John's Lake, Waushara Co. Wisconsin  
Water Quality Assessment  
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John's Lake management district has been enrolled in the Environmental Task Force self-help lake monitoring program since 1989. The monitoring program is designed to establish baseline data for lake groups and to indicate trends that may be occurring in water quality. The following narrative is an interpretation of John's lake data in laymen's terms and my recommendations for future monitoring and lake management techniques for the lake.

Watershed
John's Lake is a 70 acre groundwater drainage lake located in central Waushara county. Groundwater drainage lakes are lakes having a stream outlet with the lake fed primarily by groundwater with some recharge coming from direct rain fall and runoff from the surface watershed. Water quality in these lakes are affected by land use in the groundwater recharge area as well as development around the lake and other land use within the surface watershed. Map #1 delineates the approximate surface watershed which has an area of 0.6 square miles and is dominated by sandy, highly permeable soils situated on slight to moderate slopes. The majority of the surface watershed appears to be well vegetated. These factors help minimize direct runoff into the lake. The main threat to lake water quality in this area would come from potential erosion caused by home or road construction, lawn fertilizer, lawn mowing to the lake edge, and septic leachate. Map #2 outlines the potential groundwater recharge area for the lake which covers an area of 0.8 square miles starting at Porters lake and continuing southeast to John's lake. This area consists of sandy, highly permeable soils covered with a mix of forest, wetlands, and possibly agricultural fields (map #3). The main threat to John's lake from the groundwater watershed would come from soluble agricultural chemicals, septic leachate, and road salt that percolate into the groundwater and enter the lake through groundwater recharge.

Lake basin
John's lake has a relatively smooth bottom configuration, an average depth of 25 feet, and a good wind sweep over the lake from the west. Under normal weather conditions these factors contribute to complete mixing of lake water and should result in a large volume of well oxygenated water following spring and fall overturn. Unless there is excessive organic matter in the lake sediment, complete lake aeration should limit winter fish kill under ice cover and total depletion of oxygen in the bottom water during summer and winter stratification. Maintaining some oxygen in the water above the lake bottom is important to keep phosphorus that has been trapped in lake sediment from dissolving back into the lake water. The lake has a total area of 70 acres with 40 acres having a depth of 20 feet or greater and only 2 acres with a depth less than 3 feet. This relatively small area of shallow water should limit rooted plant growth and create an area of open water over most of the lake surface.
GROUND WATERSHED

MAP #2
Water chemistry and physical properties
John's lake is a hard water lake typical of many other water bodies in central Wisconsin. On the average the lake pH is 8.2, alkalinity and hardness is 180 mg/L as CaCO3, and conductivity is 336 umho/cm. These parameters are interrelated and important components of the carbonate system. Water pH is a measure of the hydrogen ion concentration or acidity. A pH of 7 is neutral, above 7 is alkaline, below 7 is acidic. The high pH of this water is due to the dissolution of naturally occurring calcium and magnesium carbonates in the substrate by the groundwater that recharges the lake. A high pH limits the solubility and thus the toxicity of metals such as aluminum, zinc, and mercury and is an important factor in the formation of marl in a lake. Hardness and alkalinity are also primarily due to dissolved calcium and magnesium carbonates entering the lake via groundwater recharge. Conductivity, or electro conductivity, is the ability of the water to conduct an electric current and is proportional to the dissolved ions in the water. Since most of the ions in natural water are calcium and magnesium carbonates, most of the conductivity comes from these ions. Conductivity is therefore approximately equal to two times the water hardness. The high pH and hardness in the lake is indicative of calcium carbonate precipitation also called marl formation. Marl is a grey mineral material that forms primarily during the summer months when plant activity raises water pH and causes calcium carbonate to become less soluble and come out of solution. The marl that forms is a tiny light weight particle that can float in the water and cause turbidity or cloudiness. High wind and human activity such as power boating can stir up marl deposits on the bottom and contribute to water turbidity. Marl formation has a beneficial effect on water quality by absorbing dissolved phosphorus and removing it from the water column as the marl settles to the bottom. Marl precipitation is probably an important factor in removing phosphorus from the lake water thereby limiting this important nutrient's availability for algae growth.

Nitrogen and phosphorus are the major nutrients responsible for plant growth in lakes. Reactive phosphorus is the form available for algae growth while total phosphorus includes the reactive form plus phosphorus bound to minerals and incorporated in plant and animal cells. Reactive phosphorus over 0.010 mg/L can cause algae blooms, total phosphorus over 0.030 mg/L indicates excessive algae growth and degraded water quality. John's lake has low reactive and total phosphorus concentrations, probably due to marl precipitation, and consequently has good to very good water quality based on a total phosphorus water quality index. Nitrogen is second only to phosphorus as an important nutrient for plant and algae growth. Nitrate and ammonium nitrogen are the plant available forms of nitrogen while total Kjeldahl nitrogen includes ammonium plus organically bound nitrogen. Nitrate plus ammonium concentrations over 0.30 mg/L can support algae blooms. The lake exceeds the threshold level of available nitrogen that can cause algae blooms. Algae blooms, however, should not be a problem because available phosphorus is the limiting factor as indicated by the N/P ratio (nitrogen/phosphorus ratio).

Chloride concentrations are slightly elevated for lake water in this area. Chlorides enter the lake system primarily through groundwater with some contributions possible from surface runoff. Chlorides are an indication of impacts from road salt, septic leachate, animal waste, and chemical fertilizer. I suspect that most of the chlorides are coming from road salt originating from highway 152 to the north and west of the lake. The road is upgradient from the lake and groundwater flowing under the highway moves directly towards the lake. Sodium is also slightly elevated and
is the other component of road salt which is sodium chloride. Both sodium and chloride show a slight upward trend over the last 13 years. Potassium and sulfate appear to be in a normal range for lake water in this part of the state.

Discussion
Water chemistry data collected since 1989 indicates that John’s lake is in good condition compared to other lakes in central Wisconsin. Available forms of nitrogen are present in the lake in ample concentration to cause algae blooms. Carbonate system chemistry suggests that marl deposition is occurring in the lake and is likely removing phosphorus from the water and trapping it in lake sediment as marl deposition. Since phosphorus is the limiting factor for algae growth in this lake, the formation of marl may be the main factor in preventing algae blooms. A generalized water quality, or trophic index based on total phosphorus shows the lake to be boarder-line mesotrophic/oligotrophic which means the water quality is considered good to very good. Water turbidity, color, and one recorded secchi disc reading indicate good water clarity at least during spring and fall overturn. High water clarity is another indicator of good water quality.

I do not have information on the occurrence and relative abundance of rooted aquatic plants in John’s lake. The lake basin shape (morphology) suggests that the large area of relatively deep water would limit the distribution of aquatic plants. Sediment conditions such as nutrient content, size of sediment material, water flow, etc. affect the density of plant growth in areas where adequate light can penetrate to the bottom. Some plants are necessary for fish and other aquatic life, an excess of plant growth can however, cause oxygen depletion due to respiration and decomposition. This can be a problem during winter ice cover when the water is cut off from surface aeration and plant decomposition consumes the dissolved oxygen to the point of causing fish kills. Loss of oxygen in water above the lake sediment during summer or winter also causes chemical reactions to occur in the sediment that can release phosphorus and some metals into the water.

Recommendations
The John’s Lake Management District has collected enough spring and fall overturn samples to establish baseline data for the lake. The only trends that are apparent are a slight increase in chloride and sodium which will not have a significant effect on the lake. I would recommend that the lake district sample every other year in the spring to monitor long term trends in water chemistry. The district might also consider the Total Phosphorus and Chlorophyll-a lake package to more closely assess algae growth during the summer growing season. A lake secchi disc and dissolved oxygen monitoring program run by lake residents would also be a valuable tool to help determine lake health.

To help maintain the present water quality in the lake I would recommend the following:
- avoid development in the surface watershed that could result in soil erosion flowing into the lake
- make sure that septic systems are properly sited and functioning correctly
- do not use animal or chemical fertilizers, especially those containing phosphorus, near the
lake and clean up pet waste that can enter the lake through runoff and snow melt
-leave a buffer strip of natural vegetation between the lake and lawns and do not mow
grass clippings or rake leaves and other vegetation into the lake
-do not feed or encourage large numbers of waterfowl to congregate on the lake
-avoid water craft and activities that stir up and resuspend bottom sediment or add
pollutants to the lake

I have included some brochures your lake group may find informative and helpful. More
information is available for free or a small fee from the DNR or your local extension agent.
Contact me at (715) 346-4078 if you have more questions.