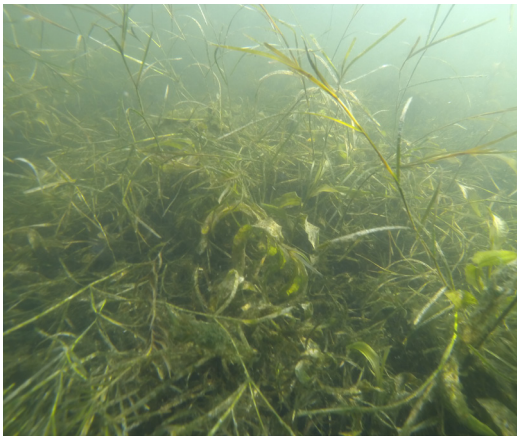

Aquatic Plant Control

Clear Lake
Mecosta County, Michigan
Aquatic Plant Control Evaluation
Summary of Findings and Recommendations

Prepared for:
Clear Lake Association

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

November 2015

Project No: 76220001

progressive|ae

Clear Lake
Mecosta County, Michigan
Aquatic Plant Control Evaluation
Summary of Findings and Recommendations

Prepared for:
Clear Lake Association

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

November 2015

Project No: 76220001

Table of Contents

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In May of 2015, Progressive AE was retained by the Clear Lake Association to evaluate alternatives to control nuisance aquatic plant growth in Clear Lake. This report contains a summary of study findings, recommendations and conclusions.

LAKE PHYSICAL CHARACTERISTICS

Clear Lake is located in Colfax Township in Mecosta County, Michigan (T.15N; R.9W). The lake was first mapped by the Michigan Department of Conservation in 1940 (Figure 1). Mapping conducted at that time indicated the lake had a surface area of 130 acres and a maximum depth of 30 feet. As part of the current evaluation of Clear Lake, an updated depth contour map of the lake was created using hydro-acoustic mapping computer software. As part of this mapping effort, the physical characteristics of the lake were calculated (Table 1, Figure 2). Currently, Clear Lake has a surface area of 132 acres, a maximum depth of 32 feet and a mean, or average, depth of about 9 feet. Much of Clear Lake is shallow enough to support aquatic plant growth. While the 1940 and 2015 maps are quite similar, the new map shows the lake to be slightly larger and deeper than the original mapping.

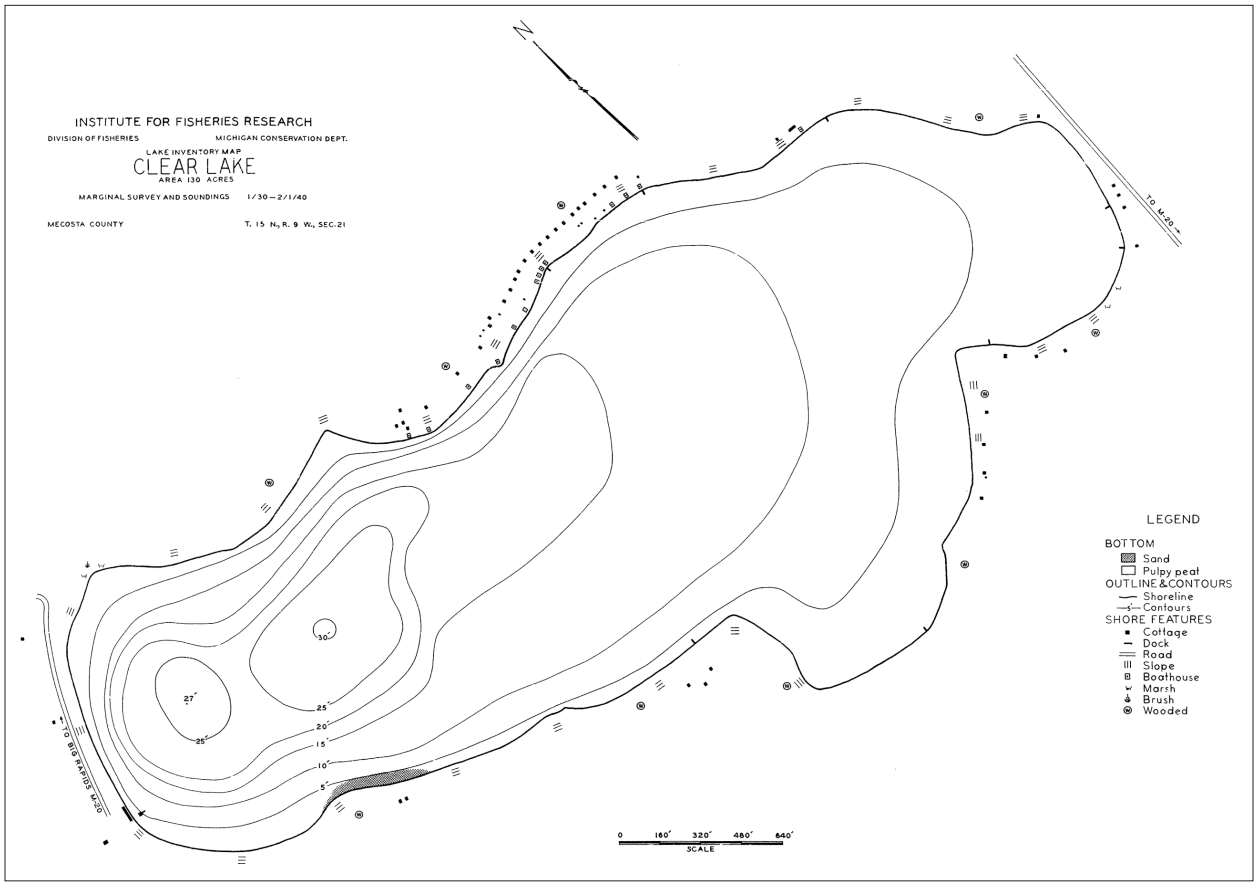

Figure 1. Clear Lake depth contour map (1940).

TABLE 1
CLEAR LAKE PHYSICAL CHARACTERISTICS

Lake Surface Area	132	Acres
Maximum Depth	33	Feet
Mean Depth	9.14	Feet
Lake Volume	1,167	Acre-Feet
Shoreline Length	2.37	Miles
Shoreline Development Factor	1.5	

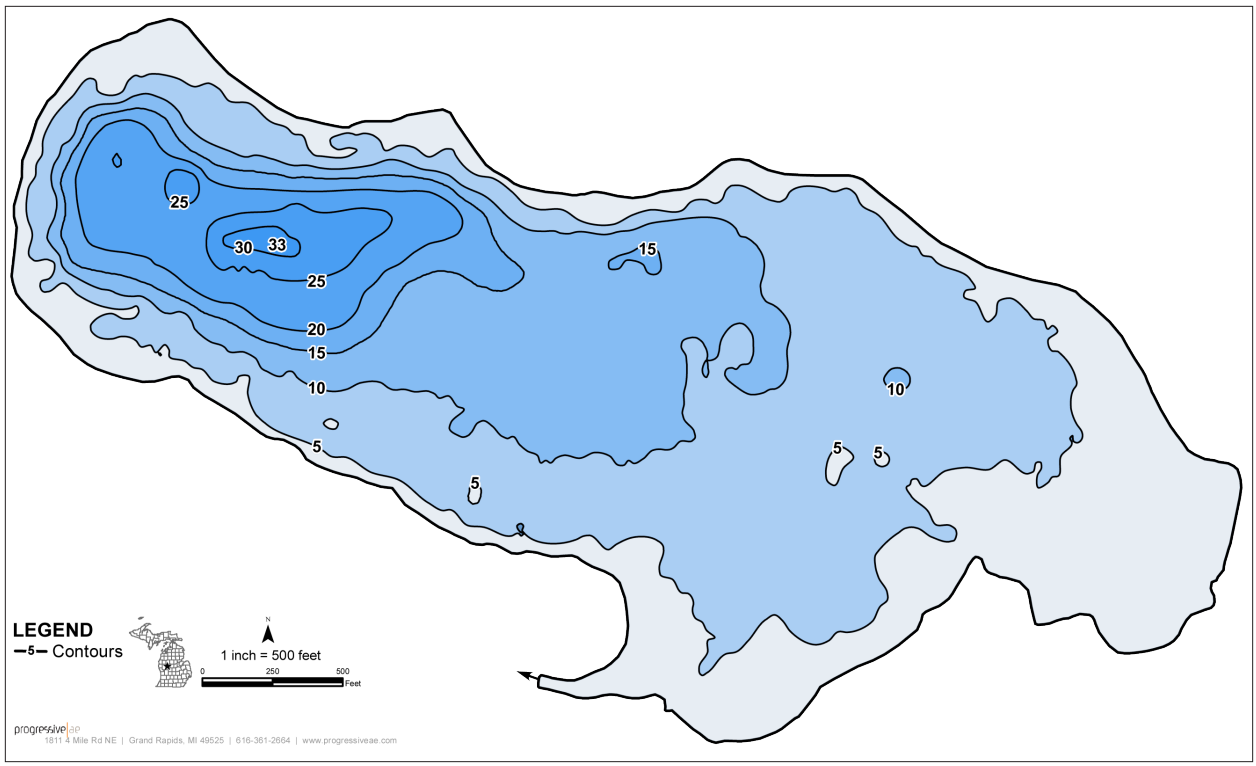

Figure 2. Clear Lake depth contour map (2015).

AQUATIC PLANTS

Aquatic plant are an important ecological component of lakes. They produce oxygen via photosynthesis, provide food and habitat for fish, and help stabilize shoreline and bottom sediments (Figure 3).

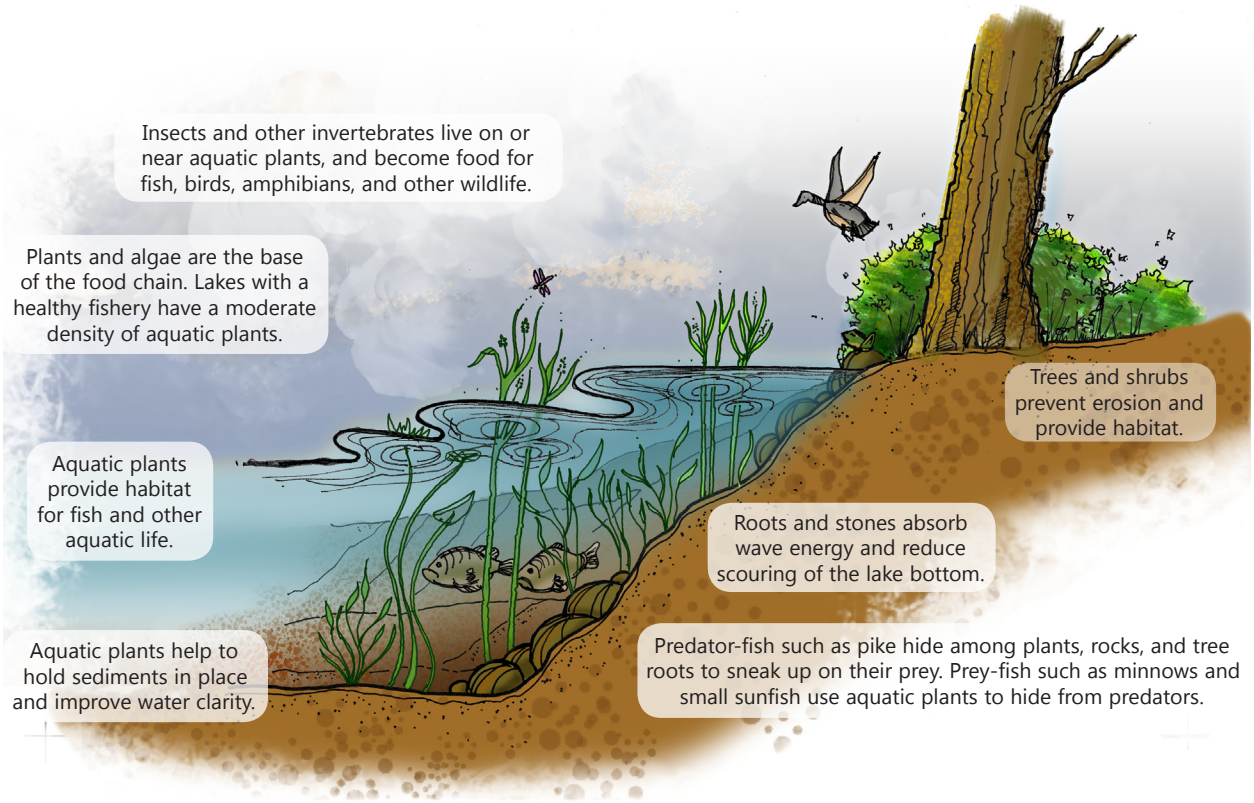

Figure 3. Benefits of aquatic plants.

The distribution and abundance of aquatic plants are dependent on several variables, including light penetration, bottom type, temperature, water levels, and the availability of plant nutrients. The term "aquatic plants" includes both the algae and the larger aquatic plants or macrophytes. The macrophytes can be categorized into four groups: the emergent, the floating-leaved, the submersed, and the free-floating (Figure 4). Each plant group provides unique habitat essential for a healthy fishery.

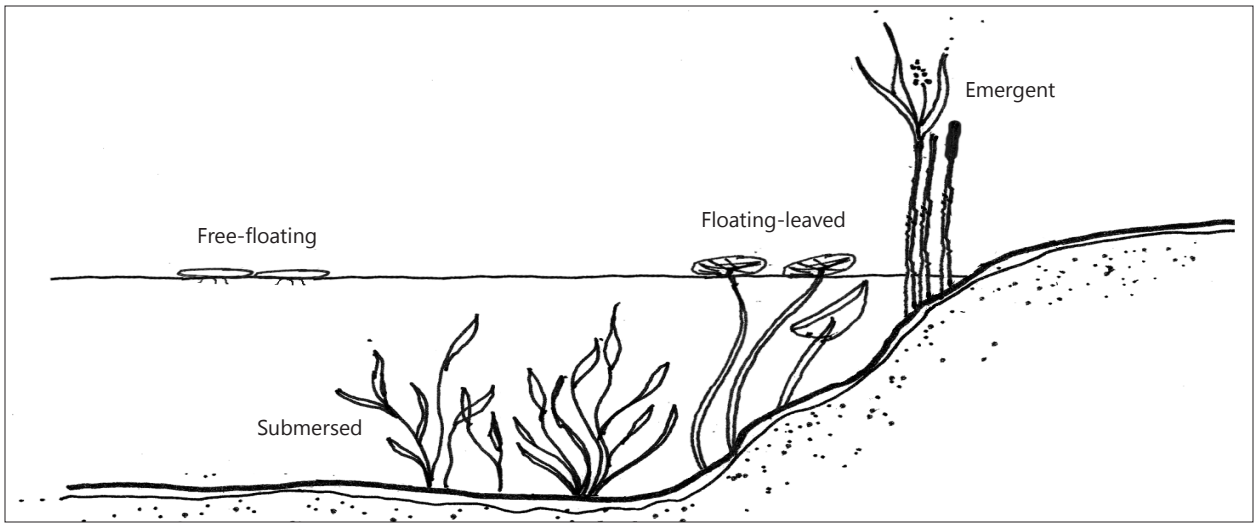

Figure 4. Aquatic plant groups.

An exotic species is one that is found outside of its natural range. Exotic aquatic plants often have aggressive and invasive growth tendencies. They can quickly out-compete native plants and gain dominance in a lake.

Exotic plant species that are a threat to Michigan lakes include Eurasian milfoil (*Myriophyllum spicatum*) and starry stonewort (*Nitellopsis obtusa*; Figure 5).

Figure 5. Exotic aquatic plants. Left: Eurasian milfoil (*Myriophyllum spicatum*); right: starry stonewort (*Nitellopsis obtusa*).

Getsinger et al. (2005) described problems associated with Eurasian milfoil as follows:

> Problems associated with this species include its aggressive displacement of native vegetation, and alteration of fish and wildlife habitat by formation of impenetrable mats with dense upper canopies that reduce light and decrease water flow. These significant changes in habitat quality quickly affect fish, wildlife, and other aquatic organisms.
>
> Over time, Eurasian watermilfoil will out-compete or eliminate more beneficial native aquatic plants, severely reducing natural plant diversity within a lake. Eurasian watermilfoil is rarely used for food by wildlife, and can displace many aquatic plants that are valuable food sources for waterfowl, fish, and insects. Dense stands of Eurasian watermilfoil provide habitat for mosquitoes and may increase populations of some species of these insects.
>
> Fish populations may initially experience a favorable increase when Eurasian watermilfoil first invades a site. However, the abundant and aggressive growth of this weed will counteract any short term benefits. It's typically dense growth habit make Eurasian watermilfoil beds poor spawning areas for fish and may lead to populations of small-sized specimens. Loss of oxygen and light caused by the dense mats can also affect the characteristics of fish populations. At high densities, Eurasian watermilfoil's foliage supports a lower abundance and diversity of invertebrates to serve as fish food. While dense cover does allow high survival rates of young fish, larger predator fish lose foraging space and are less efficient at obtaining their prey. Thus dense Eurasian watermilfoil stands are reported to reduce expansion and vigor of warm-water fisheries.
>
> The growth and senescence of dense Eurasian watermilfoil colonies also reduce water quality and water circulation, and cause lower levels of dissolved oxygen.

Eurasian milfoil is not the only type of milfoil found in Michigan. There are several native milfoil species, such as northern milfoil (Myriophyllum sibiricum). Some native species closely resemble Eurasian milfoil and are commonly mistaken for it. However, the native milfoils rarely form dense, impenetrable plant beds like Eurasian milfoil often does. In some lakes, hybridization between exotic Eurasian milfoil (*M. spicatum*) and native northern milfoil (*M. sibiricum*) is occurring. Genetic testing has found milfoil hybrids to be widely dispersed across the northern portion of the United States and hybrid milfoil appears to be widespread in Michigan (Sturtevant et al. 2009, Moody and Les 2007). The presence of hybrid milfoil is important because hybridity in plants is often linked to invasive traits. In fact, hybrid milfoil may be more invasive than Eurasian milfoil (LaRue et al. 2012). There is concern in the scientific community that hybrids could have a competitive advantage over, and ultimately displace both northern milfoil and Eurasian milfoil (LaRue et al. 2012). Recent research indicates that hybrid milfoils may exhibit increased tolerance to some herbicides (LaRue et al. 2012, Thum et al. 2012).

Starry stonewort looks like a rooted plant but it is actually an algae. It was first found in the Detroit River in the 1980s and has since infested hundreds of inland lakes (Brown 2015, Schloesser et al. 1986). Starry stonewort closely resembles the native aquatic plant Chara. However, unlike Chara, which is generally considered to be a beneficial plant, starry stonewort has a tendency to colonize deeper water and can form dense mats several feet thick. Starry stonewort can impede navigation, and quickly displace native plants. Fisheries biologists have expressed concern that starry stonewort may cover valuable fish habitat and spawning areas.

In order to evaluate aquatic plants in Clear Lake, an aquatic plant survey was conducted on June 15, 2015. The survey was conducted in accordance with Michigan Department of Environmental Quality Procedures for Aquatic Vegetation Surveys. With these procedures, the type and relative abundance of all plants species present in the lake are evaluated. To facilitate the survey, GPS waypoints were established around the shoreline and across the shallow-water portions of the lake (Figure 6).

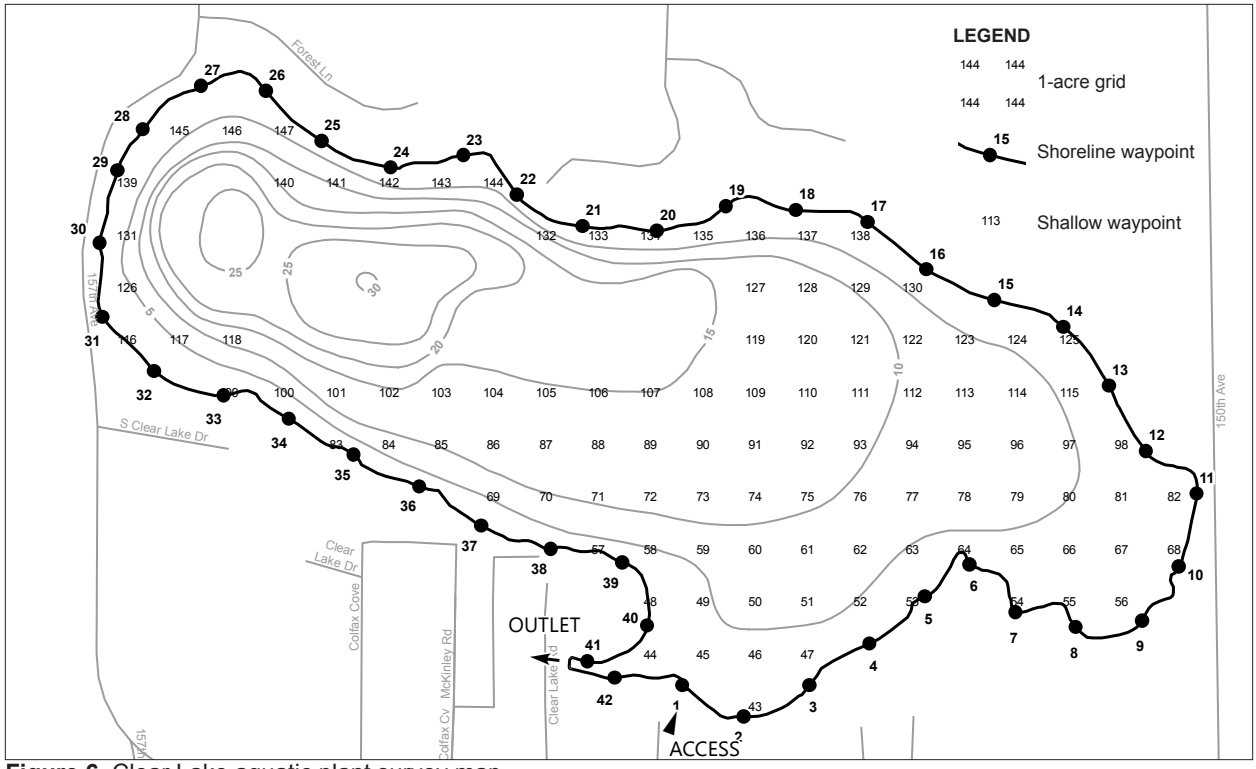

Figure 6. Clear Lake aquatic plant survey map.

At each GPS waypoint, plant samples were collected and plant type and abundance were recorded. These data are summarized in Table 2.

TABLE 2
CLEAR LAKE AQUATIC PLANTS
June 15, 2015

Common Name	Scientific Name	Group	Percent of Sites Where Present
Variable pondweed	*Potamogeton gramineus*	Submersed	83%
Eurasian milfoil	*Myriophyllum spicatum*	Submersed	79%
Robbins pondweed	*Potamogeton robbinsii*	Submersed	30%
Large-leaf pondweed	*Potamogeton amplifolius*	Submersed	30%
Elodea	*Elodea canadensis*	Submersed	26%
Chara	*Chara* sp.	Submersed	25%
Naiad	*Najas* sp.	Submersed	18%
Mini bladderwort	*Utricularia minor*	Submersed	10%
Flat-stem pondweed	*Potamogeton zosteriformis*	Submersed	5%
Sago pondweed	*Stuckenia pectinata*	Submersed	1%
Water shield	*Brasenia schreberi*	Floating-leaved	39%
White waterlily	*Nymphaea odorata*	Floating-leaved	17%
Yellow waterlily	*Nuphar lutea*	Floating-leaved	9%
Floating-leaf pondweed	*Potamogeton natans*	Floating-leaved	1%
Arrowhead	*Sagittaria latifolia*	Emergent	12%
Cattail	*Typha* sp.	Emergent	9%
Bulrush	*Scirpus* sp.	Emergent	3%
Arrow arum	*Peltandra virginica*	Emergent	1%

In addition to the qualitative assessment of aquatic plants, a hydro-acoustic survey of the lake was conducted to provide a quantitative assessment of plant growth in Clear Lake (Figure 7). With the exception of the portions of the lake greater than about 15 feet, aquatic vegetation was found across much of the lake. In many areas, plants were growing at or near the lake surface. Clear Lake has a large infestation of the nuisance, exotic plant Eurasian milfoil. Genetic testing of milfoil samples conducted during the study did not indicate the presence of hybrid milfoil in Clear Lake. In addition, starry stonewort was not found in the lake during the June survey.

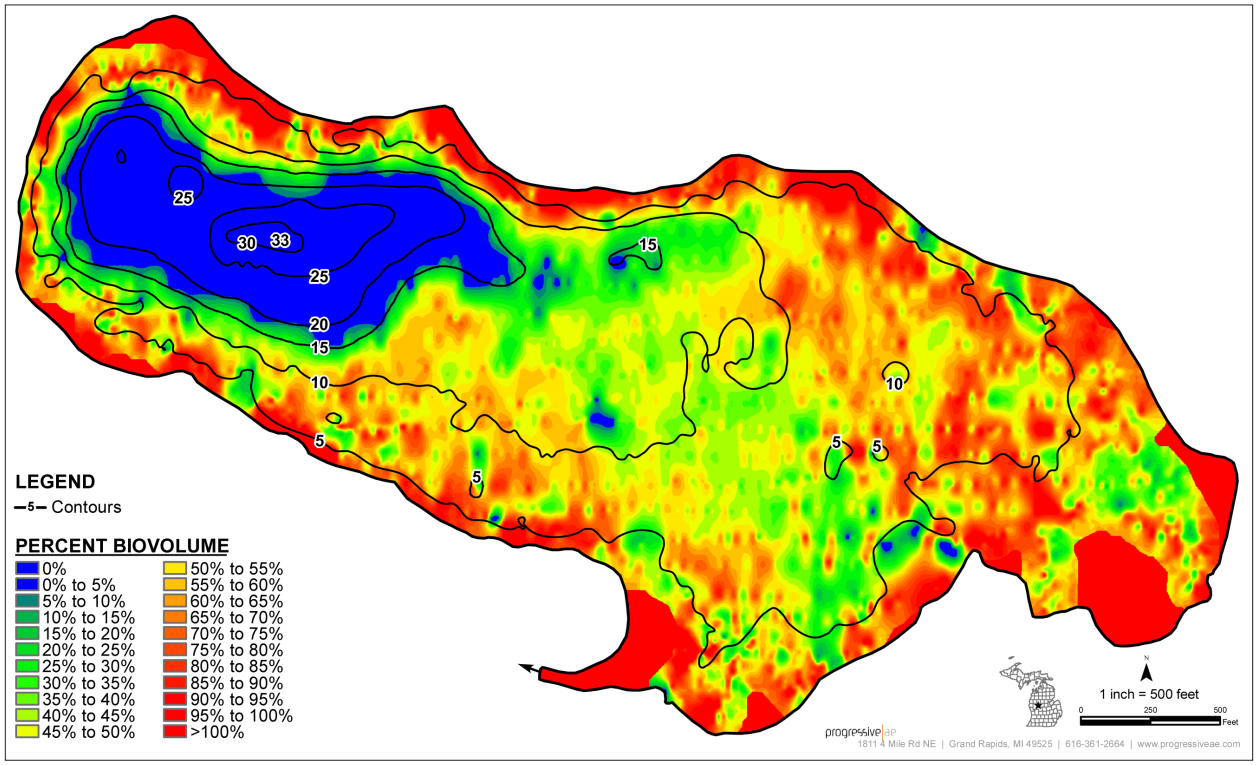

Figure 7. Clear Lake aquatic plant biovolume map, June 2015. Note: Biovolume is a measure of the height of plants in the water column. A biovolume measurement of 50% indicates plants occupy one-half of the water column.

AQUATIC PLANT CONTROL

The objective of a sound aquatic plant management program is to control the spread of invasive and exotic species while preserving beneficial native plants. Currently, nuisance growth of Eurasian milfoil is occurring throughout much of Clear Lake.

Given the problems caused by Eurasian milfoil infestations, considerable effort and funds are spent in Michigan and nationwide to control the plant. The most common method of milfoil control is the application of aquatic herbicides. In recent years, a native aquatic insect called the milfoil weevil (*Euhrychiopsis lecontei*) has also been used in an attempt to control milfoil. Because Eurasian milfoil can spread by vegetative propagation, it is generally ill-advised to attempt to control Eurasian milfoil by mechanical harvesting.

Herbicides

There are two types of herbicides: systemic and contact. Systemic herbicides are taken up by the plant and translocated to the roots, resulting in more complete control. Contact herbicides only impact the portions of the plant that come into contact with the herbicide. They also tend to be broad-spectrum; they kill both milfoil and desirable non-target plants. By contrast, systemic herbicides kill milfoil with little or no impact to non-target plants. Contact herbicides work relatively quickly while systemic herbicides generally take several weeks to kill the targeted plant. However, control with contact herbicides is usually short-lived and milfoil can re-grow within a few weeks.

In Michigan, aquatic herbicide use is regulated under Part 33, Aquatic Nuisance Control, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. Prior to herbicide treatments, a permit must be acquired from the Michigan Department of Environmental Quality (MDEQ). MDEQ regulates what herbicides are approved for use, dose rates, and areas of the lake where treatments are allowed.

The Milfoil Weevil

The milfoil weevil (*Euhrychiopsis lecontei*) is an aquatic insect that is native to North America and appears to be common in the Midwest (Figure 8). The weevil has been found to feed almost exclusively on milfoil species, especially Eurasian milfoil. Researchers have documented declines in Eurasian milfoil populations as the result of weevil feeding. These declines have been attributed largely to the burrowing and tunneling action of weevil larvae that cause the milfoil plant to lose buoyancy and fall from the water column. In addition, weevil burrowing can reduce the plant's ability to translocate nutrients and carbohydrates which can further reduce milfoil's competitive edge and ability to regrow the next spring. Stem fragments damaged by weevils have reduced viability and ability to produce new roots. Weevil burrowing may also increase the susceptibility of milfoil to infection by pathogens.

In a comprehensive review of research on biological control of Eurasian milfoil, Newman 2004 summarized his findings as follows:

> The milfoil weevil . . . can be effective . . . if adequate densities can persist through the summer and among years. However, many of the sites investigated have failed to sustain sufficient herbivore [weevil] density to effect control. We currently cannot predict when and where herbivore populations will reach sufficient densities nor when or where declines and suppression will occur. Both adequate agent [weevil] densities and proper plant response are required for predictable control . . . Further identification and prioritization of factors limiting herbivore populations is needed and methods to ameliorate these limiting factors must be developed before biological control of milfoil can be reliably applied on a large scale.

Figure 8. Milfoil weevil (*Euhrychiopsis lecontei*). Photo courtesy of Tom Alwin and Michigan State University Department of Fisheries and Wildlfie.

Several factors, including fish predation, may limit the effectiveness of weevils in controlling Eurasian milfoil. In lakes with high numbers of sunfish (*Lepomis* spp.), adult weevil density can be reduced. Sunfish predation likely accounts for the observed failure of weevils to control milfoil in many lakes (Ward and Newman 2006). Although Clear Lake has an indigenous population of weevils, and weevil stocking has been conducted in the past (EnviroScience 2013), weevil herbivory on Eurasian milfoil does not appear to have significantly diminished milfoil growth in the lake. Further, the company that supplied and stocked weevils ceased its weevil-culturing operations, and there is not currently a commercial source to purchase weevils.

RECOMMENDATIONS AND CONCLUSIONS

Based on the information presented herein, and the extent of the Eurasian milfoil infestation in Clear Lake, it is recommend that the plant control program on Clear Lake focus on the control of exotic plants such as Eurasian milfoil with the select use of aquatic herbicides.

Plant control activities are proposed to be coordinated under the direction of an environmental consultant. The consultant would be responsible for preparing specifications and bid documents for the herbicide treatment program, assisting with the acquisition of bids for the project, conducting annual GPS-guided aquatic plant surveys to determine the scope of the herbicide treatment program, and conducting follow-up surveys to evaluate the effectiveness of plant control activities. The consultant would keep a written record of the timing, scope, and cost of all plant control work. Costs associated with the recommended plant control program are provided in Table 3.

TABLE 3
CLEAR LAKE
AQUATIC PLANT CONTROL PROGRAM PROPOSED ANNUAL BUDGET (2016 – 2020)

Program Component	Estimated Cost
Nuisance Aquatic Plant Control 50 acres @ $450/acre	$22,500
Plant Control Coordination and Field Surveys	$6,500
Administration/Contingency	$1,000
Total	$30,000

The plant control program on Clear Lake is proposed to be financed through special assessment of benefitting properties in accordance with PA 188 of 1954, as amended. As with the previous plant control project on Clear Lake, the special assessment district for the project is proposed to include all waterfront properties and back lots immediately adjacent to the lake. Under this plan, waterfront parcels would be assessed one unit of benefit and back lots in the district would be assessed one-half unit of benefit. Contiguous lots in common ownership are proposed to be assessed as a single parcel provided only one house exists on the parcel. Based on these criteria, approximately 81 assessment units exist within the district, and the annual waterfront parcel assessment would be approximately $370 for five years and the approximate back lot parcel assessment would be approximately $185 for five years.

REFERENCES

Brown S. 2015. Starry stonewort: Essential information for lakefront property owners. Michigan Riparian Summer 2015.

EnviroScience 2013. Eurasian watermilfoil survey and weevil population survey at Clear Lake, Mecosta County, Michigan.

Getsinger, K., M.D. Moore, E. Dibble, E. Kafcas, M. Maceina, V. Mudrak, C. Lembi, J. Madsen, R.M. Stewart, L. Anderson, W. Haller, C. Layne, A. Cofrancesco, R. Newman, F. Nibling, K. Engelhardt. 2005. Aquatic plant management: Best management practices in support of fish and wildlife habitat. Aquatic Ecosystem Restoration Foundation, Lansing, MI.

LaRue E.A., M.P. Zuellig, M.D. Netherland, M.A. Heilman, and R.A. Thum. 2012. Hybrid watermilfoil lineages are more invasive and less sensitive to a commonly used herbicide than their exotic parent (Eurasian watermilfoil). Evolutionary Applications 6:462-471.

Moody, M. L., and D.H. Les. 2007. Geographic distribution and genotypic composition of invasive hybrid watermilfoil (Myriophyllum spicatum x M. sibiricum) populations in North America. Biological Invasions 9:559–570.

Newman, R.M. 2004a. Invited review – Biological control of Eurasian watermilfoil by aquatic insects: Basic insights from an applied problem. Archiv für Hydrobiologie 159 (2): 145-184.

Schloesser D.W., P.L. Hudson, and J. Nichols. 1986. Distribution and habitat of *Nitellopsis obtusa* (Characeae) in the Laurentian Great Lakes. Hydrobiologia 133: 91-96.

Sturtevant, A.P., N. Hatley, G.D. Pullman, R. Sheick, D. Shorez, A. Bordine, R. Mausolf, A. Lewis, R. Sutter, A. Mortimer. 2009. Molecular characterization of Eurasian watermilfoil, northern milfoil, and the invasive interspecific hybrid in Michigan lakes. Journal of Aquatic Plant Management 47:128-135.

Thum R.A., M.A. Heilman, P.J. Hausler, L.E. Huberty, P.J. Tyning, D.J. Wcisel, M.P. Zuellig, S.T. Berger, L.M. Glomski, and M.D. Netherland. 2012. Field and laboratory documentation of reduced fluridone sensitivity of a hybrid watermilfoil biotype (*Myriophyllum spicatum* x *Myriophyllum sibiricum*). Journal of Aquatic Plant Management 50:141-146.

Ward, D.M. and R.M. Newman. 2006. Fish predation on Eurasian watermilfoil (*Myriophyllum spicatum*) herbivores and indirect effects on macrophytes. Canadian Journal of Fisheries and Aquatic Sciences 63: 1049-1057.