DEER LAKE CONSERVANCY

Deer Lake Water Quality Studies (2022-2025)

The Deer Lake Conservancy (DLC) initiated two studies in 2022 to track progress toward water quality goals and to set priorities going forward. The first study analyzed the watershed and measured flow, sediment, and phosphorus concentrations from lake tributaries. The second measured phosphorus, chlorophyll, water clarity, and algae in the lake. Temperature and oxygen profiles were recorded to understand when the lake mixed and brought phosphorus from near the lake bottom to the surface. Phosphorus is the nutrient the fuels algae growth in Deer Lake.

Results were used to compile phosphorus inputs into the lake and develop a lake model that aids in understanding the significance of installed watershed practices and establishing priorities for future efforts. Studies were conducted by Steve Schieffer of Ecological Integrity Service with input from the Polk County Land and Water Resources Department and the Deer Lake Conservancy. The studies were supported by grants from the Wisconsin Department of Natural Resources.

Deer Lake Management Plan Water Quality Goals (2020)

The study reports confirm that all objectives under the water quality goal have been met or exceeded.

- ✓ Goal. Deer Lake water quality is improved and maintained.

- ✓ Objective A: Trophic State Indices for chlorophyll, Secchi depth, and total phosphorus are in mesotrophic or oligotrophic ranges.
  Trophic state indices are a measure of nutrients in the lake. Deer Lake consistently falls in the mesotrophic (moderate-nutrient) range for chlorophyll (a measure of algae growth) and total phosphorus, and in the oligotrophic (low-nutrient) range for Secchi depth (a measure of water clarity).

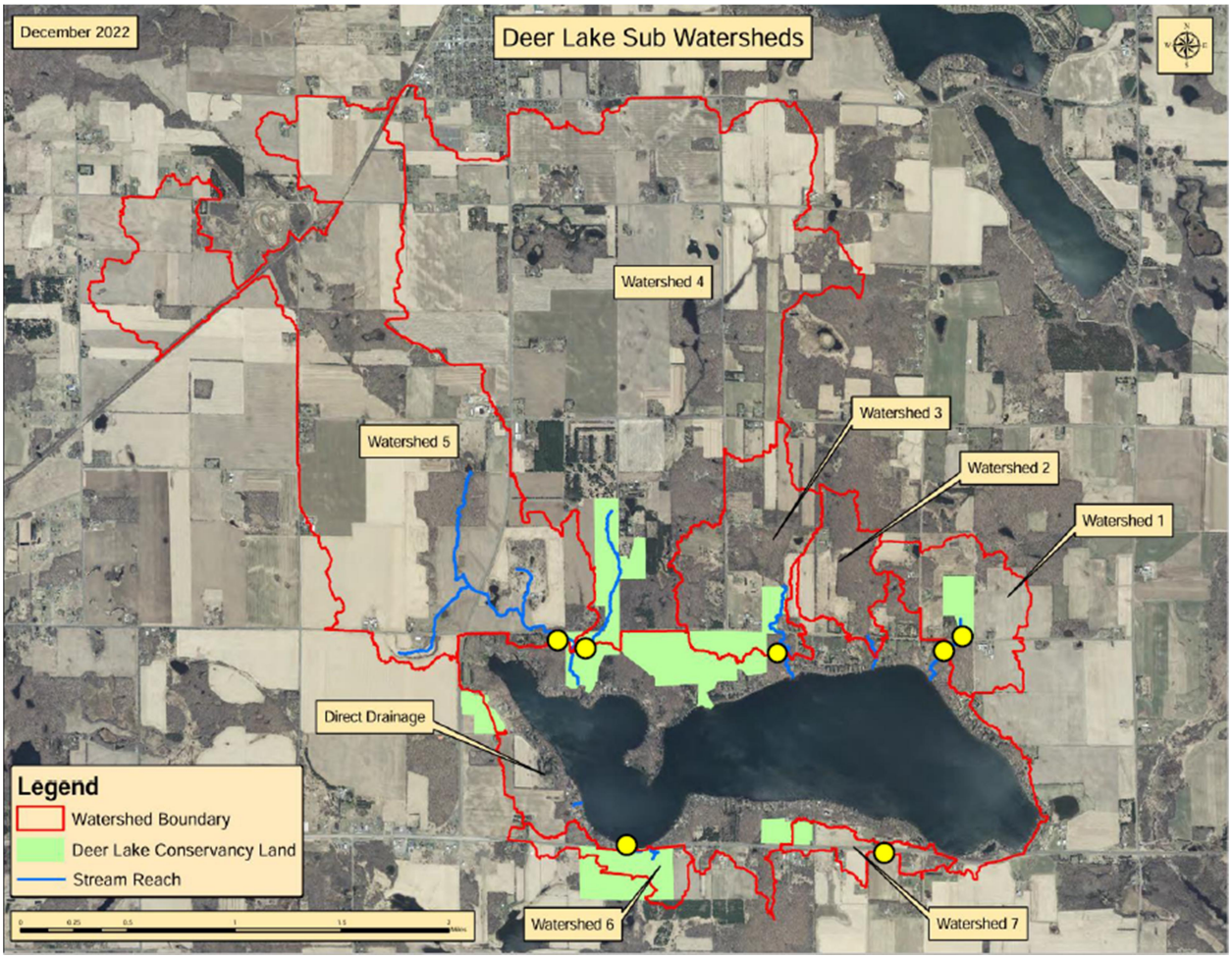
- ✓ Objective B: In-lake summer total phosphorus concentration is less than 19 µg /L.
  The current 10-year average is 18 µg /L. The lake model demonstrates the effectiveness of previously implemented watershed management practices. Without these practices, predicted growing-season mean total phosphorus concentrations would approach 30 µg/L.

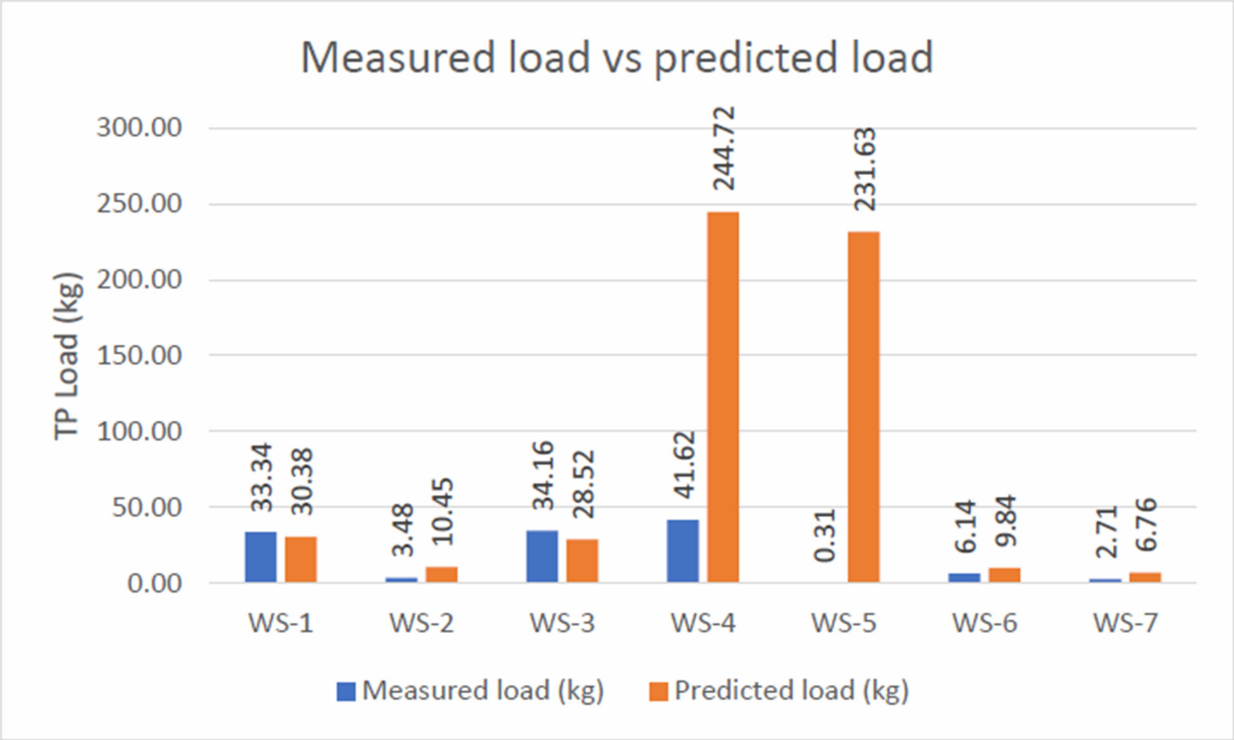
- ✓ Objective C: Watershed phosphorus loading is reduced by 65% from 1996 levels.
  The lake model was used to compare measured loading rates from tributaries compared with expected loading rates before DLC projects were installed. There was an astounding 70% less phosphorus entering the lake as compared to what was predicted with estimates of land cover only (without DLC projects installed). With large-scale practices installed in most sub-watersheds, the direct drainage area surrounding the lakes is currently the largest source of phosphorus to Deer Lake.

Watershed and Tributary Study Results

The Polk County Land and Water Resources Department updated sub-watershed boundaries, land cover, and identified internally drained areas – areas where runoff rarely drains to the lake. Ecological Integrity Services monitored flow and nutrients (total phosphorus, orthophosphate, and total suspended solids) in the seven tributaries that drain the sub-watersheds from April 2022 to September 2025. Monitoring points are shown as yellow dots on the map below.

Many best management practices (BMPs) have been implemented on DLC-owned land within the sub-watersheds. More information about the Deer Lake Conservancy lands and management practices can be found in the Deer Lake Conservancy's *Conservation Project Tour Guide*. A summary of land use and installed practices for each sub-watershed is included in the full report - *Watershed Analysis: Tributary Flow and Nutrient Loading Analysis Deer Lake Polk County, WI.* The DLC purchased a 20-acre parcel in sub-watershed 2 since the map below was created.





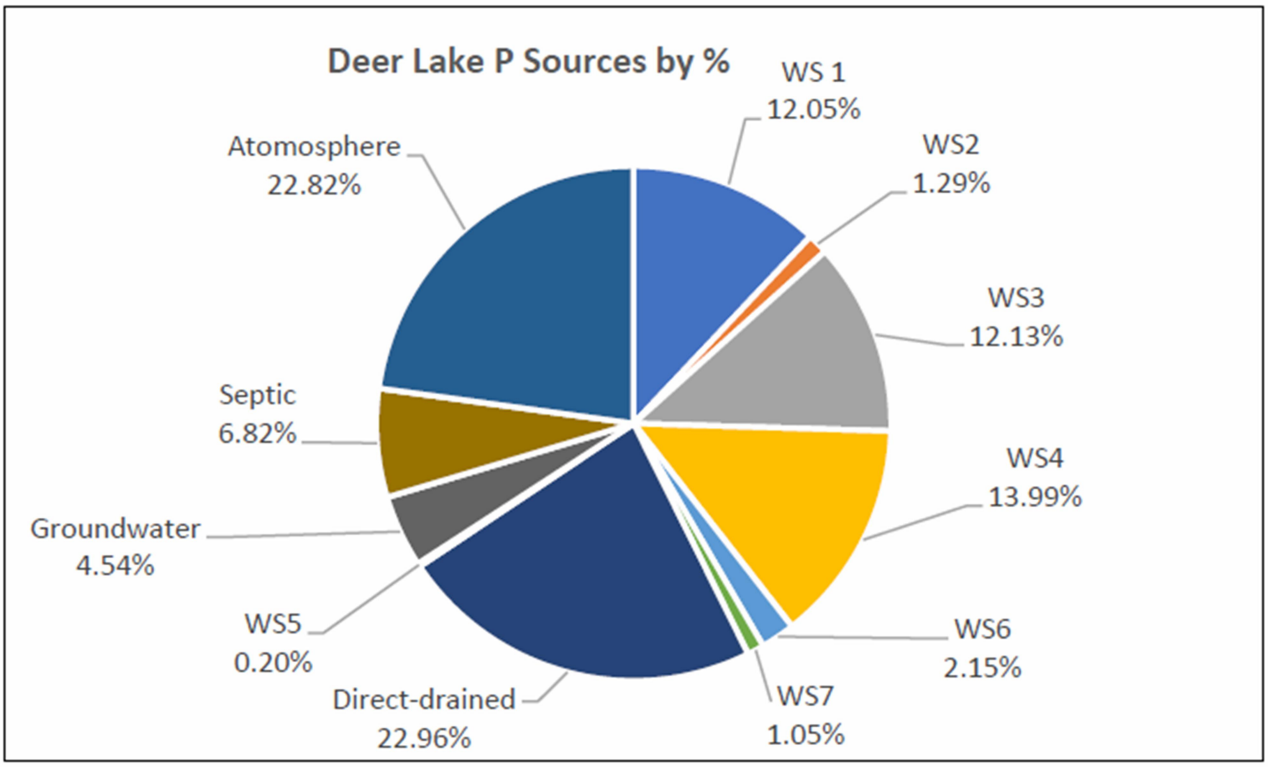
The measured phosphorus load compared with the predicted load based on land cover is shown for each sub-watershed in the figure above. The total predicted load from the sub-watersheds based on land cover was 560.3 kg/year. The mean monitored loading was 121.6 kg/year. The monitored loading was only 21.7% of the predicted loading. Reductions in loading were most striking in Watershed 4 (Rock Creek) and W5 (Lower Rock Creek).

Watershed Highlights

- Sub-watershed 1 (WS-1) has the highest phosphorus loading per acre, followed by WS-3 (Dry Creek). More nutrients are coming from the portion of WS-1 that flows to the lower pond south of the road where crop fields and a barnyard are located.
- WS-3 (Dry Creek) had the highest sediment loading per acre by a significant amount. Sediment accumulation can not only increase nutrients in Deer Lake, but accumulated sediments on the lake bottom can degrade the benthic habitat (bottom) for plants and other organisms. The DLC installed a stream stabilization project on private property along Dry Creek in 2025 to decrease the sediment load from Dry Creek.
- WS-6, which drains the Flagstad Farm area, had the highest concentration of phosphorus. However, this culvert rarely flowed and only tended to flow during intense precipitation events. Sediment appeared to come from wash-out of the driveway to the Flagstad Farm. The DLC plans to stabilize the Flagstad Farm driveway in 2026.
- With climate change, we can expect periods of below normal precipitation interspersed by intense storms and rain/snow events. The data collected in this analysis shows that installed management practices are making a significant difference under these conditions.

Lake Nutrient Budget Analysis

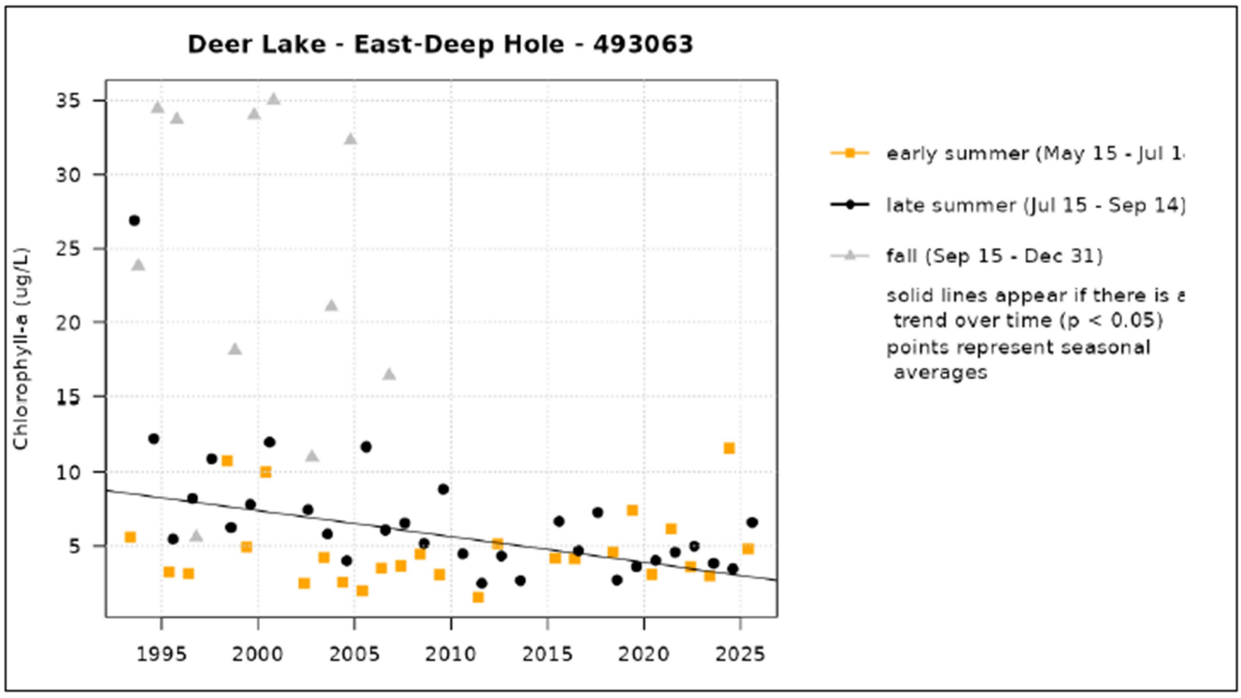
Tributary monitoring data collected from 2022–2025, combined with in-lake measurements of total phosphorus (TP), chlorophyll-a, and Secchi depth, were used to develop a comprehensive phosphorus budget for Deer Lake. Model results indicate that the direct-drained sub-watershed is the largest source of phosphorus to Deer Lake, contributing approximately 23% of the annual load under average precipitation conditions. While sub-watershed 4 has the next highest loading total, it is the largest sub-watershed and has the lowest loading per acre.



From 2007 through 2024, technical assistance addressing runoff control was provided to owners of 157 Deer Lake parcels (50% of lake parcels). This is an average of 11 properties visited per year (some are repeat visits). In total, projects such as rain gardens, rock infiltration, and native plantings have been installed on 66 lake properties. Many of these properties had multiple best management practices installed. However, over the same period, many larger homes and structures have been constructed, and lawns have replaced natural vegetation on the lake. Both can result in severe erosion during construction and long-term increases in runoff of nutrients and sediment. The direct drainage area has a large percentage of medium and high-density residential areas which tend to contribute high amounts of runoff with direct or nearly direct connections to the lake.

Lake Quality Trends

Long-term lake quality monitoring demonstrated improving trends in chlorophyll (less algae growth) and Secchi depth (water clarity). This shows the water is getting clearer in the late summer/early fall, when the water quality is typically the worst in most Wisconsin lakes. **These long-term trends likely result from reductions in watershed loading NOT recent zebra mussel infestations. Greater water clarity can be partially influenced by zebra mussels in lakes, however an algae study completed in 2022-23 showed no evidence that this is occurring on Deer Lake.** Deer Lake chlorophyll concentrations have not consistently decreased since zebra mussels were discovered in 2016 and subsequently expanded starting around 2020. An assessment of phytoplankton (algae) types and biomass was conducted to serve as a baseline for future analysis.



Lake Model Predictions

Load-reduction scenarios indicate that a 20% reduction in phosphorus loading from the direct-drained sub-watershed would reduce growing-season mean total phosphorus from 18.1 to 17.6 µg/L, decrease chlorophyll-a from 4.6 to 4.4 µg/L, and increase Secchi depth from 15.1 to 15.4 feet. A 20% reduction across all tributary sources combined would further improve water quality, reducing total phosphorus to 16.3 µg/L, chlorophyll-a to 4.0 µg/L, and increasing Secchi depth to approximately 16.4 feet. Conversely, loading increases from increased development, or changes in the types of development would lead to increased phosphorus loading and lake quality degradation.

Recommendations

The direct-drained sub-watershed represents the highest priority for future phosphorus reduction efforts since it is estimated to be the largest contributor of nutrients and can be managed. This area contains extensive residential development with impervious surfaces and manicured lawns that increase runoff and nutrient delivery. Numerous management practices have previously been implemented that reduce nutrient loading; however, these could have been offset by added development. Management practices that promote infiltration and reduce runoff such as shoreline buffers, rain gardens, infiltration practices, reduced fertilizer use, and conversion of turf to native vegetation—should be emphasized. These should be considered for currently developed areas as well as for future development.

Additional mitigation opportunities should be evaluated in other contributing sub-watersheds, particularly WS-1 and WS-3. Continued long-term monitoring is recommended to track watershed loading trends and in-lake response and to support adaptive management of Deer Lake.

Sources

Deer Lake Conservancy. *Conservation Project Tour Guide. 2025.*

Ecological Integrity Service, LLC. *Summary of Baseline Phytoplankton Composition in Deer Lake, Polk County, WI. 2022-23.*

Ecological Integrity Service, LLC. *Nutrient Budget Analysis. Deer Lake, Polk County, Wisconsin. 2025.*

Ecological Integrity Service, LLC. *Watershed Analysis: Tributary Flow and Nutrient Loading Analysis. Deer Lake, Polk County, WI. April 2022-Sept. 2025.*

Harmony Environmental and Growth Strategies. For Deer Lake Conservancy, Inc. *Deer Lake Management Plan.* 2020.

Polk County Land and Water Resources Department. Watershed Analysis and Maps. 2022.

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