsii*)	1	8	1.0	5	42	1.6	7	58	2.7	13	36	2.2
Stringy pondweed (*P. sp*)	--	--	--	2	17	2.3	--	--	--	2	6	4.5
Flatstem pondweed (*P. zosteriformis*)	1	8	1.0	3	25	1.0	4	33	1.5	8	22	1.3
Rosette (*Sagittaria sp*)	2	17	1.0	--	--	--	--	--	--	2	6	2.0
Buttercup (*Ranunculus sp*)	--	--	--	--	--	--	2	17	1.5	2	6	3
Water celery (*Vallisneria americana*)	--	--	--	3	25	1.3	2	17	1.0	5	14	1.2
Unknown flatstem	1	8	3.0	--	--	--	2	17	2.5	3	8	2.7

Table 17. Individual transect data for Middle Kimball Lake on July 16, 2004.

	T1			T2			T3			T4			T5			T6		
	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12
Marigold																		
Coontail		1													1			1
Chara				1	1					0.5								
Needle spike rush	1	4		4	2			2			2		4	4		3	3	
Elodea		1	1			1			1			2			2			
Northern watermilfoil		1	2	1		2		1			1	1		1	2	1		2
Naiads										0.5							2	
Cabbage			1			1		1	1			1	1.5		1			
Variable pondweed					2		1					1						
Illinois pondweed		1							1			2						
Whitestem pondweed									1									
Claspingleaf pondweed		1																
Fern pondweed	1	1	2			2									2		1	
Stringy pondweed																		
Flatstem pondweed							1	1	1						2			
Rosette													1			1		
Buttercup									1									
Water celery		1																
Unknown flatstem																		3

	T7			T8			T9			T10			T11			T12		
	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12
Marigold						1									1			2
Coontail														1				
Chara					2					1	2		1	1			3	
Needle spike rush	2			2	2	2	4			4			1.5			2		
Elodea			2			3		1.5				1	1	1	2		1	2
Northern watermilfoil		2	2			1	1	1	1	0.5		1	1		2	1	1	2
Naiads																		
Cabbage		1				0.5		1						0.5		1	2	
Variable pondweed					1								1					
Illinois pondweed									1		1	1						2
Whitestem pondweed																		
Claspingleaf pondweed		1				1												
Fern pondweed		3	4						3		1	4		2	2			
Stringy pondweed								2.5						2				
Flatstem pondweed						1					1			1	2			
Rosette																		
Buttercup															2			
Water celery			1					1	1		2							
Unknown flatstem	3		2															

Table 18. Lower Kimball Lake aquatic plant occurrences and densities for the July 16, 2004 survey based on 13 transects and 2 depths, for a total of 26 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0-4 feet (n=13)			Depth 5-8 feet (n=13)			All Stations (n=26)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
Watershield (*Brasenia schreberi*)	1	8	0.5	3	23	0.4	4	15	0.5
Spatterdock (*Nuphar variegatum*)	4	31	1.6	3	23	1.0	7	27	1.4
White lilies (*Nymphaea tuberosa*)	3	23	1.7	7	54	0.8	10	38	1.1
Chara (*Chara sp*)	4	31	0.6	1	8	1.5	5	19	0.8
Needle spike rush (*Eleocharis sp*)	7	54	2.0	2	15	1.0	9	35	1.8
Elodea (*Elodea canadensis*)	2	15	1.5	1	8	0.5	3	12	1.2
Naiads (*Najas sp*)	3	23	2.5	4	31	0.4	7	27	1.3
Cabbage (*Potamogeton amplifolius*)	--	--	--	1	8	0.5	1	4	0.5
Variable pondweed (*P. gramineus*)	2	15	0.5	1	8	0.3	3	12	0.4
Floatingleaf pondweed (*P. natans*)	1	8	1.0	1	8	0.5	2	8	0.8
Claspingleaf pondweed (*P. richardsonii*)	--	--	--	1	8	0.5	1	4	0.5
Fern pondweed (*P. robbinsii*)	4	31	1.1	8	62	1.2	12	46	1.2
Rosette (*Sagittaria sp*)	3	23	0.8	4	31	0.4	7	27	0.6
Stringy pondweed (*P. sp*)	2	15	1.3	2	15	0.9	4	15	1.1
Water celery (*Vallisneria americana*)	4	31	1.1	4	31	1.1	8	31	1.1

Table 19. Individual transect data for Lower Kimball Lake on July 16, 2004.

	T1		T2		T3		T4		T5		T6		T7	
	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8
Watershield				0.5						0.5				
Spatterdock	2	1	2	1			2			1				
White lilies	2	0.5	2	0.5						2		0.7		
Chara			1								0.3		2	1.5
Needle spike rush					2	0.5	4				0.5			
Elodea							2				1			0.5
Naiads				0.8								0.2	4	0.5
Cabbage														
Variable pondweed											0.5	0.3		
Floatingleaf pondweed				0.5										
Claspingleaf pondweed														
Fern pondweed						1.3		1.5			1	1		1.3
Rosette											1			
Stringy pondweed			1			1					1.5			
Water celery			1			0.3		2	0.5		1			1

	T8		T9		T10		T11		T12		T13	
	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8	0-4	5-8
Watershield					0.5					0.3		
Spatterdock					0.5							
White lilies	1					1		0.7		0.3		
Chara							1					
Needle spike rush	2	1.5	1		0.5						4	
Elodea												
Naiads	3				0.5							0.2
Cabbage		0.5										
Variable pondweed					0.5							
Floatingleaf pondweed	1											
Claspingleaf pondweed		0.5										
Fern pondweed		1.5			0.5	1.3	1		2	0.7		0.7
Rosette	1				0.5	0.5		0.5		0.3		0.7
Stringy pondweed										0.7		
Water celery	2	1										

4.7. Fishery Status

The fishery status of Kimball has been summarized by the WDNR in 1977.

Lake residents' observations of the current fishery are listed below:

- Bluegill - good, some stunted
- Crappies - good
- Northern pike - down
- Largemouth bass - outstanding, 14 inch limit

The extent of natural reproduction is unknown, but all the above species should have areas of adequate spawning habitat.

Figure 19. Only one area in the Kimball Lakes has nuisance plant growth. The plant is filamentous algae and it is at the north end of Upper Kimball Lake.

5. Lake and Watershed Assessment

5.1. Kimball Lakes Status

The status of the Kimball Lakes is mesotrophic meaning they have moderate fertility. The Kimball Lakes have comparable phosphorus concentrations to many of the surrounding lakes. One way to compare the status of Kimball Lake is to compare it to other lakes in a similar setting or ecoregion.

Ecoregions are geographic regions that have similar geology, soils, and land use. The continental United States has been divided into 84 ecoregions, and there are six ecoregions in Wisconsin. A map of Wisconsin ecoregions is shown in Figure 20. Kimball Lake is in the Northern Lakes and Forests ecoregion (Figure 20). Lakes in this area of the state have some of the best water quality values in the State. A range of ecoregion values for lakes in the Ecoregion along with actual Kimball Lakes data is shown in Table 20.

Table 20. Summer average quality characteristics for lakes in the Northern Lakes and Forest ecoregion (Minnesota Pollution Control Agency, 1988).

Parameter	Northern Lakes and Forests	Upper Kimball (2004)	Middle Kimball (2004)	Lower Kimball (2004)
Total phosphorus (ug/l) -top	14-27	21	11	15
Algae [as Chlorophyll (ug/l)]	<10	4.4	1.4	3.5
Chlorophyll - max (ug/l)	<15	5.4	1.7	4.4
Secchi disc (ft)	8-15	11 (b)*	18.4	6.0 (b)*

*(b) = Secchi dis was visible on the lake bottom.

These comparisons indicate that the water quality of Kimball Lake is within range compared to relatively unimpacted lakes within the Northern Lakes and Forests Ecoregion. The challenge will be to maintain water quality values within ecoregion ranges.

Project ideas are shown on page 46.

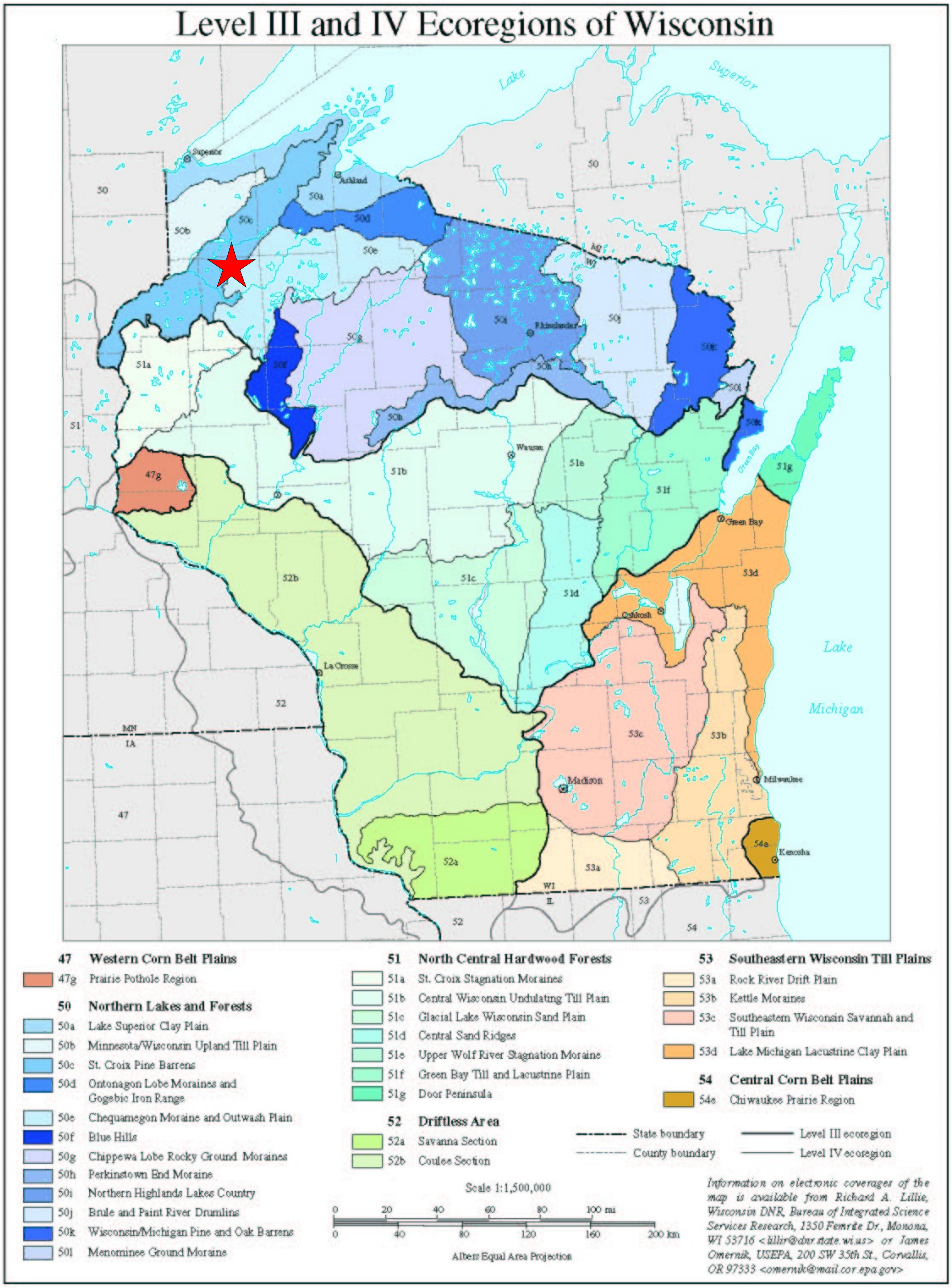


Figure 20. Ecoregion map for Wisconsin. Areas that are labeled with a "50" are within the Northern Lakes and Forest Ecoregion. Areas labeled with a "51" are in the Central Hardwood Forest Ecoregion. Kimball Lake, located in central Polk County is officially in the Central Hardwood Forest Ecoregion but close to the Northern Lakes and Forest Ecoregion.

5.2. Setting Water Quality Goals for Kimball Lake

Water quality in the Kimball Lakes appears to be close to pre-development conditions. Lake models were run to help determine feasible water quality goals for Kimball Lake. A lake model is a mathematical equation that uses phosphorus inputs along with lake and watershed characteristics to predict what a lake phosphorus concentration should be. Once a lake phosphorus concentration is determined, then seasonal water clarity and algae concentrations can be calculated as well.

Two lake models were run (Figure 21) for the following conditions and then compared to existing observed conditions.

1. Phosphorus loading to the lakes under ecoregion pre-development conditions (run-off phosphorus concentration at 20 ppb).
2. Phosphorus loading to the lakes from relatively unimpacted lakes under current ecoregion conditions (runoff phosphorus concentration at 50 ppb).

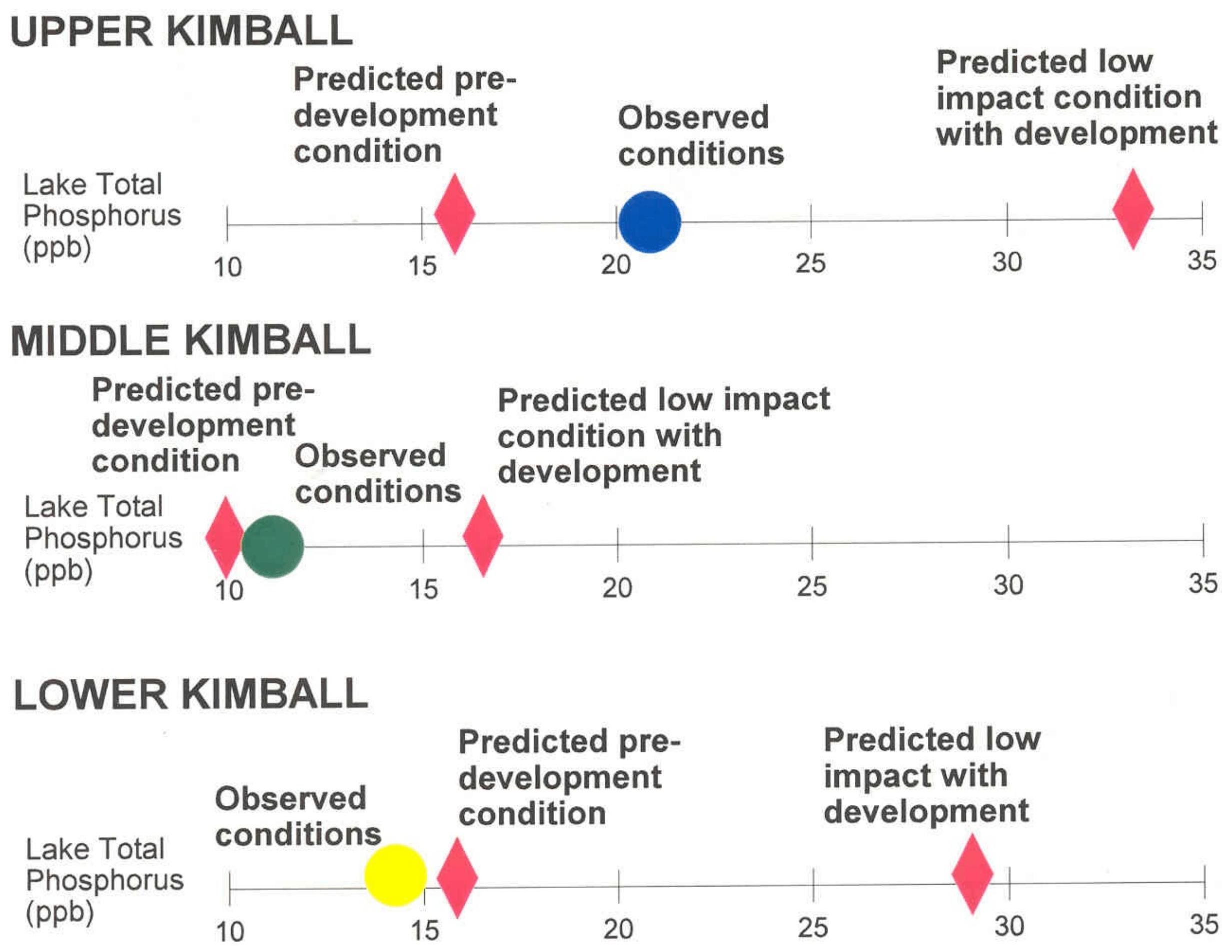


Figure 21. Predicted lake phosphorus concentrations based on modeling are shown with red diamonds. Actual lake phosphorus concentrations are shown with the solid circles.

For all three lakes, current phosphorus concentrations are less than what would be predicted for lakes with low impacts from shoreline development (Figure 21).

Lake Goals: Based on lake modeling considerations it appears the Kimball Lakes have water quality conditions that are close to pre-development conditions.

Water quality goals are to maintain lake phosphorus levels as close to pre-development conditions are possible. This will help sustain good water clarity in the Kimball Lakes.

The key to maintaining this lake phosphorus goal will be to maintain low nutrient inputs into the Kimball Lakes.

5.3. Significant Findings and Water Quality Strategy

- Water quality of Kimball is within range of lakes within the Lakes and Forests Ecoregion. Water quality parameters consisted of transparency readings, phosphorus, and chlorophyll.

- Lake water quality in Kimball is in excellent condition and is close to pre-development conditions.

- The shoreland inventory found that much of the shoreline remains in a mostly natural state.

- Aquatic plants are diverse and are of high quality. No exotic plant species, such as curlyleaf pondweed or Eurasian watermilfoil were found.

6. Lake Project Ideas for Protecting the Lake Environment

Project ideas for the Kimball Lakes are geared toward long-term protection of water quality.

A list of projects has six main components:

1. Watershed projects.
2. On-site wastewater system maintenance.
3. Aquascaping projects.
4. Aquatic plant projects.
5. Ongoing education program.
6. Watershed and lake monitoring program.

Details for these projects areas are given in the next few pages.

Project 1. Watershed Projects

The main goal of the watershed projects program is to protect the natural character of the watershed which helps maintain good runoff water quality.

Currently, a majority of the watershed is forested. However, some sources of erosion exist in the watershed. Area residents should watch for excessive erosion that can come from roadside shoulders and from logging in harvested areas. Revegetation should be ongoing for these areas.

Figure 22. Potential sediment sources to the Kimball Lakes comes from road shoulders.

Figure 23. Revegetation in forest harvest areas minimizes excessive erosion from these sites.

Project 2. On-site System Maintenance

The septic tank/soil absorption field has been one of the most popular forms of on-site wastewater treatment for years. When soil conditions are proper and the system is well maintained, this is a very good system for wastewater treatment. The on-site system is the dominant type of wastewater treatment found around Kimball Lake today.

However, problems can develop if the on-site system has not been designed properly or well-maintained. Around Kimball Lake there are probably some on-site systems that need maintenance or upgrades. At the same time, it is good practice to ensure that systems that are functioning adequately now will continue to do so in the future.

This project calls for an organized program to be developed that makes homeowners aware of all they can do to maintain their on-site systems.

A description of possible activities associated with the on-site maintenance program are described below:

- **Septic Tank Pumping Campaign**
  Washburn County requires every septic tank associated with a permanent residence pumped 2-3 years in the shoreland area to help reduce phosphorous loading to the septic system drainfield.

- **Ordinance Implementation**
  Work to maintain enforcement of the county ordinance, where septic systems must be "evaluated" at the time a property is transferred. The seller would obtain a septic system evaluation from Washburn County at the time of property transfer. The evaluation would determine if the septic system was "failing", "non-conforming", or "conforming". A "failing" septic system includes septic systems that discharge onto the ground surface, discharges into tiles and surface waters, and systems found to be contaminating a well. The county would require a "failing" system to be brought into compliance with the Washburn County ordinance within 90 days of property transfer.

Project 3. Aquascaping Projects

Controls are in place at the county level to guide new shoreland development. A number of excellent reference publications are available to assist in promoting shoreland stewardship. For existing shoreland properties, it is important to either maintain or to improve the natural vegetative buffer.

The shoreland area is valuable for promoting a natural lake environment and a natural lake experience for lake users. The shoreland is defined as the upland area about 300 to 1,000 feet back from the shoreline, and out into the lake to about the end of your dock (Figure 24). A shoreland with native vegetation offers more wildlife and water quality benefits than a lawn that extends to the lake's edge. A summary of attributes and functions of native plants in the shoreland area is shown in Table 21.

Figure 24. Cross section of the lake shoreland habitat.

Table 21. Attributes and functions of native plants in the shoreland area (Source: Henderson and others, 1999. Lakescaping for Wildlife and Water Quality. MnDNR)).

Important functions of plants in and around lakes

Submergent and emergent plants

- Plants produce leaves and stems (carbohydrates) that fuel an immense food web.
- Aquatic plants produce oxygen through photosynthesis. The oxygen is released into lake water.
- Submerged and emergent plants provide underwater cover for fish, amphibians, birds, insects, and many other organisms.
- Underwater plants provide a surface for algae and bacteria to adhere to. These important microorganisms break down polluting nutrients and chemicals in lake water and are an important source of food for organisms higher in the food chain.
- Emergent plants break the energy of waves with their multitude of flexible stems, lessening the water's impact on bank and thus preventing erosion.
- Plants stabilize bottom sediments, which otherwise can be resuspended by currents and wave action. This reduces turbidity and nutrient cycling in the lake.

Shoreline and upland plants

- Shoreline and upland plants provide food and cover for a variety of birds, amphibians, insects, and mammals above the water.
- The extensive root systems of shoreline plants stabilize lake-bank soils against pounding waves.
- Plants growing on upland slopes that reach down to lake hold soil in place against the eroding forces of water running over the ground, and help to keep lake water clean.
- Upland plants absorb nutrients, like phosphorus and nitrogen, found in fertilizers and animal waste, which in excessive concentrations are lake pollutants.

Improving Upland Native Landscape Conditions: In the glacial lake states, three broad vegetative groups occur: pine forests with a variety of ground cover species including shrubs and sedges: hardwood forests with a variety of understory species, including ferns: and tallgrass prairie with a variety of grasses as well as bur oaks and willow trees. Residences around Kimball Lake are in the hardwood forest group.

Reestablishing native conditions in the shoreland area not only improves stormwater runoff quality, it also attracts a variety of wildlife and waterfowl to the shoreland area. Benefits multiply when other neighbors naturalize because the effects are cumulative and significant for water quality and wildlife habitat.

When installing native vegetation close to the shoreline residents are actually installing a buffer. A buffer is a strip of native vegetation wide-enough to produce water quality and wildlife improvements. Much of the natural vegetative buffer has been lost in shoreland areas with development where lawns have been extended right down to the shore.

Lawns are not necessarily bad for a lake. However they can be over fertilized and then runoff carries phosphorus to the lake. Also, lawns function as a low grade open prairie, with poor cover for wildlife and a food supply that is generally poor, except for geese who may find it attractive. Replacing lawn areas with native landscaping projects reduces the need for fertilizer, reduces the time it takes to mow, increases the natural beauty of a shoreland area, and attracts wildlife.

Lawns do not make very good upland buffers. With runoff, short grass blades bend and do not serve as a very effective filter. Tall grass that remains upright with runoff is a better filter. Kentucky bluegrass (which actually is an exotic grass) is shallow-rooted and does not protect soil near shorelines as well as deep-rooted native prairie grasses, shrubs, or other perennials. Grass up to the shoreline offers poor cover, so predators visit other hiding areas more frequently reducing the prey food base and limiting predator populations in the long run. Also with short ground cover, ground temperatures increase in summer, evapotranspiration increases and results in drying conditions, reducing habitat for frogs and shoreline dependent animals.

Buffer Strip Considerations: A functional upland buffer should be at least 15 feet deep. With this you start getting water quality and wildlife habitat benefits. But a 35 foot deep buffer is recommended. In the past, before lakeshore development, buffers ringed the entire lake. For lakeshore residents it is recommended the length of the buffer extend for 75% of the shoreline, although 50% would produce buffer benefits.

A buffer strip can address two problem areas right away. Geese are shy about walking through tall grass because of the threat of predators. There will always be a few who charge right through but it is a deterrent for most of them. Also, muskrats shouldn't be a problem. They may burrow into the bank, but generally not more then 10 feet. With a buffer going back 15 to 25 feet, you won't be mowing over their dens. An occasional den shouldn't produce muskrat densities that limit desirable aquatic vegetation.

Several types of buffers can be installed or propagated that offer nutrient removal as well as wildlife benefits. Examples include:

> **Tall grass, sedge, flower buffer:** Provides nesting cover for mallards, blue-winged teal and Canada geese. Provides above ground nesting habitat for sedge wrens, common yellow throat and others.
>
> **Shrub and brush buffer:** Provides nesting habitat for lakeside songbirds such as yellow warblers, common yellowthroat, swamp sparrows, and flycatchers. It also provides significant cover during migration.
>
> **Forested buffers:** Provides habitat for nesting warblers and yellow-throated vireo, Diamond herons, woodducks, hooded mergansers, and others. Upland birds such as red-winged blackbirds, orioles, and woodpeckers use the forest edge for nesting and feeding habitat.

Even standing dead trees, which are referred to as snags, have a critical role. When they are left standing they serve as perching sites for kingfishers and provide nesting sites for herons, egrets, eagles, and ospreys. In the midwest over 40 bird species and 25 mammal species use snags. To be useful, they should be at least 15 feet tall and 6-inches in diameter.

The initial step for lake residents to get started is to simply make a commitment to try something. Just what the final commitment is evolves as they go through a selection process. The next step in the process is to conduct a site inventory. On a map with lot boundaries, house and buildings, driveway, turf areas, trees, shrubs, and other features are drawn. If there is a chance, the property is checked during a rainstorm. Look for sources of runoff and even flag the routes. Find out where the water from the roof goes, and see if there are temporary ponding and infiltration areas. Are the paths down to the lake eroding? Then the next step is to consider a planting approach.

Native Landscaping for Buffers: Three Approaches: Native landscaping efforts can be put into three categories:

1. Naturalization
2. Accelerated Naturalization
3. Reconstruction

1. Naturalization: With this approach, the resident is going to allow an area to go natural. Whatever is present in the seedbank is what will grow. If they want to install a buffer along the shoreline, let a band of vegetation grow at least 15 feet deep from the shoreline back and preferably 25 feet or deeper. Just by not mowing will do the trick. Residents can check how it looks at the end of the summer. It will take up to three years for flowers and native grasses to grow up and be noticed. Residents can also select other spots on their property to "naturalize".

2. Accelerated Naturalization: After developing a plant list of species from the area, residents may want to mimic some features right away. They can lay out a planting scheme and plant right into existing vegetation. Several Minnesota nurseries can supply native plant stock and seeds. The nurseries can also help select plants and offer planting tips. Wildflowers can be interspersed with wild grasses and sedges. Mulch around the new seedlings. With this approach lake residents can accelerate the naturalization process.

3. Reconstruction: To reestablish a native landscape with the resident's input and vision, another option is to reconstruct the site with all new plants. Again plant selection should be based on plants growing in the area. Site preparation is a key factor. Residents will want to eliminate invasive weeds and eliminate turf. This can be done with either herbicides or by laying down newsprint or other types of paper followed by 4 to 6 inches of hardwood mulch. Plantings are made through the mulch. This is the most expensive of the three native landscaping categories. Residents can do the reconstruction all at once, or phase it in over 3 to 5 years. This allows them to budget annually and continue evolving the plan as time goes by.

Also mixing and matching the level-of-effort categories allows planting flexibility. Maybe a homeowner employs naturalization along the sides of the lot and reconstruction for half of the shoreline and accelerated naturalization for the other half. Examples of the three approaches are shown in Figure 25.

1. Naturalization: The easiest way to implement a natural shoreline setting is to select an area and leave it grow back naturally.

2. Accelerated Naturalization: To accelerate the naturalization, plant shrubs, wild flowers, or grasses into a shoreland area.

3. Restoration: This involves removing existing vegetation through the use of paper mats and/or mulching and planting a variety of native grasses, flowers, and shrubs into the shoreland area.

Figure 25. Examples of three shoreland management options.

Project 4. Aquatic Plant Projects

Currently, Kimball Lake has a variety of emergent and submergent aquatic plant growth. Aquatic plants are vital for helping sustain clear water conditions and contribute to fish habitat (Figure 26). Currently, there are no exotic plant species found in Kimball Lake.

The primary aquatic plant goal is to maintain and/or protect submerged native aquatic plants in the Kimball Lakes. Two plant protection ideas are given below:

1. Maintain natural shoreland conditions to protect native aquatic plant distribution. Ongoing aquatic plant monitoring and delineation will be important.

2. Evaluate lake sediments in all three basins to determine the potential for the exotic plant species curlyleaf pondweed and Eurasian watermilfoil to grow in the Kimball Lakes.

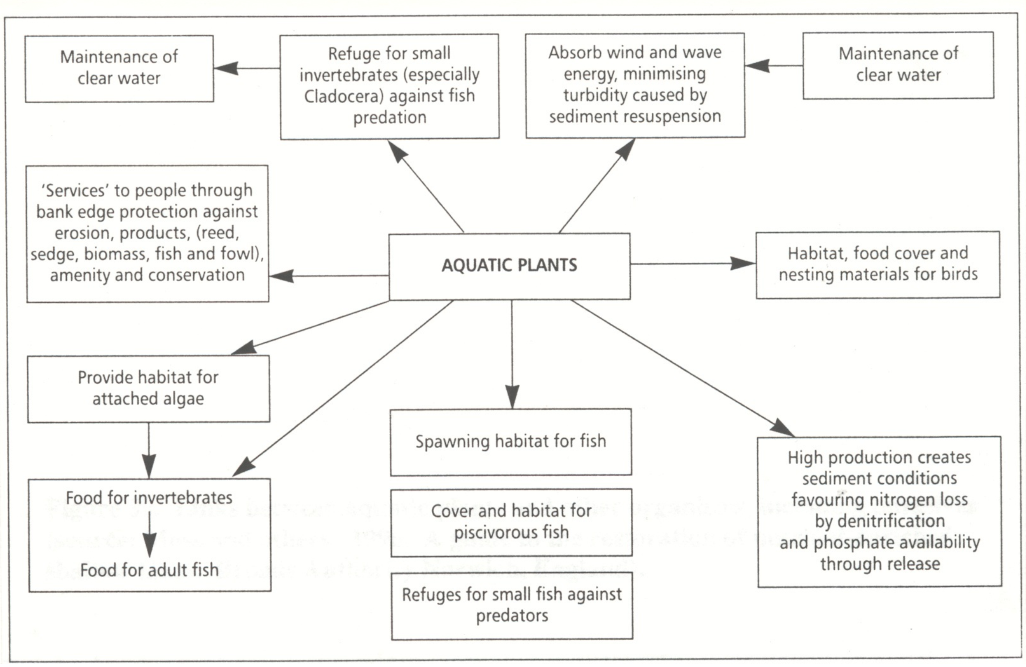


Figure 26. Links between aquatic plants and other organisms, including ourselves (source: Moss and others. 1996. A guide to the restoration of nutrient-enriched shallow lakes. Broads Authority Norwich, England).

Project 5. Ongoing Education Program

Lake residents get an important amount of lake protection information from the lake newsletter. Each issue should offer tips on lake protection techniques. There is abundant material available. An example of an informational piece is shown below (Figure 27).

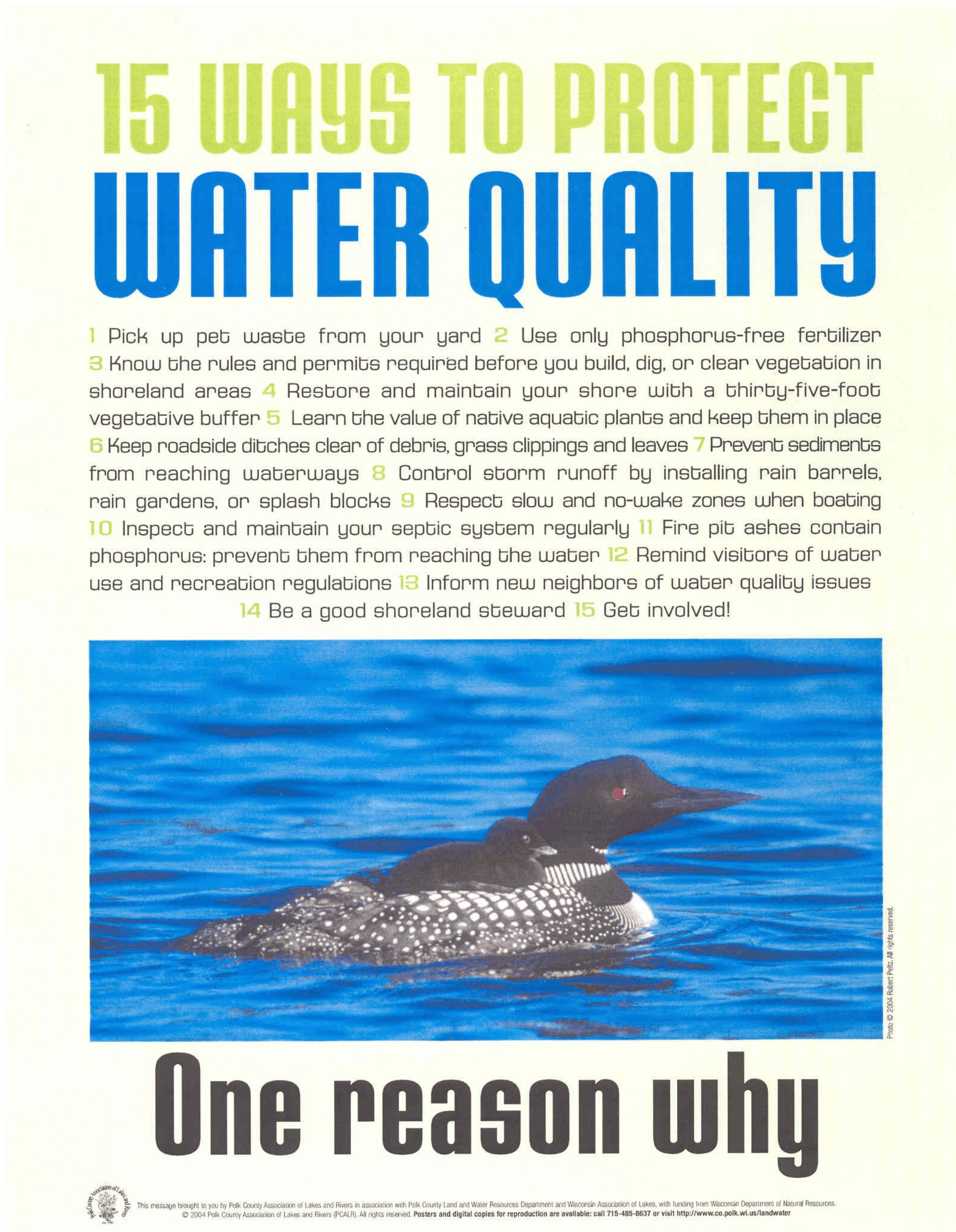


Figure 27. Example of an informational insert for a newsletter (source: Polk County, WI).

Project 6. Watershed and Lake Monitoring Program

At this time, because of good lake water quality and no permanent stream inflows, watershed water quality monitoring is not proposed. A lake monitoring program is outlined in Table 22. It is designed to be flexible to accommodate the volunteer work force and a fluctuating budget.

Table 22. Kimball Lake Water Quality Monitoring Program

Category	Level	Alternative	Labor Needed	Cost/Year
A. Dissolved oxygen and temperature profiles	1	Check dissolved oxygen in Kimball Lake every two weeks in January, February, and March depending on winter conditions.	Moderate	$0
	2	Check dissolved oxygen in Kimball Lake every one to two weeks in December, January, February, and March, depending on winter conditions and collect phosphorus samples.	Moderate	$0
	3	Check dissolved oxygen and temperatures once per month from May - September.		
B. Water clarity	1	Secchi disc taken at spring and fall turnover.	Low	$0
	2	Secchi disc monitoring once per month May - October.	Low-moderate	$0
	3	Secchi disc monitoring twice per month, May - October.	Moderate	$0
C. Water chemistry	1	Spring and fall turnover samples are collected and sent to UW-Stevens Point. Selected parameters for analysis include: TP and chlorophyll.	Low	$200
	2	Sample for phosphorus and chlorophyll once per month from May - September (surface water only) with the Self-Help Monitoring Program.	Low-moderate	$300
	3	Sample for phosphorus and chlorophyll twice per month from May - October.	Moderate	$600
	4	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N once per month (May-October)	Moderate	$960
	5	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N twice per month (May-October).	Moderate	$1,920
D. Special samples or surveys	1	Special monitoring: suspended solids, BOD, chloride, turbidity, sampling bottom water, and other parameters as appropriate. Aquatic plant surveys, etc.	--	$100-$3,000

A recommended monitoring program consists of Level A1, B3, and C annually. An aquatic plant survey (Level D1) should be conducted every three years.

- Currently, Secchi disc measurements and lake phosphorus and chlorophyll samples are being collected for all three lakes.
- A lake sediment study is also recommended.
- A follow-up study should be conducted in 3 to 5 years.