

Upper St. Croix Lake, Douglas County, WI

Erosion from construction, forestry practices, clearing below power lines, and other activities that make soil susceptible to erosion should be controlled. When soil is exposed water running off of these areas should be prevented and cover should be re-established as quickly as possible.

Vegetative shoreland buffers should be protected where they are already established and restored where they have been removed. The buffers should be at least 35 feet deep, which is consistent with the state shoreland zoning ordinance. The County should implement policies to bring all properties into compliance with these standards.

Fertilizers containing phosphorus should not be used. Most soils have sufficient phosphorus concentrations to maintain a vegetative cover. If a soil is deficient in phosphorus it may be applied according to recommendations based on soil test results.

Septic systems should be sited as far from waterways as possible or tertiary treatment systems should be included on the systems. Septic system effluent is rich in phosphorus. Over time phosphorus will move from a septic system drainfield to groundwater which in turn discharges to surface water. Traditional septic systems do not remove phosphorus but additional treatment chambers can be added to a septic system to remove phosphorus. Selecting household products that don't contain phosphorus (and other harmful chemicals) can also be beneficial.

Internal sources of phosphorus are an important part of the lake's phosphorus budget. Minimize the amount of exposed sediment in the shallows by leaving aquatic plants in place. Motor boats (especially large boats) and stir up exposed sediment. Operating motor boats in depths less than 4 feet should be minimized and start ups in this zone should be avoided.

Exploration of pilot tests of treatments could be conducted although these approaches may only provide short term relief, are generally expensive, and won't solve the problem over the long term. These treatments include the application of alum to seal off the resuspension of nutrients from the sediments for several years. Removal of sediments may be another option but would significantly disturb the lake's ecosystem and runs a large risk for the establishment of invasive aquatic species.

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Study Discussion and Recommendations

The algae issues that are related to phosphorus in Upper St. Croix Lake are fairly unique in the Upper St. Croix River Watershed. Seasonal fluctuations of phosphorus occur annually in Upper St. Croix Lake. In general, phosphorus concentrations in Upper St. Croix Lake are lowest in the spring, increase in the summer, and drop off again in the fall. Although this pattern is similar each year, the magnitude of these fluctuations varies from year to year, likely due to differences in precipitation patterns, temperatures, etc. The type and amount of algae in the lake also respond to the changes in phosphorus and temperature.

Upper St. Croix Lake shows signs of moderate nutrient enrichment and a shift towards dominance by less desirable blue-green algae. Sources of nutrients are both natural and from human inputs from land management practices and other activities. You can't control some of the physical conditions such as drought, geological conditions, or the shape of the lake. Reducing phosphorus inputs to Upper St. Croix Lake will improve conditions over the long term, although these changes may be slow. Taking no action to reduce phosphorus inputs to the lake will likely result in increased frequency and magnitude of algal blooms. Allowing an increase in phosphorus additions to the lake will result in increased frequency and magnitude of algae blooms with the potential of fish-killing oxygen depletion.

Water quality in a lake is a reflection of land use practices in its watershed. In the summer Upper St. Croix Lake has high concentrations of phosphorus. Action should be taken to reduce phosphorus inputs to the lake and its tributaries. Actions to consider:

Disseminating information is an important part of helping people understand why land management practices need to be altered. Information can be exchanged in a variety of creative ways including the use of demonstration projects in public places (with signage). There are a number of sites around Solon Springs and Upper St. Croix Lake that could be used as demonstration sites. Workshops, brochures, and newsletters are other means that can be used to get the word out.

Decrease direct runoff to Upper St. Croix Lake and its tributaries. This may include designing water conduits to direct runoff to retention basins and rain gardens and use of pervious pavement in parking lots. Road crossings over tributaries should direct water to depressions where water can infiltrate to groundwater or sediments can settle and be filtered by vegetation before flowing into surface water. Paths that provide access to the lake should be designed to minimize direct runoff to the lake; this can be accomplished by using a serpentine design and materials that are not easily eroded. Tall vegetation (grasses and forbs) should be established adjacent to the path to reduce direct runoff to the lake and to help filter runoff. Trees and shrubs reduce the direct impact of raindrops which results in greater erosive potential and should be used in landscape design.

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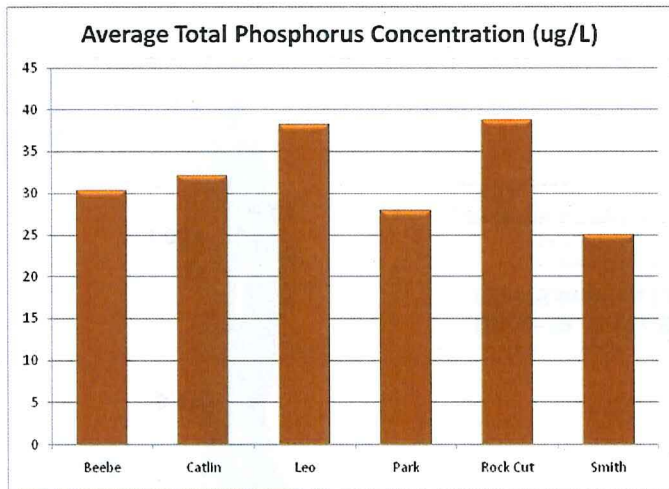


Figure 11. Average phosphorus concentrations in tributaries of Upper St. Croix Lake.

Annual Total Phosphorus Load

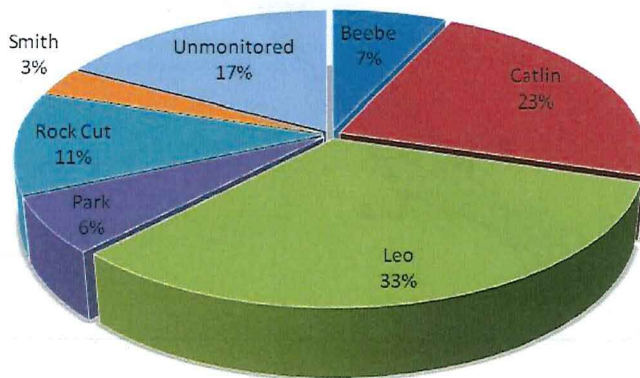


Figure 12. Phosphorus contributions from tributaries of Upper St. Croix Lake.

The average concentrations of phosphorus measured in the monitored tributaries of Upper St. Croix Lake were fairly similar. Leo and Rock Cut Creeks had the greatest average concentration and Park Creek had the lowest average phosphorus concentration (Figure 11).

Phosphorus contributions to Upper St. Croix Lake from the monitored tributaries and unmonitored portion of the Upper St. Croix Lake watershed are shown in Figure 12. These loads represent the mass of phosphorus coming into the lake; Leo and Catlin Creeks deliver more phosphorus in part because they deliver a greater volume of water than the other creeks

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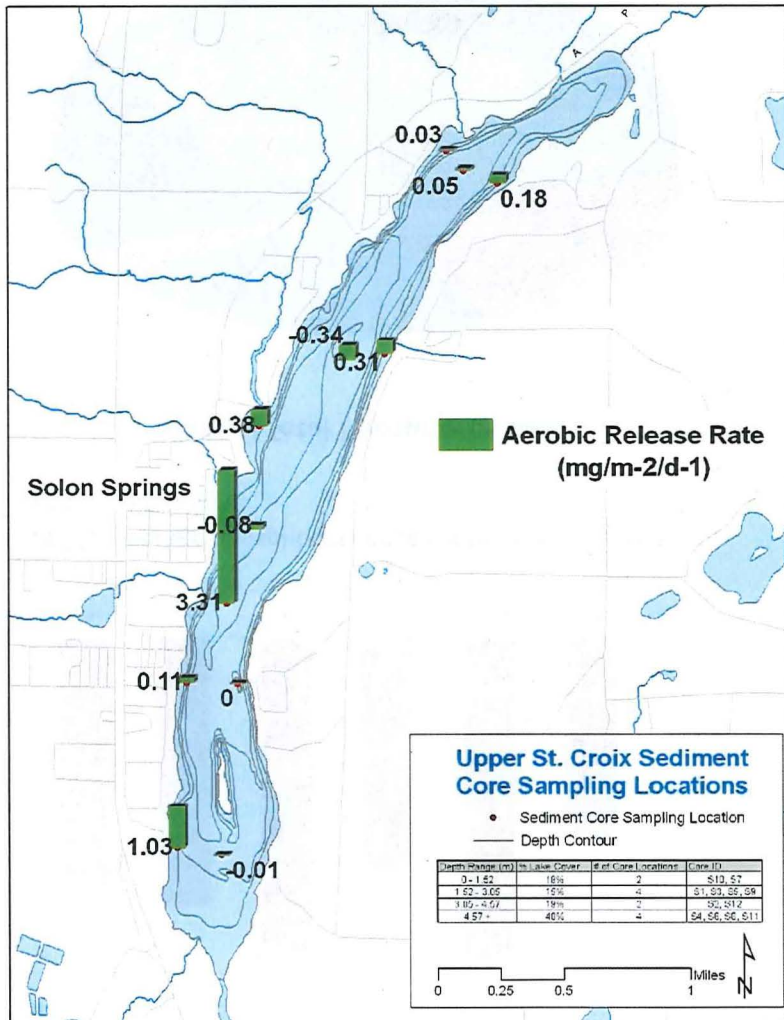


Figure 10. Location of sediment samples in Upper St. Croix Lake.

Sediment release of phosphorus occurs when the high phosphorus bottom waters mix with the lake water. The mixing can be a result of winds, storms, and boating activity. Minimizing the mixing of sediment from boats and wind can be accomplished by leaving aquatic plant growth in place.

Once in the lake phosphorus stays in the lake for years and continues to cycle within the system. **This highlights the need to prevent excess phosphorus from getting into Upper St. Croix Lake.**

During certain conditions sediment can be a source of phosphorus to a lake. Sediment cores were collected throughout Upper St. Croix Lake (Figure 10). In the samples that were collected, the greatest source of phosphorus occurred off the boat landing near Solon Springs.

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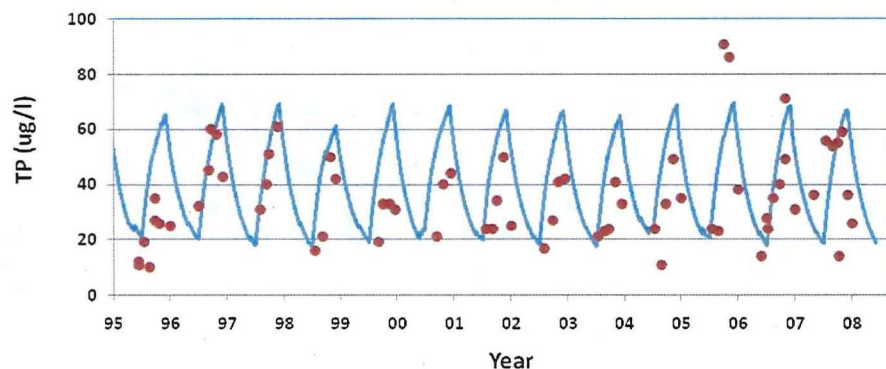


Figure 8. Model results showing the seasonal nature of the water quality data measured in Upper St. Croix Lake. Red points are phosphorus samples collected from Upper St. Croix Lake, Blue line is phosphorus predicted by a model.

Source	P Quantity pounds/year
Atmospheric Deposition	172
Streams and Groundwater	1423
Internal Release	1828-2994
Total Entering Lake	3437-4589
Total Leaving Lake in Outflow	1115-1481

Figure 9. Average annual phosphorus budget for Upper St. Croix Lake (1989-2008).

Phosphorus is the primary nutrient that fuels algae and aquatic plant growth in Upper St. Croix Lake. In spring phosphorus concentrations in the lake water start out relatively low at about 20 ug/L and increase through the summer, averaging 54 ug/L during the growing season (Figure 8).

Phosphorus concentrations above 25 ug/L result in increased algal blooms and aquatic plant growth. For lakes like Upper St. Croix Lake the WDNR recommends average summer concentrations less than 40 ug/L

The increase of phosphorus as the summer progresses is primarily due to internal sources of phosphorus in Upper St. Croix Lake.

Phosphorus contributions to Upper St. Croix Lake include direct deposition from the atmosphere, internal release, and streams and groundwater (Figure 9). The largest source is internal release which can be related to sediment release and biotic activity in the lake.

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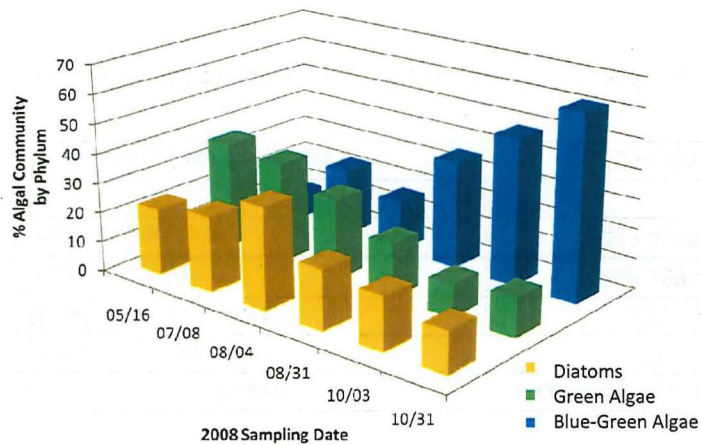


Figure 6. The dominant algae types change from spring to fall. Blue green algae are most dominant in the later part of summer in Upper St. Croix Lake.

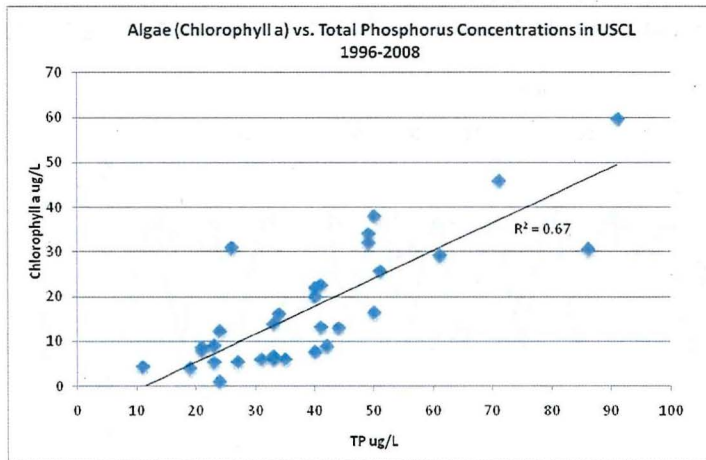


Figure 7. In Upper St. Croix Lake, increases in phosphorus result in increased amounts of algae.

The shape of Upper St. Croix Lake provides ideal conditions for algae to flourish. There are sufficient nutrients in Upper St. Croix Lake to support algae.

Warm and dry conditions favor algal growth.

Most freshwater algae need water, sunlight, nutrients, and carbon dioxide. Some species also need warm temperatures to flourish so we see changes in the algae community in Upper St. Croix Lake throughout the year.

Different types of algae are dominant at different times of the year (Figure 6). Blue green algae are often considered a nuisance type of algae because they form unsightly masses along with a bad odor. They can also be toxic and cause rashes and in rare cases a few species can cause illness or death. They are not a preferred species to zooplankton (their primary predator).

Typically algae problems take a long time to occur, and therefore take a long time to be resolved.

In Upper St. Croix Lake the algae response is closely related to increases in phosphorus in the lake; as phosphorus increases algae increases (Figure 7).

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Water level variation in Upper St. Croix Lake is usually related to precipitation; however, in early July the St. Croix River near Cut Away Bridge begins to fill with wild rice. By late July the wild rice fills much of the channel and water begins to back up upstream of this area.

Figure 5. Photos at Cut Away Bridge showing changes in channel size over the summer.

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Tributaries transport the majority of water to Upper St. Croix Lake. Like the lake, each tributary has its own watershed (Figure 4).

The positive or negative influence on the lake's water quality depends upon the amount of water delivered, the land management practices in the sub-watersheds, and where the creek enters the lake. Although Leo Creek delivers a lot of water to Upper St. Croix Lake, it enters at the lower end of the lake, and therefore has minimal influence on the overall water quality in Upper St. Croix Lake.

Figure 4. Upper St. Croix Lake Watershed: Sample site locations and sub watersheds.

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Figure 3. Upper St. Croix Lake groundwater watershed.

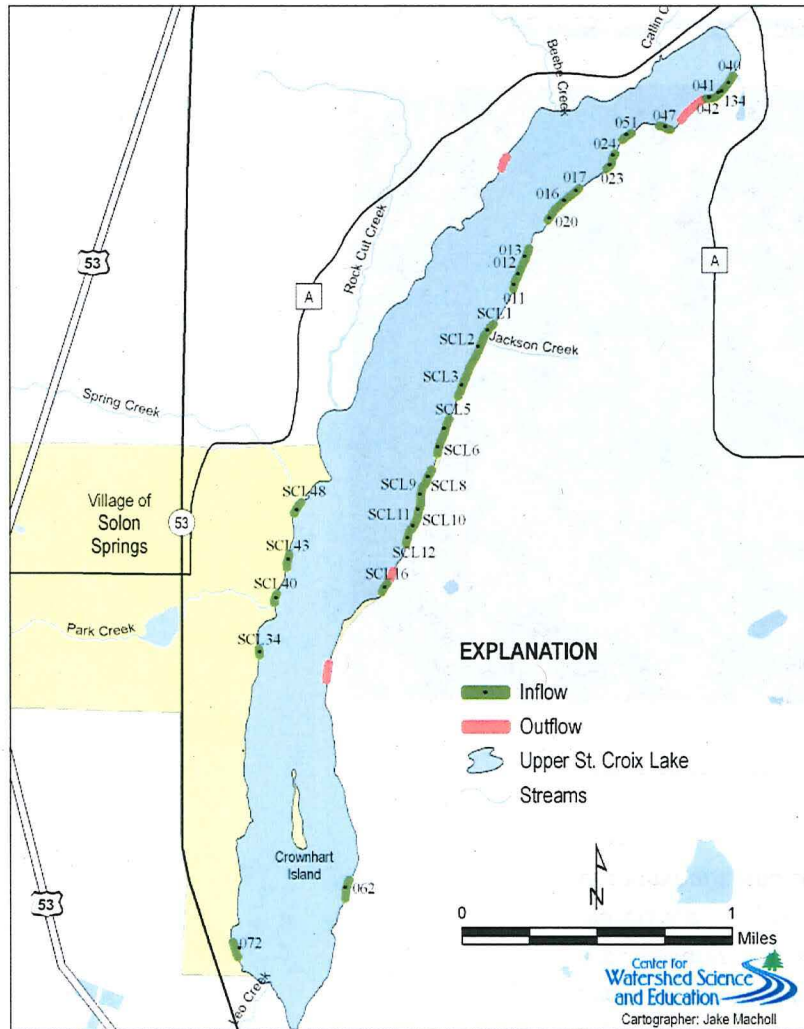


Figure 3. Areas of groundwater inflow and outflow in Upper St. Croix Lake

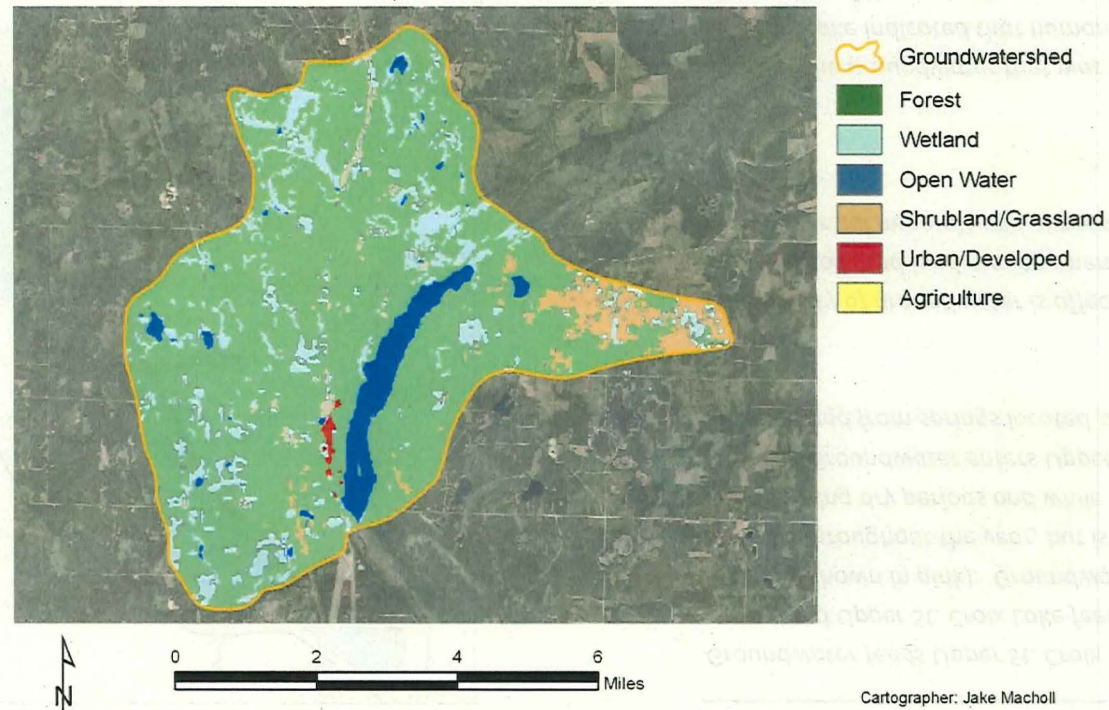
Groundwater feeds Upper St. Croix Lake (inflow shown in green) and Upper St. Croix Lake feeds the groundwater (outflow shown in pink). Groundwater supplies water to the lake throughout the year, but is the primary source of water during dry periods and while the lake is covered with ice. Groundwater enters Upper St. Croix Lake in its lake bed and from springs located on/near the shoreline.

The quality of groundwater is affected by the local geology, soil, and land management practices. It can carry essential minerals and nutrients along with pollutants.

Some of the groundwater that was tested around Upper St. Croix Lake indicated that human activity is affecting the quality of the groundwater. Indicators of human activity were sporadic around the lake with the greatest area of impact near Solon Springs and just south of Jackson Creek. Phosphorus also appears to be naturally high in some of the groundwater that is entering Upper St. Croix Lake.

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A groundwater watershed is the area where precipitation soaks into the ground and can move to a lake via groundwater. For Upper St. Croix Lake, the groundwater watershed is different than the surface watershed. The predominant land cover is forest, wetland, and shrub land.



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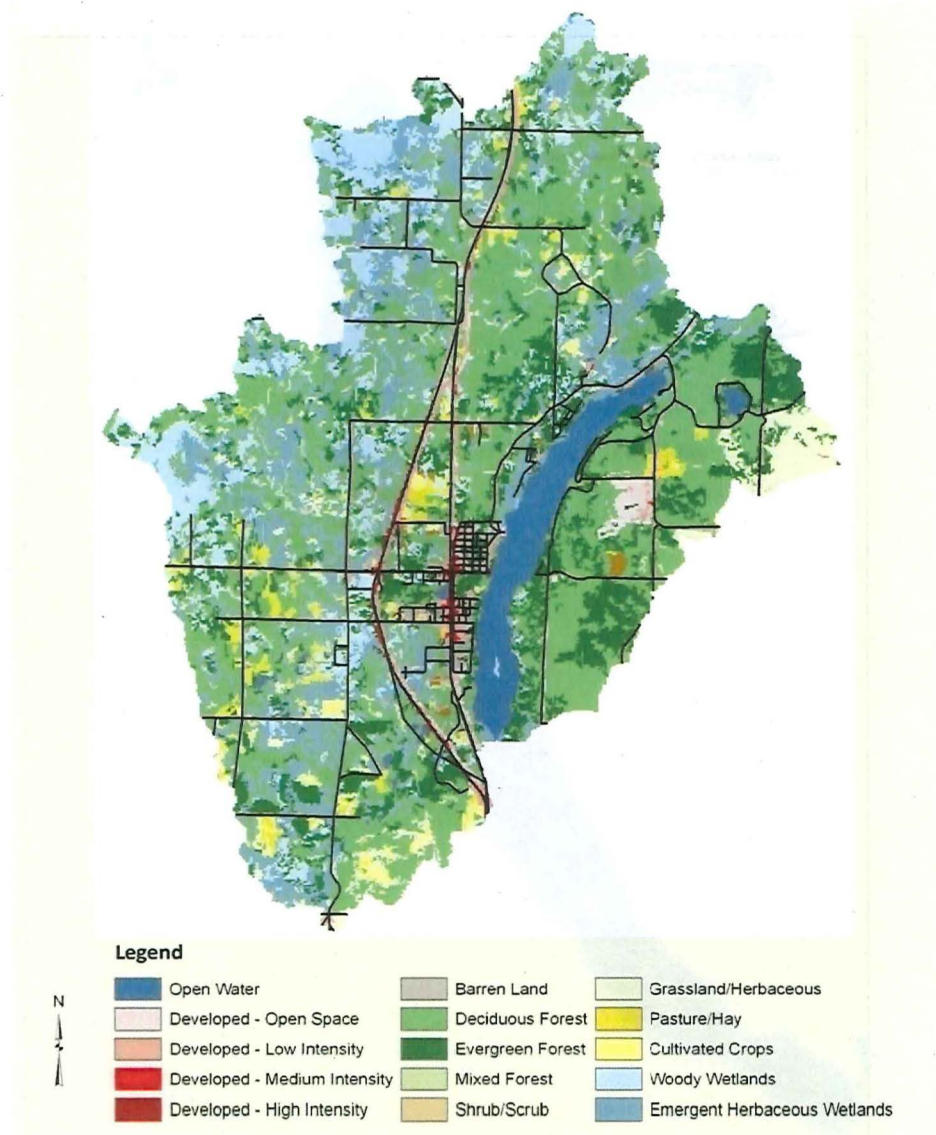


Figure 2. Upper St. Croix Lake surface watershed.

A watershed is the area of land that drains to a lake. The watershed that drains to Upper St. Croix Lake is 34.8 square miles.

Land cover and land management practices occurring in a watershed can affect the quality of water quality in a lake. These characteristics also play a large role in how water moves across the landscape and much water soaks into the ground (for long term storage) or quickly runs off the land.

The primary land cover in the watershed is forest and wetlands. The lake has residential development around some of its perimeter and the Village of Solon Springs is located on its western shore. In general, the lands closest to the lake have the greatest immediate impact on water quality.

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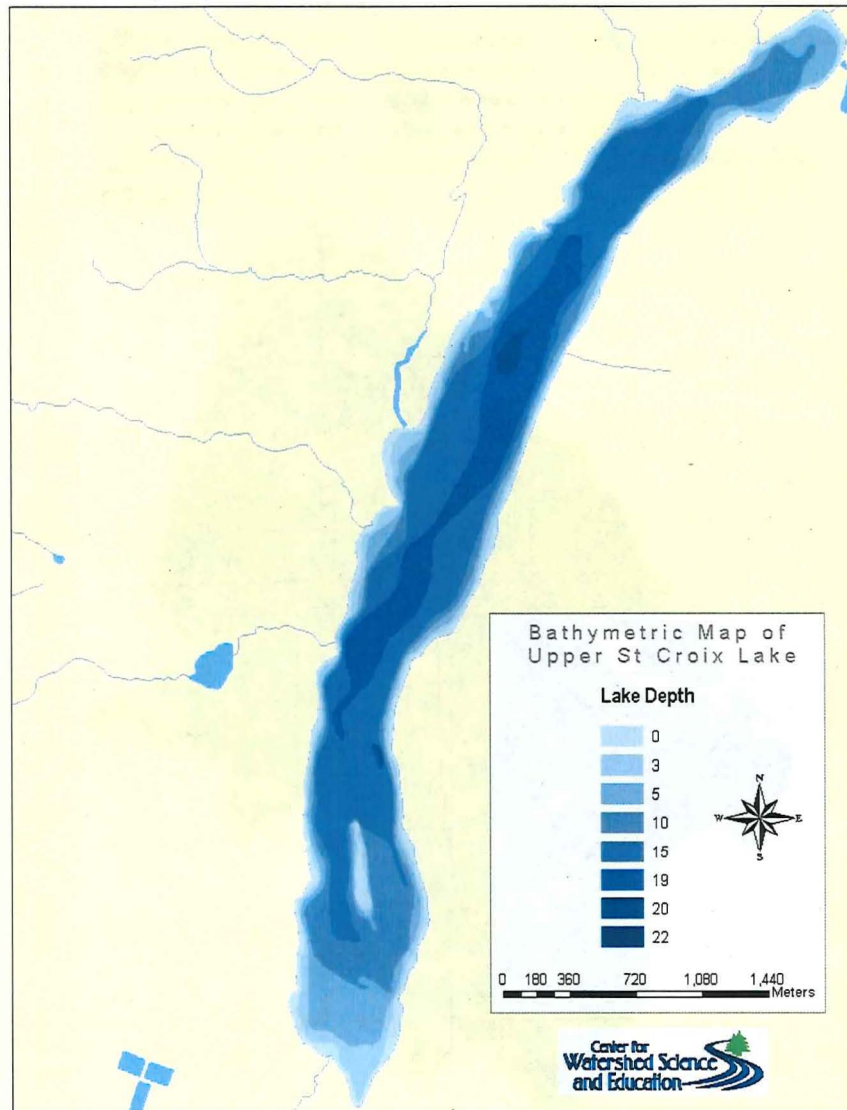


Figure 1. Map showing the water depths in Upper St. Croix Lake

Upper St. Croix Lake is 855 acres with a maximum depth of 22 feet.

Shoreline length is 9.5 miles.

Upper St. Croix Lake receives its water from 7 tributaries, runoff from Solon Springs and adjacent properties, groundwater, and precipitation falling onto the lake.

The amount of time that water spends in a lake can affect water quality and algae growth; the residence time in Upper St. Croix Lake is approximately 6 months. This period of time increases during periods of little precipitation.

The long narrow shape of Upper St. Croix Lake provides ideal conditions for the growth of aquatic plants and algae. This shape also allows winds from the west to mix the lake water and mix bottom waters and sediments periodically throughout the summer.

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Water Quality and Algae in Upper St. Croix Lake - Summary Report

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