Analysis of Current Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, like variable water levels or negative, like increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways; there may be a loss of one or more species, certain life forms, such as emergents or floating-leaf communities may disappear from certain areas of the lake, or there may be a shift in plant dominance between species. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide very useful information for management decisions.

As described in more detail in the methods section, multiple aquatic plant surveys were completed on The Cloverland Project Lakes; the first looked strictly for the exotic plant, curly-leaf pondweed, while the others that followed assessed both native and non-native species. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

Primer on Data Analysis & Data Interpretation

Species List

The species list is simply a list of all of the species that were found within the lake, both exotic and native. The list also contains the life-form of each plant found, its scientific name, and its coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in life-forms that are present, can be an early indicator of changes in the health of the lake ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of The Cloverland Project Lakes, plant samples were collected from plots laid out on a grid that covered the entire lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, relative frequency of occurrence is used to describe how often each species occurred in the plots that contained vegetation. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and we described that value as a percentage, it would mean that water lily made up 10% of the population.

In the end, this analysis indicates the species that dominate the plant community within the lake. Shifts in dominant plants over time may indicate disturbances in the ecosystem. For instance, low water levels over several years may increase the occurrence of emergent species while decreasing the occurrence of floating-leaf species. Introductions of invasive exotic species may result in major shifts as they crowd out native plants within the system.

Species Diversity

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Species richness is simply the number of species found within a system or community. Although these values are related, they are far from the same because diversity also takes into account how evenly the species occur within the system. A lake with 25 species may not be more diverse than a lake with 10 if the first lake is highly dominated by one or two species and the second lake has a more even distribution.

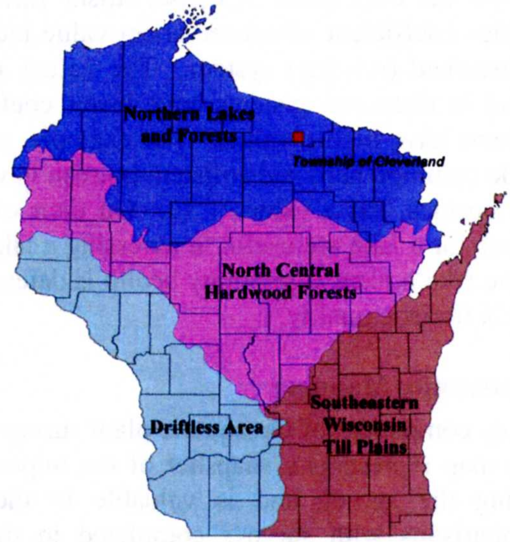


Figure 3.3-1. Location of the Town of Cloverland within the ecoregions of Wisconsin. After Nichols 1999.

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to a diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity.

One factor that influences species diversity is the "development factor" of the shoreline. This is not the degree of human development or disturbance, but rather it is a value that attempts to describe the nature of the habitat a particular shoreline may hold. This value is referred to as the shoreline complexity. It specifically analyzes the characteristics of the shoreline and describes to what degree the lake shape deviates from a perfect circle. It is calculated as the ratio of lake perimeter to the circumference of a circle of area equal to that of the lake. A shoreline complexity value of 1.0 would indicate that the lake is a perfect circle. The further away the value gets from 1.0, the more the lake deviates from a perfect circle. As shoreline complexity increases, species richness increases, mainly because there are more habitat types, bays and back water areas sheltered from wind.

Floristic Quality Assessment

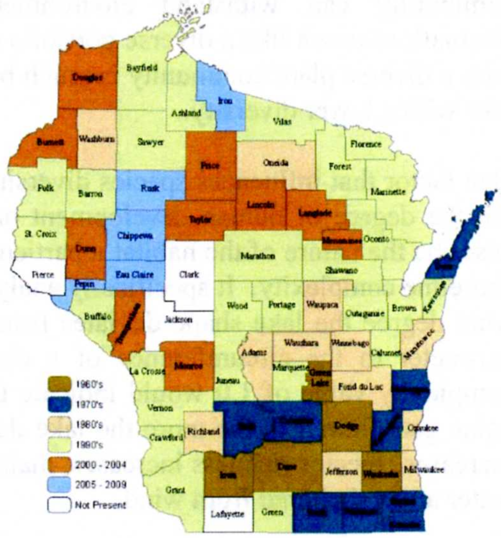
Floristic Quality Assessment (FQA) is used to evaluate the closeness of a lake's aquatic plant community to that of an undisturbed, or pristine, lake. The higher the floristic quality, the closer a lake is to an undisturbed system. FQA is an excellent tool for comparing individual lakes and the same lake over time. In this section, the floristic quality of The Cloverland Project Lakes will be compared to lakes in the same ecoregion and in the state (Figure 3.3-1).

Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states.

The floristic quality of a lake is calculated using its species richness and average species conservatism. As mentioned above, species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10. On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality.

Community Mapping

A key component of the aquatic plant survey is the creation of an aquatic plant community map. The map represents a snapshot of the important plant communities in the lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with surveys completed in the future. A mapped community can consist of submergent, floating-leaf, or emergent plants, or a combination of these life-forms. Examples of submergent plants include wild celery and pondweeds; while emergents include cattails, bulrushes, and arrowheads, and floating-leaf species include white and yellow pond lilies. Emergents and floating-leaf communities lend themselves well to mapping because there are distinct boundaries between communities. Submergent species are often mixed throughout large areas of the lake and are seldom visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.



Exotic Plants

Because of their tendency to upset the natural balance of an aquatic ecosystem, exotic species are paid particular attention to during the aquatic plant surveys. Two exotics, curly-leaf pondweed and Eurasian water milfoil are the primary targets of this extra attention.

Figure 3.3-2. Spread of Eurasian water milfoil within WI counties. WDNR Data 2009 mapped by Onterra.

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.3-2). Eurasian water-milfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, Eurasian water-milfoil has two other competitive advantages over native aquatic plants, 1) it starts growing very early in the spring when water temperatures are too cold for most native plants to grow, and 2) once its stems reach the water surface, it does not stop growing like most native plants, instead it continues to grow along the surface creating a canopy that blocks light from reaching native plants. Eurasian water-milfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating.

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly – leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment. The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced in early May, giving the plant a significant jump on native vegetation. Like Eurasian water-milfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

Because of its odd life-cycle, a special survey is conducted early in the growing season to inventory and map curly-leaf pondweed occurrence within the lake. Although Eurasian water milfoil starts to grow earlier than our native plants, it is at peak biomass during most of the summer, so it is inventoried during the comprehensive aquatic plant survey completed in mid to late summer.

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. In June, 2009 surveys were completed on all of the Town of Cloverland Lakes that focused upon curly-leaf pondweed. This meander-based survey did not locate any occurrences of curly-leaf pondweed within any of the project lakes. It is believed that this aquatic invasive species either does not occur in Town of Cloverland project lakes or exists at an undetectable level. However, an established population of curly-leaf pondweed does exist in Little Saint Germain Lake, which is in relatively close proximity to the project lakes in the Town of Cloverland.

Median Value This is the value that roughly half of the data are smaller and half the data are larger. A median is used when a few data are so large or so small that they skew the average value to the point that it would not represent the population as a whole.

The point intercept surveys were conducted Town of Cloverland Lakes in July and August of 2009 by Onterra. Additional surveys were completed by Onterra on the Town of Cloverland

Lakes to create the aquatic plant community maps (Draft Maps) during July and August of 2009. The point-intercept and aquatic plant community surveys on Lake Mary were unable to be conducted as the low water levels made it accessibility to the lake impossible.

From the 20 project lakes surveyed, a total of 78 species of plants were located (Figures 3.3-3, 3.3-4). The floating-leaf species, spatterdock, was the most widely dispersed species, found in all but one of the lakes surveyed (Finley Lake). The most frequently occurring emergent plant species was creeping-spike-rush while pipewort was the most abundant submergent plant species.

Two of the species found during the plant surveys are considered non-native, invasive species: Eurasian water milfoil, found in Boot Lake, and purple loosestrife, located on the margins of Tepee Lake. Because of their importance, both of these exotic species will be discussed in depth within the individual lake vegetation sections. Six plant species observed are considered to be relatively rare, with five being listed as species of special concern and one listed as threatened by the Natural Heritage Inventory Program (Figures 3.3-3, 3.3-4) (WDNR 2010a). These species and the lakes where they were located will also be discussed within the individual lake vegetation sections.

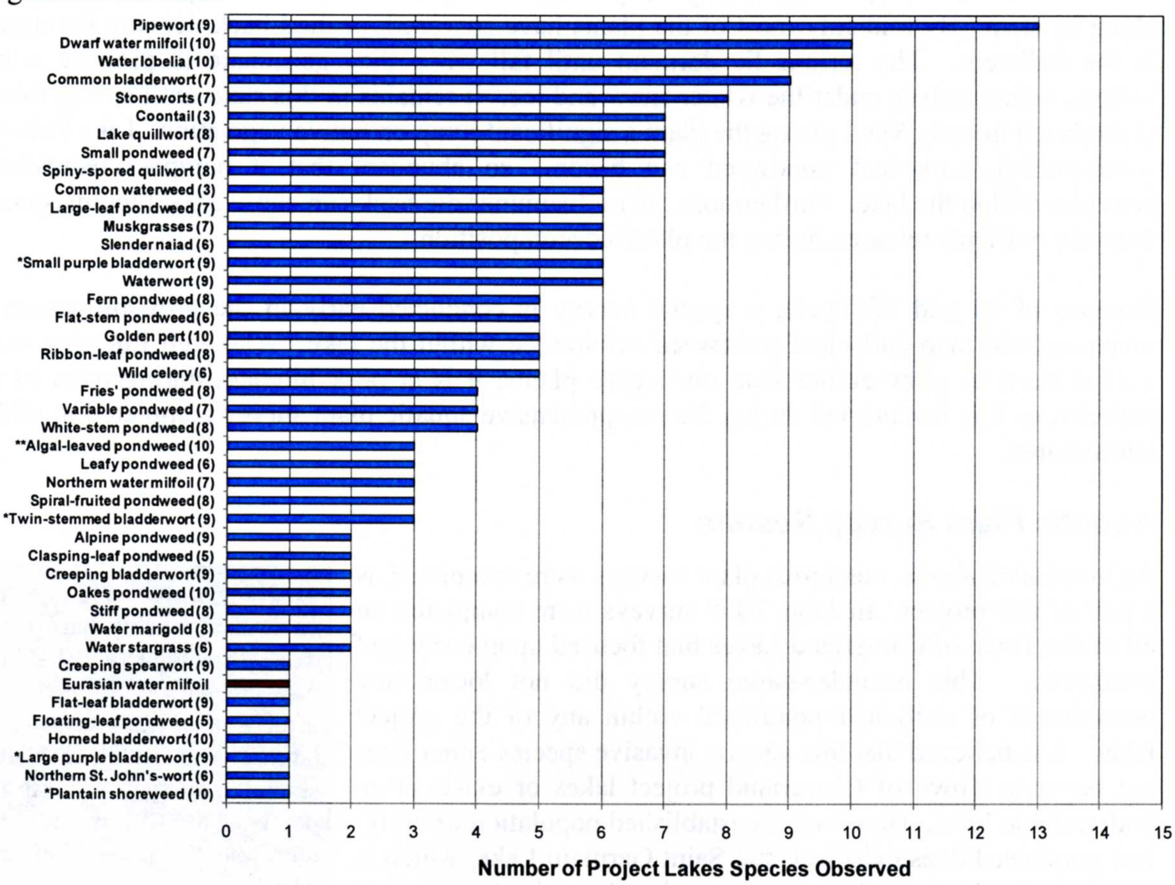


Figure 3.3-3 Cloverland project lakes town-wide submergent aquatic plant species occurrence. Created using data from 2009 aquatic plant surveys. Exotic species indicated with red. Native species' coefficients of conservatism (C) are in parentheses.
* State species of special concern

** State threatened species

As discussed in the previous sections, the Town of Cloverland project lakes vary widely in their watershed characteristics (most notably size), creating a very diverse group of lakes in terms of water quality and trophic state. This variance in water quality is responsible for influencing plant species composition and abundance, creating very different but high quality plant communities among the Cloverland lakes. The Town of Cloverland project lakes can be divided into two main groups based on plant community composition: 1) lakes that are dominated by plants of the *isoetid* growth form, and 2) lakes dominated by plants of the *elodeid* growth form.

Plant species of the isoetid growth form are small, slow growing, inconspicuous submerged plants that have evergreen leaves located in a rosette and are usually found growing in sandy soils within the near-shore areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000). Some common isoetid species found in the Town of Cloverland project lakes include pipewort, dwarf water milfoil and water lobelia. Conversely, submerged species of the elodeid growth form have leaves on tall, erect stems which grow up into the water column. The elodeid growth form includes plants such as elodea, coontail and the pondweeds. The dominant plant growth form for each project lake can be found in the individual lake sections.

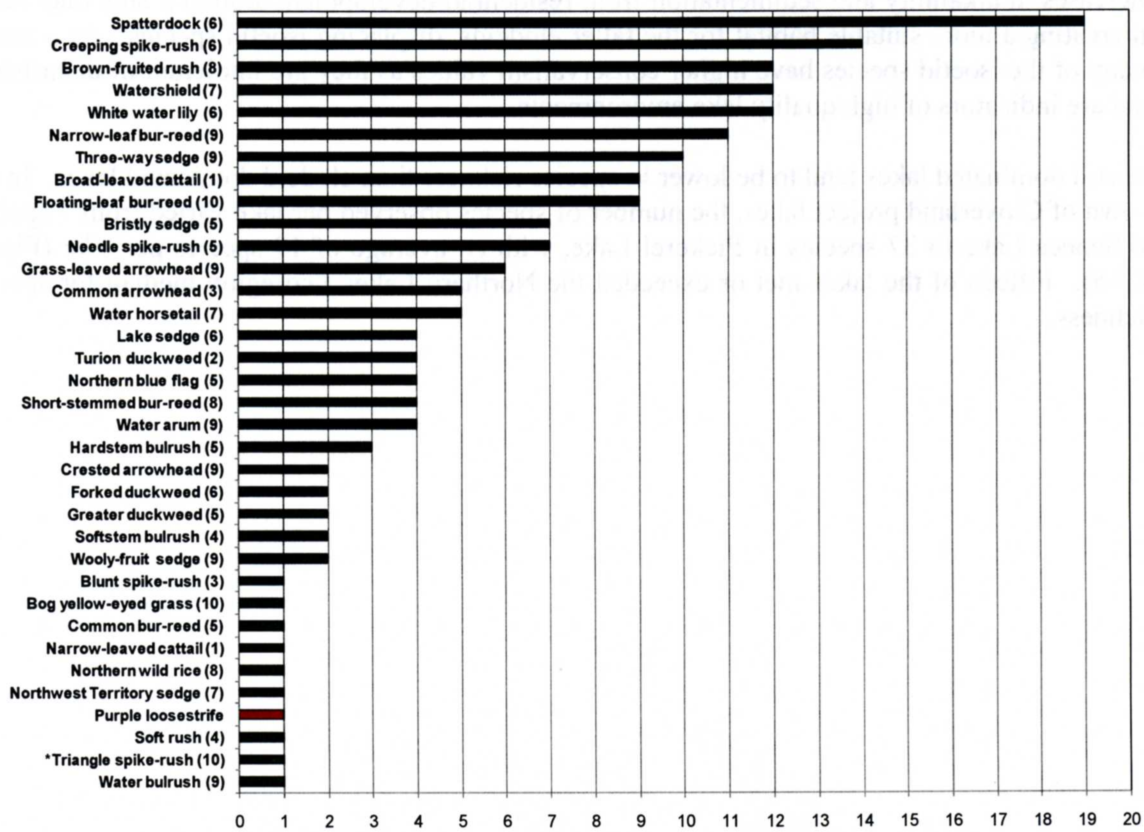


Figure 3.3-4 Cloverland lakes town-wide emergent, floating-leaf and free-floating aquatic plant species occurrence. Created using data from 2009 aquatic plant surveys. Exotic species indicated with red. Native species' coefficients of conservatism (C) are in

parentheses.
* State species of special concern

Water chemistry, specifically alkalinity, is the main factor determining whether or not a lake is dominated by plant species of the isoetid or elodeid growth form (Vestergaard and Sand-Jensen 2000). As mentioned in the water quality section, alkalinity measures the concentration of calcium carbonate ($CaCO_3$) in the lake water and is a close descriptor of the amount of bicarbonate present. Isoetids, unable to use bicarbonate as source of carbon for photosynthesis, are typically found in lakes of lower alkalinity (e.g. Aspen and Lotus Lakes) as they are adapted to grow in areas where carbon is limited. In lakes with higher alkalinity (e.g. Pickerel and Boot Lakes), elodeids grow in abundance as they are able to utilize the bicarbonate as a carbon source. In lakes with moderate alkalinity levels, both elodeids and isoetids will be found. While some of the project lakes displayed these alkalinity levels, each lake was overwhelmingly dominated by either isoetid or elodeid plants. While isoetid species are physically able to grow in lakes with higher alkalinity, their short stature makes them susceptible to shading from the much taller, leafy elodeid species which often restricts their growth to shallow, wave-exposed sites with course sediments (Vestergaard and Sand-Jensen 2000). Floating-leaf species, such as spatterdock and white water lily, obtain most of their carbon from the atmosphere, allowing them to be prevalent in most of the Cloverland project lakes.
Increases in alkalinity and sedimentation from residential development around a lake may result in creating a more suitable habitat for the taller elodeids, displacing isoetid species. As a result, many of the isoetid species have higher conservatism values as they are intolerant of disturbance and are indicators of high quality lake environments.

Isoetid dominated lakes tend to be lower in species richness than elodeid dominated lakes. In the Town of Cloverland project lakes, the number of species observed per lake varied from 7 species in Seneca Lake to 37 species in Pickerel Lake, with an average of 19 species per lake (Figure 3.3-5). Fifteen of the lakes met or exceeded the Northern Lakes Ecoregion median for species richness.

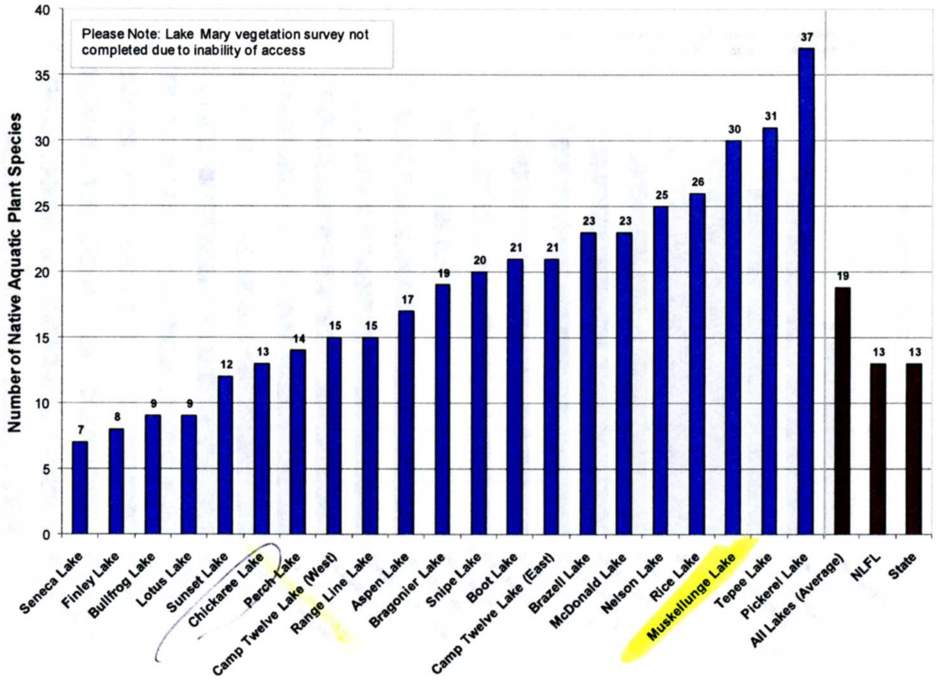


Figure 3.3-5 Town of Cloverland project lakes native species richness. Created using data from 2009 aquatic plant surveys.

Of the 8 species of bladderworts found in Wisconsin waters, 7 were located within the Cloverland project lakes. With the exception of one species, bladderworts exhibit an elodeid growth form. However, like isoetid plants, bladderworts have an advantage in low nutrient and low pH systems where other native plants have difficulty obtaining their required nutrients. As the name suggests, these plants contain small bladders that trap and digest small aquatic organisms, utilizing nutrients unavailable by other plants. As stated within the water quality section, some of the project lakes contain low pH values and this acidic condition is tolerated by bladderwort species.

Project lakes that fell below the median ecoregion value for species richness tended to be smaller in surface area and had lower alkalinity and nutrient (phosphorus and nitrogen) values. Larger lakes tend to have a larger suit of habitat types (e.g. calm back water bays, sand bars) that can support many different species. However, even a relatively large lake (e.g. Sunset Lake) can have a low number of species due to its low nutrient concentrations and low alkalinity. Small lakes with higher nutrient concentrations and alkalinity are able to support more species, as seen in Tepee Lake.

Like species richness, the Town of Cloverland project lakes had a wide range of plant species diversity (Figure 3.3-6). As discussed earlier, how evenly the species are distributed throughout the system and species richness together influence species diversity. Species diversity ranged from 0.37 in Bullfrog Lake to 0.91 in Nelson Lake, showing that some lakes were dominated by one or two species, while others had a more even distribution of plant species.

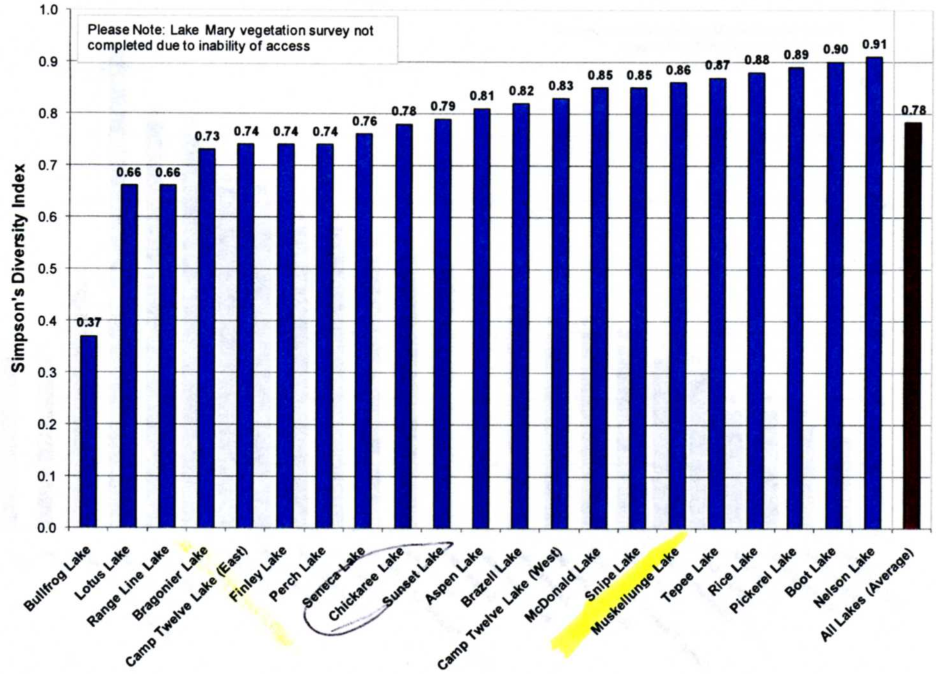


Figure 3.3-6 Town of Cloverland project lakes species diversity index. Created using data from 2009 aquatic plant surveys.

Data collected from the aquatic plant surveys indicated that 15 of the lakes met or exceed the Northern Lakes Ecoregion median and all 20 lakes surveyed met or exceeded the state median for average plant species' conservatism values (Figure 3.3-7). The majority of the project lakes have plant communities that are more indicative of a pristine condition than those found in most lakes in the state and the ecoregion. The lakes that fell below the ecoregion median had higher nutrient levels and reduced light availability, supporting mainly disturbance-tolerant plant species (e.g., coontail, flat-stem pondweed) and fewer sensitive species.

Combining the species richness and average conservatism values for each project lake to produce the Floristic Quality Index (FQI) resulted in a range of values from 21 to 39, with an average of 31 (equation shown below) (Figure 3.3-8). All of the lakes except one (Seneca) exceeded the Northern Lakes ecoregion and state median value. Again, this illustrates that the Town of Cloverland project lakes have high quality plant communities.

$$\text{FQI} = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

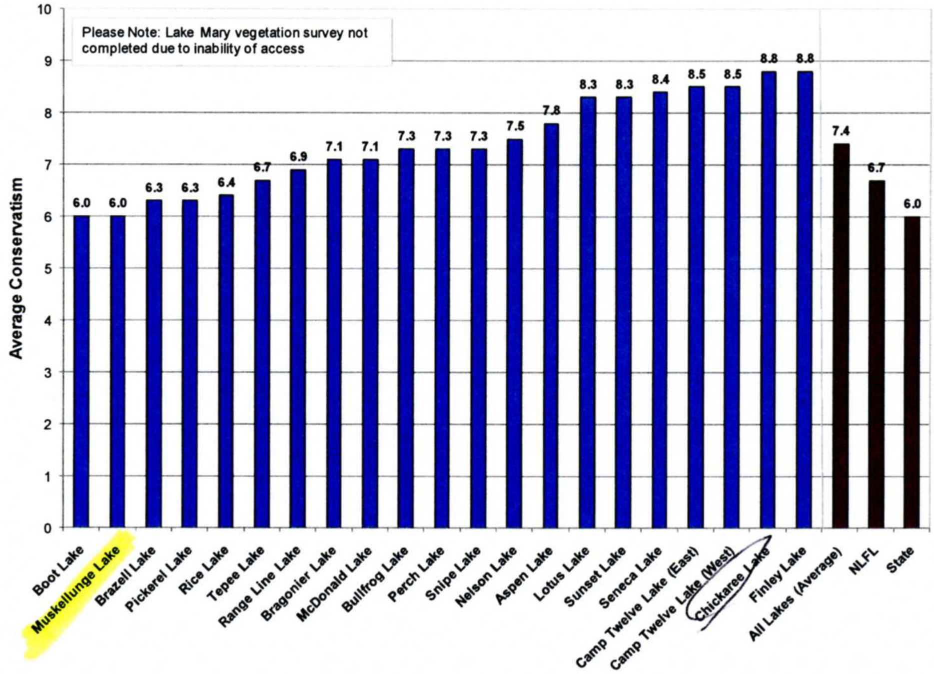


Figure 3.3-7 Town of Cloverland project lakes average native species' coefficients of conservatism. Created using data from 2009 aquatic plant surveys

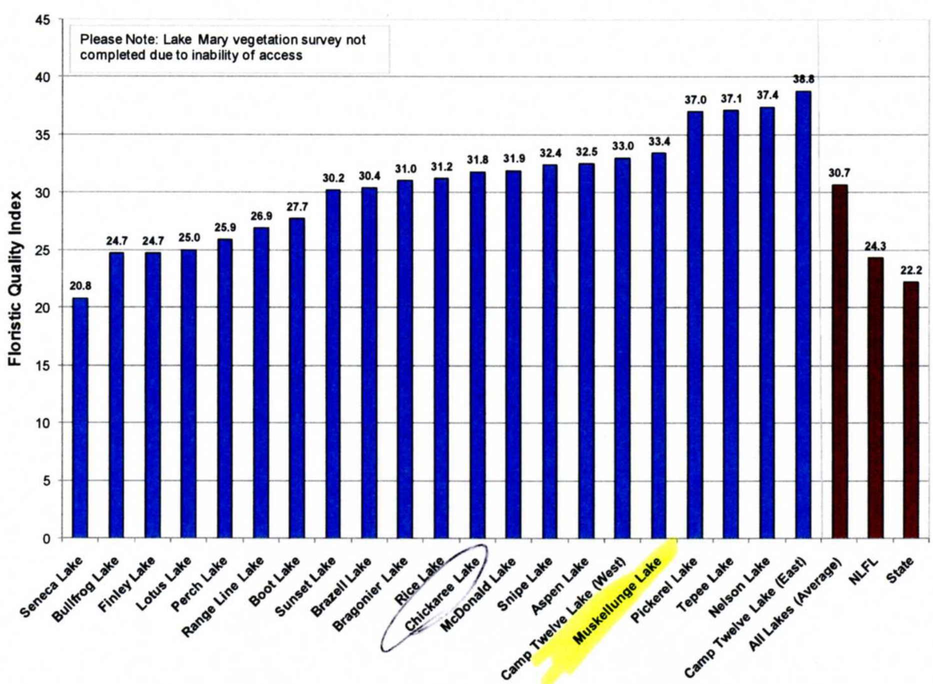


Figure 3.3-8. Town of Cloverland project lakes Floristic Quality Assessment. Created using data from 2009 aquatic plant surveys. Analysis following Nichols (1999).