Lost Lake Planning Grant Report
February 2004

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Physical Description

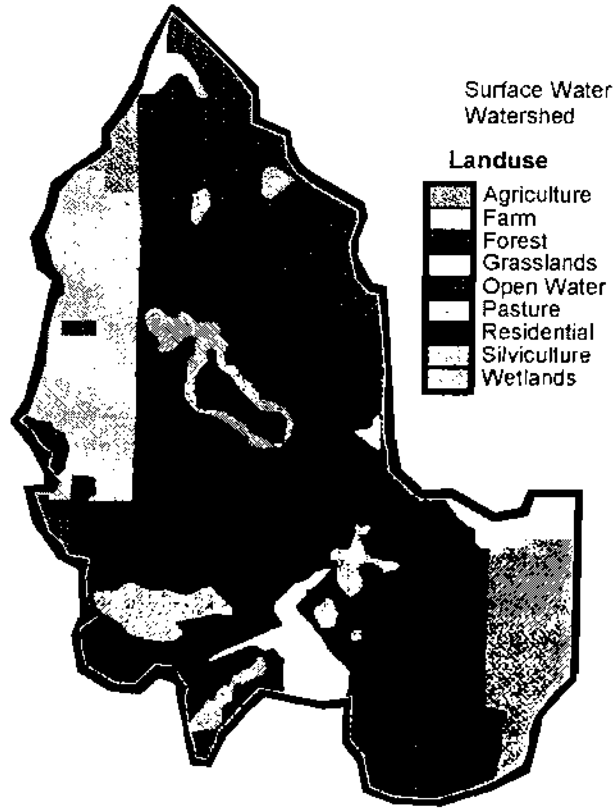
Lost Lake is a 60-acre groundwater drainage lake located in northeast Polk County. For an area that is becoming highly developed because of its 100-mile locale to the Twin Cities, Minnesota, Lost Lake remains completely undeveloped. One property owner owns the land surrounding the lake and has kept native vegetation surrounding the lake for a minimum 150-foot buffer. Lost Lake is one of three undeveloped lakes greater than 50 acres in Polk County and offers a prime opportunity to study a relatively pristine lake.

The lake has a surface area of 60 acres and a maximum depth of 40 feet. The bathymetric map shown at the right was created by LWRD staff and shows two-foot contour intervals. Lost Lake is located in the Upper Apple River Watershed, part of the larger St. Croix River Basin. The general soils surrounding the lake are described as Rosholt-Cromwell-Menahga. They are nearly level to very hilly, well-drained and somewhat excessively drained loamy and sandy soils on pitted outwash plains. An unnamed stream flows south from Lost Lake approximately a half mile to Big Blake Lake, connecting it to Fox Creek and the Apple River. Big Blake Lake has been documented in a 1981 DNR feasibility study and a 1998 Barr Engineering Macrophyte Survey to contain the exotic curly leaf pondweed. The integrity of Lost Lake's ecosystem is at risk if curly leaf pondweed establishes itself in Lost Lake.

Surface Water Watershed and Associated Land Use

The surface watershed was delineated to determine the study area of this project. Approximately 772 acres drain directly to Lost Lake. This area includes an unnamed lake to the northwest approximately 9 acres in size. The topographic map shows there is an area of concentrated flow from the unnamed lake to Lost Lake. The watershed to lake area ratio is 13:1. Because the surface watershed is so large, it is important to the water quality of the lake. Surface water commonly carries sediments and nutrients from the watershed to the lake. These nutrients, if available in elevated amounts, can trigger a change in the lake, disrupting its present balance. Lost Lake would be sensitive to development of the surrounding land because of the increase of nutrients to the lake.

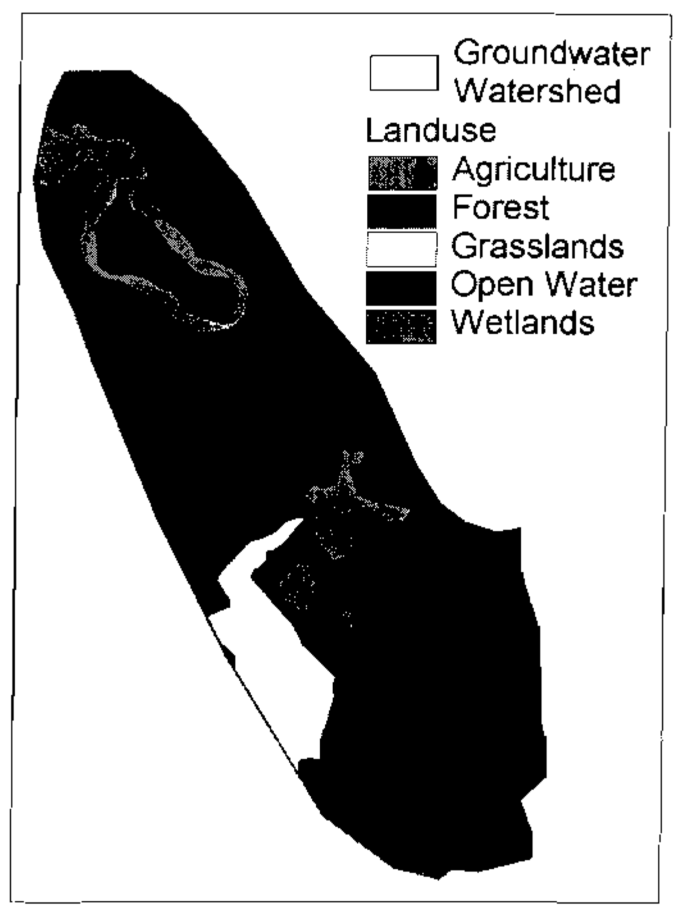
Within the 772 acres of the surface watershed, approximately 461.3 acres are forested (59.8 %), 82.3 acres are silviculture (10.7%), 72.2 acres are open water (9.4%), 58.9 acres are wetlands (7.6%), 56.8 acres are agriculture (7.4%), 24.2 acres are grassland (3.1%), 9.0 acres are pastureland (1.2%), 3.5 acres are farmstead (0.5%), and 3.4 acres are residential land use (0.4%).



Sensitive areas were noted within the watershed. Steep slopes perimeter the east and west sides of the lake. The north and south sides of the lake are mainly marshy wetlands with a diverse emergent vegetation community. Wetlands are also scattered throughout the watershed. It is known that Native American burial mounds can be found within the watershed and provide an interesting cultural resource.

<u>Groundwater Watershed and Associated Land Use</u>

The groundwater watershed is also an important land area to Lost Lake as it is groundwater fed. The groundwater watershed is approximately 275 acres and flows northwest to southeast into Lost Lake. The groundwater watershed is contained entirely within the surface water watershed, and the land use is comprised of 161.0 acres of forestland (58.8%), 71.3 acres of open water (25.9%), 23.9 acres of wetland (8.9%), and 18.8 acres of grassland (6.8%). This watershed is largely undisturbed and is important to the recharge water of the lake.

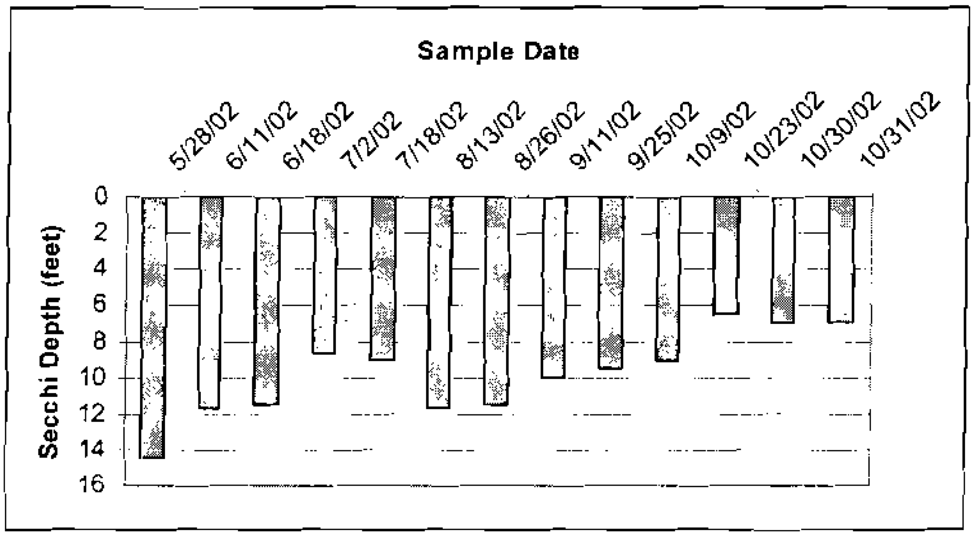


Water Quality

As no historical water quality data can be found on Lost Lake, this study provides a baseline of comparison for future years. Sampling and monitoring for this study included water clarity, temperature and dissolved oxygen profiles, water chemistry, turnover samples, lake sediments, a watershed biodiversity survey (including exotic species inventory), and lake nutrient modeling.

Water Clarity

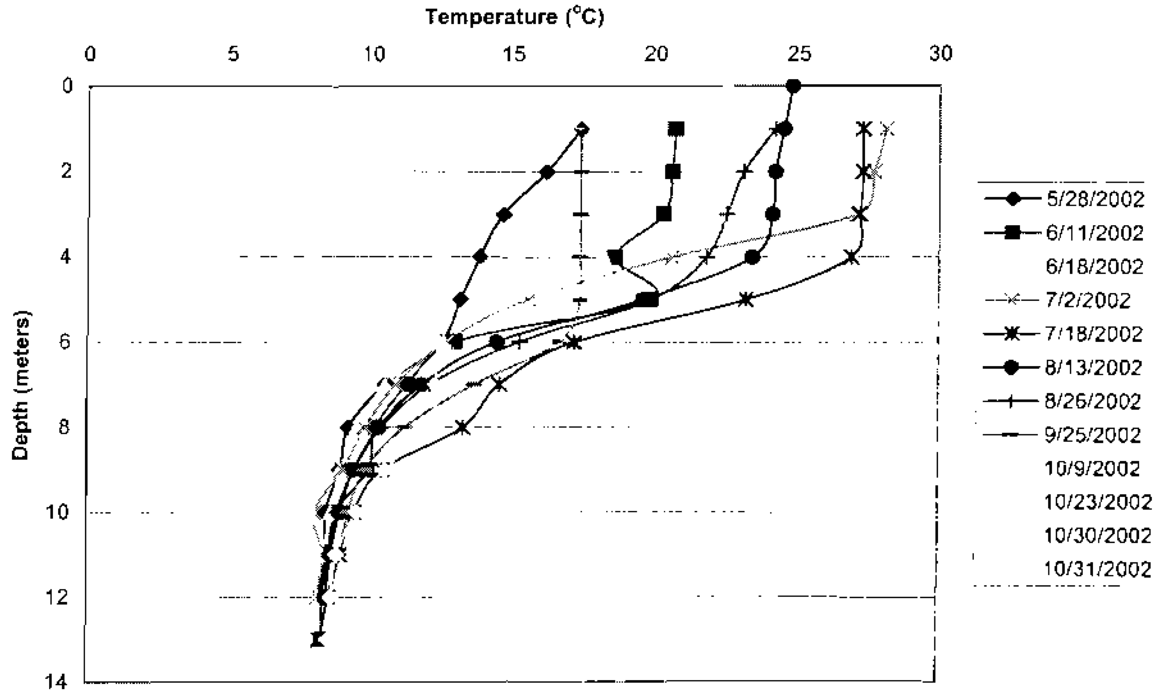
The water clarity of Lost Lake was measured during the summer season of 2002 and 2003 using a Secchi disk. Approximately biweekly from May to October, LWRD staff recorded the Secchi depth. The following figure shows the values and changes throughout the 2002 season.



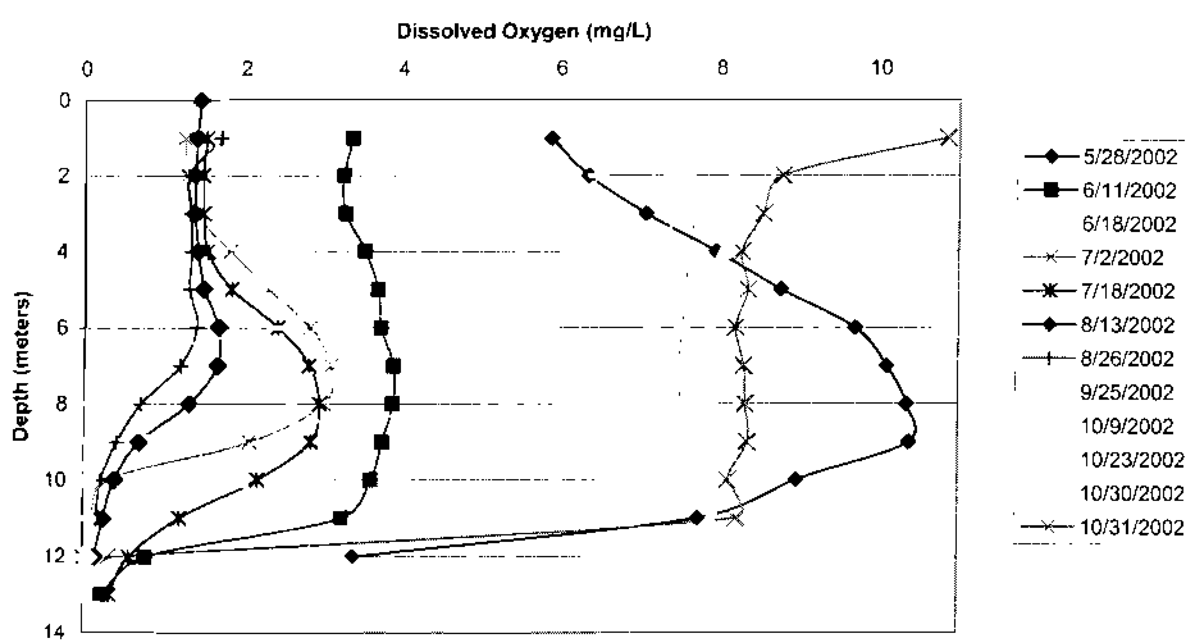
According to Shaw, et al. (2002), the water clarity of Lost Lake is good. The average Secchi depth in 2002 was 9.8 feet.

Temperature and Dissolved Oxygen Profiles

Lost Lake is a dimictic lake typical of a northern temperate lake. Lost Lake is deep enough to stratify during the summer season, clearly forming three distinct layers.



During overturn (early spring and late fall), the temperature of the water column becomes uniform, and oxygen reaches even the bottom depths. The temperature of Lost Lake warmed to 28.1°C at the surface on July 2, 2002, then gradually cooled throughout the rest of summer. The dissolved oxygen profile of Lost Lake also shows the presence of algae with a positive heterograde curve during early and mid summer.



The water column from mid summer to the end becomes nearly devoid of oxygen. Dissolved oxygen concentrations are anoxic (less than 2 mg/L) from June 18 to August 26 unless increased by photosynthesis. Low oxygen concentrations are important not only because they restrict wildlife, but also in that this condition may allow phosphorus to be released from lake bottom sediments as the benthic chemistry is changed.

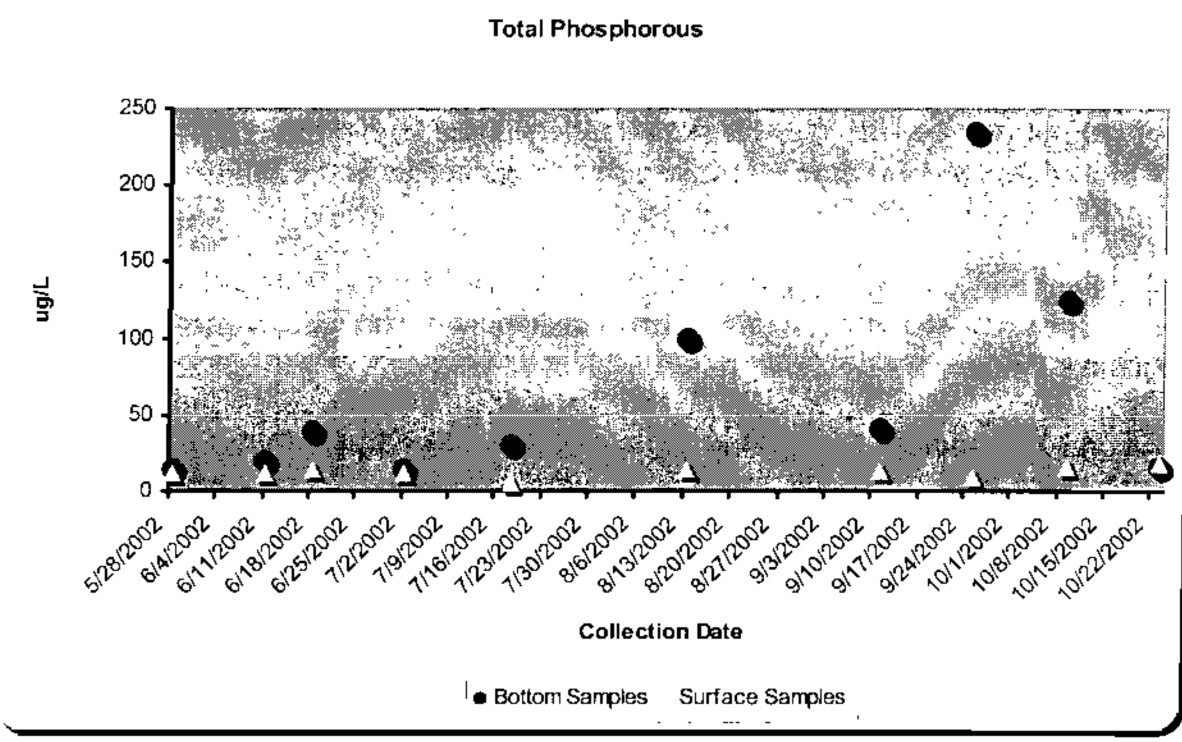
Water Chemistry

Phosphorus

Phosphorus is considered the limiting nutrient in more than 80% of Wisconsin's lakes and affects the amount of plant and algae growth in the lake. The total phosphorus (TP) of Lost Lake averaged 13 μg/L at the surface during the summer months of 2002 and 2003. This number is very good for natural lakes, and classifies Lost Lake as an oligotrophic to mesotrophic lake. Oligotrophic lakes are generally clear, deep lakes with a low level of nutrients. They typically do not support a large fish or macrophyte population. Mesotrophic lakes contain more nutrients, and thus, more fish and macrophytes. Lost Lake is somewhere between these two categories.

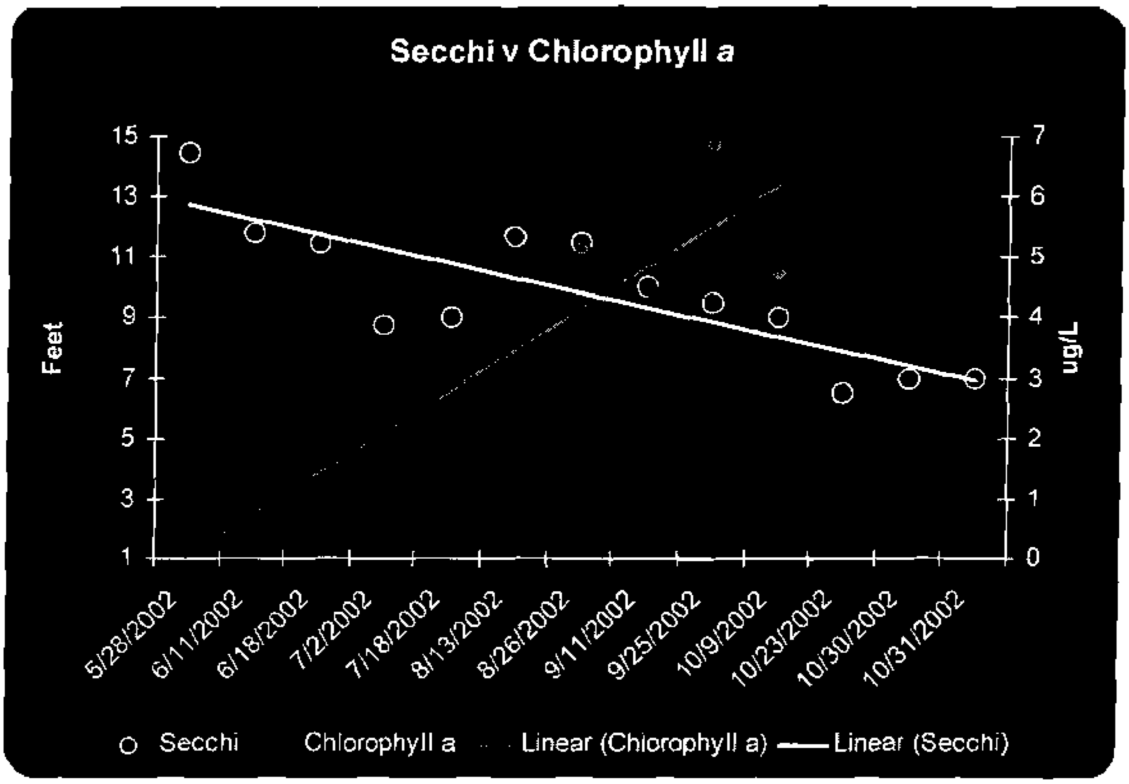
During turnover events when lake water is mixed, sediments or organic material, which may contain phosphorus, are suspended in the water column and counted in the TP value. The average turnover TP concentration for 2003 was 20 μg/L. Shaw et al. (2002) recommends that lakes have a total phosphorus concentration below 20 μg/L to prevent nuisance algal blooms.

When the dissolved oxygen at the bottom of a lake is depleted, the chemistry of the bottom water changes. Redox conditions cause nutrients to dissolve and become chemically available. The bottom layer of Lost Lake was sampled during 2002 to assess how much phosphorus was present under limited oxygen. Bottom phosphorus concentrations ranged from 15 μg/L to 234 μg/L. The following graph shows the range of phosphorus concentrations throughout the summer in Lost Lake. This phosphorus could be utilized by algae or macrophytes if the phosphorus assimilates into the rest of the water column. This source of phosphorus is termed internal loading, but its effects have not been evaluated on Lost Lake. Phosphorus concentrations collected over more seasons would give a better indication of any changes occurring in Lost Lake.



Chlorophyll *a*

Chlorophyll *a* gauges the amount of algae in the water of a lake. Algae and other microorganisms are a natural part of a lake's e cosystem, composing the base of the food chain. Dense growths of algae are mainly an aesthetic problem of lakes, unless certain species are present which release toxic biproducts. Chlorophyll *a* concentrations often correspond to phosphorus concentrations and Secchi depth measurements. Additions of phosphorus will typically increase the amount of algae in a lake. And a dense growth of algae will inhibit light penetration, affecting the water clarity (thus, Secchi depth) of a lake. The following graph shows Secchi depth measurements versus chlorophyll *a* concentrations in Lost Lake. The trend lines indicate that as the chlorophyll *a* increases, the water clarity decreases.



Nitrogen

Nitrogen was analyzed in the form of nitrate-nitrite on the samples collected in 2003. Concentrations were low in the lake water, not being detected on two of the three samples. The third sample, taken August 20, 2003, had a NO_2+NO_3 concentration of less than 0.034 mg/L. This does not appear to impose problems for Lost Lake.

Turnover Samples

Three turnover samples were collected on Lost Lake, and additional parameters were analyzed for these samples. Turnover samples give us an overview of the characteristics of the lake water quality without being influenced by biological processes. A complete listing of the water quality data can be found in the appendix.

Lost Lake is considered a soft water lake, having an average total hardness concentration of 36 mg/L as $CaCO_3$. The cations (positively charged ions) that typically make up the total hardness value, namely calcium, magnesium, potassium, and sodium, readily bind with nutrients or anions (negatively charged ions). Since the cation content of the lake water is low, this makes the lake sensitive to an increase in nutrients. Any change in the land use of the watershed which would increase the nutrient loading to the lake could rapidly cause the lake to become eutrophic.

Lost Lake has an average alkalinity of 35 mg/L as $CaCO_3$. This means that there is enough carbonate in the lake system to buffer effects of acid rain, and the lake is not sensitive to acid rain.

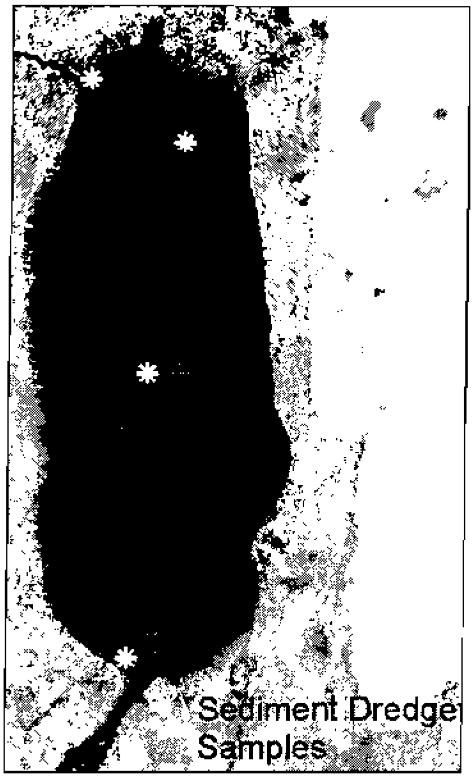
The nutrients in Lost Lake are relatively low compared to other lakes of the region. The average total nitrogen found during turnover samples was 0.51 mg/L. The total phosphorus averaged 12 μg/L. Potassium, the third most important nutrient to plants, had an average concentration of 0.4 mg/L. Another ion measured was chloride (average 2.0 mg/L), which can indicate the influence of human disturbance at high levels. The chloride also appears to be in check on Lost Lake. The color of Lost Lake reflects the type and amount of dissolved organic chemicals in the water. The color at turnover was 15 standard units, which is considered low. Turbidity, which is caused by particles of matter in the water column, was also low at 5.3 NTU.

Lake Sediments

Lake sediments are an important part of a lake ecosystem because they host benthic organisms and aquatic plants, receive organic and sediment deposits from the lake and watershed, and can act as a source of nutrients to the lake.

Lake sediments were collected from Lost Lake in 2002 with a Ponar dredge. The samples were sent to the Soil & Forage Analysis Lab in Marshfield. The samples were analyzed for percent total nitrogen, percent dry matter, percent total phosphorus, and total minerals.

	TN %	% Moisture	TP %	Ca %	Fe ppm
Lost-1	2.2	94.5	0.10	0.61	36500
Lost-2	1.8	91.7	0.06	0.56	57826
Lost-3	2.0	91.6	0.08	0.57	54600
Lost-4	1.6	91.7	0.04	0.40	26580



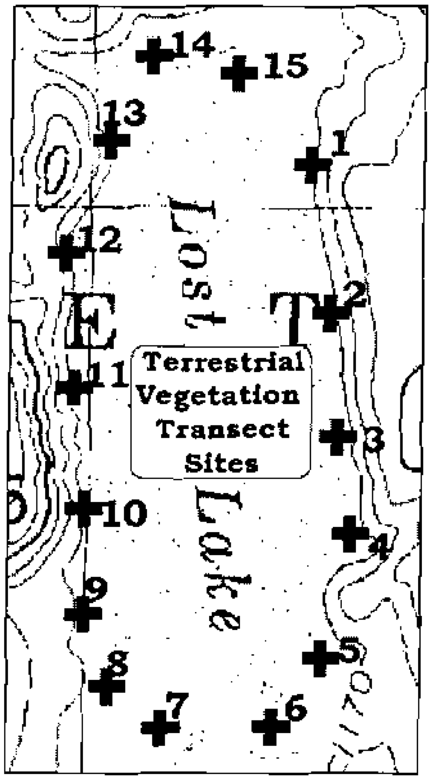
Sample 1 seems to be an area of accumulation on the lake. All parameters except iron have a slightly higher value than the other sites. Total nitrogen, phosphorus, and calcium are ions that bind with solids. The higher percent moisture also tells us that this site has relatively more organic matter than the other sites, indicating an area of deposition of plant material and other solids.

Sample 4 has the lowest amount of TN, TP, calcium, and iron. Conversely, this site may be flushed by wave action or wind, or may not have nearby vegetation contributing to the nutrients. The lower concentration of iron indicates there is not as much decomposition going on as at the other sites (redox conditions are not as low). All samples have relatively the same composition, but a few characteristics of the lake give slightly different values. The high percent moisture in the sediment samples of the lake indicates the sediment was very mucky and finely decomposed. A sample with a much lower percent moisture would have more sand, pebbles, or silt and less of the organic matter that is found in Lost Lake.

Watershed Biodiversity Survey

Terrestrial Survey

The riparian zone of Lost Lake is an incredibly diverse ecosystem that is both ecologically and hydrologically important. This community is an incredible transition from a floating sedge meadow on the lake edge to upland second growth forest.



The objective of the terrestrial vegetation survey was to assess biodiversity in the plant community of theriparian zone. The vegetation survey was carried out August 20, 2002. Fifteen sampling points were established around the lake. Transects lines were set at the shore and extended landward 40 feet. The vegetation was then assessed every 10 feet along the transect in a one-meter square.

Each species in the sampling area was identified, and the approximate density of each species was estimated within the meter square. The results can be used to determine species composition or dominance of a species at a site or certain community. The communities were then evaluated using the Shannon-Wiener Diversity Index to find the riparian average biodiversity.

One hundred fifteen (115) species were found in the sampling areas. A dominance matrix was not run on the results because there was such an assortment in the species, from lowland, marshy plants to upland trees and shrubs. The rich plant community of Lost Lake's watershed is most likely an invaluable part of the lake's e cosystem, particularly to birds, small mammals, and herpetiles. In order to protect the lake, the riparian community needs to be protected. The plant community within the watershed should continue to be monitored to ensure a healthy ecosystem and gauge the effectiveness of management techniques. A major disturbance to the natural community of Lost Lake could be detrimental to its ecosystem and the surface and groundwater quality. Spring sampling would also increase the number of species found.

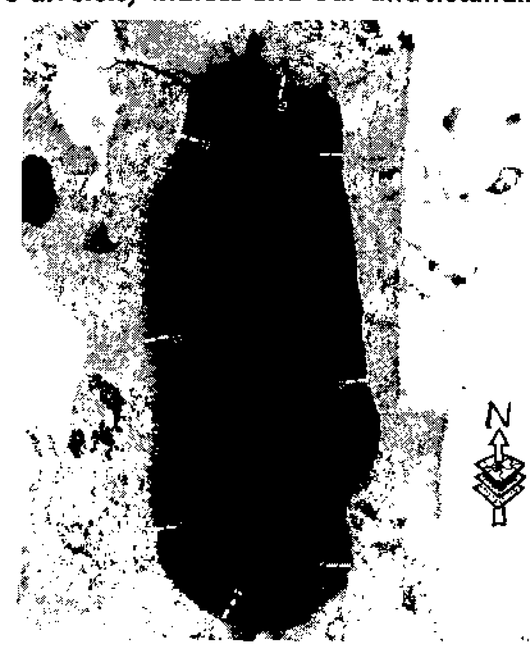
The Shannon-Wiener Index is based on information theory and determines how difficult it would be to correctly predict the species of the next individual collected. This, in turn, tells us how diverse the plant community is. A number close to 1 indicates that an individual could easily predict correctly the next plant collected, which means there is low diversity in the lake. A higher number indicates a more diverse lake. The Shannon-Wiener Index uses the equation:

$$H = -\sum_{i=1}^{s}(p_i)(\log_2 p_i)$$

Where H = Shannon-Wiener Diversity, $\sum$ = sum of species, s = the number of species, p_i = the proportion of individuals of the total sample belonging to species i, calculated as ni/N for each species i with ni being the number in species i and N being the total number of individuals in the sample (Barbour, et al, 1987). Because the total number of individuals was not determined in this survey, the density of the species was substituted for the total number. It was thought that the density of the species would accurately represent the population of each individual species.

The Shannon-Wiener diversity index for Lost Lake was calculated to be 4.4. As the watershed has little human impact and is dominated by forest, this is to be expected. The actual diversity rating is probably slightly higher than calculated as other species, such as Indian Pipe (*Monotropa uniflora*), trillium (*Trillium grand iflorum*), woodland sedges, and many others, were observed in passing but were not collected in the transects. Additional monitoring would improve diversity indices and our understanding of the riparian community.

Aquatic Macrophyte Survey



The aquatic macrophyte survey was carried out on Lost Lake August 25-27, 2002, to assess the aquatic ecosystem biodiversity. Seven sampling points were established around the lake approximately every 1000 feet. Transects lines were set at the shore and extended seaward 100 feet, as shown in the figure to the right.

The method used to assess aquatic macrophytes was to snorkel to the bottom of the sampling point and remove all vegetation present in a 1/16-m^2 sample. The macrophytes were brought to the surface. Each species in the sampling area was identified, and the approximate density of each species was determined (e.g. seven-angle pipewort *(Eriocaulon aquaticum)*, density of 4) by placing all of the species on a 12 x 18" tray broken into 24 equal squares. Density was determined by the coverage of the plant species on the squares. This method can then be used to determine species composition or dominance of a species at a site or certain water depth. The results were evaluated using three different indices or metrics, the Floristic Quality Assessment, Shannon-Wiener Diversity Index, and the Frequency of Occurrence.

The Frequency of Occurrence (FO) is defined as the number of sites along all transects that the species occurred in divided by the total number of sites in the lake with vegetation, expressed as a percent. The FO showed that fern-leaved pondweed *(Potamogeton robinsii)* was the dominant species during this sampling event, occurring at 75.4% of the intervals. However, there were several species with a FO of more than twenty percent, including watershield *(Brasenia schreberi)* at 40.4%, water celery (*Vallisneria Americana*) at 35.1%, coontail (*Ceratophyllum demersum*) at 31.6%, large leaved pondweed *(Potamogeton amplifolius)* at 21.1%, and common waterweed *(Elodea Canadensis)* at 21.1%.

Clasping leaf pondweed *(Potamogeton robbinsii)* was by far the densest species in Lost Lake. The relative amount was two fold denser than any other species in the survey. Twenty-six (26) species total were found in the aquatic macrophyte survey.

The Shannon-Wiener Diversity Index was also calculated for the aquatic macrophytes. Because the total number of individual plants of each species was not determined in this survey, the density of the species was substituted for the total number. It was thought that the density of the species would accurately represent the population of each individual species. The Shannon-Wiener diversity index was calculated to be 2.6. Again, the lake has little human impact and is completely buffered by forest, resulting in a relatively high diversity rating. The actual diversity rating is probably slightly higher than calculated as other species, such as white stemmed pondweed *(Potamogeton praelongus)*, where observed in passing but were not collected. Additional monitoring would improve diversity indices and our understanding of the aquatic plant community.

The Floristic Quality Index was also determined to assess the quality of the macrophyte community in Lost Lake. The Floristic Quality Index is designed to evaluate the closeness of the flora in an area to that of an undisturbed condition. It can be used to identify natural areas, compare the quality of different sites or locations within a single lake, monitor long-term floristic trends, and monitor habitat restoration efforts. This is an important assessment in Wisconsin because of the demand by the Department of Natural Resources (DNR), local governments, and riparian landowners to consider the integrity of lake plant communities for planning, zoning, sensitive area designation, and aquatic plant management decisions (Nichols, 1999).

Using the equation $I = \overline{C}\sqrt{N}$ (where I is the floristic quality, $\overline{C}$ is the average coefficient of conservation (obtainable from http://www.botany.wisc.edu/wisflora/FloristicR.asp) and $\sqrt{N}$ is the square root of the number of species), the floristic quality of Lost Lake was determined to be 31.56. The average for this area of Wisconsin (North Central Hardwood Forest) is 17 to 24.4 with a median of 20.9. Lost Lake appears to be a completely undisturbed lake. The floristic quality of Lost Lake is more than likely so high because such high quality species such as buttercup *(Ranunculus sp.)* and bladderwort *(Utricularia sp.)* were collected, which are sensitive to disturbance.

The rich aquatic plant community of Lost Lake is most likely an invaluable part of the lake's ecosystem, particularly to invertebrates and fish. In order to protect the lake, the aquatic plant community needs to be protected. The aquatic plant community should continue to be monitored to ensure a healthy ecosystem and gauge the effectiveness of management techniques. A major disturbance to the macrophyte community of Lost Lake could be detrimental to its ecosystem.

Woody Debris

Another measure of habitat for fish and aquatic wildlife is the amount of coarse woody debris in the riparian area. Coarse woody debris (CWD), such as fallen logs and limbs, supply a place for floating plants to root, structure and hiding places for fish, sunning locations away from predators for small animals, and habitat for insects which provide food. CWD has increasingly been discovered as prime habitat and essential for the aquatic community. Measurements were not taken on Lost Lake during this grant, but current conditions seem to be adequate to support fish and aquatic wildlife. Further studies should be conducted to assess woody debris on Lost Lake.

Lake Nutrient Modeling

The Wisconsin Lake Modeling Suite (WiLMS) was used to model current conditions, pre-development conditions, and projected development conditions for Lost Lake's watershed. Phosphorus was the key parameter in the modeling scenarios, because it is the limiting nutrient for algal growth in most lakes.

The following tables were based on annual external source loading estimates and the Nurnberg model for estimating gross internal loading. The models that appeared to be the best "fit" for Lost Lake were the Reckhow Natural Lake Model (1979) and the Vollenweider Shallow Lake Model (1982). The Reckhow model calculates growing season concentrations. The Vollenweider calculates a spring turnover and growing season average. Both models estimate phosphorus concentrations in the water column.

Table 1. Lost Lake Current Conditions Prediction

Annual Total P Loading	Reckhow, 1979 Natural Lake Model Predicted P []	Vollenweider, 1982 Lake Model Predicted P []
72 kg	17 μg/L	26 μg/L

Table 2. Lost Lake Projected Development Conditions Prediction

Annual Total P Loading	Reckhow, 1979 Natural Lake Model Predicted P []	Vollenweider, 1982 Lake Model Predicted P []
206 kg	49 μg/L	64 μg/L

Table 3. Lost Lake Undeveloped Conditions Prediction

Annual Total P Loading	Reckhow, 1979 Natural Lake Model Predicted P []	Vollenweider, 1982 Lake Model Predicted P []
39 kg	9 μg/L	15 μg/L

Tables 1, 2 and 3 indicate that prior to European settlement of the watershed, Lost Lake had a phosphorus concentration of 9 μg/L versus the modeled and observed concentration today of 17 μg/L and 12 μg/L, respectively. Maintaining the current in-lake phosphorus level in Lost Lake is an attainable management goal. Such a level would maintain water clarity and ensure a quality lake for generations.

The projected development condition bodes grim for Lost Lake. The projected development condition assumes that all forestland (67% of the Lost Lake watershed) will be converted into low density rural residential (approximately 1 house per 2 acres). The annual phosphorus loading to the lake would more than double from 72 kg/yr to 206 kg/yr. It is not unreasonable to assume that 40% of the developable forestland and cropland will eventually be converted, as it is possible under the current zoning law. The predicted 64 μg/L in-lake phosphorus concentration for a developed lake would likely bring nuisance algal blooms and decaying scums on the water's surface. Therefore, a majority of efforts should be focused on maintaining the undeveloped conditions of the shoreline and the natural state of the watershed.

The implementation of best management practices (BMPs) or the use of permanent conservation easements throughout the watershed, and especially in the riparian areas, would allow the phosphorus concentration to remain low in the lake. Continuing to limit boat traffic on the lake could also further reduce internal phosphorus loading. The empirical models in WiLMS estimate that internal loading makes up approximately 16% of the total phosphorus in the water column.

Management Implications

Lost Lake is a very unique lake in Polk County. Nutrient levels are low in the lake, and nutrient loading in the watershed is low because of its undeveloped status. The lake is currently classified as an oligotrophic lake. Lost Lake is a soft water lake and may not have a lot of ionic bonding capacity to buffer nutrients if the lake is exposed to future development. The lake would rapidly accelerate to a eutrophic condition because of the anthropogenic influence.

Therefore, it is in the best interest of the water quality of the lake and its ecosystem to remain in a natural state and be further protected. The lake currently has a vegetative buffer of 150 feet minimum surrounding the lake, which inhibits sediments from reaching the lake, reduces shoreland erosion, and provides critical habitat. Putting this riparian land into a conservation easement to forever protect it will no doubt protect the lake. Maintaining the vegetative buffer would also prevent the infestation of invasive species.

Continued monitoring of the lake and surrounding watershed would be a great educational resource as Lost Lake is one of the few lakes in Polk County that remain in a native state. Baseline data should be established on the lake for use as a comparison for developed lakes in Polk County to realize their potential. Monitoring of the ecosystem could also indicate to lake managers the importance biological components have on water quality.

References

Nichols, Stanley A. 1999. *Journal of Lake and Reservoir Management* 15:133-141.

Shaw, B., C. Mechenich, and L. Klessig. 2002. Understanding Lake Data. UW Extension SR-02/2002-1M-525

Turnover Data

Date	pH	Condo	Alk	T Hard	NH4	NH3	NO2+NO3	TKN	TP	SRP	K	Na	Cl	Color	Turbidity (NTU)	Ca	Mg	S
11/26/2002	7.54	82	34	35.4		0.099	ND	0.46	0.015	0.003	ND	1.9	2.2	15	1.9	8.9	3.2	ND
5/9/2003	7.6	78	36	38	0.04		0.06	0.79	0.02	0.004	1.2	2	1.5	15	11			
10/29/2003	7.5	83	34	35.7		0.07	ND	0.23	0.019		ND	1.8	2.2	15	3.1	9.2	3.1	

Secchi Depth

2002	Depth (feet)
5/28/2002	14.5
6/11/2002	11.67
6/18/2002	11.5
7/2/2002	8.75
7/18/2002	9
8/13/2002	11.7
8/26/2002	11.5
9/11/2002	10
9/25/2002	9.5
10/9/2002	9
10/23/2002	6.5
10/30/2002	7
10/31/2002	7
Average	**9.82**

Secchi Depth

2003	Depth (feet)
5/7/2003	9.5
7/15/2003	8
8/20/2003	10
9/24/2003	12
10/8/2003	8
10/29/2003	5.75
Average	**8.88**

Phosphorus Samples

Collection Date		TP (ug/L)
5/28/2002	LLSUR	12
5/28/2002	LLBOT	15
6/11/2002	LLSUR	12
6/11/2002	LLBOT	19
6/18/2002	LLSUR	14
6/18/2002	LLBOT	39
7/2/2002	LLSUR	12
7/2/2002	LLBOT	15
7/18/2002	LLSUR	5
7/18/2002	LLBOT	30
8/13/2002	LLSUR	15
8/13/2002	LLBOT	100
9/11/2002	LLSUR	13
9/11/2002	LLBOT	41
9/25/2002	LLSUR	9
9/25/2002	LLBOT	234
10/9/2002	LLSUR	16
10/9/2002	LLBOT	125
10/23/2002	LLSUR	18
10/23/2002	LLBOT	16
10/31/2002	LLSUR	15

Chlorophyll *a* (µg/L)

7/18/2002	1.15
8/13/2002	4.59
9/11/2002	5.13
9/25/2002	4.5
10/9/2002	6.82
10/23/2002	4.75
7/15/2003	3.7
8/20/2003	5.01
9/24/2003	5.19

2003 Data

	Chloro A	TP	NO2+NO3-N
7/15/2003	3.7	0.016	ND
8/20/2003	5.01	0.013	<.034
9/24/2003	5.19	0.011	ND

Sediment Samples

	TN %	% Moisture	TP %	Ca %	Fe ppm	TN:TP	K %	Mg %	S %	Zn %	B ppm	Mn ppm	Cu ppm	Al ppm	Na ppm
Lost-1	2.2	94.5	0.1	0.61	36500	22	0.09	0.11	0.67	76.41	168.5	15710	15.65	3940	289.6
Lost-2	1.8	91.7	0.06	0.56	57826	30	0.1	0.29	0.61	107.52	208.02	1749.5	34.26	13818	175.3
Lost-3	2	91.6	0.08	0.57	54600	25	0.1	0.3	0.61	108.1	197.7	1344	32.03	13890	142.4
Lost-4	1.6	91.7	0.04	0.4	26580	40	0.07	0.27	0.91	63.34	133.9	397.6	30.78	11340	153.1

Lost Lake Profile Monitoring - 2002

Date	Weather	Depth (m)	D.O. (mg/L)	Temp. (^oC)	Conductivity (uS/cm)	Specific Condo	Secchi Reading
5/28/2002		1	5.89	17.4	68	79.4	14.5
		2	6.35	16.2	66.2	79.4	
		3	7.07	14.7	63.8	79.4	
		4	7.95	13.9	62.3	79.1	
		5	8.76	13.2	61.2	79.3	
		6	9.7	12.5	60.1	79	
		7	10.1	10.5	58.6	79.5	
		8	10.35	9.2	56.2	79.8	
		9	10.38	8.9	55.3	80.3	
		10	8.97	8.4	55.4	80.8	
		11	7.74	8.4	56.3	82.5	
		12	3.4	8.2	92.1	137.6	
6/11/2002	Rain the night before	1	3.36	20.7	79.0		11.67
		2	3.25	20.6	79.0		
		3	3.28	20.3	79.7		
		4	3.53	18.6	79.1		
		5	3.71	19.9	79.2		
		6	3.75	13.0	78.8		
		7	3.91	11.3	79.9		
		8	3.90	10.2	81.5		
		9	3.77	9.9	82.0		
		10	3.62	8.8	89.6		
		11	3.25	8.5	88.2		
		12	0.78	8.3	184.7		
		13	0.23	8.3	214.8		
6/18/2002		0	1.72	22.5	75.4	79.3	11.5
		1	1.70	22.4	75.4	79.3	
		2	1.69	22.4	75.4	79.4	
		3	1.70	22.2	75.1	79.4	
		4	2.11	18.2	68.6	79.1	
		5	2.52	14.5	62.7	78.9	
		6	2.70	12.6	60.2	79.2	
		7	2.81	10.5	57.7	80.1	
		8	2.61	9.5	57.6	82.2	
		9	2.48	8.9	57.8	83.6	
		10	2.0	8.6	59.9	87.6	
		11	0.92	8.3	63.1	92.8	
		12	0.15	8.1	127.3	199.5	
7/2/2002	Overcast. 90 degrees.	1	1.24	28.1	84.3	79.5	8.75
		2	1.28	27.7	83.5	79.4	
		3	1.38	27.1	82.7	79.4	
		4	1.82	20.6	71.9	79.5	
		5	2.31	15.6	65	79.7	
		6	2.84	12.7	60.7	79.4	
		7	3.11	10.9	60	82	
		8	3.02	9.8	58.9	83	

Date	Weather	Depth (m)	D.O. (mg/L)	Temp. (°C)	Conductivity (uS/cm)	Specific Condo	Secchi Reading
		9	2.08	9	59.2	85	
		10	0.29	8	63.7	91.2	
		11	0.12	8.3	67.5	99.4	
		12	0	8.1	137.3	203.4	
7/18/2002		1	1.51	27.3	83.8	80.1	9
		2	1.47	27.3	83.7	80.1	
		3	1.48	27.2	83.5	80.3	
		4	1.53	26.9	82.9	80.2	
		5	1.84	23.2	75.3	79.5	
		6	2.43	17.2	66.0	78.7	
		7	2.83	14.6	62.5	79.7	
		8	2.96	13.3	60.5	81.5	
		9	2.85	10.4	60.0	89.1	
		10	2.18	9.4	62.3	88.9	
		11	1.20	8.9	68.2	99.1	
		12	0.57	8.5	76.0	111.3	
		13	0.33	8.2	122.8	183.8	
8/13/2002		0	1.43	24.8	77.5	77.8	11.7
		1	1.39	24.5	76.8	77.7	
		2	1.38	24.2	76.5	77.7	
		3	1.37	24.1	76.3	77.7	
		4	1.41	23.4	74.8	77.2	
		5	1.49	19.6	70.8	79.5	
		6	1.68	14.5	64.2	80.9	
		7	1.67	11.8	61.6	82.3	
		8	1.32	10.3	69.2	89.6	
		9	0.69	9.4	75	106.9	
		10	0.39	8.9	84.3	122	
		11	0.25	8.6	90.1	131.4	
		12	0.14	8.4	115.9	169.3	
8/26/2002		1	1.69	24.2	76.1	77.2	11.5
		2	1.3	23.1	74	76.8	
		3	1.32	22.5	73	76.8	
		4	1.33	21.8	72.1	77	
		5	1.31	19.9	69.8	77.5	
		6	1.41	15.3	65.9	81.1	
		7	1.21	12.1	63.2	84.1	
		8	0.72	10.4	66.5	92.3	
		9	0.42	9.4	77.8	111	
		10	0.22	8.8	87.7	127	
		11	0.16	8.6	91.4	133.2	
9/11/2002	No wind, sunny	1		23.5			10
		2		23.3			
		3		23.3			
		4		22.8			
		5		20.9			
		6		15.6			

Date	Weather	Depth (m)	D.O. (mg/L)	Temp. (^0C)	Conductivity (uS/cm)	Specific Condo	Secchi Reading
		7		12.7			
		8		11			
		9		9.6			
		10		9.1			
		11		8.8			
		12		8.6			
9/25/2002		1	6.26	17.4	65.1	76	9.5
		2	6.45	17.4	65	76.2	
		3	6.16	17.4	65.1	76.3	
		4	6.12	17.4	65.1	76.2	
		5	6.46	17.4	65.1	76.3	
		6	2.42	16.7	67.5	80.7	
		7	0.33	13.7	66.6	86.5	
		8	0.09	11.2	69.6	95.6	
		9	0.06	9.8	83.1	117.5	
		10	0.04	9.2	96.5	138.9	
		11	0.04	8.9	104.4	150.9	
		12	0.01	8.6	127.9	186.8	
		13	0.01	8.5	121.5	177.7	
10/9/2002		1	7.87	13.2	59.4	76.7	9
		2	7.57	13.1	58.4	76.4	
		3	7.43	12.6	58.2	78.4	
		4	7.33	12.5	58.1	76.3	
		5	7.55	12.4	58	76.4	
		6	7.15	12.4	58.2	76.7	
		7	6.98	12.3	58.4	77.3	
		8	5.37	12.1	67.1	91.1	
		9	0.18	10.5	83.6	119.9	
		10	0.03	9.5	102.5	147.5	
		11	0.08	8.8	111.3	161.3	
		12	0.09	8.6	132.3	191.8	
		13	0.02	8.5	180.6	263.7	
10/23/2002		1	7.92	8.1	53.9	79.6	6.5
		2	7.4	8	53.7	79.5	
		3	7.65	8	53.6	79.4	
		4	7.6	7.9	53.6	79.4	
		5	7.57	7.9	53.5	79.4	
		6	7.53	7.9	53.5	79.5	
		7	7.49	7.9	53.5	79.5	
		8	7.51	7.9	53.5	79.4	
		9	7.49	7.8	53.5	79.5	
		10	7.59	7.8	53.5	79.4	
		11	6.32	8	80.5	140.3	
10/30/2002	Windy, cloudy, snow	1	8.41	7.4	52	79.2	7
		2	8.16	7.1	52.2	79.4	
		3	8.02	7	52.1	79.4	
		4	8.03	7	52.2	79.6	

Date	Weather	Depth (m)	D.O. (mg/L)	Temp. (^0C)	Conductivity (uS/cm)	Specific Condo	Secchi Reading
		5	7.81	7	52.2	79.6	
		6	7.88	7	52.2	79.6	
		7	7.88	7	52.2	79.5	
		8	7.86	7	52.2	79.5	
		9	7.87	7	52.2	79.6	
		10	7.9	7	52.2	79.6	
		11	7.89	7	52.2	79.6	
		12	5.42	7	52.2	79.6	
		13	4.03	7.1	100	141.8	
10/31/2002	Sunny, cold, windy	1	10.85	7.7	51.2	77.9	7
		2	8.78	7	51.4	78.2	
		3	8.54	6.9	51.2	78.3	
		4	8.27	6.7	51.1	78.5	
		5	8.35	6.6	51.4	79.4	
		6	8.2	6.6	51.5	79.4	
		7	8.3	6.5	51.4	79.4	
		8	8.32	6.5	51.4	79.4	
		9	8.35	6.5	51.4	79.5	
		10	8.11	6.5	51.4	79.5	
		11	8.22	6.5	51.3	79.5	
		12	0.31	6.8	121.8	186.8	

Lost Lake profile monitoring - 2003

Date	Weather	Depth (meters)	D.O. (mg/L)	Temp. (°C)	Conductivity (uS/cm)	Specific Conductance	Secchi Reading
5/7/2003		1	10.11	13.5	61.9	79.7	9.5
		2	10.19	12.8	60.8	79.7	
		3	8.79	12.4	60.4	79.6	
		4	8.53	12.2	60.2	79.7	
		5	8.84	9.9	57.4	81	
		6	9.34	7.7	54	81	
		7	8.34	7	53.2	81.2	
		8	8.17	6.7	52.9	81.4	
		9	7.87	6.5	52.6	81.5	
		10	6.7	6.3	53	82.4	
		11	2.91	6.2	59.4	92.6	
7/15/2003	heavy rain yesterday	1	7.53	23.7	69.6	71.3	8
		2	7.18	23.2	68.7	71.3	
		3	7.07	23.1	68.9	71.6	
		4	6.96	23	68.9	71.6	
		5	6.83	16.6	62.4	74.4	
		6	6.02	12.4	57.3	75.2	
		7	1.83	9.9	60.5	85.5	
		8	0.31	8.9	59.4	86.9	
		9	0.2	7.5	65.3	99.9	
		10	0.16	7	80.4	122.4	
8/20/2003		1	4.59	27.9	78.3	75.6	10
		2	4.8	26.9	78.6	75.8	
		3	4.84	26.8	78.4	75.9	
		4	4.93	23.5	73	75.1	
		5	5.52	18.5	66.2	76	
		6	6.12	14.3	60	77.3	
		7	5.69	11.5	62.8	85.8	
		8	3.03	9.3	63.7	91.9	
		9	0.48	7.9	73.4	108.9	
		10	0.23	7.4	87.8	132.6	
		11	0.2	7.2	94.1	142.8	
		12	0.13	7	129.2	209.2	
9/24/2003		1	4.54	17.1	64.7	76.2	12
		2	4.92	17.1	64.7	76.2	
		3	5.19	17.1	64.6	76.2	
		4	5.28	17.1	64.6	76.1	
		5	5.37	17	64.6	76.2	
		6	5.36	16.9	64.5	76.4	
		7	1.09	11.5	64.9	87	
		8	0.32	9.3	68.9	98.4	
		9	0.14	8.1	80	119.8	
		10	0.11	7.5	93.1	144.4	

Date	Weather	Depth (meters)	D.O. (mg/L)	Temp. (^{o}C)	Conductivity (uS/cm)	Specific Conductance	Secchi Reading
		11	0.1	7.2	119.6	181	
10/8/2003		1	4.7	14.3	59.8	75.7	8
		2	5.15	13.8	59.8	76	
		3	5.21	13.7	59.9	76.6	
		4	4.86	13.5	60.1	77.2	
		5	4.22	12.6	58.7	77.1	
		6	3.36	12.3	58.5	77.2	
		7	3.33	12.4	58.8	77.9	
		8	3.24	11	61	83	
		9	2.36	9.5	74.5	105.1	
		10	0.6	7.7	101	151	
		11	0.28	7.5	102.5	198.8	
		12	0.2	7.4	106.3	155.4	
10/29/2003		1	7.9	9.5	56.9	80.7	5.75
		2	7.82	9.5	57	80.8	
		3	7.71	9.5	57	80.8	
		4	7.56	9.5	57	80.9	
		5	6.77	9.5	57	80.8	
		6	5.84	9.5	57	80.9	
		7	4.93	9.5	57	80.8	
		8	4.5	9.5	57	80.9	
		9	4.39	9.5	56.9	80.9	
		10	4.18	8.5	102.9	151.5	
		11	3.02	7.7	114.1	170.3	
		12	1.07	7.5	161.5	242	