Aquatic plant diversity in an undisturbed, clear water lake in northern Wisconsin

Ruth Weiland ✧ Advisor: Dr. David Lonzarich ✧ Project Manager: Mary Lonzarich
Department of Biology ✧ University of Wisconsin-Eau Claire, Eau Claire, WI 54701

Abstract

Pine Lake, a deep, clear water lake in northwestern Wisconsin had remained relatively undisturbed since European settlement in the 1800s. Because of current land use activity pressures on lakes, we began a long-term study to examine the macrophytes (including mosses and algae) of Pine Lake. Macrophytes are commonly used as indicators of water quality in lakes. A modified point-intersect survey was conducted at 140 sites during the summer of 2007 using a one-meter square plot, and examined by SCUBA, snorkeling, and rake toss methods. Six depth zones were studied in which four distinct flora were identified. Two major functional plant groups based on height and growth rate, the isoetids and elodeids, also were identified. Isoetid diversity, in particular, was unusually high, and because they are sensitive to degraded water quality, their presence is a strong indicator of the lake’s health. Also remarkable were the mosses, which were represented by a large number of species and occurred at depths to at least 15 m (51 ft). Future surveys will be conducted every five to seven years to monitor and aid in preserving these unique qualities of Pine Lake.

Background

Pine Lake located within both Chippewa and Rusk counties is the deepest lake in northwestern Wisconsin, with a maximum depth of 115 feet (35 meters). Over the past 100 years many studies have been conducted within its waters. In particular, eight aquatic macrophyte surveys have been conducted all utilizing their own methods, which unfortunately are not statistically comparable. By using a point-intersect method, we have created sites that can be accessed and studied repeatedly and are statically sound for future comparisons.

Macrophytes may be used as an indicator of how healthy a lake is and it is important to take note of what is present and what is not with attention paid to invasive species. Many lakes in Wisconsin have been affected by land use and have invasive species. Currently, there are two known invasive species in Rusk and Chippewa counties and it is important to know if they are present in Pine Lake.

This clear, undisturbed lake has plants growing from shoreline to depths of over 50 feet (15 meters). When considering the depth range of the plant community, an interest arose for research to monitor the distribution and diversity of the aquatic macrophytes. To accomplish this we initiated a long term study of the aquatic macrophytes of Pine Lake in 2006 by creating a collection and guide and continued with an extensive survey into 2007.

Methods

The plant community within a lake is not segregated into one depth zone or area. To test sample Pine Lake, we set up a grid on the lake with point-intersect sampling method in mind and chose 20 randomly selected points from the six depth zones (A: 0 - 5 ft; B: 6 - 10 ft; C: 11 - 15 ft; D: 16 - 20 ft; E: 21 - 40 ft; F: 40 - 55 ft). Our sample sites were chosen from a bathymetric map to attain a cross-section of the six depth zones found within the lake. Before our survey, we went to some of these sites to ensure they were within the correct depth zone and made sub-samples if necessary. We sampled 140 sites with a one-meter square plot by snorkel, SCUBA, or camera and rake toss. The site was then sampled according to the depth zone; sub-scores were utilized at 18 sites (0 - 3 ft depth); SCUBA was used at 102 sites (3 - 40 ft depth) and camera and rake toss was used at 20 sites (40+ ft depth). At each site six general observations were taken including: percent coverage of vegetation within the plot, substrate type (e.g., clay, sand, gravel, cobbles), percent coverage of each plant species, temperature, percent species, and percent depth. Percent cover was determined in the plot based on increments of 20 %. These variables were collected to inform us of the plant and habitat of our sample sites. At each site we collected a representative specimen that was identified along with the plants within the plot. We collected data from at least 20 sites from each depth zone. At the deeper sites, we employed a rake to give us an idea of plants present, an underwater camera to observe the plot area for percent coverage and a dredge to collect substrate.

The data collected from each site allowed us to calculate the following results: total number of species in a depth zone, percent frequency of each species by depth zone, average percent cover of individual species and all species combined, and species associations. In Wisconsin, an aquatic plant community biotic index (Nicholls et al. 2000) was published which allowed us to compare our plant data to this biotic index and gives the following for plant community attributes: total number of species, maximum depth of plant growth, species diversity, percent of littoral area vegetated, percent submerged species, percent exotic species, and percent sensitive species (Table 1 and Figure 2).

Results and Conclusions

During our initial collection in 2006, we found 58 aquatic and wetland plant species. However, in our 2007 survey we observed twenty-four aquatic plant species within our sites. The greatest abundance of plants were found in the shoreline, shallow depths zone. Because this was not the first macrophyte survey on this lake, we were able to compare our findings to previous studies completed in 2002 (32 species) and in 1978 (54 species). Our species count was lower than the previous methodologies, a disadvantage of this methodology is under-sampling of shallow, shoreline areas where the plant diversity is highest. To compensate for this, we made visual observations from the boat. These observations cannot be analyzed with the quantitative sample data. The species we observed in 2007 were identified in previous studies (Table 1). Pine Lake has an outstanding aquatic plant community when it is compared to other lakes in Wisconsin (Nicholls et al., 2000).

Species Within Each Depth Zone

The zones can be divided into areas with a distinctive flora and the representative species were:

- **Zone A (0-5 ft):** Brown-ruled Rush (Juncus pseudocyperus f. submersus), 17% Needle Rush (Juncus articulatus), 16%
- **Zones B (6-10 ft) and C (11-15 ft):** Quillwort (Isoetes sp., 20% and 48%), respectively.
- **Zones D (16-20 ft) and E (21-40 ft):** Smooth Stonewort (Nitella flexilis, 52% and 68%), respectively.
- **Zone F (40+ ft):** Giant Calliergon Moss, Despansocladus Moss, Antifever Fontinalis Moss, and Fontinalis Moss (Calliergon giganteum, Despansocladus aduncus, Fontinalis antipyretica, and F. sphagnifolia, 88%). No flowering plants were found at these depths.

Distribution of Isoetid and Elodeid Guilds

We observed plants growing in much denser plant coverage from shoreline to depths of 40 feet than what was present in sites at depths greater than 40 feet. However, since we did not actually dive to these sites, but used a camera and a rake to sample them we must not make hasty conclusions. We did however make direct observations of the shoreline to 40 feet and have some data of interest on what we observed there. In particular, there was a group of small plants that are of ecological importance found in Pine Lake at these depths. This group is a strong indicator of lake health and needs to be noted (Figure 2).

Isoetids are small, slow growing evergreen plants typically found in oligotrophic lakes. This plant function group is sensitive to land use changes and can be out-competed by elodeids. They are able to survive in low nutrient environments due to their high root to shoot ratio, and low leaf turnover. This group has become very specialized to their environment, in such a way that it forms follows function. Their specializations have managed to utilize everything they have available to them and alter their environments to do this. When the nutrient levels in a lake increase, the isoetids may lose habitat to the elodeids which will grow closer to the shore if the water becomes highly turbid.

Elodeids are a group of perennial plants with a high shoot to root ratio giving them a large stature. Plants of this functional group will extract their leaves and do not have a root system. They are more adapted to survive in lakes with high nutrients levels and higher alkalinity with nutrient rich soils. When a lake is impacted by the surrounding land use in such a way that the nutrients are readily available these plants will thrive and become the dominant plant type within the lake.

Mosses grow at least 51 feet (15 meters) in Pine Lake. To our knowledge the deepest recorded depth of mosses in Wisconsin is 20 meters (Crystal Lake, Judd 1934). These mosses were at a disadvantage due to the trophic status of the lake. Like other plants, mosses require light and nutrients including CO2 and O2 for metabolic processes. Yet they were growing well below the thermocline and seculs depth zone. At this point in time, I do not know how the mosses are surviving at these depths. Also more significant may be the fact that moss communities in Pine Lake is comprised of at least four species. This is interesting because moss communities in lakes are usually monospecific.

Outcomes

The plant community of a lake illustrates its quality and health. In our survey, we were able to find several features of the lake that had previously been unknown and were found due to our exhaustive and comprehensive study. The major findings were: the number and abundance of isetid species, moss found at 51 feet (15m), and four species of mosses within Pine Lake. The characteristics of Pine Lake make it especially clear and allow for these exceptional plant communities to grow and thrive. It is important to keep monitoring the water quality and aquatic flora to ensure that it is not disturbed. Our methodology provides a means for this since it is statistically rigorous and repeatable which will encourage future research and studies.

Works Cited


Figure 2: Plant function groups may compete for the same area at around 11-16 feet deep.

Figure 3: The plant diversity decreases as depth increases. The type of plant changes as well from vascular to nonvascular.

Acknowledgments

I would like to thank the Pine Lake Association for their continued support and funding of my research. I am also grateful for additional funding from ECOHAB II: The Northern Great Lakes Biogeochemical Cycle Study. I would like to extend a special thanks to Dr. Joseph Robins from Michigan State University for being patient and providing advice and encouragement on the projects currently in progress of segmentation and revision. I would also like to thank Steve Murdock and Carlene Nunn for being a steady rock and allowing the data from the depths of Pine Lake. Some elements were found through the joint collaborative work between our study group and Minnesota/Loyal/Green Bay macrophyte monitoring methods and ability to keep me on track. Special thanks to Dr. Joe Lonzarich for seeing in me something that I did not and for choosing me to be a part of a very special endeavor.