Lake Survey Report

Crystal Lake, Oneida County, Wisconsin

May 2019

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Adapted by the Tesomas Conservation Foundation

Introduction

Students and professors from the University of Wisconsin – Stevens Point sampled Crystal Lake on May 29 and 30, 2019 for their WATR 380 – Field Experience in Aquatic Ecosystem Evaluation course. The goals were for students to gain experience in sampling water quality, habitat, and organisms, identifying organisms, interpreting data, and completing a short report.

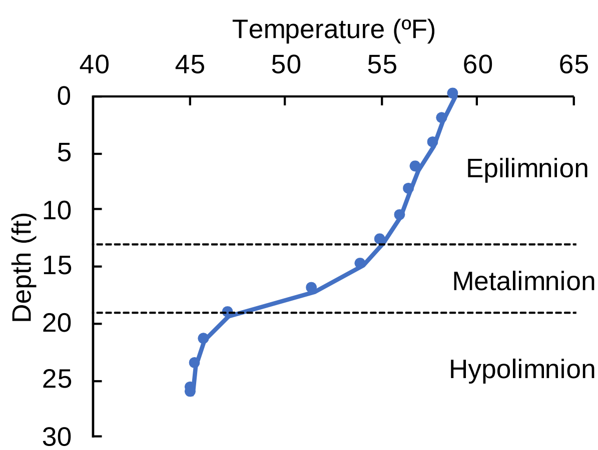
Disclaimers: Given sampling was primarily conducted by inexperienced students, data may not be as reliable as if collected by experienced personnel. In addition, it is recommended to sample multiple times throughout a year as water quality and organisms can change seasonally, and to sample in multiple years to evaluate temporal trends.

Water Quality

Water quality critically influences basic functions such as metabolism and respiration of all organisms and was sampled using various equipment. A Secchi disc was lowered into the water and the depth at which it was no longer visible was recorded, providing information on water clarity and lake productivity. A Hydrolab electronic sonde was lowered from the surface at two foot intervals (known as a vertical profile) to measure water temperature, dissolved oxygen, conductivity (or specific conductance), and pH. Hach chemical kits were used to measure water hardness and alkalinity, but were determined unreliable due to issues with the chemical reagents.

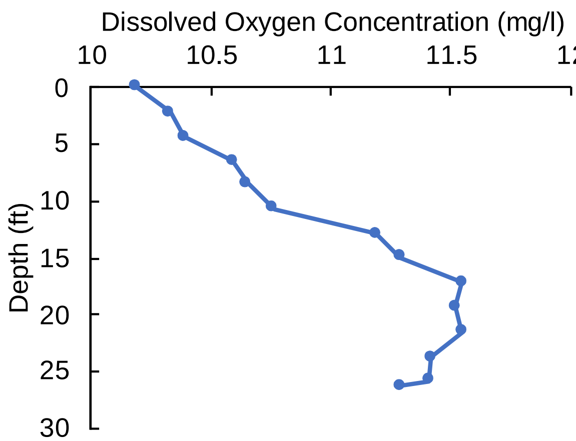
The Secchi disc depth averaged 24 feet across student groups. Based on this Secchi disc depth, the water clarity is considered very good and the trophic status is considered oligotrophic (low productivity). This high Secchi disc depth also indicates sunlight can reach deep into the lake. However, we observed relatively low phytoplankton (algae) levels, most likely due to limited nutrients such as phosphorous and nitrogen.

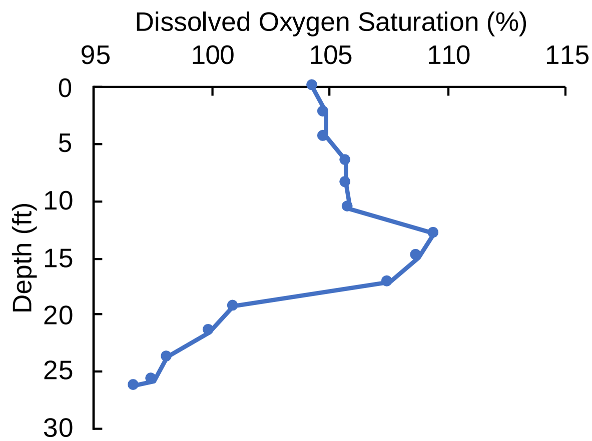
Water temperature was relatively cool, ranging from around 59 °F at the surface to 45 °F near the lake bottom. The lake exhibited signs of thermal summer stratification (different zones), with the upper, warmer (55-59 °F) metalimnion ranging from the surface to 13 feet, the metalimnion or thermocline (zone of relative rapid change, 47-55 °F) from 13 to 19 feet, and the lower, colder (45-47 °F) hypolimnion from 19 to 26 feet. The cool temperatures are likely due to groundwater



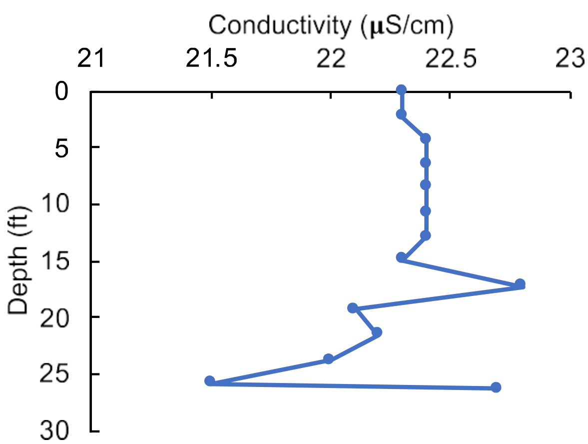
input, a later ice-off and abundant recent precipitation, combined with the lake morphometry that is relatively deep and has steep drop-offs.

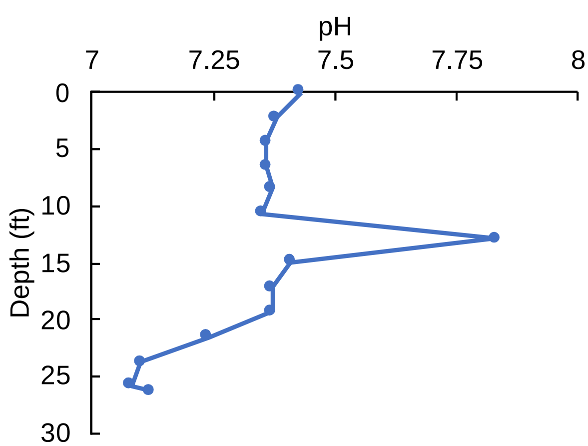
Dissolved oxygen concentrations were above 10 mg/l at all depths, and above 11 mg/l around 12 feet and deeper. These levels exceed the requirement of most fish species of 5 mg/l or higher for extended periods. Dissolved oxygen percent saturation was also high, ranging from 97% at the deepest point to 109% at 13 feet. Dissolved oxygen percent saturation measures compares the current concentration to the maximum concentration for that temperatures, as cold water can hold more dissolved oxygen than warm water. Above 100% indicates dissolved oxygen is actually being released to the atmosphere. Dissolved oxygen levels are primarily increased by mixing with the atmosphere at the surface (e.g., wave activity) and photosynthesis by phytoplankton and macrophytes (aquatic vegetation), and in some cases groundwater input, and decreases primarily through respiration and decomposition. There likely is some photosynthesis by phytoplankton at deeper depths based on the increased in dissolved oxygen levels.





Conductivity was consistent (21.5-22.7 µs/cm) throughout all water depths. These levels are relatively low overall, consistent with an oligotrophic system, likely due to the surrounding geology and limited external inputs (e.g., road salts, fertilizers). The pH was neutral to slightly basic at all water depths.





Physical Habitat

Physical habitat includes lake characteristics (e.g., depth, surface area) along with substrates and structure. Physical habitat can influence water quality and also is important for organisms for spawning, feeding, and finding cover.

The water depth was recorded throughout the lake with a sonar containing an internal GPS. The deepest point was 35.6 feet in the southeast corner of the lake. The sonar data were transferred to GIS to create a bathymetric map that is still in progress.

Substrates and structure were coarsely assessed by slowly boating along the shore to observe aspects such as substrates, fallen trees, and macrophytes (aquatic vegetation). Nearshore substrates were dominated by sand, although gravel and cobble were abundant along shorelines and larger rock was observed in some deeper points. Fallen trees were observed at various locations throughout the lake, both immediately along shore and in deeper water. Docks were present at a few locations along shore. No macrophytes were found along the shoreline or in deeper water, likely due to nutrient limitations as water clarity would allow sufficient light for photosynthesis.

Plankton

Phytoplankton (algae) are primary producers, and thus are critical in terms of dissolved oxygen and the base of the food web. Zooplankton (small crustaceans) feed on phytoplankton and also are an important food source for small fish and other organisms.

Wisconsin plankton nets have very fine mesh to collect phytoplankton and zooplankton. The nets were lowered deep into the water, retrieved slowly to the boat, and the sampled contents are flushed into a storage container.

We observed limited phytoplankton, which is not surprising given the low productivity of the lake. We did collect zooplankton including cladocerans and copepods, but in relatively low numbers. Future sampling should increase sampling efforts at deeper depths where increased dissolved oxygen levels may indicate higher levels of phytoplankton, and in turn zooplankton.

Macroinvertebrates & Amphibians

Macroinvertebrates such as insects and crustaceans are the next level up in the food web, and thus are important as both predators and prey. Sampling along shore for macroinvertebates included d-nets, seine nets (see below), and examining items that were picked up by hand. Macroinvertebrates found along the surface included water boatman, water strider, fishing spider, and water scorpion, while damselfly, dragonfly, crawling water beetle, midge, snail, and amphipod (scud) were sampled from the lake bottom or picked up items.

We did not specifically sample for amphibians, but tadpoles were also sampled during seine net pulls but were not identified to species.

Fish Community

The fish community was sampled using seine nets and boat electrofishing. Seine nets were pulled through low complexity habitat (e.g., no trees, large rocks) near shore to collect small individuals. Boat electrofishing sent an electrical current into the water to temporarily stun fish so they could be netted and placed into a livewell on the boat. Boat electrofishing was used along shore in all habitat types and can sample all fish sizes, but tends to be more effective for medium to large fish. We sampled the entire shoreline on both days.

Seine netting sampled a large number of small bluegill, along with some small largemouth bass and a few small yellow perch. These small individuals indicate recent successful natural reproduction. Bluegill and largemouth bass create nests for spawning that males guard. Largemouth bass nests were observed during sampling but not bluegill as water temperatures may have been too cool. Yellow perch deposit their eggs in a little deeper water in long strands (skeins) that may drift along the bottom or settle onto trees.

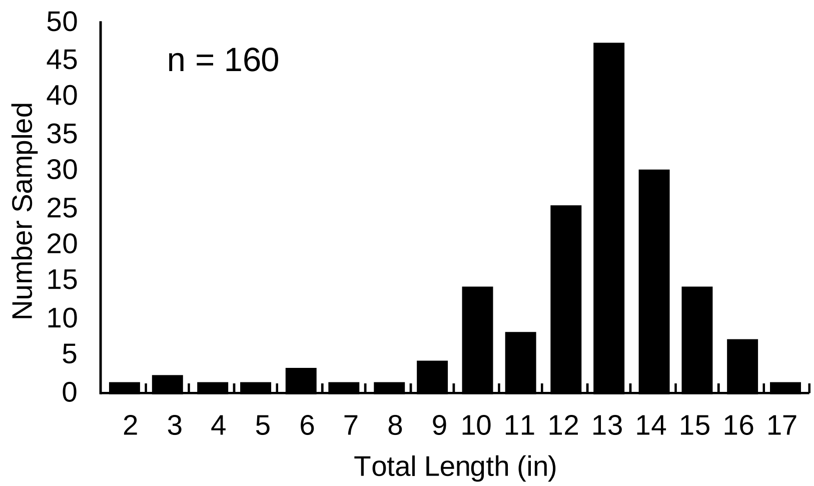
During two days of boat electrofishing largemouth bass were the most abundant (168), followed by bluegill (124) and a few rock bass (6), yellow perch (4), and black crappie (2). Additional small bluegill were not always captured. We did not capture or observe small forage fish such as minnows species. Fish were captured along the entire shoreline, but more prominently from fallen trees in particular trees with higher complexity (i.e., more branches). We captured a 13 inch black crappie from the same fallen tree on different days, so this may have been one individual. Although we did not measure bluegill, most individuals were small (shorter than 6 inches), indicating poor growth or high mortality such as being consumed by largemouth bass.

Largemouth Bass

Largemouth bass typically are most abundant in warm, shallow, vegetated eutrophic systems. Therefore, their dominance in Crystal Lake which is cool, clear, deeper, lacking macrophytes and oligotrophic is interesting, as those conditions are more conducive for smallmouth bass. Most likely largemouth bass accessed the lake naturally or through stocking and smallmouth bass never did. We observed an abundance of spawning habitat (gravel and sand in 10 feet or shallower) and various structure such as fallen trees and docks for largemouth bass to complete their life cycles. However, prey items were less abundant than in eutrophic systems.

We conducted a largemouth bass mark-recapture population estimate and also calculated relative abundance as the number captured per hour of electrofishing. Individuals captured on May 29 received a small fin clip (mark) on their caudal fin (tail) that will regrow, allowing us to know if we had previously sampled an individual (recapture) on May 30. For individuals five inches or larger we marked 67 on May 29, sampled 96 on May 30 and 8 of these individuals were recaptures. These numbers resulted in a population estimate of 804 largemouth bass larger than five inches, with a 95% confidence interval of 392 – 1480 individuals (true population size should be within that range with 95% confidence). This population estimate is large for this size lake, and the relative abundance (average catch of 52 / hr) also indicates a higher abundance compared to other Wisconsin lakes.

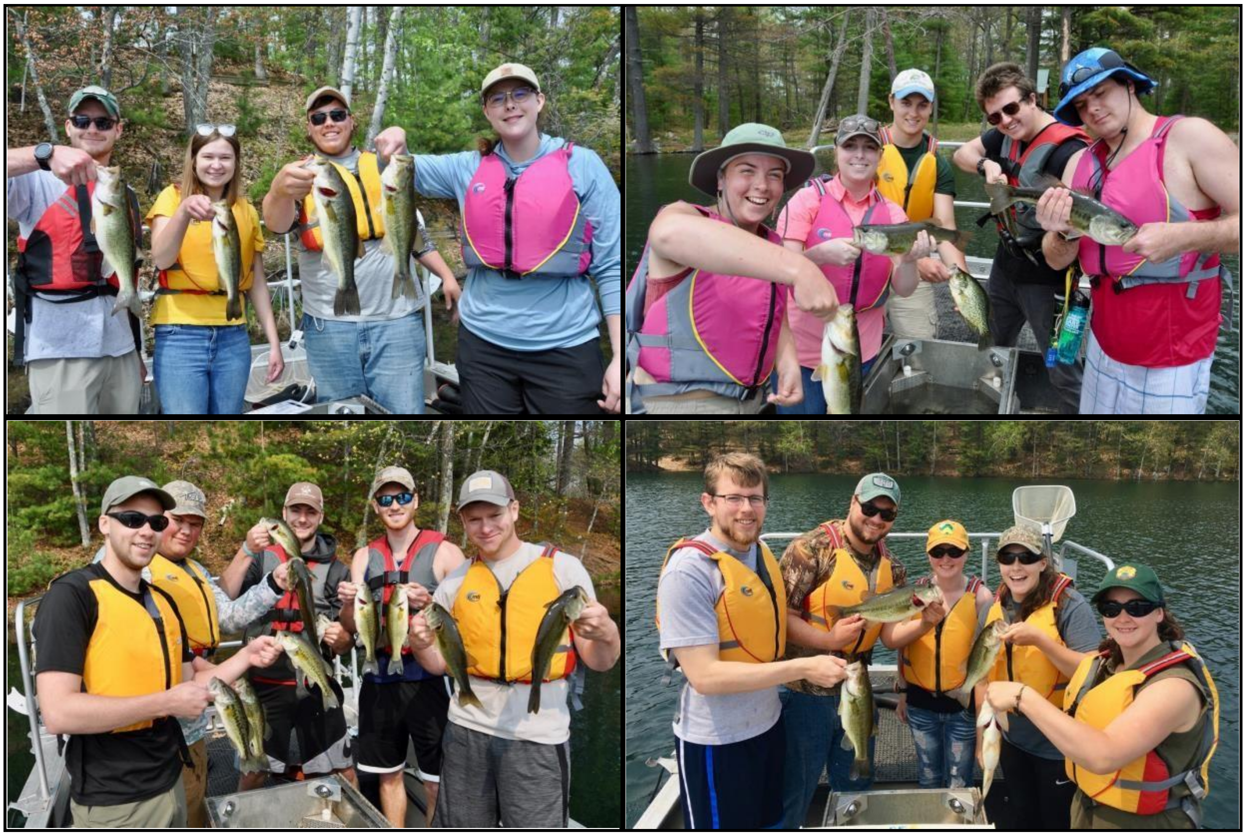
We also measured total length (inches) for largemouth bass captured during boat electrofishing. The shortest fish was 2.75 inches and the longest was 17 inches. However, most fish were between 12 and 14 inches.



We calculated a proportional size distribution (PSD) by dividing the total number of fish 12 inches and larger ("quality" size, 124) by the total number of fish 8 inches and larger ("stock" size, 151) and multiplying by 100, resulting in a PSD of 82. A largemouth bass population that is in balance with their prey sources should have a PSD around 40-70, so this population is "top heavy" or lacking stock size only individuals (8 – 11 inches).

The unbalanced population is also evident in the limited number of small (<10 in) and large individuals (> 17 inches). A lack of small individuals indicates poor reproduction or recruitment, possibly due to poor survival of young bass due to limited resources or cannibalism of young bass as other prey sources are limited for adults. A lack of large individuals could be due to poor growth or mortality. Mortality of large individuals by fishing is unlikely due to being a private lake with few residents and campers limited to a section of the lake, and even with high natural mortality there likely would be some larger individuals. Therefore, the lack of larger individuals is most likely due to poorer growth or "stunting" that can occur when resources such as food and space are limited. The cool water temperatures can also inhibit or slow growth.

Additional sampling would help determine what is driving the lack of smaller and larger largemouth bass. Aging the fish would help determine if there are old, small bass that would indicate growth issues. If old fish are lacking, then mortality would be the more likely explanation for few large individuals. Weighing fish can also provide information on their body condition, which we did not do, but some individuals were skinny indicating a lack of resources. Diet studies would help determine what the bass are consuming, including if they are cannibalizing young bass.



Black Crappie

Largemouth Bass

Fin Clip Mark

Largemouth Bass

Dragonfly Nymph

Fishing Spider

Conclusions

The lake is in great condition. The nutrients/productivity is low, which is limiting the phytoplankton (food base, oxygen) and macrophytes (cover, food, oxygen) that in turn limits the rest of the organisms. However, the lake naturally is low productivity and it's a good thing that the watershed is not putting in a lot of extra nutrients, as the depth, steep drop-offs, and cool water also contribute to being oligotrophic and any flux of nutrients likely would cause issues. Additionally, the water clarity is great aesthetically and for swimming. A small increase in nutrients likely could be beneficial to boost production, but further testing would need to be done to determine how much and what would be the best way to do that.

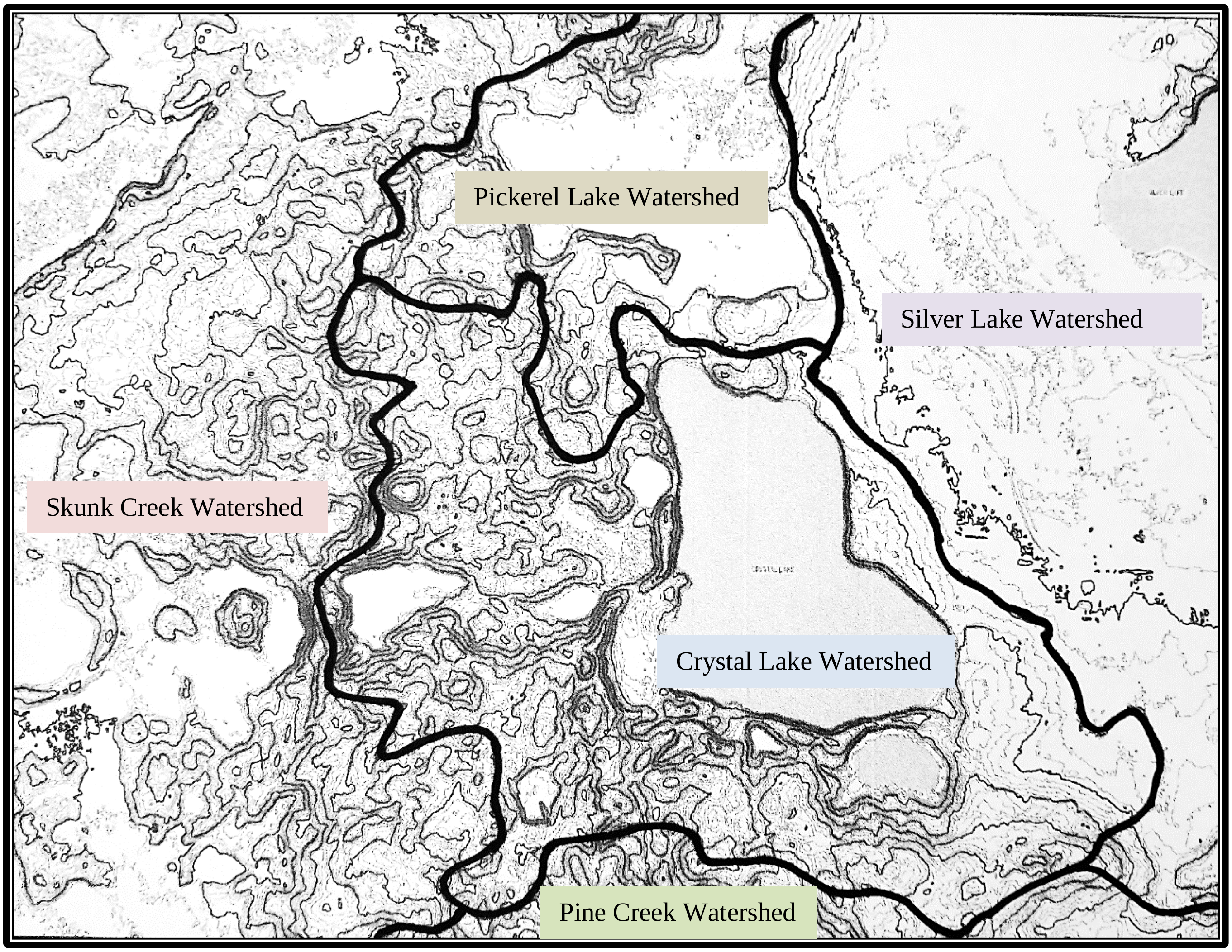
Without an increase in primary production there likely won't be huge increases in the food web. With that said, the surrounding trees do contribute carbon to the lake (leaves, insects, etc.) and also provide structure when they overhang and fall in. The largemouth bass appear to be overpopulated based on the population estimate, no large individuals, limited recruitment of smaller individuals, and skinnier individuals. Given how clear the lake is it really is not conducive to walleye that are very sensitive to light and the smaller size and lack of vegetation means northern pike and muskellunge likely will not thrive. Smallmouth bass are probably better suited to the lake than largemouth bass, but at the same time the largemouth are persisting well.

Recommendations

Nutrients:
Continue to focus on keeping the watershed clean as possible (limiting fertilizers and runoff) and maintaining the forested shoreline. Without further study adding specific nutrients to the lake would be ill-advised and would ultimately dilute the clarity of the water while boosting productivity. Limit the shoreline development and could consider "adding" trees for structure by cutting them (this would require a permit from the DNR) and placing in the lake. The additional trees would provide more structure for periphyton, invertebrates, and small fish.

Fishing:
If you are seeking to maximize bass, you would either need more forage or to remove bass. Forage may increase some by adding trees to the lake, other times people will stock forage fish such as minnows (short term solution that needs to be repeated). For removal you would want to focus on the smaller fish (say 14 inches or less) and likely would need to remove a good number of them to see major effects. In some cases you need to remove 25%, so that would be around 200 bass. At a minimum, it won't be a big deal if a few bass are harvested or die due to catch and release.Increasing panfish is tricky, especially when there is not a lot of small food, but the options would be to increase cover or reduce the bass population.

Future Monitoring:
Look into getting a secchi disk and basic monitoring equipment to sample the lake once or twice a year (in the spring and fall)



Watersheds near Crystal Lake