2008 Sand Lake Aquatic Plant Management

Prepared for
Sand Lake Management District

December 2008

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Executive Summary

Eurasian watermilfoil (EWM), a problematic aquatic invasive species (AIS), was discovered in Sand Lake during 2002. Initial handpulling efforts did not control EWM and EWM infestation increased to approximately 10 to 15 acres in 2004 and 31 acres in 2005. An aquatic plant management plan was prepared by the newly formed Sand Lake Management District in 2005 to manage EWM and thereby protect the lake's native plant community from harm.

In 2006, the Sand Lake Management District began to execute the Sand Lake Aquatic Plant Management Plan by treating both large and small EWM growth areas. In 2008, the District completed the third treatment year funded in part by a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS) grant. This report presents the results of the program as well as future management recommendations.

To attain control, the District treated EWM with a herbicide, granular 2,4-D (Navigate). Treatment of large growth areas occurred during the early spring and treatment of small growth areas, termed spots, occurred at various times during the growing season—as soon as possible after discovery. Treatment dose was generally 150 pounds per acre.

The three years of treatment attained 80 percent control of Eurasian watermilfoil (EWM) within large growth areas. We treated 31.06 acres in 2006, 11.2 acres in 2007, and 19.98 acres in 2008. Of the 31.06 acres treated in 2006, 6.1 acres currently contains EWM and will require treatment in 2009.

The three years of treatment attained 100 percent control of EWM in small growth areas termed spots. We treated a total of 148 spots during 2006 through 2008 and none of the spots currently contain EWM. A total of 22 spots, however, fall within the proposed 2009 treatment area because current EWM growths are located close to these spots.

Spot treatment has curtailed the spread of EWM within Sand Lake. Of the 148 treated spots, 124 are outside of the 2006 through 2008 treatment areas—EWM spread to new areas in the lake. Because total EWM control was attained with the spot treatments, this spread of EWM to new areas was curtailed by the treatment.

Spot treatment has enhanced the effectiveness of large treatments by curtailing reemergence of EWM. A total of 24 spots have fallen in one of the treatment areas—reemergence of treated EWM.

Because total EWM control was attained with the spot treatments, reemergence of EWM was curtailed.

EWM currently infests about 15 percent of the Sand Lake littoral area—60 of the 408 sample points in depths less than 20 feet contained EWM during the fall 2008 survey. A 10.9 acre area will require treatment during early spring of 2009. The treatment area includes 6.1 acres that was present in 2006—reemerged EWM not yet controlled. The remaining 4.5 acres is new EWM growth that has resulted from EWM spreading to new areas. Much of the new growth is along the tribal shoreline.

Control of EWM has positively impacted the lake's native plant community. Floristic Quality Index (FQI) is a tool that evaluates the quality of a lake's plant community by assessing species' tolerance to degradation and the number of species within the lake's plant community. We used this tool to evaluate Sand Lake before and during EWM treatment. The lake's FQI score improved (increased) steadily during the treatment period, beginning at 25.47 before treatment in 2005 and ending at 28.78 after treatment in 2008. Improved FQI resulted from improved quality of individual species as well as an increase in the number of species found in the lake.

Control of EWM has had a neutral impact on the diversity of the lake's native plant community. Diversity, measured on a scale of 0 to 1 (increasing scores indicate increasing diversity) has ranged from 0.89 to 0.90 during 2005 through 2008. The lake's diversity was high before treatment began and has remained high during the treatment period.

Control of EWM has significantly changed the lake's plant community in a positive manner. Percent Similarity is a tool that determines how similar or different a lake's plant community is over time. The tool was used to compare the lake's plant community in 2005, before treatment began, with the lake's plant community in 2008, after the third year of treatment had been completed. The comparison indicates the communities are 73 percent similar—less than 75 percent is considered significantly different. Over time, the reduction in EWM and the continuing increase in native species significantly changed the plant community in a positive manner.

Programs to reduce the spread of EWM within Sand Lake, in addition to herbicide treatment, and programs to prevent new Aquatic Invasive Species infestations were implemented by the Sand Lake Management District during 2006 through 2008. The District used its newsletter to implement an education program for residents. Articles addressed EWM management in the lake to reduce EWM spread. Articles also educated residents regarding the prevention of new infestations of aquatic invasive species.

To reduce the spread of EWM within Sand Lake due to boat traffic through areas containing EWM, the Sand Lake Management District purchased marker buoys and has annually used the buoys to mark the treatment areas. Lake users are annually asked to avoid traveling through the treatment areas marked by the buoys. A map of the treatment areas is annually posted on a bulleting board at the boat launch together with a request that boaters avoid travel through treatment areas. Also, a sign posted at the boat launch asks boaters to remove vegetation from boats to avoid introducing EWM or other AIS to the lake.

Finally, several riparian residents received Clean Boats/Clean Lakes training and have completed a boat inspection program each year at the Sand Lake boat landing during holidays, the weekend of the Cumberland Rutabaga Fest, and on periodic weekends. The program began in 2006 and has been ongoing since 2006.

The 2006 through 2008 treatment program implemented the Sand Lake Aquatic Plant Management Plan completed and adopted by the District in 2005. The Sand Lake Management District intends to update the plan in 2010. During 2009, the Sand Lake Management District will work with WDNR staff to determine current plan requirements and will determine the workscope, budget, and schedule for updating the lake's aquatic plant management plan. The District will also work with WDNR staff to prepare and submit an AIS grant application in 2009 to try to obtain funding assistance for the 2010 plan update.

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1.1 Introduction

A macrophyte management plan was developed for Sand Lake (See Figure 1) to control Eurasian watermilfoil (EWM) and protect the lake's native species from harm. The plan, based upon data collected during 2005, was finalized in 2005. In May of 2006, an early spring herbicide treatment of Sand Lake initiated the implementation of the Sand Lake Aquatic Plant Management Plan (Barr 2005). The treatment was intended to manage *Myriophyllum spicatum* (Eurasian watermilfoil). Three years of treatment have now been completed. This report presents the results of the program and recommendations for future control of EWM in Sand Lake.

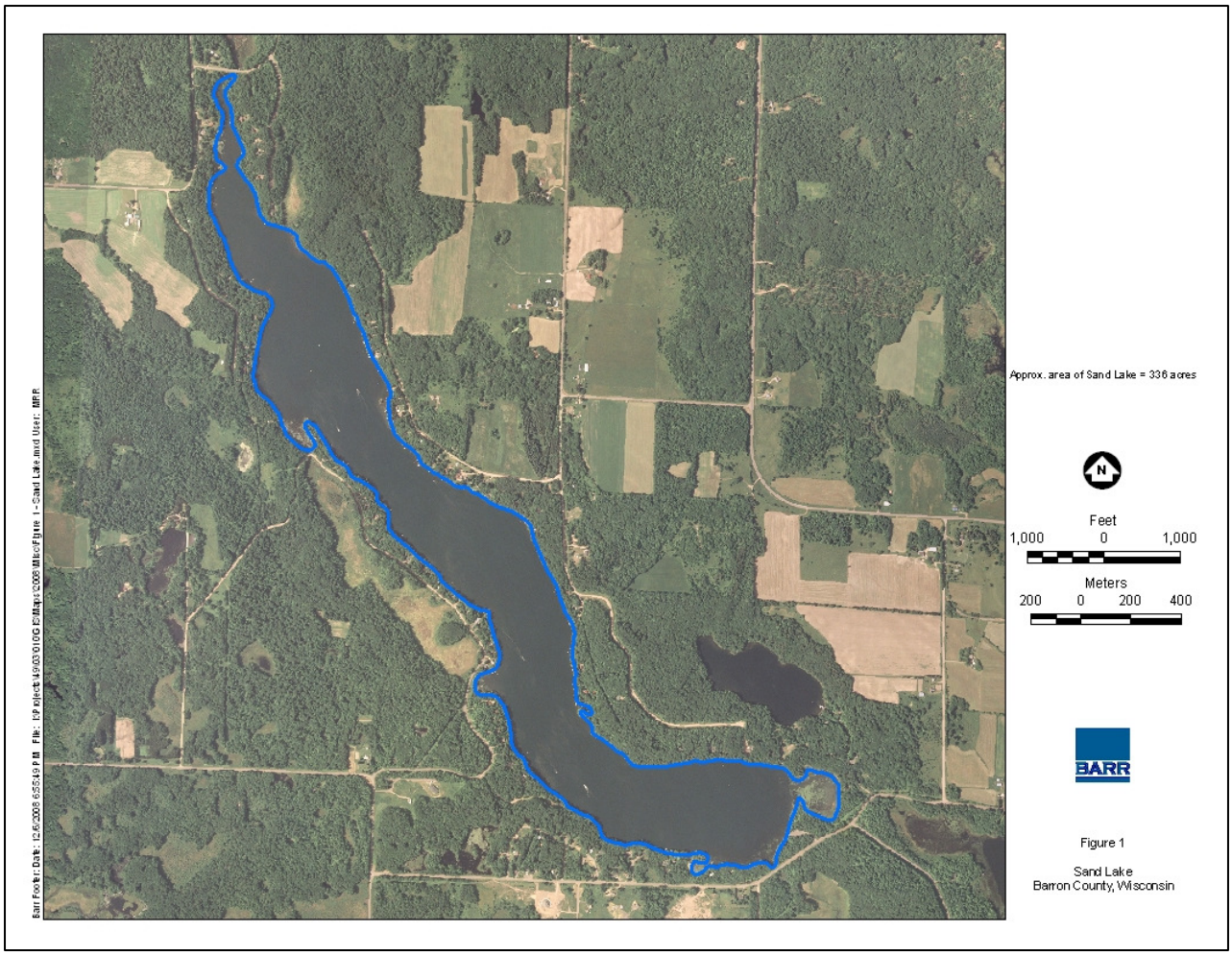

Figure 1. Sand Lake

1.2 Goals

Treatment of Sand Lake during 2006 through 2008 attained goals one through four of the aquatic plant management goals for Sand Lake stated in the lake's Aquatic Plant Management Plan. Goal five was attained through the Clean Boats program as well as postings at the lake's boat access. The goals are:

1. Preserve native species
2. Preserve and/or improve fish and wildlife habitat
3. Protect the lake's ecosystem by removing current EWM growth to the greatest extent practicable and eradicate EWM from Sand Lake if possible
4. Prevent the spread of EWM to other area lakes by removing EWM from Sand Lake to the greatest extent possible
5. Prevent the introduction of additional non-native species to the greatest extent practicable, including education, postings, etc.

The Sand Lake Management District revised the lake's aquatic plant management goals in July of 2008 to define the District's goals for future EWM management. The revised and, hence, current aquatic plant management goals for Sand Lake are:

Goal 1: Stop the spread of EWM within Sand Lake.

Objective 1A Survey Sand Lake during spring, summer, and fall to document and map EWM plant locations provided adequate grant funding is available

Objective 1B Using a trained observer, inspect the lake at intervals between surveys to identify and map EWM plant locations

Objective 1C Treat EWM plant locations with herbicide using best scientific aquatic plant management techniques regarding herbicide, dose, and treatment timing to maximize treatment effectiveness.

Objective 1D Check treatment areas for presence of EWM within one month of treatment and retreat if necessary to attain control of EWM

Goal 2: ***Reduce the EWM large treatment areas by more than two thirds of what is currently treated and reduce the EWM spots within Sand Lake that require treatment by more than one half of what is currently treated.***

Objective 2A Treat EWM in early spring when the plant is most vulnerable to eradication by herbicide treatment.

Objective 2B During the growing season, treat spot locations containing EWM as soon possible after identification

Goal 3: ***Preserve native species***

Objective 3A Select herbicide, dose, and treatment timing that maximizes control of EWM and minimizes risk of harm to native plants

Objective 3B Using GPS technologies, annually document and map native plant communities using WDNR approved point intercept methods

Goal 4:Preserve and/or improve fish and wildlife habitat

Objective 4A Preserve and/or improve fish and wildlife habitat by stopping the spread of EWM and reducing current EWM coverage by more than two thirds of what is currently treated.

1.3 Treatment

1.3.1 2002 Through 2005 Treatment

EWM was first observed in Sand Lake in 2002 when a WDNR staff person observed a few plants growing near the lake's boat landing. The Sand Lake Association attempted to hand pull the EWM with scuba divers for two years per the WDNR's recommendation. This effort proved to be unsuccessful and EWM spread rapidly. Approximately 10 to 15 acres of EWM were observed in front of the boat landing during 2004.

Lake management concerns led to the formation of the Sand Lake Management District during 2004. The District immediately voted to pursue an aquatic plant management plan to manage the EWM growth within the lake.

To reduce the spread of EWM prior to the completion of the Sand Lake Aquatic Plant Management Plan, treatments were completed during 2004 and 2005. Until the management plan was completed, however, the treatment area allowed by WDNR was small relative to the area of the lake infested with EWM. A 1.12 acre area near the boat landing was treated with granular 2,4-D at a rate of 100 pounds per acre on August 10, 2004. The treatment area was 150 feet wide and had a length of 325

feet. In 2005, approximately 3 acres of EWM were treated with herbicide (2,4-D) at a treatment rate of 150 pounds per acre. The treated areas were "high traffic" areas located near the boat landing, on silo bay flat, and near the lake's outlet at the north end of the lake. These treatment areas are within 2006 treatment areas 1, 2, and 4, respectively (See Figure 2).

1.3.2 2006 Through 2007 Treatment

In 2006, the Sand Lake Management District began to execute the Sand Lake Aquatic Plant Management Plan. On May 16, 2006, a total of 31.1 acres infested with EWM was treated with Navigate, a granular form of 2,4-D (2,4-dichlorophenoxy acetic acid) at a dose of 125 to 150 pounds per acre. The treatment areas are shown as striped polygons named Areas 1, 2, 3, and 4 on Figure 2. Trained observers inspected the lake for re-emergence or new growth areas of EWM during the late May through early June period. A total of 6 spots were identified in this inspection and treated on June 19 (See Figure 2). Spot treatment consisted of treating single plants, small clumps, or small patches of plants within the spot treatment area which totaled 2.1 acres. Treatment was with Navigate at a dose of 150 pounds per acre.

The 2006 treatment was effective in removing the large areas of EWM growth within the lake. Since 2006, EWM re-emergence has been limited to small areas, but the number of these small areas has increased.

During 2007, a total of 14.9 acres was treated. On May 29, 2007, 11.2 acres were treated with Navigate at a dose rate of 150 pounds per acre (See the striped polygons on Figure 3). During June, trained observers inspected the lake for EWM re-emergence or new growth areas. A total of 22 spots were identified and treated with Navigate at a dose rate of 150 pounds per acre on June 22 (See Figure 3). Spot treatment consisted of treating single plants, small clumps, or small patches of plants within the treatment area.

1.3.3 2008 Treatment

In 2008, changes were made in the Sand Lake herbicide treatment program to increase treatment effectiveness and further reduce re-emergence of EWM. The areas containing EWM near the boat launch were treated as one large treatment polygon rather than several small treatment polygons to increase the concentration and contact time of the herbicide. A more aggressive inspection program was initiated to more quickly detect re-emergence or spread of EWM to new areas. Spot treatments of areas noting re-emergence or EWM spread were completed throughout the growing season to curtail the growth, reproduction, and spreading of EWM. Details of the 2008 program follow.

On June 9, 20 acres were treated with Navigate at a dose rate of 150 pounds per acre (See the striped polygons on Figure 4). A couple of weeks after treatment, trained observers inspected the lake for

Figure 2 2006 Eurasian Watermilfoil Treatment Areas

Figure 3 2007 Eurasian Watermilfoil Treatment Areas

Figure 4 2008 Eurasian Watermilfoil Treatment Areas

EWM re-emergence. A total of 59 spots were identified and treated with Navigate at a dose rate of 150 pounds per acre on June 23 (See Figure 4). Spot treatment consisted of treating single plants or small clumps of plants within the treatment area. After we discovered EWM at 59 locations, it was evident that a more aggressive inspection program and spot treatments throughout the growing season may be necessary to curtail the spread of EWM in Sand Lake.

A presence absence EWM survey on June 29 through 30 evaluated the treatment effectiveness of the 20 acre June 9 treatment area (it was too soon to evaluate the treatment effectiveness of the June 23 spot treatment area). A total of 6 locations within the June 9 treatment area and 3 locations near the treatment area contained EWM.

An inspection of the lake by trained observers in mid-July indicated EWM re-emergence or spread at 16 locations. One location was within the June 9 treatment area, 7 were near spots treated on June 23, and 8 locations were new locations that had not previously noted EWM (See Figure 4). The 16 spots were treated with Navigate at a dose rate of 150 pounds per acre on July 16.

On July 23 through 24, an aquatic plant survey further evaluated treatment effectiveness as well as the positive or neutral effects of the treatment on the native plant community. A total of 7 locations noted EWM and hand pulling removed EWM from 3 of these locations.

An inspection by trained observers in early August identified EWM at 13 sites. Single EWM plants were observed at 11 sites and small clumps or small patches were observed at two sites (Figure 4). The 13 sites were treated with Navigate at a dose rate of 150 pounds per acre on August 4. It was the applicator's observation that the single EWM plants at the 11 sites appeared to be new plants that grew from fragments or seeds in 2008.

An inspection of the lake by trained observers in mid-September indicated EWM re-emergence at 7 sites. Single EWM plants were observed at 6 sites and small clumps or small patches were observed within a 30 foot by 40 foot area along the St. Croix reservation shoreline. The seven locations were treated with Navigate at a dose rate of 150 pounds per acre on September 22 and this area was noted as a candidate for large scale treatment in 2009.

On October 26 through 28, a point intercept survey was completed to survey all areas within the lake's littoral zone for presence of EWM. EWM was present at 60 of the 408 sample points for a frequency of occurrence of 15 percent (See Figure 5).

Figure 5 2008 Eurasian Watermilfoil Fall Survey Results

1.4 Analysis of 2006-2008 Treatment Effectiveness

An analysis of the effectiveness of EWM treatment completed during 2006 through 2008 indicates that the early spring treatments have attained in excess of 80 percent control of EWM. The treatment area during 2006 was 31.06 acres. Of this area, 6.1 acres still contains some EWM and is recommended for treatment during 2009 (See Figure 6).

Spread of EWM to new areas as well as re-emergence of EWM within treated areas resulted in small spot growths of EWM in need of treatment during 2006 through 2008. A total of 148 spots were treated and 100 percent control of EWM was attained with the treatment.

The spot treatment program helped curtail the spread of EWM within Sand Lake. Of the 148 spots, 124 are new areas of EWM growth (See Figure 7). They are located outside of the 2006 through 2008 treatment areas. Of these 124, 15 fall in the treatment area recommended for 2009. Although full control was attained of treated spots, EWM was found near enough to 15 spots that they were included in the treatment area proposed for 2009.

The spot treatment program also helped control reemergence of EWM within treated areas. Of the 148 spots treated, 24 were found within previously treated areas (See Figure 8). Although full control was attained of treated spots, EWM was found near enough to 7 spots that they were included in the treatment area proposed for 2009.

Despite the control of EWM attained during the 2006 through 2008 treatment program, EWM continues to spread to new locations. Of the 10.6 acres requiring treatment during 2009, 4.5 acres are new EWM growth areas that have not been previously treated (See Figure 9).

Figure 6 2006-2008 Treatment Effectiveness

Figure 7 2006-2008 Spot Treatments Not Within Treatment Areas

Figure 8 2006-2008 Treated Spots Within Treatment Areas

Figure 9 New EWM Growth Areas

1.5 Recommended 2009 Sand Lake Herbicide Treatment Program

The fall 2008 aquatic plant survey data were used to determine areas within Sand Lake requiring treatment during 2009. Barr Engineering Company determined treatment polygons for 2009 using the following process. All sample points containing EWM during the fall survey were mapped in ESRI Geographical Information System (GIS) (Figure 5). Treatment polygons were then created:

- A circle with a diameter of 50 feet was drawn around each sample point with the sample point comprising the center of the circle. The distance of 50 feet was selected because it is a little less than half way to the next sample point within the sampling grid.
- Sample points within 200 feet of one another were joined into a single treatment polygon

Using this methodology to determine 2009 treatment polygons, a total area of 10.6 acres is recommended for treatment (See Figure 10). Of this area, 6.1 acres was present in 2005. Hence, in excess of 80 percent control has been attained of the 31.06 acres present in 2005. The remaining 4.5 acres was not present in 2005 and has resulted from the spread of EWM to new areas.

It is recommended that Sand Lake Management District have trained observers again inspect the lake periodically throughout the growing season for the purpose of identifying EWM locations within the lake. Prompt spot treatment of these small EWM growth areas will increase the control of EWM by preventing its spread and addressing reemergence within treated areas.

Figure 10 EWM Treatment Areas Based on Fall 2008 Results

1.6 FQI—A Measure of Plant Community Quality

Control of EWM has positively impacted the lake's native plant community. Based on the Floristic Quality Index (FQI), the quality of the Sand Lake plant community improved following herbicide control of EWM. The quality of a plant community is measured by the Floristic Quality Index (FQI) which considers the quality of the individual species found in the lake and the number of species. To compute FQI, each individual plant species in a lake is assigned a number depicting its quality, termed a Coefficient of Conservatism or C, which indicates how tolerant a species is to degraded conditions, including water quality degradation. C values are on a scale of 0 to 10 with increasing values indicating increasing intolerance toward degraded conditions. An average of the C values of the individual species within a plant community indicates the average tolerance of the plant community to degraded conditions. Increases in the average C of a plant community indicate a change toward species less tolerant of degraded conditions and a higher quality plant community. During 2005 through 2006, the average C value for species within Sand Lake ranged from 5.6 to 5.8. During 2007 and 2008, the lake's average C value was 5.9 (See Figure 11).

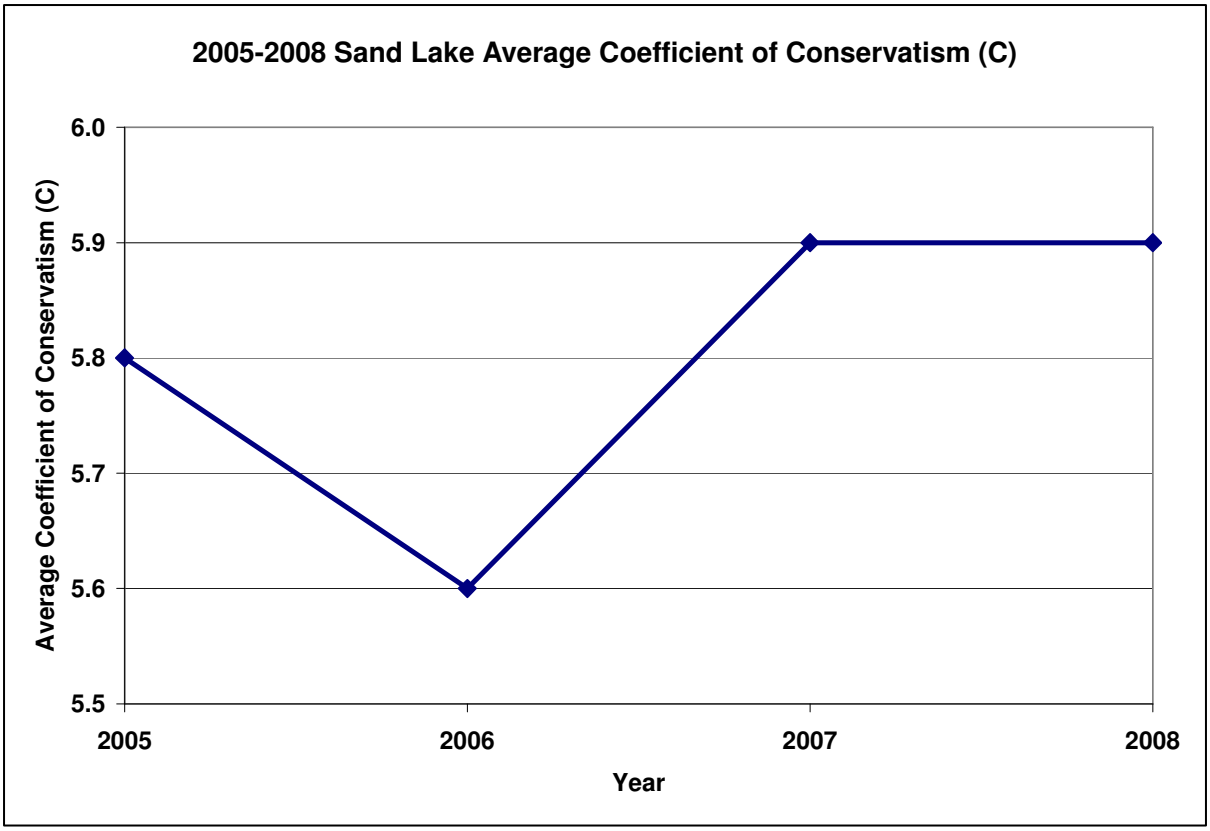

Figure 11. 2005-2008 Sand Lake Average Coefficient of Conservatism

The increased average C values in Sand Lake during 2007 and 2008 reflect the impact of EWM control which shifted the plant community toward species less tolerant of degraded conditions. Hence, the C value changes indicate the lake's plant community increased in quality following the treatment.

Improved quality of the lake's plant community was not only evident from increased C values, but also from increased FQI values. FQI considers changes in species tolerance to degraded conditions (C values) as well as changes in the number of species within the lake. During 2005 through 2008, Sand Lake not only noted a shift toward species less tolerant toward degraded conditions, but also noted an increase in the number of species found in the lake. The number of species found in Sand Lake ranged from 19 to 22 during 2005 through 2007 and 24 species were found in 2008. A shift toward species less tolerant of degraded conditions and more species in the lake resulted in annual increases of FQI during 2005 through 2008 (See Figure 12). Sand Lake's FQI, ranging from 25.47 in 2005 to 28.78 in 2008, has consistently been higher than the median value for Wisconsin Lakes which is 22.2.

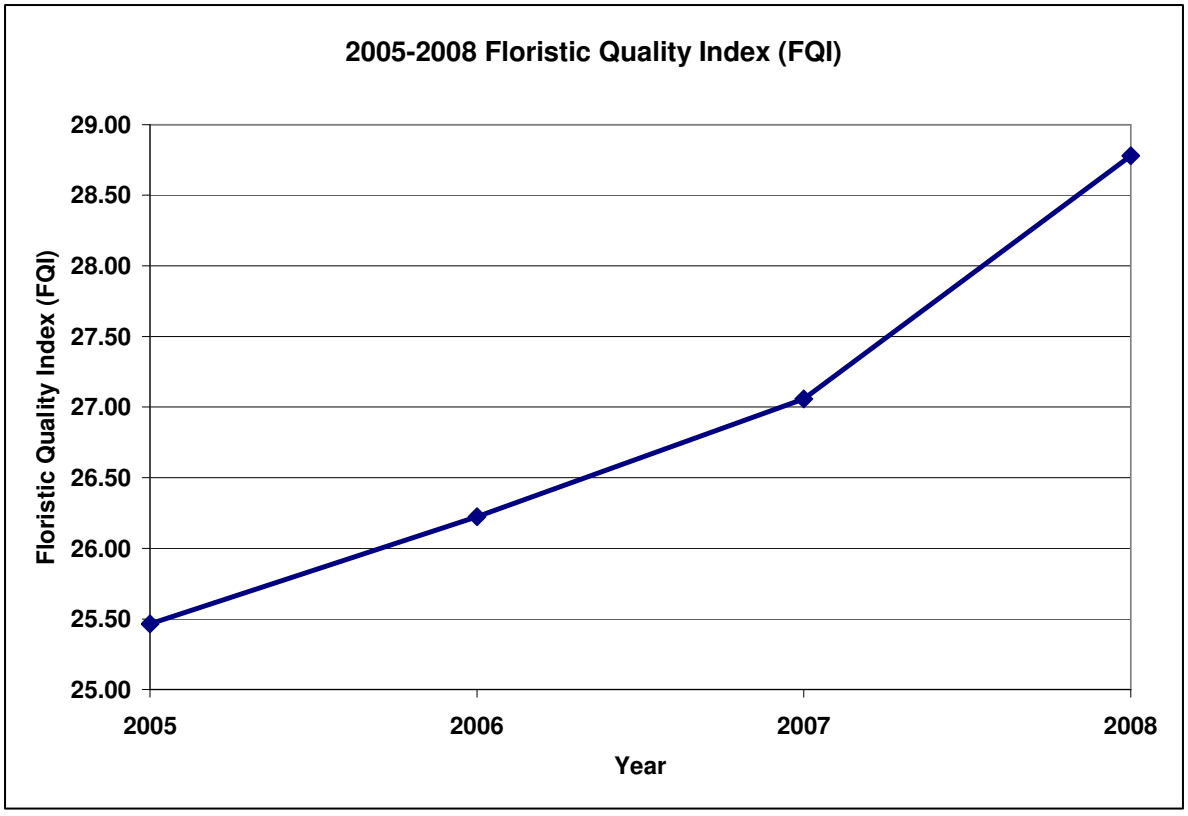

Figure 12. 2005-2008 Floristic Quality Index

1.7 Diversity

Control of EWM has had a neutral impact on the diversity of the lake's native plant community. Diversity within a plant community indicates the number of species present together with the evenness or equitability with which the individuals are distributed among the different species. If two communities each noted 100 individuals distributed among 10 species, the community in which each of ten species noted ten individuals would be a more diverse community than the community in which nine species each noted one individual and the tenth species noted 91 individuals. Simpson's Diversity Index was used to assess diversity within Sand Lake. The index uses a scale of 0 to 1 with increasing values indicating increasing diversity.

Diversity within Sand Lake was high before treatment began and has remained high during the treatment period. Diversity has ranged from 0.89 to 0.90 during 2005 through 2008 (See Figure 13.

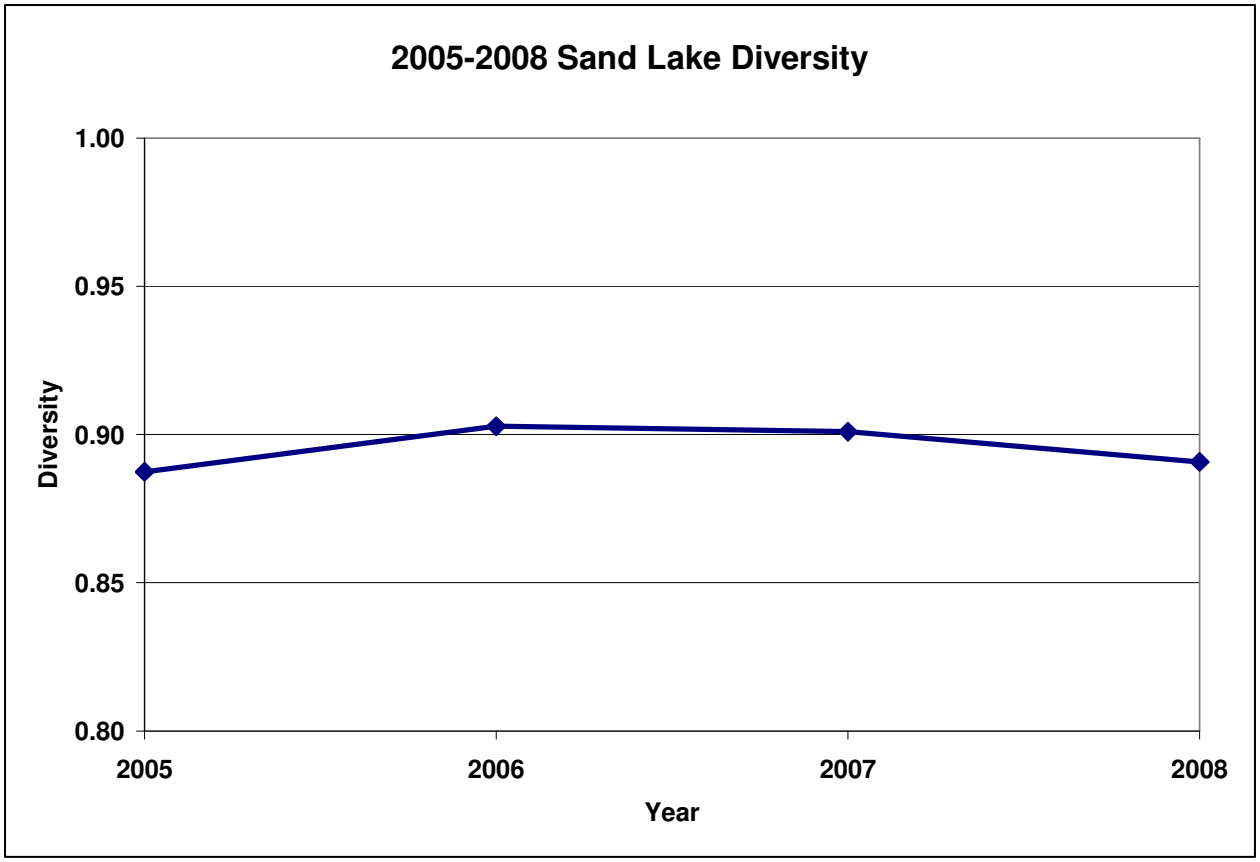

Figure 13. 2005-2008 Sand Lake Diversity

1.8 Percent Similarity

Control of EWM has significantly changed the lake's plant community in a positive manner. Percent similarity is a statistic which determines how similar or different a lake's plant community is

between years or between sample events. The tool was used to compare the lake's plant community in 2005, before treatment began, with the lake's plant community in 2008, after the third year of treatment had been completed. The comparison indicates the communities are 73 percent similar—less than 75 percent is considered significantly different. Over time the reduction in EWM and the continuing increases in native species significantly changed the plant community in a positive manner.

The tool was also used to compare the lake's plant community during the treatment period. The comparison indicates changes in the lake's plant community during the treatment period of 2006 through 2008 were not significant. Communities were 87 to 89 percent similar.

Finally, the tool was used to compare the lake's pre-treatment plant community with the lake's plant community during the first two years of treatment. A comparison of the lake's pre-treatment plant community (2005) with the 2006 and 2007 communities indicates changes were not significant. The communities were 77 to 78 percent similar.

The data indicate that reduction of EWM alone did not significantly change the plant community. However, as the number of species within the lake has increased and frequency of occurrence in native species has increased over time, the plant community has changed significantly as compared with the pre-treatment community (See Table 1).

Table 1. Percent Similarity of Sand Lake Plant Community During 2005 Through 2008

Pre-Treatment/Post-Treatment Comparison	Comparison Years	Percent Similarity (%)
Pre-Treatment Compared With Post Treatment	2005 Compared With 2006	78
	2005 Compared With 2007	77
	2005 Compared With 2008	73
Post-Treatment Compared With Post Treatment	2006 Compared With 2007	89
	2006 Compared With 2008	87
	2007 Compared With 2008	87

1.9 Recommended 2009 Aquatic Plant Monitoring Programs

Two monitoring programs, as well as in EWM inspections by trained observers, are recommended for 2009. One program will identify EWM areas in need of treatment during the following year. For

this program, monitoring of 408 locations within the lake's littoral zone during the fall is recommended to determine 2009 treatment effectiveness and to identify areas requiring treatment during 2010 (See Figure 5). The second monitoring program will assess the positive or neutral effects of the treatment on the lake's native plant community. For this program, monitoring of 43 annual monitoring locations during the summer is recommended (See Figure 14. A trained observer will periodically inspect the lake for EWM following the early spring treatment and at intervals during the growing season to identify re-emergence of EWM within the lake.

Figure 14 2009 Sample Locations For Native Community Assessment

2.0 Sand Lake Management District AIS Reduction and Prevention Programs

Programs to reduce the spread of EWM within Sand Lake, in addition to herbicide treatment, and programs to prevent new Aquatic Invasive Species infestations were implemented by the Sand Lake Management District during 2006 through 2008. The programs included education, marker buoys, and Clean Boats/Clean Lakes.

2.1 Education

The Sand Lake Management District used its newsletter to implement an education program for residents. Articles addressed EWM management in the lake to reduce EWM spread. Articles also educated residents regarding the prevention of new infestations of aquatic invasive species. Newsletters used in the education program are found in Appendix I.

The Sand Lake Management District posted a sign at the boat launch which asks boaters to remove vegetation from boats and to avoid introducing EWM or other AIS to the lake. A map showing where EWM is currently found in the lake (i.e., current year's treatment map) is posted at the boat launch with a request that boaters avoid travel through treatment areas.

2.2 Marker Buoys

To reduce the spread of EWM within Sand Lake due to boat traffic through areas containing EWM, the Sand Lake Management District purchased marker buoys and has annually used the buoys to mark treatment areas during 2006 through 2008. Lake users are annually asked to avoid traveling through the treatment areas marked by the buoys.

2.3 Clean Boats/Clean Lakes

Several riparian residents received Clean Lakes/Clean Boats training and have completed a boat inspection program each year at the Sand Lake boat landing during holidays, the weekend of the Cumberland Rutabaga Fest, and on periodic weekends. The program began in 2006 and has been ongoing since 2006.

3.0 Sand Lake Aquatic Plant Management Plan Update

The 2006 through 2008 treatment program implemented the Sand Lake Aquatic Plant Management Plan completed and adopted by the District in 2005. The Sand Lake Management District intends to update the plan in 2010. During 2009, the Sand Lake Management District will work with WDNR staff to determine current plan requirements and will determine the workscope, budget, and schedule for updating the lake's aquatic plant management plan. The District will also work with WDNR staff to prepare and submit an AIS grant application in 2009 to try to obtain funding assistance for the 2010 plan update.

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Appendix A

2008 Sand Lake EWM Presence/Absence Survey Data

Appendix B

2008 Sand Lake Plant Community Assessment Data

Appendix C

2008 Sand Lake Fall Survey Data

Appendix D

Annual Plant Community Assessment: Frequency of Occurrence

Appendix E

Annual Plant Community Assessment: Average, Low, and High Density

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Annual Plant Community Assessment: Floristic Quality Index

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Annual Plant Community Assessment: Diversity

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Annual Plant Community Assessment: Percent Similarity

Appendix I

Sand Lake Management District Newsletters