-9-
MANAGEMENT GOALS AND EXPECTATIONS

"We have met the enemy, and he is us."

-- Pogo (a cartoon character created by Walt Kelly)

9-1 RECONSTRUCTION OF HISTORIC LAKE AND WATERSHED CONDITIONS

PALEOECOLOGICAL METHOD

A sediment core is extracted from the bottom of Lake Ripley in 2007.

Understanding Lake Ripley's past can provide clues as to what kind of future we might expect, and what level of improvement might be possible. The lake's water quality has changed through time as a result of changing watershed conditions and land use. This history is well preserved within the deep-water sediment profile of the lake. By extracting and analyzing a sediment core from the lake bottom, a great deal of information can be revealed about trends related to water quality, nutrient loading, watershed erosion rates, sediment infilling, and changes in aquatic plant and algal communities. Paleoecology is the branch of science that analyzes lake-bottom sediment to reconstruct past changes in the lake ecosystem.

Lake Ripley acts like regional settling basin, trapping particles delivered from its watershed or created in the lake itself. Lake sediments then entomb a selection of fossil remains that are more or less resistant to bacterial decay or chemical dissolution. These remains may include diatom frustules, the silica-based cell walls of certain algal species, and subfossils from aquatic plants. In addition to the fossil records, sedimentation rates and certain types of pollution indicators are also preserved in the bottom sediment. The top sediment layers were deposited recently while deeper sediments represent historic lake conditions. Specific layers are dated using a naturally occurring radionuclide, lead-210.

A sediment core was first taken from the bottom of Lake Ripley in 1991, which marked the first year of operation for the Lake District. [1] A second core was taken in 2007, signifying the year after the Priority Lake Project officially ended. [2] These two sediment cores were used to reconstruct the lake's paleoecological history from 1800-2007.

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[1] Wisconsin Department of Natural Resources. 1993. Lake Ripley Paleolimnological Study.
[2] Garrison, Paul J., Pillsbury, R. 2009. Paleoecological Study of Lake Ripley, Jefferson County. Wisconsin Department of Natural Resources, Bureau of Science Services, and University of Wisconsin-Oshkosh, Department of Biology. PUB-SS-1062 2009.

WATERSHED EROSION AND SEDIMENTATION

Key findings indicate that water quality degradation began around the mid- to late-1800s as a result of European settlement and subsequent farming and wetland drainage throughout the watershed. By about 1900, watershed erosion and sediment loading to the lake had dramatically accelerated, causing a corresponding increase in plant and algal production (see Figure 55). An even more dramatic peak in erosion and sedimentation rates occurred around 1940. These two peaks are likely to have been caused by a combination of land-clearing activity, wetland ditching, and stream dredging/channelization that was occurring during those timeframes.

Watershed erosion rates began to stabilize around 1950, and even declined beginning around 1960. This was most likely due to the widespread implementation of soil conservation practices. Around 1970, sediment runoff to the lake and associated nutrient loading increased once again, most likely from residential development, and the lake's water quality again declined. By 1990, water quality had somewhat improved along with declines in watershed erosion, but the lake still remained much worse than it was prior to settlement.

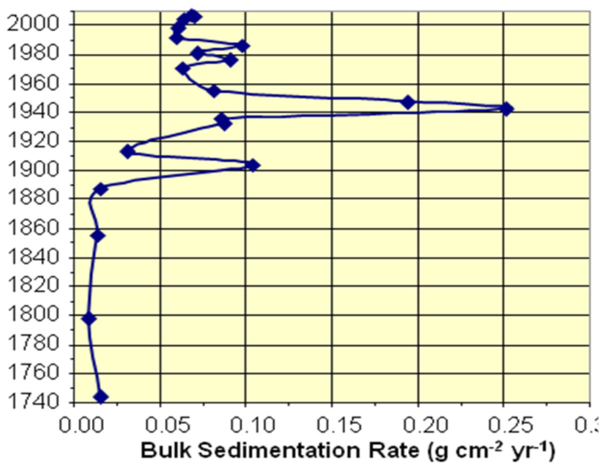


Figure 1: Lake Ripley Sediment Accumulation Rate (1740-2007)

A second sediment core was extracted in 2007 for the purpose of evaluating the impacts of the Priority Lake Project (1993-2006) and other Lake District efforts. Results show clear evidence of water quality improvements and further reductions in watershed-erosion and sedimentation rates over the prior 16 years. In 1990 and 2007, the mean sedimentation rates were 0.074 g cm^{-2} yr^{-1} and 0.069 g cm^{-2} yr^{-1}, respectively. Lake Ripley's mean mass sedimentation rate for the last 200 years (of which half this time was characterized by pre-settlement conditions) was 0.067 g cm^{-2} yr^{-1}. This value is at the higher end of rates that have been measured in 52 Wisconsin lakes (see Figure 56). It may be, in part, due to the fact that Lake Ripley is a marl lake in which calcium carbonate is precipitated during part of the year. Nonetheless, the Priority Lake Project appears to have been successful in reducing erosion rates to their lowest levels since about 1900.

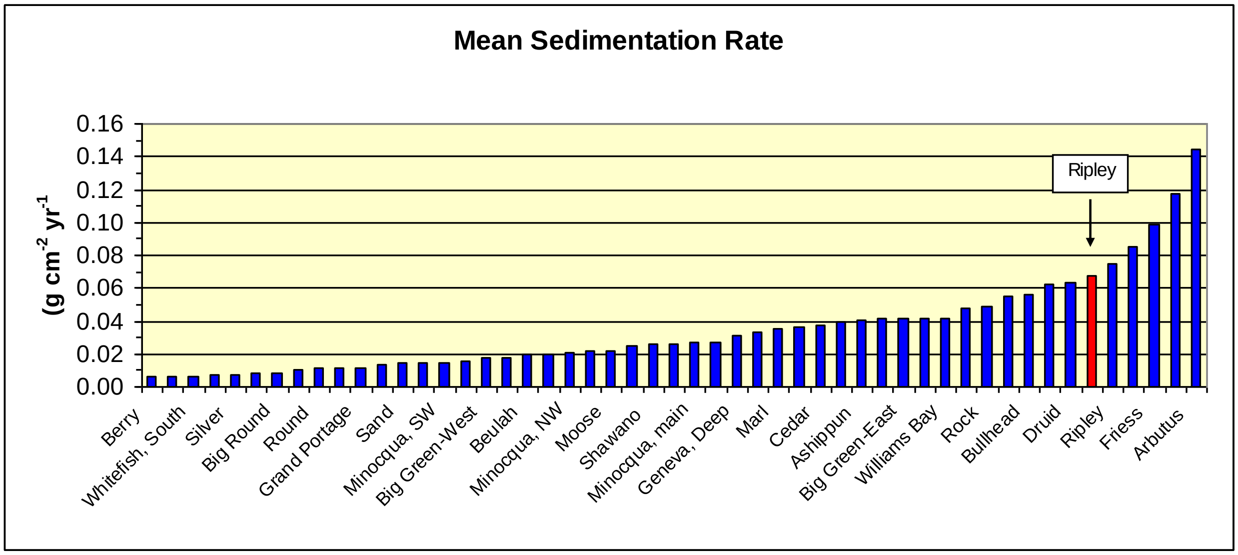
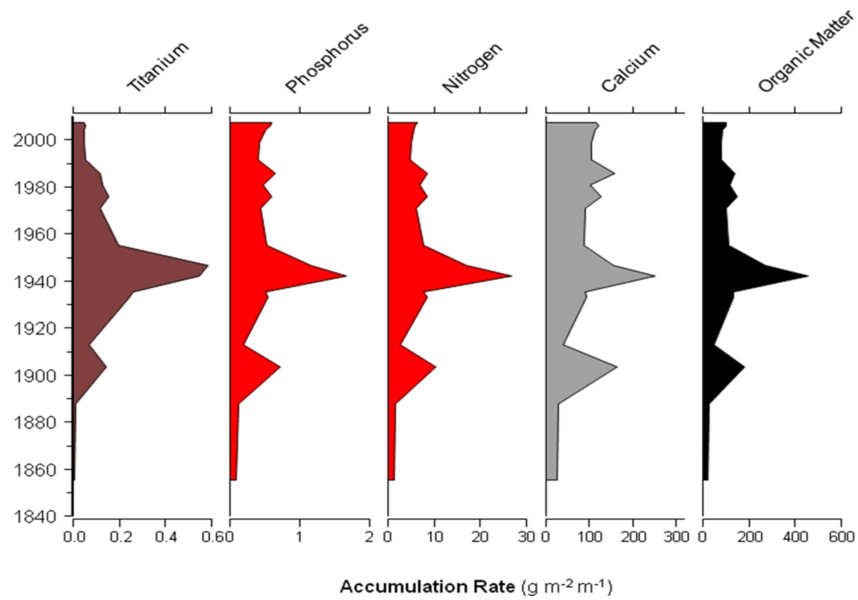


Figure 2: Mean Sedimentation Rate for the last 150 years for 52 Wisconsin Lakes

CHANGES IN NUTRIENT LEVELS

The study also showed a decrease in phosphorus and nitrogen levels (among other geochemical elements) since the mid-1950s and following the 1940 peak, and even further decreases since 1990 (Figure 57). The apparent increase in phosphorus and nitrogen at the top of the core does not indicate an increase in deposition in the last few years but, instead, that diagenesis is ongoing. Diagenesis is the conversion of organic material to other forms. These other forms may be volatile so that the element leaves the system. Phosphorus and nitrogen reductions, however, were not as significant in recent years compared to reductions in soil erosion. Since 1950 and even after 1990, productivity in the form of algal and/or plant growth appears to have increased. This may be the result of generally increasing water clarity combined with nutrient levels that remain elevated compared to pre-settlement times.



Titanium
Phosphorus
Nitrogen
Calcium
Organic Matter
2000
1980
1960
1940
1920
1900
1880
1860
1840
0.0 0.2 0.4 0.6
0 1 2
0 10 20 30
0 100 200 300
0 200 400 600
Accumulation Rate (g m-2 m-1)

Figure 3: Accumulation Rate Profiles of Selected Geochemical Elements for Lake Ripley (1840-2007)

The diatom community (a type of algae) was used to estimate changes in the summer phosphorus levels throughout the core (Figure 58). Pre-1860, phosphorus levels remained low and stable at about 12-13 µg/L, which translates into a pre-settlement TSI of 40. There was a sudden and significant increase around 1900, which corresponds with an early episodic sedimentation event. Phosphorus levels continued to increase and reached their highest points during the period 1940-1990.

The large spike in phosphorus levels in the 1940s was depositional in nature, and most likely related to the dredging and straightening of stream channels during this period. It appears that more phosphorus was delivered to the lake at this time from the watershed, but this did not result in an episodic increase in phosphorus levels within the water column. Much of this increase in phosphorus deposition may have happened over a relatively short time and been in the form of sediment particles that quickly settled to the lake bottom. Diatom evidence suggests that in-lake phosphorus concentrations probably peaked in the 1970s. Since 1990, levels have declined, although they are not as low as pre-settlement estimates. The diatom-estimated phosphorus concentrations at the top of the core (representing the most recent period) are 17-19 µg/L, which closely approximates observed values.

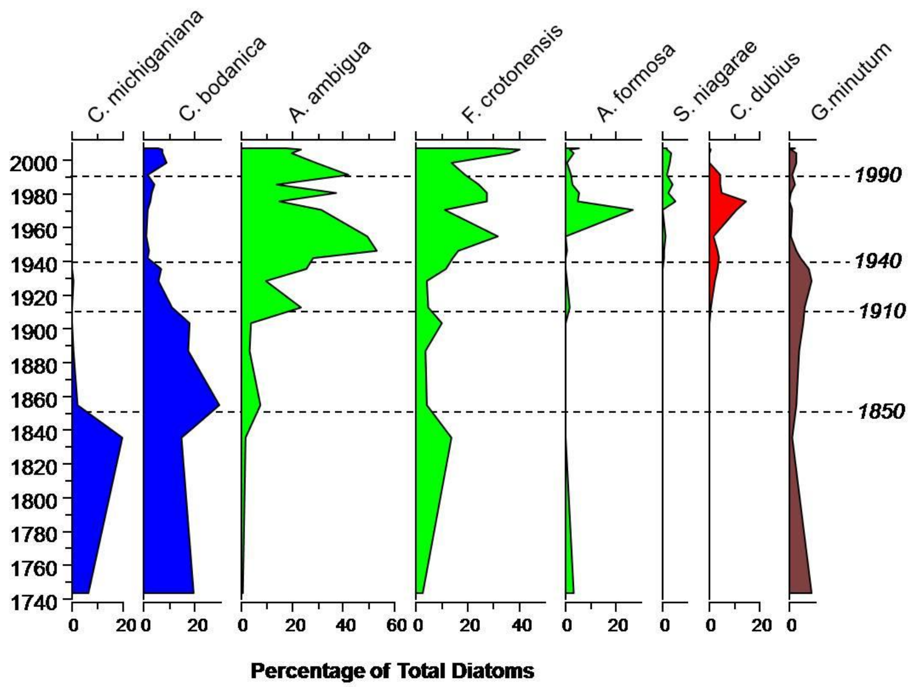


Figure 4: Profiles of Common Diatoms Found in the 2007 Lake Ripley Sediment Core (1740-1997)

Diatoms in blue are indicative of low nutrients, green suggest moderate nutrient levels, and red represent higher nutrient levels. The brown diatom is the only one shown which grows attached to plants. The other diatoms float in open water.

Conclusions

Study findings show that Lake Ripley has been significantly impacted by actions in the lake's watershed. The biggest water quality declines followed periods of major watershed disturbance, while the biggest improvements followed the widespread implementation of soil-conservation and erosion-control practices. Since large portions of the watershed have been permanently altered, it is not feasible for the lake to return to pre-settlement conditions. These conditions were characterized by in-lake total phosphorus concentrations of about 12-13 µg/L, and a corresponding Trophic State Index (TSI) of around 40. However, at a minimum, the lake can be protected from further degradation by limiting those watershed disturbances that cause sediment and phosphorus loading to the lake. At best, loadings could be reduced to the point where the lake shifts to a somewhat lower trophic state, which would lead to increased water clarity conditions and improved lake health.

9-2 POLLUTANT-LOADING AND LAKE-RESPONSE MODELING

METHODOLOGY

Establishing water quality goals requires understanding the relationship between watershed nutrient loading and in-lake phosphorus concentration. This relationship is best described by applying a lake phosphorus response model. Basic computer modeling was used on Lake Ripley to assess existing water quality and its potential for improvement. The Wisconsin Lake Modeling Suite (WiLMS) was selected to estimate phosphorus content, phosphorus loading, and lake trophic response based on various input parameters.[3] WiLMS is a collection of empirical models developed from statistical analyses of regional lake and reservoir systems. It was first used on Lake Ripley as part of a 1994 Water Resources Appraisal conducted by the Wisconsin DNR.[4]

Fixed input variables and model calculations consisted of the following hydrologic and morphometric data: tributary drainage area minus lake-surface area (4,262 acres); lake-surface area (423 acres); lake volume (7,561 acre-feet); lake mean depth (17.9 feet); precipitation minus evaporation calculation (2.8 inches); total unit runoff calculation based on built-in default data for Jefferson County (7.2 inches); hydraulic loading calculation (2,656 acre-feet/year); annual runoff plus baseflow volume calculation (2,557 acre-feet); aerial water load calculation (6.3 feet/year); lake flushing rate calculation (0.35/year); water residence time calculation (2.85 years); observed spring overturn total phosphorus (24.4 µg/L); and observed growing season mean phosphorus (19.8 µg/L).

Other input variables included estimated acreages of different land-use categories within the watershed: row-crop agriculture (2,179 acres); mixed agriculture (142 acres); pasture/grass (189 acres); 1/8-acre, high density urban (126 acres); 1/4-acre, medium density urban (684 acres); > 1-acre, rural residential (90 acres); wetlands (568 acres); forest (284 acres); and lake surface (423 acres). This information was used by the model to generate estimates for non-point source phosphorus loadings. Point-source loadings from septic tanks, storm sewer outfalls, etc. were not identified and would not be considered significant. This is because most of the lake area is served by a municipal wastewater treatment facility, rather than private septic systems, and there are no major storm sewer outfalls or other point-source discharges to the lake.

PREDICTED PHOSPHORUS LOADING AND IN-LAKE CONCENTRATIONS

Estimated phosphorus loading to the lake from the watershed was predominantly from agricultural sources, and particularly from row-cropped fields (70.3%). Urbanized areas were estimated to contribute 17.4% of total phosphorus loads, and mostly from higher-density residential land uses. Total annual phosphorus loading from both urban and rural areas ranged from an estimated low of 648 kg to a high of 3,312 kg, with a "most likely" value of 1,254 kg. While the relative percent loadings from different land uses are probably fairly representative,

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[3] Wisconsin Lake Modeling Suite (WiLMS), Version 3.3.18.1
[4] Wisconsin Department of Natural Resources, and Lake Ripley Management District. 1994. Lake Ripley Water Resources Appraisal.

the actual mass-loading estimates should be considered crude approximations within a typical range of possibilities built into the model. More rigorous modeling would be needed to generate more refined numbers for advanced planning purposes.

The impact of a hypothetical, but reasonably probable, land-use-change scenario was also evaluated. This scenario involved the theoretical conversion of 200 acres of cropped agricultural land—representing the approximate acreage of large, open tracts of developable land still remaining within the urban service area—to high-density residential land use. Running this hypothetical land-use scenario resulted in a "most likely" increase in the predicted annual phosphorus loading of 5.6%. Interestingly, converting the same row-cropped areas to rural residential land use resulted in a "most likely" decrease in annual loadings of 3.4%. If this cropped agricultural land was instead planted to forest or converted to wetland, predicted annual phosphorus loading would "most likely" decrease by about the same amount (3.6%). These modeling results highlight the degree to which different land uses and the relative amount of impervious area influence annual loading scenarios, even on relatively small scales.

The Reckow (1979) natural lake model within WiLMS was the closest to predicting the observed phosphorus concentration in Lake Ripley. This phosphorus-prediction model is based on information from 47 north temperate lakes from the EPA-Natural Eutrophication Survey. It predicted an in-lake total phosphorus concentration of 33 µg/L, which is somewhat higher than observed values. Based on the Reckow model and using the Phosphorus Predictions and Uncertainty Analysis module in WiLMS, an estimated total annual phosphorus loading of 471 kg/year was back calculated from the observed growing season mean phosphorus concentration of 19.8 µg/L. This represented a significantly lower annual loading value than what was estimated above.

Back calculations were also performed for mean lake phosphorus concentrations of 24 µg/L (571 kg/yr) and 16 µg/L (381 kg/yr). This exercise was intended to estimate the load increase and reduction that might translate into these in-lake concentrations. Results indicate that a 21% (100 kg/yr) annual loading increase would translate into a 4 µg/L increase in in-lake phosphorus concentration, while a 19% (90 kg/yr) loading reduction would translate into a 4 µg/L decrease. The latter finding gives an idea of a total annual load reduction that could be targeted through future BMP implementation to achieve a corresponding TSI below 50.

The Lake Eutrophication Analysis Procedure (LEAP) in WiLMS was also investigated. LEAP is a computer program designed to predict eutrophication indices in lakes based upon watershed area, lake depth and ecoregion. It can be used to compare Lake Ripley to similar, undisturbed lakes within the same Southeast Wisconsin Till Plain ecoregion. Ecoregion is used to predict runoff and average stream phosphorus concentration. The program is intended primarily to estimate conditions in the lake with minimal input data to identify "problem" lakes. It should be noted that the model acknowledges that individual lakes may deviate greatly from regionally-defined patterns.

LEAP predicted a total annual phosphorus load to the lake of 408 kg, and an average total phosphorus inflow concentration of 100 µg/L. This compares to 1993 observed values from the inlet stream of 1,073 kg and 198 µg/L, respectively.[5] Since this time period pre-dates the implementation of major watershed-conservation measures, current values are likely to be much lower, although they have not been re-measured. The LEAP analysis predicted an in-lake total phosphorus concentration of 32 µg/L (observed: 20 µg/L), a chlorophyll-*a* concentration of 10.6 µg/L (observed: 8.6 µg/L), and a Secchi clarity of 6.2 feet (observed: 6.0 feet). It also estimated chlorophyll-*a* interval frequencies (nuisance frequencies) for both observed and predicted lake conditions. Based on observed conditions, the model estimated that a chlorophyll-*a* concentration of 10 µg/L, representing visible algal blooms, would be exceeded 29% of the time (3 out of every 10 days). This increased to about 45% (4.5 out of every 10 days) under predicted conditions. Lake Ripley fell within the average ecoregion TSI ranges for all three trophic variables.

Wisconsin regional predictive equations allow the model user to predict in-lake chlorophyll-*a* concentration from Secchi depth, as well as Secchi depth and chlorophyll-*a* from in-lake total phosphorus concentration. Modeling results for observed in-lake phosphorus levels ranging from a low of 12 µg/L to a high of 24 µg/L are as follows:

12 µg/L phosphorus = 7.5-ft. Secchi depth and 5.4 µg/L chlorophyll-*a*
16 µg/L phosphorus = 6.2-ft. Secchi depth and 7.7 µg/L chlorophyll-*a*
20 µg/L phosphorus = 5.6-ft. Secchi depth and 10.0 µg/L chlorophyll-*a*
24 µg/L phosphorus = 4.9-ft. Secchi depth and 12.5 µg/L chlorophyll-*a*

Modeling results for observed chlorophyll-a values ranging from a low of 4 µg/L to a high of 13 µg/L are as follows:

4 µg/L chlorophyll-*a* = 8.5-ft. Secchi depth
7 µg/L chlorophyll-*a* = 6.6-ft. Secchi depth
10 µg/L chlorophyll-*a* = 5.6-ft. Secchi depth
13 µg/L chlorophyll-*a* = 4.9-ft. Secchi depth

PREDICTED ALGAL RESPONSE

Algal nuisance frequency was estimated using the Trophic Response Module within WiLMS. Input parameters included a 3-24 µg/L range of summer mean chlorophyll-*a* values, which represented the range of mean values observed over the 1986-2009 monitoring period. They also included the chlorophyll-*a* temporal coefficient of variation (standard deviation divided by the mean) of 0.56. Based on a 10 µg/L nuisance algal condition threshold, the chance the lake might exceed this threshold at any given time is presented below for the range of observed, summer mean chlorophyll-*a* values (in µg/L):

[5] Ibid

3 = 0.8%	8 = 24.9%	13 = 57.5%	18 = 77.9%	23 = 88.6%
4 = 2.8%	9 = 32.0%	14 = 62.6%	19 = 80.7%	24 = 90.0%
5 = 6.5%	10 = 39.0%	15 = 67.2%	20 = 83.1%	
6 = 11.7%	11 = 45.6%	16 = 71.2%	21 = 85.2%	
7 = 18.0%	12 = 51.8%	17 = 74.8%	22 = 87.0%	

SUMMARY OF MODEL OUTPUT

The following is a copy of the actual printout that was generated from the WiLMS analysis:

Hydrologic and Morphometric Data

Tributary Drainage Area: 4262.0 acre
Total Unit Runoff: 7.2 in.
Annual Runoff Volume: 2557.2 acre-ft
Lake Surface Area <As>: 423 acre
Lake Volume <V>: 7561 acre-ft
Lake Mean Depth <z>: 17.9 ft
Precipitation - Evaporation: 2.8 in.
Hydraulic Loading: 2655.9 acre-ft/year
Areal Water Load <qs>: 6.3 ft/year
Lake Flushing Rate <p>: 0.35 1/year
Water Residence Time: 2.85 year
Observed spring overturn total phosphorus (SPO): 24.4 mg/m^3
Observed growing season mean phosphorus (GSM): 19.8 mg/m^3

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	2179	0.50	1.00	3.00	70.3	441	882	2646
Mixed AG	142	0.30	0.80	1.40	3.7	17	46	80
Pasture/Grass	189	0.10	0.30	0.50	1.8	8	23	38
HD Urban (1/8 Ac)	126	1.00	1.50	2.00	6.1	51	76	102
MD Urban (1/4 Ac)	684	0.30	0.50	0.80	11.0	83	138	221
Rural Res (>1 Ac)	90	0.05	0.10	0.25	0.3	2	4	9
Wetlands	568	0.10	0.10	0.10	1.8	23	23	23
Forest	284	0.05	0.09	0.18	0.8	6	10	21
Lake Surface	423	0.10	0.30	1.00	4.1	17	51	171

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	1427.5	2764.5	7300.8	100.0
Total Loading (kg)	647.5	1254.0	3311.6	100.0
Areal Loading (lb/ac-year)	3.37	6.54	17.26	0.0
Areal Loading (mg/m^2-year)	378.26	732.55	1934.57	0.0
Total NPS Loading (lb)	1389.8	2651.3	6923.4	100.0
Total NPS Loading (kg)	630.4	1202.6	3140.4	100.0

Phosphorus Prediction and Uncertainty Analysis Module

Observed spring overturn total phosphorus (SPO): 24.4 mg/m^3
Observed growing season mean phosphorus (GSM): 19.8 mg/m^3
Back calculation for SPO total phosphorus: 0 mg/m^3
Back calculation GSM phosphorus: 19.8 mg/m^3
% Confidence Range: 70%

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	37	72	189	52	263
Canfield-Bachmann, 1981 Natural Lake	47	72	130	52	263
Canfield-Bachmann, 1981 Artificial Lake	40	56	89	36	182
Rechow, 1979 General	27	53	139	33	167
Rechow, 1977 Anoxic	122	237	626	217	1096
Rechow, 1977 water load<50m/year	45	87	230	67	338
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	85	165	435	141	578
Vollenweider, 1982 Combined OECD	53	90	201	68	308
Dillon-Rigler-Kirchner	50	96	254	72	295
Vollenweider, 1982 Shallow Lake/Res.	45	80	188	58	262
Larsen-Mercier, 1976	74	142	376	118	484
Nurnberg, 1984 Oxic	49	94	249	74	374

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	43	148	Tw	347	GSM
Canfield-Bachmann, 1981 Natural Lake	22	207	FIT	170	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	175	GSM
Rechow, 1979 General	30	110	FIT	471	GSM
Rechow, 1977 Anoxic	144	487	FIT	105	GSM
Rechow, 1977 water load<50m/year	50	181	P Pin	285	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	83	356	FIT	0	SPO
Vollenweider, 1982 Combined OECD	45	181	FIT	197	ANN
Dillon-Rigler-Kirchner	58	198	P	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	40	164	FIT	259	ANN
Larsen-Mercier, 1976	89	290	P Pin	0	SPO

Nurnberg, 1984 Oxic	50	200	P	263	ANN

Expanded Trophic Response Module

Cholorphyll a Nuisance Frequency
Chla Mean Min: 3
Chla Mean Max: 24
Chla Mean Increment: 1
Chla Temporal CV: 0.56
Chla Nuisance Criterion: 10

Mean	Freq %	Mean	Freq %	Mean	Freq %
3	0.8	10	39.0	17	74.8
4	2.8	11	45.6	18	77.9
5	6.5	12	51.8	19	80.7
6	11.7	13	57.5	20	83.1
7	18.0	14	62.6	21	85.2
8	24.9	15	67.2	22	87.0
9	32.0	16	71.2	23	88.6
				24	90.0

9-3 RESULTS OF PUBLIC OPINION SURVEYS

PURPOSE

Lakes cannot be all things to all people, and there is bound to be conflict when a common resource is expected to support often conflicting interests. Opinion surveys have long been used by the Lake District to help evaluate public perceptions and priorities about lake use, as well as attitudes about general resource conditions, problems, and possible management solutions. Prioritization allows for the allocation of resources so that the benefits of management intervention out-weigh costs, the results are measurable, and the work is supported by the public. Surveys also facilitate public involvement, and can help educate residents and users about the lake ecosystem. It is believed that a greater understanding and awareness of Lake Ripley and its problems will generally lead to increased cooperation and a greater likelihood of program success.

The first comprehensive opinion survey was conducted in 1992 as part of a Creative Marketing Unlimited research project at the University of Wisconsin-Whitewater.[6] This initial effort was followed by comprehensive opinion surveys conducted in 1999, 2005 and 2007 by the Lake District.[7] These surveys were disseminated to area property owners to gauge general attitudes on a wide range of lake topics. Respondents were asked to share their opinions regarding the condition of Lake Ripley, the effectiveness of current management policies and programs, and what actions were believed to be needed to improve overall lake health.

DEMOGRAPHICS

[6] University of Wisconsin-Whitewater. 1992. Lake Ripley Management District: Lake Resident Study.
[7] Lake Ripley Management District. 1999, 2005 and 2007. Lake Ripley Property Owner Opinion Survey.

The most recent, 2007 survey (see Appendix F) placed the average age of the respondent at 57 years old. Male respondents outnumbered female respondents by a ratio of 1.5:1. Average household size was 2.8 individuals. Most reported living within one-quarter mile of the lake, with 37% of survey respondents owning lakefront property. Of all residential homeowners, 57% identified themselves as full-time residents and 43% as part-time residents. Part-time residency tended to increase as property ownership moved closer to the lake. Slightly more than half of those living off the lake claimed to have deeded lake-access rights. Length of property ownership near Lake Ripley varied widely, although a majority (58%) owned the property for over a decade. The above demographics patterns appear to be fairly consistent with those identified in earlier surveys.

ACCESS, CROWDING AND GENERAL LAKE CONDITIONS

Respondents to the 2007 survey generally visited or used the lake on a routine basis, but there was an evident split between frequent and sporadic users. Most felt that adequate public access was provided with respect to boating. However, there were more mixed feelings in terms of the availability of shore fishing and swimming access, despite the addition of a public fishing and swimming pier at Beach Lane around the time of the survey. This seems to mark a shift from earlier surveys when public-access availability was overwhelmingly viewed as sufficient. The apparent shift may be the result of increasing lake-use demands, particularly from area property owners without private, lake-access rights. It does not account for the lack of awareness related to the recent installation of the new fishing and swimming pier.

In 2007, most survey respondents claimed not to feel a sense of crowding on the lake during summer weekdays, but felt at least moderately crowded on summer weekends. Average water clarity was generally viewed as being clear to somewhat cloudy, but weed growth was perceived as slightly excessive. The above perceptions seem to be fairly consistent with those documented in previous surveys.

PREFERRED LAKE ATTRIBUTES AND USES

In descending order, the top four preferred lake-use activities included the enjoyment of peace and tranquility, swimming, observing wildlife, and walking or biking around the lake. Earlier surveys showed higher preferences for motor boating and fishing over the latter two activities. The top two attributes identified for their high "quality of life" value included safe water quality and natural scenic beauty. High marks were also given to peace and tranquility, clear water, a healthy aquatic plant community, abundant fish and wildlife habitat, and rule enforcement. These findings paralleled those of earlier surveys, with the exception that minimal boat traffic was previously held to a higher standing.

PERCEIVED PROBLEMS AND THREATS

Zebra mussels (and Canada geese in 2005), development pressure, lake weeds, crowding and algae were most often blamed for limiting the use and enjoyment of the lake. This is a change over prior surveys that gave higher rankings to boat traffic, poor water clarity and noise. Possible reasons for the change include the infestation of zebra mussels around the time of the survey, the adoption of new lake-use policies that increased slow-no-wake zones within 200 feet of shore, and perhaps a more consistent law-enforcement presence during the boating season. As far as the lake's biggest threats, top choices included invasive plant and animal species, polluted runoff, overcrowding, overdevelopment, and the overuse of fertilizers and pesticides. These perceived culprits have remained relatively consistent compared to prior surveys, but with invasive species gaining greater prominence.

VIEWS ON CURRENT MANAGEMENT

The 2007 survey showed that a vast majority of respondents were very positive about their quality of life living near the lake. Most felt that local lake rules were fair and appropriate, and that rule enforcement was sufficiently aggressive. "Misguided lake-management programs" was ranked last as far as being a perceived threat to the lake. If fact, there was largely moderate to strong support for the various Lake District efforts employed to protect and improve Lake Ripley. Respondents generally felt well informed about the lake, its management, and the availability of landowner cost sharing, with the vast majority citing the Ripples newsletter as their preferred information source. While opinions varied, the amount of taxes collected to finance the protection and management of Lake Ripley was generally viewed as sufficient to slightly excessive.

9-4 STATUS OF PRIOR MANAGEMENT RECOMMENDATIONS

Below is a listing of prior management recommendations and their implementation status. Recommendations are listed under the appropriate planning documents from which they were derived. Latest publication dates are referenced in parentheses. Almost all of these earlier planning recommendations have since been acted upon, or are the target of ongoing management action.

Legend
■ Completed
◘ Ongoing with dedicated management program
□ Not Completed or unknown status (as of Plan date)

NONPOINT SOURCE CONTROL PLAN FOR THE LAKE RIPLEY PRIORITY LAKE PROJECT (1998REV)

■ Reduce overall sediment delivered to Lake Ripley by 50% of inventoried load
■ Reduce overall phosphorus load by 30% (achieved through the above sediment reductions)
◘ Maintain Trophic State Index below 50 (variable status)
◘ Protect ecologically-sensitive areas in and around the lake
◘ Prevent further wetland loss or disturbance; protect wetland acres east of the lake as well as stream/lakeside buffer areas; increase total number of wetland acres through restoration measures

◘ Preserve natural shoreline areas as water quality buffers and wildlife refuges; enhance developed shoreline areas by planting native vegetation to serve as buffers
◘ Reestablish native aquatic plant communities, where feasible
◘ Protect the Lake Ripley largemouth bass fishery, aquatic diversity and endangered resources within the lake and watershed
◘ Protect groundwater resources; maintain groundwater contribution to the hydrologic budget by not building on groundwater-infiltration areas

LAKE RIPLEY MANAGEMENT PLAN (2001)

■ Expand slow-no-wake zones to better incorporate shallow, near-shore areas
■ Develop emergency slow-no-wake policy addressing extreme flooding and high-water events
◘ Continue selective mechanical harvesting of milfoil; regularly update plant management plan
□ Determine extent of in-lake nutrient recycling from anoxic sediment phosphorus release
◘ Continue sport fishery enhancement programs through habitat protection, carp removal and limited fish stocking
◘ Continue intensive, long-term water quality monitoring program
■ Ensure proper lake-rule postings at all public access points
■ Raise public launch fee in accordance with State regulations to acquire additional funds for site maintenance and upkeep
■ Adopt local ordinance that prohibits the feeding of waterfowl, and implement other nuisance waterfowl-control strategies
■ Complete 13-year Lake Ripley Priority Lake Project (a state-funded, pollution-abatement program)
■ Encourage the use of no-phosphorus lawn fertilizers within 200 feet of the lake
□ Propose shoreland zoning modification that regulates the type and placement of high-intensity lighting on piers, boathouses and shorelines
◘ Continue implementation of an intensive information and education campaign
◘ Continue to acquire and/or establish voluntary land-preservation agreements (conservation easements) on critical wetland properties throughout the Lake Ripley watershed
◘ Continue public education and wetland/prairie restoration activities at the Lake District Preserve
◘ Continue to track public and private funding opportunities at the local, state and federal levels. Submit grant applications whenever appropriate to obtain support for both new and ongoing management efforts
◘ Continue litter cleanup projects to remove debris from area waterways and shorelines
◘ Support the continued funding of a summer lake patrol officer to maintain an enforcement presence on weekends and holidays throughout the boating season
◘ Continue implementation of the volunteer “Lake Watch” program to compliment law enforcement efforts

LAKE RIPLEY AQUATIC PLANT MANAGEMENT PLAN (2002)

◘ Recognize the value of a diverse, native aquatic plant community and ecologically-significant “sensitive areas” prior to implementing any type of management program

◘ Focus control efforts on non-native, invasive species like Eurasian watermilfoil, while protecting native plant beds needed for water quality and habitat purposes
◘ Work to understand and address the root causes of excessive, symptomatic weed growth
◘ Use targeted mechanical harvesting as the primary weed-control strategy, with cutting intensity dictated by the specific habitat and recreational requirements of a particular location
◘ Focus mechanical harvesting on managing dense, monotypic stands of Eurasian watermilfoil just prior to or following canopy formation at the water surface. Priority control areas include high-traffic boating lanes and around weed-choked public access points.
◘ Employ strategies that are compatible with mechanical harvesting as warranted, and particularly in areas that are otherwise inaccessible to mechanical harvesting equipment
■ Use boating ordinances to divide the lake into distinct recreational user zones to support multiple, mutually-exclusive activities
◘ Increase management effectiveness by implementing strategies at specific times and in specific locations, depending on spatial and seasonal variations in plant growth, fish and wildlife behavior, recreational use of the water, and other factors
◘ Inform the public of the goals, objectives and limitations of aquatic plant management, and the responsibilities of lakefront property owners
◘ Conduct an aquatic plant inventory at least every several years for monitoring purposes, and adjust management approaches as appropriate

9-5 CURRENT GOALS, OBJECTIVES AND TARGETS

OUR MISSION

The Lake Ripley Management District seeks to preserve and enhance Lake Ripley's water quality, its fish and wildlife communities, and its overall ecological health, while ensuring public access and use of the lake that is safe, fair and practical.

A VISION FOR THE FUTURE

Scenic shorelands, good fishing, abundant wildlife and clean water are a part of our local culture. They are why many of us choose to live here, why tourists come to visit, and why area property values remain so strong. While our connections to and preferred uses of the lake vary greatly, all of us share in the responsibilities of its care. By investing in Lake Ripley's continued stewardship, we believe the community and future generations will be rewarded by a clearner, healthier lake and a higher quality of life than would otherwise be possible.

We envision Lake Ripley as a clean and naturally scenic water body that improves regional property values and economies, provides opportunities for outdoor recreation, and contributes positively to our collective quality of life. Specifically, we consider the following to be realistic expectations that we should strive to fulfill. Taken together, they represent an ambitious but practical vision for the future of Lake Ripley.

➢ High-quality aquatic plants and shoreland habitats support a lake ecosystem that is rich in native flora and fauna.

- The lake and its surroundings abound with opportunities to view a diversity of native species and natural features that inspire learning, nature appreciation and outdoor exploration.

- Recreation occurs in a shared manner that equitably balances the competing demands and expectations found among diverse user groups.

- The mix of lake uses is compatible with the general public interest, identified community priorities, and the lake's ecological and sociological carrying capacities.

- The lake is safe and attractive for swimming, and there are no beach closings due to high bacteria levels or potentially toxic blue-green algal blooms.

- The watershed that drains surface water to the lake contains high-functioning wetlands and protected natural areas that help safeguard water quality and general lake health.

- Local development and associated land-use practices incorporate effective conservation measures that control soil erosion, preserve wetlands and groundwater-recharge areas, and generally minimize adverse impacts to the lake.

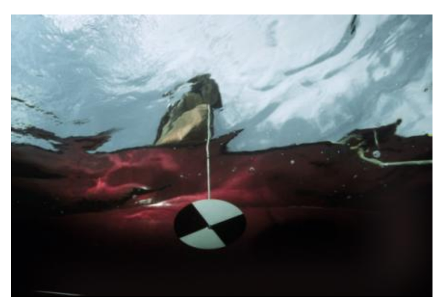
- Residents, property owners, local government entities and other stakeholders are aware of Lake Ripley's environmental, economic, recreational and cultural value to the community.

- The public maintains a vested interest in the lake's long-term protection and rehabilitation, and is committed to making the necessary investments for the benefit of future generations.

- There is broad understanding and support of ongoing management designed to address problems and threats through cost-effective action.

To achieve our mission and vision for the future, we have set forth five goals for which the Lake District is committed to pursuing. These goals are: 1) **Clean, clear water**; 2) **Thriving, native aquatic life**; 3) **Safe, fair and responsible lake use**; 4) **Cost-effective management action**; and 5) **A well-informed and engaged citizenry**. A brief status report is provided for each goal, as well as the objectives necessary for attaining the goal. Also included are some specific, representative metrics (or health indicators) combined with realistic targets for what we hope to achieve that we can use to continually track and evaluate our progress.

GOAL #1: CLEAN, CLEAR WATER



A Secchi disk being lowered from a boat to measure water clarity. Photo credit: UW-Extension

Status:
Landscape condition and land uses within a 7-square-mile watershed affect Lake Ripley's water quality. How we live on the land dictates the amount of stormwater runoff and pollutants delivered to the lake. In fact, the fossilized evidence in sediment cores extracted from the lake bottom indicate much better water quality prior to 1870, which was

when the land was first cleared for agriculture and early European settlement. Water quality then rapidly declined in response to increased watershed-erosion rates. It was not until the 1950s when erosion rates and lake conditions first began to stabilize, primarily due to improved agricultural practices. Further improvements were made after 1990, following the start of the Lake Ripley Priority Lake Project and implementation of watershed-conservation measures. Recent lake modeling estimates that the main sources of continued phosphorus loading—the drivers of algal growth—include row-cropped agriculture (70%) and higher-density urban areas around the lake (17%).

Water quality monitoring reveals that Lake Ripley routinely exceeds its desired Trophic State Index (TSI). TSI is a water quality index ranging from 1-100, with values less than 50 being desirable for most lakes. The index is used as a well-accepted indicator of overall lake health. TSI is based on the lake's phosphorus concentrations (plant nutrient), chlorophyll concentrations (algal pigment) and water clarity. A combination of high phosphorus, high chlorophyll and low water clarity translates into poor water quality for lakes. Monitoring records show that Lake Ripley's water quality has ranged from very good to poor, with TSI values frequently in the 50s, particularly during high-runoff periods. Prior to 1870, TSI values were closer to 40 and representative of less eutrophic conditions. Lake modeling that was done as part of a 1994 Water Resources Appraisal predicted further water quality declines if pollutant-loading rates at the time remained unchanged.

Objectives:

1. Reduce the delivery of pollutants to the lake, especially phosphorus and sediment originating from construction sites, existing urban areas, and row-cropped farm fields within the outlying watershed.
2. Minimize lakebed disturbances—such as carp activity and aggressive motor boating in shallow-water areas—that contribute to the re-suspension of bottom sediment and mobilization of phosphorus into the water column.
3. Permanently protect and restore groundwater-recharge zones, wetlands, and shoreland buffers that improve the quantity and quality of stormwater runoff.
4. Maximize the capacity of the 167-acre Lake District Preserve to absorb runoff and protect Lake Ripley's only inlet tributary stream.

Metrics:

1. Trophic State Index (TSI)

   Targets:
   - TSI < 50 (mesotrophic conditions)
   - Summer mean total phosphorus < 24.0 µg/L (ideal: < 20 µg/L; best case: 12 µg/L)
   - Summer mean chlorophyll-*a* < 7.3 µg/L
   - Summer mean Secchi clarity ≥ 6.5 ft

2. E. coli (*Escherichia coli*) bacteria levels

   Target: < 235 cfu/100 ml (or no beach closings)

3. Macroinvertebrate diversity

   Target: Macroinvertebrate populations in the inlet and outlet streams are comprised of diverse species, particularly those intolerant to pollution and poor water quality.

4. Watershed landscape condition

   Targets:

   - Rural watershed land uses are retained outside the Town's urban service boundary (east of County Rd. A).
   - Well-vegetated shoreland buffer areas are increased along all shoreline, stream and drainage-ditch corridors.
   - Remaining wetland acreage is permanently protected around the lake, and filled or drained wetland acreage is restored whenever feasible.
   - Agricultural acreage under conservation farming practices is increased, including acreage subject to no-till cropping and nutrient-management planning.
   - Number of rain gardens and rain barrels used in residential areas is increased.
   - Eroding drainage ditches that connect to the inlet tributary stream are repaired or, preferably, plugged.
   - Total annual phosphorus loading is reduced by at least 19% through the implementation of watershed Best Management Practices (BMPs) in order to maintain a TSI below 50.

GOAL #2: THRIVING, NATIVE AQUATIC LIFE

A pair of bluegills is seen guarding a nest. Photo credit: UW-Extension

Status:

Lake Ripley is home to a diverse assemblage of aquatic plants, fish and animals. Some indigenous species documented in and around Lake Ripley are listed as rare or endangered, while other species are classified as non-native and invasive. All require particular habitat conditions and demonstrate varying sensitivities to pollution, habitat loss and other disturbances. A species-rich community of native aquatic plants and fish is an indicator of good lake health, whereas their absence or displacement by non-native species is often a sign of trouble.

Wetlands and near-shore littoral areas are particularly important for sustaining much of the aquatic life found in Lake Ripley. Since the early 1900s, over a third of the wetlands around Lake Ripley have been lost due to drainage and filling. Loss of wetlands causes hydrologic instability, reduces spring flow to the lake, increases the rate of runoff and pollutant delivery, and reduces vital habitat for fisheries, wildlife and endangered resources. The quality of the lake's biologically-rich littoral zone (shallow, near-shore area) is of equal importance in sustaining aquatic life, but remains threatened by the ongoing effects of shoreline development, beach grooming, motor boating and other recreational-use pressures.

Lake Ripley is currently plagued with the non-native Eurasian watermilfoil, curly-leaf pondweed, zebra mussel and common carp. Aquatic plant inventories indicate that Eurasian watermilfoil has been on the decline since it peaked in the late 1980s, while curly-leaf pondweed continues to maintain a limited but potentially-expanding presence. Sediment and nutrient loading has favored these tolerant, weedy species while reducing overall biodiversity. As for the lake's fishery, field surveys show fairly stable populations of all species, with carp currently comprising a small component of the overall community. Zebra mussels were a relatively recent introduction to the lake, and are still sustaining high numbers after their apparent peak in 2008. Other invasive species that pose immediate threats due to their close geographic proximity to Lake Ripley include the spiny waterflea, quagga mussel and New Zealand mudsnail—among others. Many of these species enter the Great Lakes through transoceanic shipping, and spread to inland lakes primarily through transient, recreational boat traffic.

Objectives:
1. Protect and restore native fish and wildlife habitat found in and around the lake.
2. Reduce the potential for the introduction and spread of aquatic invasive species.
3. Manage existing biological communities (plants, fish, etc.) in a manner that supports identified management goals and priorities.

Metrics:
1. Aquatic plants

   Targets:
   - Stable or increased *native* species richness (total number of species).
   - Eurasian watermilfoil and other non-native species comprise a small and decreasing fraction of overall plant community.
   - The aerial extent of bulrush and lily pad beds is maintained or expanded.
   - No further fragmentation or disturbance of identified "Critical Habitat Areas."

2. Fish

   Targets:
   - Stable or increased *native* species richness (total number of species).
   - Sustained presence of previously inventoried sensitive species, including the lake chubsucker (*Erimyzon sucetta*), least darter (*Etheostoma microperca*) and pugnose shiner (*Notropis anogenus*).
   - Carp represent a small and decreasing fraction of the overall fishery.
   - Desired size-frequency distributions are maintained for sport fish populations.
   - Increased number of littoral tree-drops to serve as coarse woody habitat.
   - Increased number of native trees growing near the shoreline for cover and a source of food, and for future recruitment of coarse woody habitat to the lake.
   - Maintenance of water quality conditions sufficient to sustain pollution-sensitive biota.

3. Wetlands

   Targets:
   - No further loss of existing wetland acreage.
   - Existing wetlands are protected and restored to their fullest functional value.
   - Wetland acreage and function are returned (when feasible) to areas subjected to past hydrologic manipulation.

GOAL #3: SAFE, FAIR AND RESPONSIBLE LAKE USE

Anglers enjoying the morning slow-no-wake period on Lake Ripley.

Status:
While Lake Ripley is of modest size, it is both a popular and accessible recreational destination that can support a range of activities. This popularity has created challenges as different user groups compete for time and space on the lake. Public opinion surveys consistently reveal that boat traffic and congestion routinely interfere with people's use and enjoyment of the lake. According to a 2003 recreational boating study, Lake Ripley's estimated carrying capacity was regularly exceeded during summer weekends and other peak-use times.

Such high-intensity lake use, combined with the expansion of private and public access facilities, can create a host of safety and environmental problems. A number of lake-use and lakeshore-development policies are in effect at the state and local level to help address these concerns. These pertain to slow-no-wake times, slow-no-wake areas, and shoreland zoning provisions that set permitting standards for certain development activities next to the lake.

Objectives:
1. Minimize the potential for user conflict by supporting policies that fairly balance competing recreational demands.
2. Promote recreational uses and intensities that are compatible with the lake's physical, ecological and social carrying capacities.

Metrics:
1. Public access
   Target: The current level of public access is maintained with no expansion or increase in the number of public boat-access facilities.

2. Private pier development
   Targets:
   - Pier sizes, densities and number of mooring spaces meet Wisconsin DNR standards (NR 326).
   - No further pier development—except for the repair, maintenance or replacement of existing piers—in designated "Critical Habitat Areas" (formerly called "Sensitive Areas"), unless it can be shown that impacts will be fully mitigated.

3. Boating densities
   Target: Boating does not exceed estimated carrying-capacity thresholds as per the formula described in *Lake Ripley Watercraft Census and Recreational Carrying Capacity Analysis* (LRMD, 2003).

4. Law enforcement
   Target: Lake rules are enforced through regular Town of Oakland police patrols during the boating season, with emphasis on summer weekends and other peak lake-use periods.

5. Public survey input
   Target: Opinion survey results reflect favorable reviews regarding the lake's overall recreational atmosphere (i.e., fairness of rules, perceived compliance levels, degree of crowding, adequate enforcement, etc.).

GOAL #4: COST-EFFECTIVE MANAGEMENT ACTION

Dennis McCarthy, a Lake District board member and volunteer lake monitor, inspects a zebra mussel plate sampler on Lake Ripley.

Status:
In 1991, the Lake Ripley Management District began operations under authority of Chapter 33 of the Wisconsin Statutes. It is a local, special-purpose unit of government that serves property owners living around the lake. The mission of the District is to preserve and enhance Lake Ripley's water quality, its fish and wildlife communities, and its overall ecological health, while ensuring safe, fair and practical lake use. To accomplish this mission, the District engages in a number of tax- and grant-supported programs in accordance with approved management plans and operating permits. A seven-member board of directors is responsible for directing the affairs of the District with the help of a full-time lake manager and two part-time weed-harvesting employees.

Objectives:
1. Management actions advance stated planning goals.
2. Management programs are appropriately targeted and cost-effective as set forth in approved guidance documents.
3. Monitoring is routinely conducted to evaluate resource conditions and management progress.
4. Funding and staffing resources are sufficient to implement recommended management actions.
5. The latest scientific information, strategy guidance and technological innovations are fully utilized as they become available.

Metrics:
1. Management-planning directives
   Target: Plan recommendations are regularly reviewed, implemented and updated according to an approved schedule.

2. Lake District operating budget
   Target: The Lake District budget provides for sufficient resources to implement, on a timely basis, recommended management activities necessary to achieve identified goals.

3. Public survey input
   Target: Realistic management expectations are maintained, and programs are viewed as effectively addressing community priorities.

4. Monitoring-data archives

Targets:

- The lake's shoreline is videotaped every few years to document changes in shore conditions and development activities.
- An annual census of piers, boat lifts, rafts and moored watercraft is maintained to document resident boating facilities and lake-use potential.
- Documentation of on-lake boat counts and lake-use observations is maintained during each boating season to track trends over time.
- Secchi depth measurements are taken at least twice per month (May to September).
- Basic water chemistry (total phosphorus, chlorophyll-*a*, etc.) is evaluated at least three times per year (after spring turnover, during mid-summer stratification, and after fall turnover).
- Invasive species information (locations, population estimates, etc.) is collected as per Wisconsin DNR guidance.
- Documentation of cost-shared conservation measures and estimated pollutant reductions is maintained as projects are completed.
- Aquatic plant inventories are performed every 4-5 years.
- Annual weed harvesting reports are maintained that document staff hours, cutting areas, number of loads harvested, and plant species collected.
- Public opinion solicitations are conducted every 5-7 years to track awareness and general attitudes associated with ongoing management challenges and their proposed solutions.

GOAL #5: A WELL-INFORMED AND ENGAGED CITIZENRY

Status:
Results of public opinion surveys show that most respondents feel well informed of issues related to Lake Ripley and its management. The Lake District seeks to communicate with and solicit participation from its constituents using multiple media outlets. These include public meetings and hearings, dissemination of printed materials (such as newsletters), e-mail bulletins, local newspaper articles, educational workshops, Web postings, and lake and watershed tours—among others. Social-marketing strategies are now being tested as a way of increasing the effectiveness of these communications, and to improve participation rates in the Lake District's landowner cost-share program.

Lisa Reas of LJ Reas Environmental Consulting Corporation shows Lake Ripley residents how to design and build their own rain gardens in this 2008 photo.

Objectives:

1. Maintain open lines of communication with Lake District constituents, watershed property owners, and affected stakeholders using diverse media outlets.
2. Use the *Ripples* newsletter as the primary means of information sharing.
3. Actively solicit community participation and involvement in protection and rehabilitation efforts.

<u>Metrics</u>:

1. Outreach tools

   <u>Targets</u>:
   - A minimum of three Ripples newsletters are disseminated each year.
   - E-mail bulletins are used as needed to distribute announcements and time-sensitive information to interested constituents.
   - The Lake District website is updated on at least a quarterly basis.
   - Welcome Wagon informational packets are mailed on at least a quarterly basis to new District and watershed property owners.
   - All meeting agendas and proposed operating budgets are posted and published on a timely basis.
   - Board meetings and public hearings are well publicized and aired on local cable television.
   - An informational boat tour is offered each year for the benefit of Town of Oakland Board members.
   - Community events (watershed tours, lake fairs, litter cleanups, etc.) are regularly used to educate and engage citizen volunteers.
   - Social-marketing strategies that target specific, meaningful behavior changes are incorporated into existing outreach programs.

2. Public survey input

   <u>Target</u>: Opinion survey results give favorable reviews for quality of outreach materials and effectiveness of communication strategies.

3. Volunteer and landowner participation

   <u>Targets</u>:
   - Mechanisms are in place for attracting and retaining volunteers to support ongoing programs.
   - A critical mass of targeted landowners adopt recommended conservation measures as a result of outreach and incentive programs.
   - School groups are solicited to participate in service-learning projects.

Cambridge High School students display some of the trash collected around Lake Ripley during a litter cleanup.