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**YEAR END REPORT**
**2006 LAKE MANAGEMENT PROGRAM / ACTION PLAN**
**MOUNT KEMBLE LAKE**

The following year-end report is a summary of the Lake Management Program conducted during the 2006 season at Mount Kemble Lake. Included in the summary are highlights of the lake management strategy, water quality data, pesticide treatments, and observations noted during surveys and treatments. Recommendations for future management practices are also included. A report from the vegetation mapping program completed in 2006 is included in the appendix of this report.

## Pesticide Applications and Aquatic Plants

The following chart details the surveys and treatments that were performed at Mount Kemble Lake.

| Date | Survey/ Treatment | Vascular Plants Species | Survey Notes |
|---|---|---|---|
| 05/26/06 | Survey | *Ludwigia repens* | Very few plants or algae were observed. This is likely due to the recent drawdown and dredging activities. Trace benthic algae was observed along the west shore. One stem of *L. repens* was noted floating in the lake. The water appeared to be turbid. |
| 07/06/06 | Survey/ Treatment | ~ | The water was beginning to show signs of an algal bloom. The secchi was 4 feet during this visit. Very light filamentous algae were found along the shoreline during this visit. |
| 09/11/06 | Survey | *Callitriche* sp. | During the scheduled vegetation mapping survey both filamentous algae and *Callitriche* sp were found in trace densities. |

## Algae

Filamentous algae are multicellular, macroscopic algae that are found as two types: floating (visible mats on the surface of the lake), or benthic (attached to bottom substrate). Planktonic algae, sometimes referred to as unicellular algae, are microscopic, free-floating algae that impact the water clarity. Planktonic algae, when populations are elevated, can "coagulate" and resemble filamentous algal mats or pea soup. An application of copper sulfate was performed on July 6 to control sparse densities of both phytoplankton and shoreline filamentous algae. No other problem algae were noted during the 2006 season.

## Vascular Plants

The occurrence of vascular plants in Mount Kemble Lake was limited to trace densities of *Callitriche* species along the central region of the western shoreline and a stem of *Ludwigia repens* found floating in the lake. Both of these species are considered desirable and were at non-nuisance densities. The limited growth of vascular plants is due largely to the completion of a dredging project earlier in 2006, the drawdown performed in order to dredge the lake, and the limited littoral zone of Mount Kemble Lake.

## Water Quality

Water quality records reveal changes in water chemistry affecting other characteristics of the lake. Information gained through testing of water quality parameters is used to determine the nature of management issues in lakes. Over-population of algae or aquatic plants, excessive nutrient loading and the presence of anoxic conditions are a few common problems. Before each treatment and during boat surveys dissolved oxygen, secchi measurements, ph, and temperature were recorded. Nitrates, nitrites, phosphorus, total dissolved solids, turbidity, ammonia, $CO_2$, and Iron were the parameters tested for at the laboratory on three dates this season. Conductivity, temperature, dissolved oxygen, and pH were sampled at the surface near the inlet and with a one meter incremental profile near the outlet of Mount Kemble Lake. Parameters not discussed in the following text returned acceptable values. An explanation detailing water quality parameters is included in the Appendix.

The secchi reading is a clarity measurement obtained using a small disk with quadrants that alternate from black to white. The disk is lowered into the water until it can no longer be seen and is then is raised back into view. The average of these two values is the accepted clarity measurement. This measurement is important in determining the extent of dissolved or solid material, such as phytoplankton or organic debris, in the water column. A secchi measurement recorded on July 6 was 4' indicating water clarity was slightly reduced due to phytoplankton densities in the lake. The remaining secchi measurements were between 4.5' and 7', acceptable values which do not indicate nuisance phytoplankton growth.

Dissolved oxygen measurements indicate the amount of molecular oxygen in the lake water. This oxygen is necessary to sustain the flora and the fauna of the lake, and affects various chemical attributes of the lake. The range for acceptable oxygen concentrations is 6ppm-13ppm. Readings above the upper limit typically indicated that excessive photosynthesis is occurring in the lake. Below 6ppm is insufficient for most organisms, causing stress and possibly mortality. Low oxygen levels are typical in areas that have limited aquatic plant growth and high organic sediment that is undergoing bacterial degradation because respiration from the bacteria depletes dissolved oxygen. Anoxia directly adjacent to the substrate allows nutrients to dissolve into the water column more readily. This is a common problem in deeper lakes, usually 10+ feet, where wind and wave action is not sufficient to mix the water column. Dissolved oxygen profiles indicated that Mount Kemble Lake's water column was stratified on all three sample dates. Results from July 7 indicated that insufficient oxygen concentrations were present at 6' depth. This correlates to ¾ of the lakes volume having insufficient oxygen to sustain lake organisms. The Action Plan section will include recommendations to improve oxygen concentration throughout the lake.

Iron concentrations in the lake were elevated at the bottom sample near the outlet during the July and September sample dates. Surface concentrations were well below the lowest detectable limits for humans. At these depths mild elevation in iron concentration will not create a noticeable affect in any aspect of the lake. If surface concentrations had been elevated distinct orange/brown water color would be visible along with odor and taste problems.

The two most important nutrients contributing to algal and vascular plant growth are nitrogen and phosphorus. Nitrogen sampling results revealed that seven of the nine total samples taken this season were elevated. Ammonia concentrations were elevated at the lake bottom sample near the outlet during both the July and September sample dates. The ammonia level was about four times the acceptable maximum level at depth but was not elevated through the water column. These concentrations may be attributed to the collection of fecal material from fish and other aquatic organisms. Phosphorus concentrations also remained elevated for at each sample site during each of the three sample dates this season. Concentrations of phosphorus directly in front of the inlet and near the bottom of the lake were generally the most elevated. This would seem to indicate extensive external and internal nutrient loading occurred in the lake. Further sampling and study would be necessary to confirm this hypothesis. Internal loading is likely facilitated by anoxic conditions present at the substrate-water interface. Because the lake water remained stratified during each of the visits this season, phosphorus concentration were segregated from the upper portion of the water column, and did not effect phytoplankton population to the degree usually experienced. Lab results are included in the appendix of this report.

Based on the results from sampling and surveys during the 2006 season Mount Kemble Lake has excessive nutrient loading, limited vascular plant populations, and a phytoplankton driven lake system. Though the dredging process was a acceptional undertaking and is bound to yield results that improve the quality of the lake, the above mentioned issues, will not be solved through the dredging process. The following action plan consists of several techniques, appropriate to the Mount Kemble Lake ecosystem that can be added to the management program to improve or maintain conditions in the lake and to help the community be more proactive in managing the lake. Recommendations are made to add new strategies or to improve those already initiated at Mount Kemble Lake.

## Action Plan

### *Water Quality Monitoring*

Currently, the water quality regimen includes sampling on three dates and in three locations; at the inlet on the surface and at the outlet on the surface and bottom of the lake. Nutrient sampling in the first season has revealed excess nutrient concentrations present in the lake for the majority of the sample dates. With the major excavation performed at the lake last season, it is important to continue this sampling to determine if elevated nutrients were caused by the dredging performed, or is it an ongoing condition of the lake that needs to be addressed. This information is important in creating a baseline for the lakes water quality history. The current location and frequency of this sampling is sufficient to warn lake managers of common problems associated with lakes in this region. Continuation of the present water quality regimen is recommended.

### *Lake Aeration and Circulation*

Mount Kemble Lake exhibited stratification through each sample date this season. This segregation of the water column into distinct layers can cause two major issues in the lake; reduction of dissolved oxygen necessary for aquatic organisms to respire, and anoxic conditions at the water substrate interface which facilitates the introduction of nutrients from the substrate and slows the decomposition process allowing sediment to build up quicker. Aquatic organisms are an important aspect of aquatic ecosystems. These organisms help to balance the food web of Mount Kemble Lake and create a valuable recreational feature. The most effective strategy to eliminate the oxygen deficiency is the addition of an aeration system.

Aeration systems can be installed in a variety of configurations depending on the situation and the desired outcome. One common aeration system configuration is installed along the perimeter of the beach swim area. This system would be installed to improved conditions of the water in and immediately adjacent to the beach area. In a system such as this a small compressor would be installed at the beach with three diffuser plates installed along the boundary of the beach swimming area.

A more extensive aeration system can be installed in one configuration to improve the oxygen condition in the epilimnion (upper water column), and in another configuration to eliminate stratification and oxygenate the water. This system would involve installation of one or two large three phase aeration compressors and eight to twelve large volume aeration diffusers throughout the lake. If the goal was to aerate the epilimnion the diffusers would be situated throughout the lake, but

instead of sinking the diffusers to the lake bottom with weights they would be elevated up to several meters from the bottom in order to affect only the portion of the lake above the diffuser. As an alternative to this method the diffusers can be positioned so they lay on the substrate. Placing the diffusers in this manner will oxygenate the entire water column and help to circulate the lake. Oxygenation of the entire water column will aid in reducing the internal nutrient load in the lake and improve decomposition of organic material on the bottom.

As an addendum to the water quality/chemistry monitoring program, additional temperature and dissolved oxygen profiles should be performed if an extensive lake wide aeration system is to be installed. These profiles will help in determining the extent of stratification throughout the lake, and will allow for proper design of the aeration system to eliminate the oxygen deficiency.

*Vascular Plant Control (herbicides)*

Herbicide applications were not necessary during the 2006 season in Mount Kemble Lake. Typically, vascular plant control in this lake is limited to site selective shoreline control. Increases in vascular plant density would not be detrimental to the lake system, however, growth in certain areas can reduce recreation and aesthetics. Herbicide application should be limited to areas along the shoreline where plant growth has reduced aesthetics or recreation. Currently the lake is driven by phytoplankton production. Increased vascular plant biomass may will help balance the lake ecosystem and reduce nuisance phytoplankton blooms that occur in the lake. Control of species typically present in Mount Kemble Lake is achieved through the use of the aquatic herbicide Reward. This is a site selective contact herbicide. Additional herbicides should be permitted as the necessity arises based on the identification of new species in the lake.

*Algal Control Methods*

For the 2007 season it will be necessary to continue applying copper based algaecides to control excessive phytoplankton growth through the season. The current program relies on copper sulfate, however, chelated copper based algaecides are less harmful to zooplankton that reside in the lake and feed on phytoplankton. These formulations of algaecides remain in solution longer than copper sulfate and may control algae better. Allied Biological Inc. will be exclusively utilizing chelated formulations of copper based algaecides for algal control beginning in 2007.

*Plant Control in the Clubhouse Pond*

Plant control in the clubhouse pond should be limited to treatment of nuisance densities of filamentous algae and submersed vascular plant species. This pond can be utilized as a nutrient reduction for the inlet of Mount Kemble Lake. The more plant growth that is present in the pond the lower the nutrient concentration of the water flowing into the lake. This condition helps to reduce the outbreak of phytoplankton in the main lake. Review the aquascaping section for information on the 2006 planting.

*Nutrient Reduction/Inactivation*

Mount Kemble Lake supports limited submersed and emergent plants, therefore phytoplankton drives productivity through most of the season. Water quality sampling has documented elevated phosphorus in the water column, which is a main nutrient source of these phytoplankton. While nutrient loading should be reduced from outside the lake, internal nutrient loading along with nutrients already dissolved in the water column can be targeted immediately. This is best accomplished utilizing aluminum sulfate (alum) to bind phosphorus in the water column and in the sediment. Alum applied in the spring, prior to algal development can remove the algae's prime food source and limit plankton productivity for weeks to months, depending on application rates. As the alum precipitates through the water column it settles on the substrate and forms a nutrient barrier eliminating further suspension of nutrients from the substrate. The nutrient barrier helps to reduce the affects of anoxia on nutrient introduction into the water column. The alum blanket remains effective until all of the Al ions are bound. Research into Mount Kemble Lakes nutrient loading would be necessary to determine exact rates necessary to eliminate internal nutrients for a given time period. The expense of such a study may well exceed the cost of an alum application. Typically it is sufficient to perform "Alum Jar Tests" to determine the appropriate concentration of alum necessary to bind dissolved nutrients and solids, and estimate additional alum to create the nutrient barrier. An additional effect of the alum application is substantially increased water clarity. Increases in water clarity will increase the photic zone, allowing additional vascular plant species to populate the lake. This will further reduce phytoplankton dominance at Mount Kemble Lake.

*Zooplankton Population Enhancement*

Zooplankton are the primary predators of phytoplankton. Most immature fish, and some mature fish feed primarily on zooplankton. On a small scale this feeding is part of the natural balance in a lake ecosystem. It was reported that alewives (*Alosa pseudoharengus*) are present in Mount Kemble Lake. Large populations of this species can reduce zooplankton densities and add nutrients to the lake which further exacerbate phytoplankton blooms. A study on zooplankton would be beneficial for the lake. Stocking of zooplankton is an available management option. Zooplankton can be stocked at typical rates or a study could be initiated to determine if zooplankton densities in the lake are lacking, then steps could be taken to reestablish their numbers, which would reduce phytoplankton populations. Control of the alewife population is discussed in the next section.

*Fish Population Restructure*

Fish stocking can be used to manipulate zooplankton plankton populations to balance the food web and increase fishing success. Currently, an excess of alewives in the lake may be adversely affecting the zooplankton populations. Because the alewives feed primarily on zooplankton through their life cycle they have potential to significantly reduce the zooplankton population and in turn increase phytoplankton. Reports from the lake have noted large dense schools of alewives visible in the water column and on fish finders. The introduction of additional predatory species or increase in a species that is present could maintain acceptable alewife biomass. If anoxic conditions in the lake were addressed, a deep water fish such as hybrid stripped bass, or brown trout could be added to the lake and would feed primarily on alewives. Stocking can be performed at typical stocking rates for a lake of this size, or following a thorough fisheries study of the lake via electro fishing and netting.

*Aquascaping*

Vegetation in the Clubhouse Pond helps to reduce nutrients entering Mount Kemble Lake. The addition of shoreline plantings was performed in 2006 in order to increase the amount of nutrients absorbed by the biomass in the pond. The installation of these plants along the shoreline will also mechanically reduce the amount of silt and nutrients entering the pond from runoff along the shoreline. Finally, the species planted for this project create a desirable aesthetic border around the lake with many producing flowers and dense foliage. This project must be monitored to ensure that the installed plants survive. If necessary, additional plants may be installed based on inspections of coverage and mortality from the initial installation.

SUMMARY

The following table summarizes the initiatives discussed in the previous pages.

| **Action** | **Benefit** | **Status** |
|---|---|---|
| Water Quality Monitoring | Provides early identification of problems and improvement methods | Active Program (2006) |
| Lake Aeration and Circulation | Increases decomposition, reduces nutrient recycling and improves habitat for aquatic vertebrates. | Proposed |
| Vascular Plant Control | Reduction of nuisance vascular plant growth, increased recreation. | Active Program |
| Algal Control (Chelated Copper Algaecides) | Reduction of nuisance algal growth, more balanced lake ecosystem | Program Enhancement |
| Plant control in the pond (Limited) | Reduction of Nutrients | Active Program (2006) |
| Nutrient Reduction/Inactivation (Alum Application) | Large scale nutrient reduction inactivation. Reduced phytoplankton blooms. | Proposed |
| Zooplankton Population Enhancement | Balanced lake ecosystem, decreased phytoplankton populations. | Proposed |
| Fish Population Balance | Balance fish population, increase species variety, possible reduction of alewife and increase in zooplankton populations | Proposed |
| Aquascaping | Reduction off runoff into lake, competition with algae for nutrients. | Active (2006) |

We look forward to being of service next season and genuinely appreciate the opportunity to assist in the ongoing quality lake management at Mount Kemble Lake.

Sincerely,

Allied Biological Inc.

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