Phosphorus Levels in the Red Cedar River Basin

A Source of Concern

The Red Cedar River begins its journey flowing forth from Red Cedar Lake in northwestern Wisconsin. As the river makes its southern descent to its final destination, the Chippewa River, it passes through forests, farmland, and two urban areas – Rice Lake and Menomonie (Fig. 1). Canoeists paddle its tranquil course while bicyclists enjoy the riparian habitat as they cycle through the wooded corridor of the Red Cedar River State Trail. Efforts to protect this bountiful natural resource acknowledge the fact that the Red Cedar River is more than a flowing stream of water. Therefore, major protection efforts have encompassed its entire drainage basin. The Red Cedar River Basin is 1,893 square miles and consists of eight watersheds: Red Cedar Lake, Brill & Red Cedar Rivers, Yellow River, Lake Chetek, Pine Creek & Red Cedar Rivers, Hay River, South Fork Hay River, and Wilson Creek. Stepped-up improvement efforts for the Red Cedar River Basin began in 1995, when local citizens, businesses, governments, and natural resource groups created a partnership to protect and improve the waters of the Red Cedar River Basin through the Red Cedar River Basin Steering Committee. When this team of river stakeholders began to identify issues of concern, phosphorus was singled out as a major contributor to the decline in water quality in the basin.

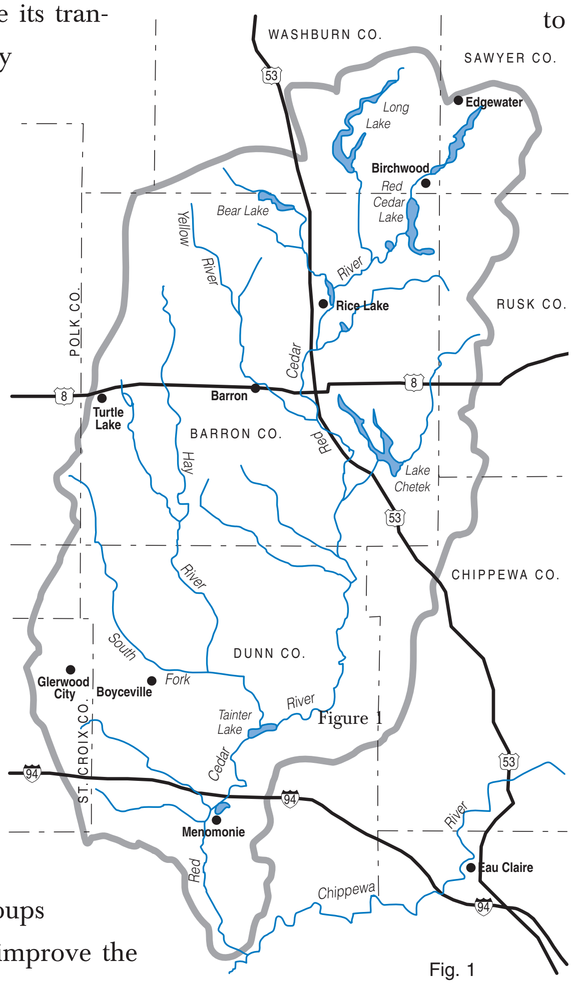


Fig. 1

The Significance of Phosphorus Contamination

Phosphorus is a primary nutrient essential for healthy plant and algae growth. However, increased phosphorus levels speed up the process of eutrophication, where excess nutrients stimulate plant growth to such a degree as to create extensive algae blooms. Excess plant growth lowers dissolved oxygen levels due to plant decay and oxygen consumption. As a result, water clarity and quality suffer, and recreational uses are lost. In the Red Cedar River Basin, problems with eutrophication are most evident in lakes and impoundments with stagnant water and phosphorus recycling from sediments in the lake bottom.

The Wisconsin Trophic State Index (WTSI) assessed the extent of eutrophication in lakes of the Red Cedar River Basin (Table 1). The values are calculated by averaging measures from three parameters: water clarity, phosphorus, and chlorophyll. Water clarity is determined by measuring turbidity, or the amount of suspended materials in the water, and to a certain extent assessing water color, although color is a less accurate measure of contamination because waters may naturally look brown or green without having any significant pollution. Total phosphorus concentrations are measured and chlorophyll concentrations (indicating the amount of algae present) are determined. Impoundments such as Tainter Lake and Lake Menomin rank poor on the list. Lakes in the excellent water quality range tend to be closer to the headwaters of the river system, where phosphorus loads are smaller.

Phosphorus Sources

Phosphorus loads enter the Red Cedar River Basin from both point and non-point sources (Fig. 2). A “load” is a measure of the amount of phosphorus or any other nutrient entering a water body, usually expressed as pounds per year. Point sources include municipal wastewater treatment plant discharges and industrial discharges such as food processing plants. Non-point sources consist of urban runoff from storm drains and animal waste, and runoff due to excess fertilizer from yards and cropland. Agricultural practices take up a significant area of the land base and this type of land use contributes a large amount of unregulated phosphorus loads to lakes and rivers in the basin. Even though the majority of land in the basin lies in forested cover, it accounts for a relatively small percent of the total phosphorus load. (Fig. 3).

History of Phosphorus Loadings in the Basin

In order to grasp the extent to which phosphorus loads have increased in the basin, it is necessary to look at historical data and what factors have changed over time to allow for these increases. Collecting and analyzing a lake sediment core provides one method of obtaining historical nutrient data chronologically. In 1995, sediment core analysis of Tainter Lake’s bottom helped determine long-term water quality trends. A sediment core of 112 cm long was brought to the surface and sliced into 2 cm sections for analysis. In order to determine specific dates within the core, cesium, a metal used in atomic weaponry, and potassium levels were measured. The presence of cesium indicates the time period of 1954 to 1963, when the metal was released into the atmosphere during peak nuclear weapons testing. Potassium levels provide an indication of major flood events, and when cross-referenced with USGS flood records, specific dates can be determined.

Table 1: Wisconsin Trophic State Index for studied lakes in the Red Cedar River Basin

Lake Name	***WTSI***	
Pine Lake	32	Excellent 0-50 WTSI
Fenton Lake	42	
Silver Lake	42	
Beaver Dam, upper	43	
Big Devil Lake	45	
Long Lake	47	
Big Dummy Lake	48	
Balsam Lake	48	
Red Cedar Lake	49	
Bear Lake	49	
Bass Lake	49	
Kekegama Lake	50	Moderate 50-60 WTSI
Shallow Lake	51	
Lower Vermillion Lake	51	
Granite Lake	52	
Duck Lake	53	
Beaver Dam, Lower	53	
Turtle Lake, Lower	56	
Hemlock Lake	58	
Chetek Lake	59	
Rice Lake	59	
Big Moon Lake	59	
Chetac Lake	60	Poor 60-70 WTSI
Pokegema Lake	60	
Prairie Lake	62	
Ten Mile Lake	64	
Lake Menomin	64	
Poskin Lake	65	
Mud (Ojaski) Lake	66	
Tainter Lake	70	

Impoundments such as Tainter Lake and Lake Menomin rank poor on the list. Lakes in the excellent water quality range tend to be closer to the headwaters of the river system, where phosphorus loads are smaller.

Clues to the Past

Microscopic algae, or diatoms, are useful indicators of historic water quality due to the fact that certain species require specific nutrient levels. As diatom type and abundance change

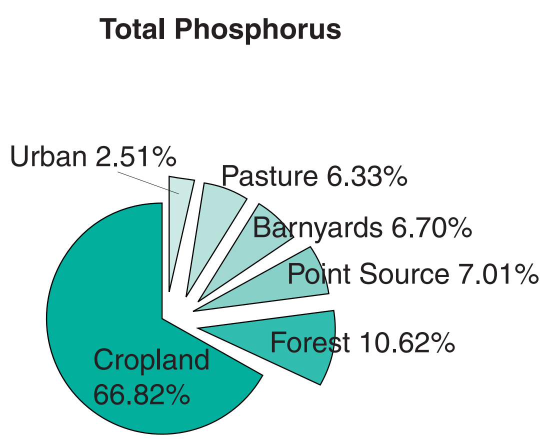


Figure 2: Total Phosphorus Loads Routed to Tainter Lake.

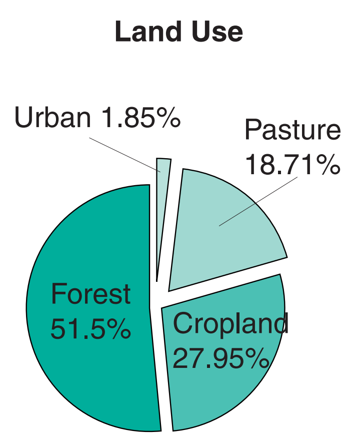


Figure 3: Land Use in the Red Cedar River Basin.

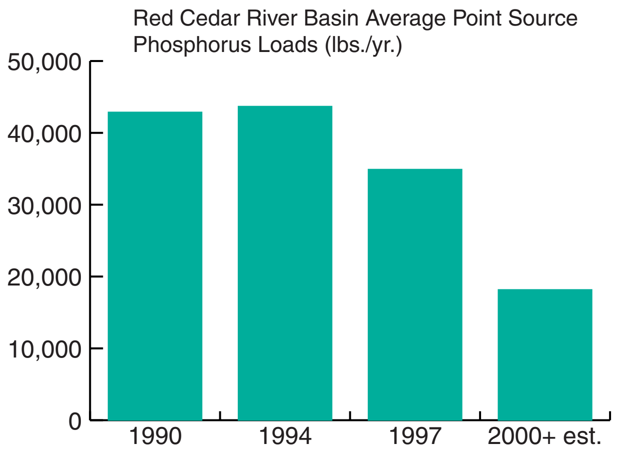


Figure 4

This graph illustrates the estimated amounts of phosphorus loads coming from point sources such as waste water treatment plants and industrial sources in the Red Cedar River Basin.

throughout the sediment core of Tainter Lake, we can infer that nutrient levels, especially phosphorus, have also changed. Overall, the study concluded that nutrient levels appear to have been highest from 1965 to 1980. In the early 1980s the levels became much lower, but have since begun to increase.

In order to help quantify phosphorus loads from point sources, the team used a computer model. Called the Simulator for Water Resources in Rural Basins – Water Quality, it simulates a natural basin and the processes that take place therein. One facet of the model identified point sources that currently discharge into the Red Cedar River Basin. Phosphorus loads were estimated from both municipal and industrial facilities for the years 1990, 1994, 1997 and predicted for 2000 (Fig. 4).

A comparison of phosphorus production sources such as livestock, poultry and people during the years 1940, 1960, and 1992 indicates that the most significant increase took place in turkey production in 1992 (Fig. 5). This rate of more than four million pounds is not offset by a decrease in any other category. Of course, not all phosphorus produced ends up in waterways. All other animal and poultry amounts have continued to decrease in the '90s, albeit at a much smaller rate. It may seem counter-intuitive that the increase in human population over time does not correspond to an increased phosphorus rate; however, due to improved technology and increased point-source control in the recent past, municipalities now discharge lower loads.

PHOSPHORUS REDUCTION METHODS

Examples of Best Management Practices in the Red Cedar River Basin:

- **Buffer Zones (residential & agricultural)**
- **Crop Residue Management**
- **Stormwater Management**
- **Nutrient Management**

Do Green Acres Mean Green Lakes?

Over the past forty years, this region of the state has also seen a growing trend in row crop production and an increase in commercial fertilizer use (Figs. 6 and 7). Both factors have led to greater phosphorus runoff.

In addition, as development pressures in the Red Cedar River Basin continue, construction activities and homeowners also contribute to phosphorus runoff levels. As native shoreland habitats are destroyed, a natural vegetative buffer no longer exists. A thick vegetative buffer along a shoreline acts as a filter by allowing runoff to infiltrate into the ground instead of into the lake or river. Therefore, as soils are unearthed in construction processes and property owners replace native plants with lawns, it is much more likely that eroded soil, fertilizers such as phosphorus and other pollutants will reach our waterways. What may seem an insignificant amount of sedi-

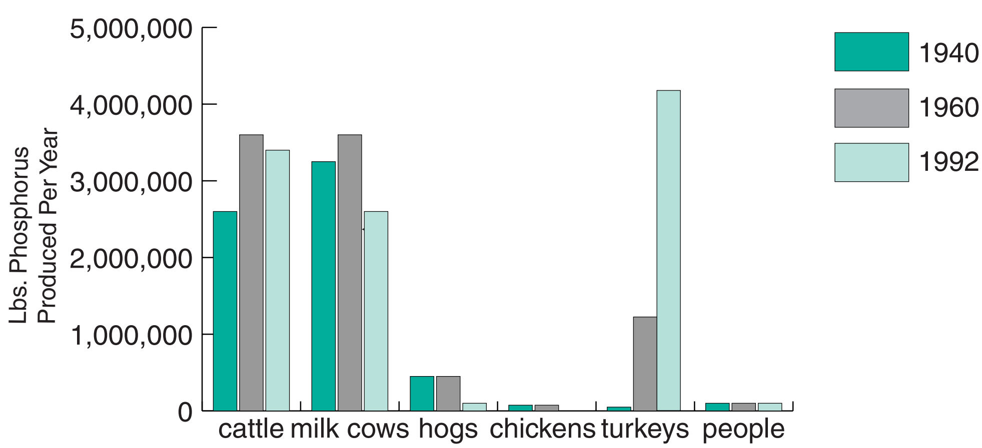


Figure 5: Comparison of Phosphorus Produced From Various Sources Over Time in the Red Cedar River Basin.

ment and attached phosphorus can ultimately add up to a significant impact on lakes and rivers.

Phosphorus in the Future

In 1996, a lake user survey was conducted to assess physical water parameters and lake user water quality perceptions. Physical parameters included measurements of water clarity, total phosphorus, and chlorophyll concentrations. Sociological data consisted of lake users' perceptions regarding water clarity, recreational suitability, and use. The analysis indicated that when chlorophyll levels are between 15-25 ug/L, public perception of water quality substantially declines. This finding coincides with similar work elsewhere which indicates that chlorophyll levels above 20 ug/L discourage recreational use. But what amount of phosphorus reduction will result in a decrease in chlorophyll levels and provide a noticeable improvement in water quality?

A Lake Response Model was created in order to provide a reasonable answer to this question (Fig. 8). By assessing phosphorus loads from point and non-point sources, modeling the lake, and estimating the amount of phosphorus in the system, a phosphorus reduction goal can be set. The model helps illustrate the relational improvement in water quality resulting from each percentage reduction in phosphorus loads. For example, a 50% to 70% reduction in the phosphorus load would increase water clarity to several feet, allowing more native, rooted aquatic plants to grow instead of algae, and providing a noticeable improvement in the lake's appearance.

The reduction of phosphorus in the Red Cedar River Basin will not be quick and easy. There are likely to be significant costs to improving the water quality. However, the Steering Committee has emphasized the need for holistic solutions to this complex problem. While no one practice or activity alone will solve the Red Cedar River's water quality problems, each has potential to make a difference.

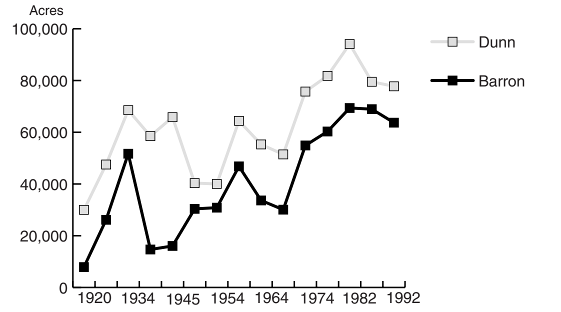


Figure 6: Corn for grain, seed, silage and green chop

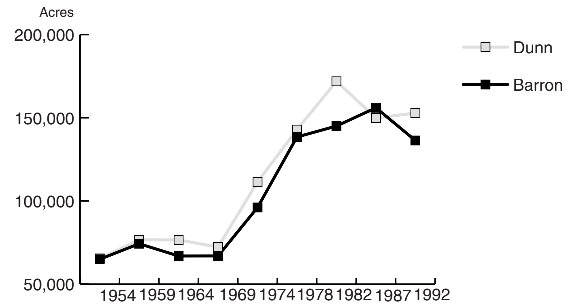
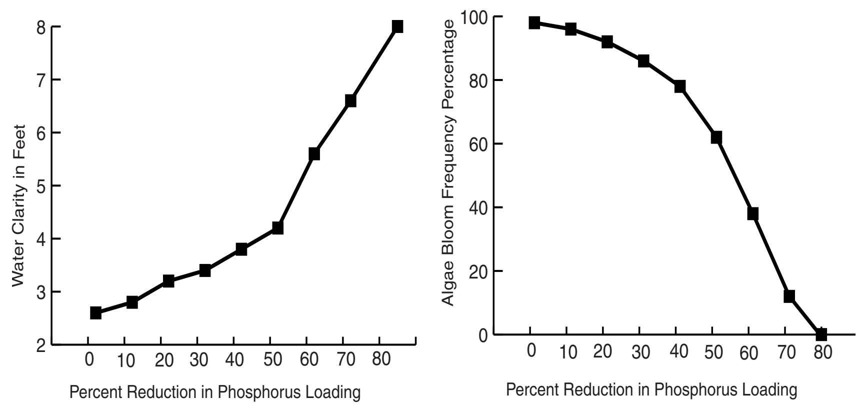


Figure 7: Use of commercial fertilizer

Figure 8: Predicted Water Clarity Improvements and Bloom Frequency Reductions From Reduced Phosphorus Loads for Tainter Lake, Wisconsin



For More Information, Contact:
Red Cedar River Basin Project Coordinator
Phillips Hall, Room 146
UW-Eau Claire
Eau Claire, WI 54702-4004
(715) 836-5513

References

Garrison, Paul *Paleoecological Study of Tainter Lake, Dunn County*. Wisconsin Department of Natural Resources; pp. 1-6

LaLiberte, Paul and Kampa, Eric (1999) *Phosphorus Content of Water and Suspended Sediment in the Red Cedar River Basin.* Wisconsin Department of Natural Resources; p.10

Red Cedar River Basin Steering Committee *(1997) Framework for Managing Phosphorus in the Red Cedar River Basin, pp.3-5.12, 21-22.*

Schreiber, Ken (1992) *Red Cedar River/Tainter Lake Phosphorus Assessment.* Wisconsin Department of Natural Resources.

U.S. Census of Agriculture, U.S. Department of Agriculture.

Wisconsin Agricultural Statistics: 1940, 1960, 1992. Department of Agriculture, Trade and Consumer Protection.

Wisconsin DNR (1999) *Prediction of Suspended Solids and Total Phosphorus Yields in the Red Cedar River Drainage System*, pp 1-2, 37, App. 3.

Printed on
Recycled Paper