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Running Head: Macrophytes in Pewaukee Lake: Fall 2000

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Introduction

Although lakes constitute a very small percentage of water on the Earth, they have much value. They are series of interlocking systems. They store water and are connected to rivers and streams. Precipitation, surface runoff and groundwater seepage are also variables which directly affect lake water quality. Lakes serve as places for fishing, boating, and swimming. They also provide life-sustaining functions such as protection from floods, electricity generation, and a source for drinking water. The depth of a lake influences the natural water quality that might be expected. Because lakes can serve many purposes, it is common for those purposes to conflict. It is important to determine what uses of a lake are desired and focus on these goals while attempting to maintain the lake (Moore and Thornton 1988).

Lakes are influenced by hydrologic conditions, the watershed, the shape of the lake basin, the lake water, and bottom sediments. These components support a community of organisms that is unique to lakes. They are constantly changing. It is impossible to alter one characteristic without affecting another. For example, if a lake association decides to remove all weeds using mechanical harvesting, they will destroy important fish habitat. A chain reaction of events would occur, whose results may not have been predicted (Moore and Thornton 1988). Each lake is unique, but lakes in the same general vicinity often share similar characteristics because of location, climate and desired uses for lakes.

Lakes in southeastern Wisconsin have similar morphology because of glacial drift. In addition, because of the urbanization of much of southeastern Wisconsin, many of the lakes in this area have similar water quality. Water quality depends on the size of the watershed and amount of groundwater, so quality can vary somewhat between these lakes. For example, Crystal Lake in Lodi, Wisconsin has very good water quality because of its small watershed and abundant groundwater supply. The majority of the lakes in this area have undergone some aquatic plant control via aquatic herbicides, mechanical harvesting, or both. Because of the potential of unknown impacts of chemicals in these lakes, some of the lakes are only using mechanical harvesting (Aron et al. 1988).

Despite the control efforts, many of these lakes still struggle with overgrowth of aquatic plants. Eurasian Water Milfoil is a primary target of plant control efforts because it can be a big nuisance for recreational activities. Because some of these lakes have areas that were previously wetlands, there is an organic substrate, which is ideal for plant growth (Aron et al. 1988).

One of the largest lakes in southeastern Wisconsin is Pewaukee Lake, which is located in Waukesha County. It is a 2493-acre lake, containing 36,863 acre-feet of water, with 13.7 miles of shoreline. Its mean water elevation is 852.58 feet above mean sea level. Only 20 miles from Milwaukee, this lake is of great recreational interest (WDNR 1970). The shoreline is sewered and developed, with the exception of two sections: a 2000 foot wetland area on the west end of the lake and a 3500 foot section on the north shore. The section on the north shore is a combination of wetland area and a narrow piece of land next to a railroad line (Aron et al. 1988).

Pewaukee Lake is a preglacial erosion valley, blocked by glacial drift and more recently dammed by man (WDNR 1970). Many small streams empty into this lake, which contain agricultural and urban runoff. On the northeastern corner of the lake is a dam that allows discharged water to flow into the Pewaukee River. There are both eastern and western basins in the lake. The eastern basin, which was originally a marsh before the construction of the dam, has a maximum depth of 8 feet, while the western basin has a maximum depth of 45 feet (Aron et al. 1988). The mean depth of the lake, however, is only 10 feet (WDNR 1970). As with any lake, many vital segments are responsible for the overall productivity of Pewaukee Lake. Aquatic plants, or macrophytes, are very important to the lake ecosystem.

The morphology of Pewaukee Lake is partially responsible for the aquatic plant population. Because the eastern end of the lake is so shallow, it supports a very dense aquatic plant community. The high organic substrate and shallow water makes macrophyte growth ideal. Eurasian Water Milfoil is an abundant invader species in Pewaukee Lake, as it is in many other southeastern Wisconsin lakes. The over abundance of macrophytes has prompted frequent mechanical harvesting of the weeds (Aron et al. 1988). The history of Pewaukee Lake provides a background for the examination of the present condition of this lake.

Pewaukee Lake was formed by the movement of the Lake Michigan glacier over the valley where Pewaukee Lake now sits. Several small streams once flowed into the lake supplying it with water along with springs on its north side. Originally, Pewaukee Lake only included the present west half of the lake (Fenneman 1910). Deacon Asa Clark came from the East hoping to find opportunity farther west. When he arrived in Pewaukee he obtained permission to build a sawmill and a dam to power the mill at Pewaukee Lake. The building of the dam at the outlet of the lake in 1838 formed the eastern half of the lake, which, in 1837, was only a stream flowing through a marsh

(Pewaukee's History 1976). The dam held the water in the western half six feet above its natural level (Pewaukee's History 1976), and maintained a depth of less than seven feet in the eastern half of the lake (Fenneman 1910). This allowed for the ice industry in Pewaukee to begin. Ice was mainly cut on the eastern half of the lake because it froze nicely. Icehouses for storage of the ice popped up all around the lake since there was a high demand for natural ice during this time. Ice harvesting took place when the lake was frozen, but preparation for the harvesting began in September. Lake weeds were cut in the harvesting areas using a 20-foot sickle attached to a boat first powered by steam (Pewaukee's History 1976).

The entire bottom of the eastern half of the lake was covered with weeds. Away from the shore, the weeds were kept from growing to the surface by cutting because of the ice harvesting. No cutting was done near the shore, leaving the weeds and fields of matted bog grasses to grow. The western half of the lake had little vegetation compared to the eastern half. This made the shores of the western half of the lake more desirable for summer homes and resorts. The characteristics of the eastern half made hunting and fishing on the lake possible (Fenneman 1910). The floating bogs hid the wild rice from residents, allowing it to grow in abundance and attract ducks and other birds, which attracted hunters. The reeds in this area made breeding places for the fish (Sunday Sentinel 1899). The lake appealed to many, and as it did, the number of summer homes and businesses on its shores increased. Lakefront improvement was sought to make the area more appealing. This resulted in the removal of the "unsightly" bogs from the shores perhaps causing the first of the ecological problems of Pewaukee Lake (Pewaukee's History 1976).

Presently, lakes are classified according to their nutrient content, which is called trophic status, by monitoring water quality. Nitrogen and phosphorus are two of the important nutrients in determining whether a lake is oligotrophic (nutrient-poor), mesotrophic (moderately fertile), or eutrophic (nutrient-rich). Pewaukee Lake has been classified in the past a mesotrophic and, more recently, a eutrophic lake. A eutrophic lake results in an overabundance of aquatic macrophytes, algae blooms, and can support productive fisheries. A eutrophic lake is not usually favorable for recreational use (SWRPC 1984). The levels of nitrogen and phosphorus in a lake are affected by the use of the watershed around the lake whether it is urban development or agriculture. Water that enters the lake contains nitrogen and phosphorus in inorganic, organic, and particulate forms (Moss 1998). Phosphates and nitrates have been present at levels that produce excessive plant growth (WDNR 1970). Plants are not only affected by water quality of the lake, but they contribute to it. The dissolved oxygen content in the lake is maintained, in part, by the photosynthesis of the macrophytes (SWRPC 1984). The plants in a lake play a crucial role in determining its ecological status.

Aquatic plants have a variety of functions in the aquatic ecosystem. In addition to providing shelter for fish food organisms, rooted plants convert light and chemical into living plant tissue. Through the process of photosynthesis, they replenish the aquatic environment with oxygen, which is essential for the survival of the aquatic fauna.

A simple classification divides aquatic plants into two categories: The algae and the macrophytes. Algae are divided into categories of planktonic, filamentous, and macroalgae. The planktonic forms are miniscule and can cause the water to look green, yellow, or red, depending on the species of the plant. Filamentous algae usually attach to the bottom of the lake, or to the macrophytes. Macroalgae, like Chara, are so large that they resemble macrophytes (MI DNR 1984).

Macrophytes, or the rooted plants, are divided into three groups according to leaf location. Submergent plants have all their leaves under water, emergent plants have leaves that protrude on the surface of the water, and free floating plants are not attached to any substrate.

Emergent plants, in addition to providing food and shelter for the aquatic animals, play other important roles as well. Their protruding leaves on the surface of the water, for example, serve to dampen waves. They also play a crucial role in the protection and restoration of shorelines; they anchor the fine muddy sediments in shorelines to prevent suspension of the sediments, thereby reducing turbidity. To keep water clarity, restoration projects at shorelines may be developed in order to increase diversity of native plants. This restoration is also important for the slowing of water flow and runoff into the lake (Krischik et. al 1999).

Although aquatic plants play crucial roles in a lake, many lakes suffer from high densities of submergent macrophytes. Excessive plant growth creates problems by interfering with man's economic, as well as recreational benefits such as fishing and swimming. Feeding rates are reduced in lakes with high densities of macrophytes. While macrophyte density increases, refuge for fish food organisms becomes more efficient. Therefore, as prey abundance is reduced, so is the feeding rate (Olson et. al 1998). Moreover, interactions among fish become more competitive, and the fittest ones eliminate the weak.

Mostly limited by light and nutrient availability, plant growth increases when nutrients are washed into the lake from the watershed. Due to human activity, excessive nutrients are being deposited on the watershed and washed down into the lake, thus accelerating its eutrophication (MI DNR 1984).

Excessive aquatic plant growth can also be the consequence of invasive plants such as Eurasian Water Milfoil. It was probably introduced into lakes in North America from Europe and Asia by boats. Where native species are unable to adapt to harsh conditions of pollution, Eurasian Water Milfoil is tolerant. It is a threat to lakes in that it can spread and cover a large surface of the water as it displaces the native plants, thus preventing light from penetrating and reaching them. The aquatic plants commonly identified in Pewaukee Lake are shown in Table 1.

Because of the threat that high densities of aquatic plants can have on a lake, a plan for management of the lake should be developed in order to control plant population in the aquatic environment. A very important step in proper lake management is the identification of the aquatic plants. The purpose of this study is, therefore, to determine aquatic plant species and relative abundance during the fall in Pewaukee Lake and compare our results with previous studies to determine whether the plant community changes seasonally. The hypothesis, based on a statement by Charlie Schong (personal communication 2000), is that plant distribution and its effect on the entire ecosystem will differ in the fall and summer mainly due to the abundance and distribution of Eurasian Water Milfoil in the plant community.

Table 1. Aquatic plants commonly found in Pewaukee Lake (SWRPC).

SCIENTIFIC NAME	COMMON NAME
Ceratophyllum Demersum	Coontail
Chara Sp.	Muskgrass
Elodea Canadensis	Elodea
Zosterella Dubia	Water Star Grass
Myriophyllum Spicatum	Eurasian Water Milfoil
Myriophyllum Sibiricum	(Northern) Water Milfoil
Najas Flexilis	Bushy Pondweed
Najas Marina	Spiny Naiad
Potamogeton Sp. 1	
Potamogeton Sp. 2	
Potamogeton Sp. 3	
Potamogetom Sp. 4	
P. Amplifolius	Large Leaf Pondweed
P. Crispus	Curly Leaf Pondweed
P. Pectinatus	Sago
P. Richardsonii	Clasping Leaf Pondweed
P. Robbinsii	Robbins Pondweed
P. Gramineus	Variable Pondweed
P. Zosteriformis	Flatstem Pondweed
P. Natans	Floating Leaf Pondweed
P. Illinoensis	Illinois Pondweed
P. Foliosus	Leafy Pondweed
Utricularia Sp.	Bladderwort
Vallisneria Americana	Eel Grass
Nymphaea Tuberosa	White Water Lilly
Nuphar Variegarum	Yellow Water Lilly

Methods

The plant data were collected from Pewaukee Lake (Figure 1) located in Waukesha County, Wisconsin on September 9, 2000 from 1:00 p.m. to 4:00 p.m. Collections were also taken on September 20 and 27, 2000 from 12:00 p.m. to 3:30 p.m. The sampling method used was taken from an evaluation of sampling techniques written by Robert Jessen and Richard Lound in 1962.

Beginning the collection process, a 10-foot long metal rake with an extension of the same length was marked with tape at the 1.5, 5, 9, and 11.5-foot points to indicate water depth when collecting samples at each sampling station. The base of the rake was 13.5 inches wide, and its teeth were one inch apart. A total of twelve transects were surveyed (Figure 2). At every transect, four pulls were made at each of the sampling stations. The four pulls were taken from four evenly spaced areas around the front of the plant barge (Figure 3).

At each transect, the barge was driven to the specified depths. While the barge was moving, the rake was submerged into the water until the desired depth was obtained using the markings on the rake as a guide. The Global Positioning System (GPS) device was then used to determine the exact location of the transect point, which was recorded on the data sheet (Figure 4).

The rake was cleared of any debris before sampling took place. At each of the four pull areas, the rake was drawn along the bottom of the lake to retrieve any submerged vegetation. The substrate on the bottom of the lake was recorded on the data sheet. To avoid losing any vegetation, the rake was turned over and pulled up to the barge where identification could take place. Each plant was removed from the rake, identified, and recorded in the appropriate section of the data sheet. Those plants that could not be immediately identified were placed in a plastic bag and preserved in the cooler until further examination.

Results

Based on the results shown in Table 3, a total of twelve different species of aquatic plants were found in the study. Figure 5 shows the distribution of the species at each transect sampled. Frequency, average density, and relative density of the plants were determined. Frequency is the number of sample points where a species was found divided by the total number of sample points. Average density is the average density rating of a species in the sample point where it occurred. Relative density is the average density rating of a species averaged over all sample points (Aron et al. 1988).

Graphs 1-3 show there was significantly less vegetation present at the 1.5-3 foot depth where the substrate is rocky or sandy. If significant vegetation was found at the 1.5-3 foot depths, the usual species were Coontail, Bushy Pondweed, and Eurasian Water Milfoil found in fairly equal in abundance. Almost no vegetation was found at the 11-foot depth where minimal sunlight could reach. Only Eurasian Water Milfoil was found at this depth but not in any significant amount. At the 5 and 9-foot depths where the substrate is generally silty, there was greater diversity of plant species than at the other depths. The most common species were Coontail, Bushy Pondweed, Eel Grass, and Eurasian Watermilfoil at the 5-foot depth. Eurasian Watermilfoil was more abundant than any of the other species. Coontail, Bushy Pondweed, and Eurasian Watermilfoil were most frequently found at the 9-foot depth, although Eurasian Watermilfoil was found in much greater quantity.

Table 3. Comparison of plant species found in Pewaukee Lake studies in 1967, 1976, 1988, 1998, 1999, and 2000 (Aron et al. 1988; Draeger and Schmidt 1998; Thomas 1998; Barthel and Frederick 1999).

Species Name	**Summer 1967**	**Summer 1976**	**Summer 1988**	**Summer 1998**	**Fall 1998**	**Fall 1999**	**Fall 2000**
Coontail			X	X	X	X	X
Muskgrass	X	X	X	X	X	X	X
Elodea		X	X	X		X	X
Water Star Grass			X	X			X
Eurasian Water Milfoil	X	X	X	X	X	X	X
Bushy Pondweed		X		X	X	X	X
Large Leaf Pondweed			X	X		X	X
Curly Leaf Pondweed	X	X	X	X	X	X	X
Sago Pondweed	X	X	X	X	X		X
Clasping Leaf Pondweed		X	X				
Variable Pondweed					X		X
Flatstem Pondweed			X	X			
Floating Leaf Pondweed			X				
Pondweed		X	X			X	
Bladderwort	X	X	X	X		X	X
Eel Grass			X	X	X	X	X
White Water Lily			X				
Yellow Water Lily	X	X	X		X		
Duckweed			X				
Common Naiad			X				
Aquatic Buttercup			X				
Cattail			X				
Softstem Bulrush	X	X					
Bur Reed	X	X					
Broadleaf Cattail	X	X					
Waterweed	X	X			X		
Water Lily	X	X					
Bassweed		X			X		

Graphs 4-6 show the aquatic plant abundance over the entire lake. Coontail and Eurasian Watermilfoil were most frequently found in Pewaukee Lake, but Eurasian Watermilfoil outnumbered any other species in the lake.

Discussion

Aquatic plant populations are directly related to the amount of nutrients that enter the lake. A high nutrient level is the cause of uncontrollable growth of plants. Generally, the nutrients that limit plant growth in a lake are phosphorus and nitrogen. In southeastern Wisconsin lakes, nitrogen is present in adequate amounts, and growth is usually limited by phosphorus.

The recommended level of phosphorus set by the Southeastern Wisconsin Regional Planning Commission is 0.02 mg/L or less during the spring turnover (SWRPC 1984). This level is adequate for the limitation of plant growth to an amount that would not hinder recreational use, and other aquatic organisms. From 1973 to 1977, the mean phosphorus concentration was 0.06 mg/L for Pewaukee Lake. The projected level of phosphorus for the year 2000 under the conditions of the year 1975 was 0.08 mg/l (SWRPC 1984). The actual mean concentration estimated in fall 2000 was 0.15 mg/L.

Compared to the standard amount of 0.02 mg/L, phosphorus concentrations in Pewaukee Lake were found in an excessive amount. This amount of phosphorus, which is perhaps due to chemical fertilizers and runoff entering the lake, has altered the plant community in Pewaukee Lake and other organisms. As phosphorus stimulates large growth of aquatic plants, these die and decompose, depleting the water of dissolved oxygen thus killing fish and other aquatic life.

Degradation of water quality seen in the large concentration of nutrients results in the elimination of many native species in the lake. The species that tolerate the harsh conditions outcompete the ones that cannot adapt to the alteration. As shown by this study, Eurasian Water Milfoil, an exotic species, is the dominant macrophyte identified in many of the Southeastern Wisconsin lakes. It has reduced the abundance of the native species such as Pondweeds, which are beneficial for the lakes.

Many studies have been done on aquatic plants in Pewaukee Lake in recent years in both summer and fall seasons. The plant community in the lake has changed over the years and also changes according to the seasons. Table 3 shows the variation in the number of different species over the years and from the summer to fall season. The summers of 1976 and 1988 seemed to be more prosperous for species richness producing 16 and 20 different species respectively. In 1998,1999, and 2000, regardless of season, near equal numbers of different species were found resulting in near equal species richness. This does not alone describe species diversity in Pewaukee Lake.

The abundance and distribution of the plant species (species evenness), along with species richness, determines diversity among plant species in Pewaukee Lake. Approximately sixty-five percent of the lake is able to support aquatic plant growth (Thomas 1998). This proportion covers the depth of water that allows enough sunlight to reach the plants, from one foot to twelve feet. None of the previous studies done on Pewaukee Lake resulted in plant growth beyond the twelve feet water depth.

The summer 1988 study of Pewaukee Lake done by Ambient Lakes Monitoring Program used the same method of sampling used in this study, fall 2000. Therefore, it can be directly compared to the results presented in this study to determine changes that have taken place in the percent frequency, average density, and relative density of plant species. Eurasian Water Milfoil, Coontail, and Bushy Pondweed generally occur most frequently and in the highest densities at each depth in both studies. Lack of growth at eleven feet in fall 2000 could indicate decreased light availability in the fall and over the years (Graphs 1-3 and 7-9).

The remainder of the comparison studies from 1998 and 1999 used an alternate method of sampling, which limits comparisons to generalities over the area of the lake that can support plant growth. Percent abundance of the comparison studies and relative density of this study both show that Eurasian Water Milfoil has dominated and continues to dominate the plant community in Pewaukee Lake. However, in the fall season other species of plants, mainly Coontail, comprise a larger part of the plant community than they do in the summer because abundance of Eurasian Water Milfoil decreases. Milfoil appears to outcompete other plant species more efficiently in the summer than in the fall (Graphs 10-12). Other lakes show similar results.

The impact of the increase of nutrients in a lake is seen in the 1987 Lac La Belle study of the aquatic plant community. Prior to this year, the lake supported many species of plant. However, the use of aquatic herbicides has resulted in an increase in nutrient content of the lake, altering the abundance and diversity of aquatic plants. This study shows that the lake is dominated by Eurasian Water Milfoil.

The study done in Crystal Lake in 1986 shows that the plant community in this lake is quite diverse. Among the common species found in this lake are Coontail, Chara, Naiad, Pondweeds, and Eurasian Water Milfoil. Although the Milfoil does not dominate the lake, its presence could be a threat to the native species in the future. The diversity of the plant community in Crystal Lake is due to the adequate water quality that supports plant growth. The lake also has a small watershed, which minimizes the amount of runoff into the lake and abundant groundwater supply.

Browns Lake shows abundance and diversity in its plant community in the survey of 1988. Coontail, Chara, Naiad, and Pondweeds are present. Eurasian Water Milfoil is also present but has not taken over the lake. Browns Lake is shallow, and has good water quality that can support plant growth.

Nagawicka Lake, as recorded in the 1987survey, contains a very diverse aquatic plant community. The presence of Eurasian Watermilfoil, however, is threatening this diversity. The lake has good water quality and supports recreational activities (Aron et al. 1988).

Besides being a nuisance, Eurasian watermilfoil can physically affect sportfishes by obstructing predation, sheltering panfishes, and covering spawning areas. Because of the overabundance of this invader species, the delicate food web of Pewaukee Lake may become disrupted. Eurasian watermifoil provides refuge for many fish and thus their populations can become too high and they may overgraze macrophyte-dwelling macroinvertebrates. These fish then experience poor growth and lower abundance when the fish mature at smaller size (Engel 1995). The underwater environment, which supports the food web, is drastically changed by the overgrowth of macrophytes.

Submerged macrophytes, when well balanced, increase the diversity of habitats and resources for macroinvertebrates. They also reduce the susceptibility of macroinvertebrates to fish predators and the vulnerability of prey fish to piscivores. All of this affects the habitat choice, survival, and growth of macroinvertebrate-feeding fish. This ultimately feeds back on the population dynamics of the fish and the predation pressure by fish on macroinvertebrates and the remaining elements of the food web (Jeppesen et al 1998).

During periods of high weed density, some generalized feeders can switch from eating plant-dwelling prey to pelagic zooplankton, which makes them competitors with offshore planktivores. However, these planktivores can also be impaired because open water is restricted and the vertical migration of zooplankters is inhibited. Phytoplankton growth can also be limited and therefore herbivorous zooplankton as well. The excessive presence of Milfoil leads to assimilation of nitrogen and phosphate, which is also nutrition for the phytoplankton. The high density of Eurasian Water Milfoil in Pewaukee Lake reduces the sunlight available for the native species, reduces the effectiveness of sight-feeding predators, and depletes dissolved oxygen levels via respiration (Engel 1995). Where Milfoil growth is high, sunlight is the limiting resource for the plants in Pewaukee Lake.

Weed cutting has various purposes in lakes similar to Pewaukee Lake. Because Eurasian Water Milfoil is such a problem in Pewaukee Lake and many others, this mechanical harvesting of weeds can serve many purposes. It can control the surface growth, eliminate presence in high-use areas, maintain intermediate levels of Milfoil in other areas, and create channels for fish (Engel 1995).

The mechanical harvesting on Pewaukee Lake is done from early May until the end of September or as late as the middle of October. The harvesters cut down as deep as possible without disturbing the muck at the bottom of the lake. The productivity of other plants in these areas will increase because of increased sunlight penetration. This weed cutting will also create swimming lanes for fish (Lake Pewaukee Sanitary District 1992).

The removal of the cut macrophytes prevents dissolved oxygen loss and reduces the buildup of organic materials on the bottom of the lake. It is important to remove the debris because plant parts could drift into other areas, take root, and grow. Because macrophytes contain nutrients within their tissue, removal of the cut material reduces the nutrient level in the lake. This nutrient loss will have little or no effect in lakes such as Pewaukee Lake, however, because they receive a large amount of nutrients from their watersheds (MI DNR 1984).

Conclusion

Plant growth is generally limited by amount of nutrients that drain into a lake. These nutrients originate in the rocks and soil surrounding the lake, and may have natural, as well as, cultural sources. Natural sources such as soil erosion and precipitation contribute a very small amount of nutrients in the lake. Higher levels of nutrients are the result of human activities within the watershed, or land around the lake. These cultural sources may include domestic and industrial watershed, agricultural runoff, septic tank discharges, and fertilizers (MI DNR 1984).

As more nutrients enter the lake from the watershed, more plants are produced, accelerating the eutrophication of the lake. Therefore, a plant management program should be developed in order to maintained a proper plant balance in a lake. A plant control program may include mechanical, chemical, biological removal of plants, and measures to reduce nutrient levels on the lake (Moore 1987).

As mentioned earlier, weed-cutting can increase plant diversity since light penetration into the lake is increased, and other species are allowed to grow. Chemical methods of plant control include the use of herbicides that poison the plants. This latter method may be successful in some lakes, but not in others. It may also result in fishkill (Moore 1987). Therefore other methods of control are preferred.

A biological control against Eurasian Water Milfoil using weevils was suggested by Christina Brandt. Brandt's experiment on Big and Little Swartswood Lakes located in New Jersey shows that introduction of weevils into the lakes had reduced the density of Eurasian Water Milfoil. The weevils had damaged the weeds by preventing their flowering. Brandt and her group were able to note that Coontail had replaced the Eurasian Water Milfoil as the dominant plant as a stable weevil population was established in the Lakes (Brandt 2000).

Nutrients source management should include restriction of commercial products such as detergents and fertilizers to reduce amounts of nitrogen and phosphorus. It is also useful to treat inflowing water in order to reduce levels of nutrients before it enters the lake. Proper land use should be developed in order to minimize movement of sediments, or soil erosion. Diversion of water high in nutrients away from the lake has also shown that this method can increase water quality (MI DNR 1984).

To control the population of Eurasian Water Milfoil in Pewaukee Lake, the current method of weed-cutting does not seem to be completely effective. Therefore, chemical or biological control should be considered. These control methods should be implemented during the summer months when activity levels on the lake, and the density of the Eurasian Water Milfoil are higher. If plant levels are controlled in Pewaukee Lake, plants can better maintain their diversity, which in turn benefits the other organisms in the lake ecosystem. The lake will then be able to best serve the needs of those who use it.