Early Detection/Rapid Response to Control Eurasian Watermilfoil in Blackhawk Lake, Iowa County, Wisconsin

Final Report
for Wisconsin Department of Natural Resources
AIS Early Detection/Rapid Response Grant AIRR-018-07

Cobb-Highland Recreation Commission
Blackhawk Lake Recreation Area
and
Donna and Laura Sefton
DFS Conservation Consulting

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Summary and Recommendations

Blackhawk Lake in Iowa County, Wisconsin, is a 220 acre impoundment with a maximum depth of 45 feet. The lake is surrounded by public lands with a mostly wooded shoreline. The Cobb-Highland Recreation Commission oversees a 600-acre recreation area associated with the lake, including a beach, campgrounds, concessions, public boat landing and other amenities. The popularity of Blackhawk Lake as a recreation destination is due in part to its natural scenic beauty, good water quality (usually exceptionally clear in spring), easy boating navigation except in shallow areas, and excellent fisheries (2006 Blackhawk L user survey).

Three small colonies of the non-native, invasive Eurasian water-milfoil (*Myriophyllum spicatum* or EWM) were found in Blackhawk Lake in 2006: two on the NNW side near the sand ridge between the dams and one near the SSE pontoon mooring bay. Blackhawk L. was one of the last lakes in south-central Wisconsin to be infested with EWM. Discovery of EWM was of great concern, because the assets that make Blackhawk Lake a desirable recreation destination can be greatly degraded by EWM. EWM threatens native aquatic plant communities and forms thick underwater beds of tangled stems and vast mats of vegetation on the water's surface. These dense beds cause loss of plant diversity, degrade water quality, and reduce desirable habitat for fish, invertebrates, and wildlife. They also hinder boating, swimming, and fishing.

An aquatic plant management plan was prepared and implemented using a Wisconsin DNR Early Detection/ Rapid Response grant. By 2007, the EWM had spread around the lake. In May 2007, 2,4-D granular herbicide was applied on larger patches, and an experimental manual harvest was done. This helped to reduce the EWM in the areas of highest density. However it was still found in scattered locations post-treatment.

Surveys found no EWM in 2008 when the water was turbid from spring rains. In 2009, EWM was found near the locations of the pioneer infestations. Colonies were manually harvested as feasible by snorkeling. In June 2010, abundant EWM was found in 5 acres on the sand ridge spawning area. 2,4-D granular applied at near maximum rates effectively controlled the EWM infestation. Only a few plants were found in 2011, and none was found in 2012. Monitoring and rapid response with manual removal and herbicides to pioneer infestations of EWM helped control its spread in Blackhawk L. Competition from abundant curly-leaf pondweed and lush native vegetation inhibits its growth. Weather affecting water clarity also affected EWM distribution and abundance.

The following recommendations are made regarding the future prevention and control of EWM in Blackhawk L

- The Commission and Blackhawk L Recreation Area staff should continue diligent monitoring of EWM and be prepared to rapidly respond to discovery of any infestation. Manual removal and/or treatment with herbicides should be used to prevent spread of the EWM.

- Like any other maintenance required for upkeep of the park, maintenance of the lake is required to make it a desirable place to visit and an economic asset. The lake is the major focus and draw for the recreation area and EWM can substantially impair lake quality and usability. Therefore, it is very important that the Commission budget funds annually toward the prevention and control of EWM.

- The Commission should apply for a DNR AIS Education, Prevention and Planning grant to continue monitoring and education. The grant would pay 75% of the costs up to $10,000, with in-kind match.

- The Commission should consider applying for a DNR Clean Boats/Clean Waters grant for watercraft inspections/education at the boat landing. The grant would pay 75% up to $4,000, with in-kind match.

- The Commission should also pursue opportunities to educate the public and school groups about EWM and other factors that affect lake quality and engage them in activities to help protect the lake. Some of these activities might include sponsoring workshops and training volunteers to identify EWM and serve as first responders in notifying of infestations and helping with EWM removal. Involving the Friends of Blackhawk Lake could also provide support for this.

Background

Blackhawk Lake is a 220-acre impoundment located in Iowa County, Wisconsin. The lake construction was authorized and funded by PL-566 administered by the USDA Soil Conservation Service for the purpose of recreational and flood control. The impoundment was completed in 1971. The dam is owned by Iowa County and is operated by Iowa County Land Conservation Department. The management of Blackhawk Lake is a partnership of the Cobb-Highland Recreation Commission, Iowa County, the Iowa County Land and Water Conservation Department, and the Wisconsin Department of Natural Resources (WDNR). The locations of the inlets, 2 dams, the outlet to Otter Creek, and the sand ridge spawning area are shown in Fig 1. The lake physical characteristics are summarized in Table 1.

The Cobb-Highland Recreation Commission oversees a 600-acre recreation area associated with the lake, including 500 feet of sand beach and a beach house, 150 campsites, picnic and playground areas, a public boat landing, boat rentals, concessions, ski and hiking trails, and a nature center. Fig. 2 shows the beach and concession area. The fisheries includes bass, walleye, crappie, perch, bluegill, and northern pike.
The entire lake is designated as Slow-No Wake at all times. The entire shoreline is publicly owned and there is no lake association or friends group.

Phase 1 and Phase 2 Planning Grants from the WDNR were used to collect extensive water quality, biological, and watershed data from Blackhawk Lake from 2004- 2006. Underwater Habitat Investigations (UHI) performed the study. Goals were set for the lake and a comprehensive management plan was developed to implement them.

Fig. 1. Blackhawk L inlets, left (dry) dam, right dam outlet to Otter Ck, and sand ridge spawning area

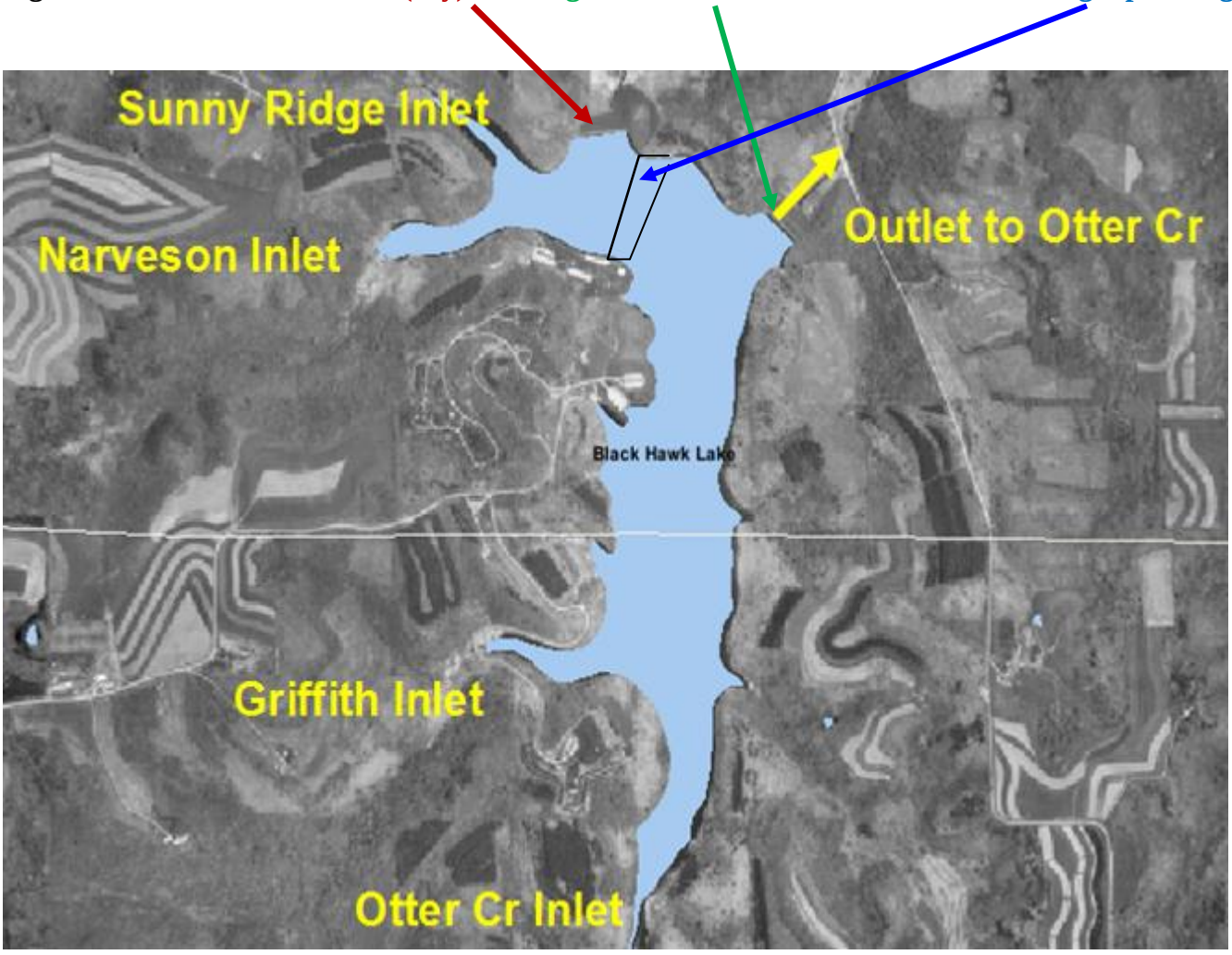


Fig. 2. Blackhawk L Beach & Concession Area

Table 1. Blackhawk L, Iowa Co., WI		
Physical Characteristics		
Area	220	acres
Maximum Depth	45	feet
Mean Depth	14.8	feet
Volume	3260	acre-feet
Littoral Area	80	acres/36%
Max. Depth Plants	15	feet
Flushing Rate	2.1	times/year
Residence Time	0.48	year
Watershed Area	9780	acres
Discharge	60%	bottom
	40%	surface

As a recreational impoundment, Blackhawk Lake is considered to have much better water quality than similar impoundments in southwest Wisconsin. Even though the drainage basin to lake surface area is fairly high (45:1), in spring the water quality is usually excellent and is typical of mesotrophic lakes in Wisconsin (WDNR Office of Inland Lake Renewal 1978). The tributaries and lake receive some groundwater input and the lake has a bottom withdrawal, with approximately 60% of the discharge from the bottom and 40% from the surface. The lake is usually very clear in spring. In 2006, Secchi disk clarity reached 31 feet and averaged 20 feet from April – mid-July. Average transparency was reduced to 11 feet in from mid-July - August, 2006 as *Potamogeton crispus* (curly-leaf pondweed) senesced and released nutrients to promote the growth of algae.

The popularity of Blackhawk Lake as a recreation destination is due in part to its natural scenic beauty, good water quality (usually exceptionally clear in spring), easy boating navigation except in shallow areas, and excellent fisheries (2006 Blackhawk L user survey).

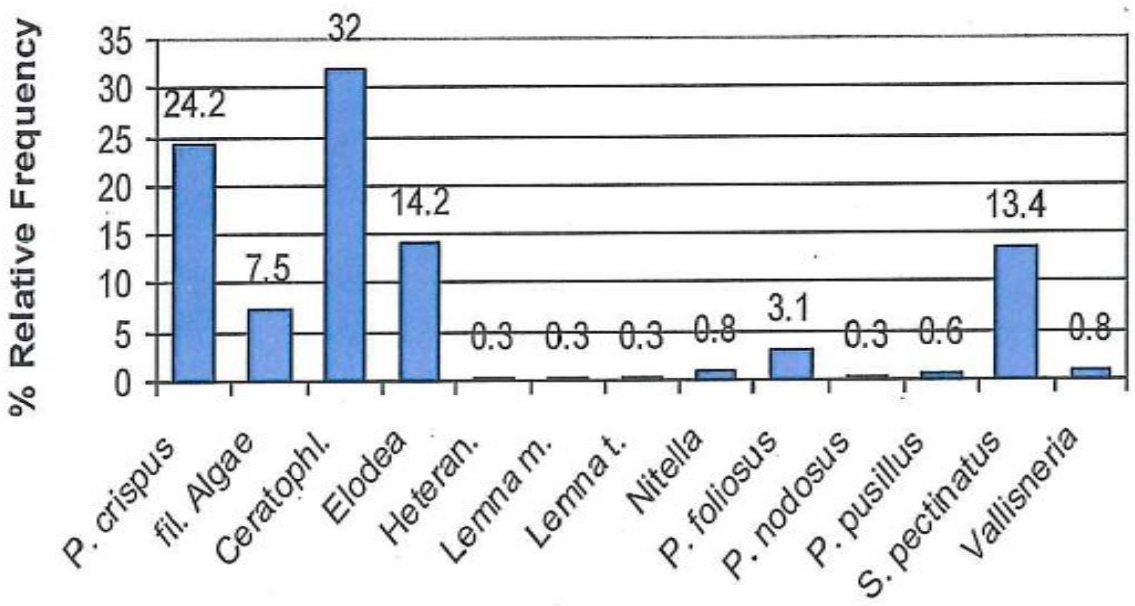
History of Invasives in Blackhawk L and 2006 Aquatic Plant Survey

Visual and rake surveys of the littoral area of Blackhawk Lake by WDNR South-Central Region aquatic invasives staff in 2004 and 2005 found invasive *Potamogeton crispus* (curly-leaf pondweed) and *Cipangopaludina chinensis (*Chinese mystery snails), but did not find any *Myriophyllum spicatum* (Eurasian watermilfoil - EWM). Blackhawk Lake was one of the last remaining lakes in south-central Wisconsin that was not infested with EWM at that time.

In conjunction with Phase 1 & Phase II Lake Planning grants to determine lake and watershed quality and develop a comprehensive management plan, the Cobb-Highland Recreation Commission, its consultants, and WDNR aquatic invasives staff performed an aquatic plant survey on Blackhawk Lake between June 15-22, 2006. The point-intercept survey used a grid designed by WDNR Integrated Science Services staff that consisted of 346 sampling points. These points were located on the lake using a Garmin-76S GPS unit. At each point in the littoral zone (depth less than 20 feet), aquatic plants were collected with a rake. Plants were identified to species and their abundance was recorded. Visual observations of plants within 6 feet circumference of the sample point were also recorded.

Fourteen plant species were recorded at the sampling points; a total of 21 were observed visually. Species richness is mapped in Fig.3, and the distribution of major species is illustrated in Fig. 3. The most common species were *Ceratophyllum demersum* (coontail), *Potamogeton crispus* (curly-leaf pondweed), *Elodea canadensis* (waterweed), and *Stuckenia pectinata* (sago pondweed), with 32%, 24.2%, 14%, and 13.4% relative frequency. The Floristic Quality Index was 22.7, above average for the region (20.9) and state (22.2).

Fig. 3. Blackhawk Lake aquatic plant survey relative frequency, 2006.



Eurasian watermilfoil was not found at any of the points sampled with a rake during the June, 2006 survey. However, two small (10' X 10' and 15' X 20') pioneer infestations of EWM were visually recorded in 10-15 feet of water between aquatic plant sampling sites near the NNW side of the lake just S of the left dam and sand ridge spawning area. A third colony was later found on the SSE side of the lake pontoon mooring bay. (See Fig. 4-7).

Fig. 4. Blackhawk L, areas of pioneer EWM infestation, 2006.

NNW side of lake, right side of photo (to right of left dam)

SSE side of lake, Pontoon Bay

Fig. 5. Blackhawk L aquatic plant survey, June 2006

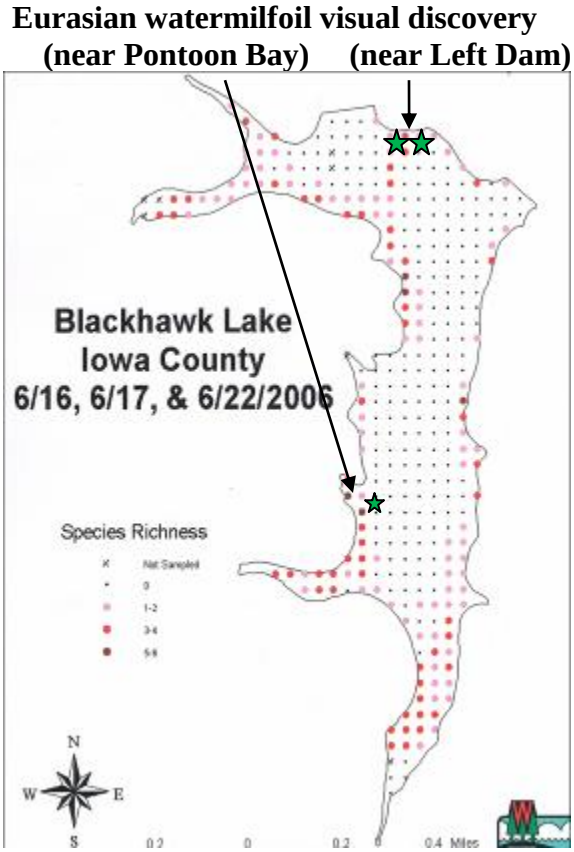


Fig. 6. EWM colony in Blackhawk L, June 2006 (photo by UHI)

Early Detection/Rapid Response Grant

Discovery of EWM was of great concern, because the assets that make Blackhawk Lake a desirable recreation destination can be greatly degraded by EWM. As has been seen at other lakes in south-central Wisconsin, EWM threatens native aquatic plant communities and forms thick underwater beds of tangled stems and vast mats of vegetation on the water's surface. These dense beds cause loss of plant diversity, degrade water quality, and reduce desirable habitat for fish, invertebrates, and wildlife. They also hinder boating, swimming, and fishing.

The Cobb-Highland Recreation Commission applied for and received a WDNR Aquatic Invasive Species Early Detection/Rapid Response grant (AIRR-018-07) in June 2006. The purpose of the grant was to GPS locate and map the extent of the EWM infestation, develop a plan for EWM eradication, control, and prevention; inform the public/hold public meetings; obtain necessary permit(s) for EWM control; implement the APM plan; perform follow-up monitoring, and information/education.

The goals of the grant were to:

- Geo-locate and map pioneer infestations of EWM and perform follow-up monitoring to determine effectiveness of aquatic plant management.
- Prevent further introduction and spread of EWM.
- Control pioneer populations of EWM.
- Maintain a diverse native community of aquatic plants to serve as collective competition against further invasion of EWM.
- Control EWM in a manner so it does not degrade mesotrophic water quality or reduce lake clarity.

- Protect fish spawning areas and maintain a productive fishery.
- Maintain natural scenic beauty, lake aesthetics, and recreational opportunities.
- Interface with management planning under lake planning grant.
- Undertake educational activities to prevent the spread of EWM and other invasives.
- Monitor to track effects on water quality and the spread of invasives.

Underwater Habitat Investigations (UHI) was hired to develop and implement the Aquatic Plant Management Plan.

Eurasian Watermilfoil Surveys and Treatment by Year

2006 Results

On June 24, 2006, the two beds of EWM on the NNW side of the lake were uprooted and/or cut at the root crown below the sediment surface by a SCUBA diver from UHI. Abundant *Ceratophyllum demersum* (coontail) on the bottom made uprooting difficult. The uprooted plants were collected in nets by volunteers as they came to the surface. The wind was blowing toward the NNW shoreline, and fragments that drifted in were collected to the extent feasible.

Fig. 7. EWM growing above native species, Blackhawk L, 2006 (photo by UHI)

The pioneer infestation on the SSE side of the lake near the pontoon mooring bay was not addressed on June 24 because of the wind direction that would bring fragments out into the lake and lack of volunteer support. By July 16, the pioneer population on the SSE side had grown to 20’ x 10’ in 4-10 feet of water. Conditions prevented mechanical removal the population at that time.

A follow-up visual and rake survey of the shoreline performed by UHI on August 16, 2006 noted more extensive growth of EWM (about 3 acres altogether):

- NNW shore between dams – closer to shore than previously mechanically removed (maximum of 1 acre)
- SSE pontoon mooring bay (maximum of 1 acre)
- Patches/individual plants all along western shore, especially in bays
- Patches/individual plants in Cave Hollow/Otter Creek inlet arm
- Patches/individual plants along shoreline of South area campground and southern edge of Griffin Creek inlet arm

Because of poor water visibility (less than 4 feet), the scattered nature of the plants, and lack of volunteer assistance in August, 2006 to develop and implement an eradication strategy, it was decided to develop a preliminary Aquatic Plant Management Plan, and mechanically remove and/or chemically treat the EWM in early spring 2007 according to the plan.

2007 Results

On April 20, 2007, UHI conducted an assessment of EWM along the shorelines with previously identified EWM beds. At the time, EWM growth was advanced compared to most other species in the clear water, including the dominant plant coontail (Fig. 8). Locations were mapped using a Garmin 76 GPS unit. Water temperature was 53 degrees F and the Secchi clarity was 16 feet. Based on the survey results, an early season 2,4-D application was recommended and a chemical Aquatic Plant Management permit received from WDNR.

Fig. 8. EWM, Blackhawk Lake, 2007 (photo by UHI)

UHI purchased 200 lbs of 2,4-D (Navigate) and on May 4, 2007, UHI and a certified applicator treated approximately 3 acres along the east and west shores. Water temperature in the nearshore areas was 63 degrees F. High turbidity in the bays prevented EWM assessment and potential treatment. The application of 2,4-D along the east and west shores was targeted at individual colonies so that the ultimate application rate was lower than the typical broadcast treatments that require 100-200 lbs/acre. The targeted treatment required only about 67 lbs/acre. EWM was also found and chemically treated in the area of SCUBA root-crown removal that was completed in 2006. The infestation of EWM was greater than originally detected. Fig. 9 displays the treatment areas on May 4, 2007.

Fig. 9. Blackhawk L EWM distribution/ treatment, May, 2007, Xs where treated with 2,4-D. Spot treated in areas along the black lines.

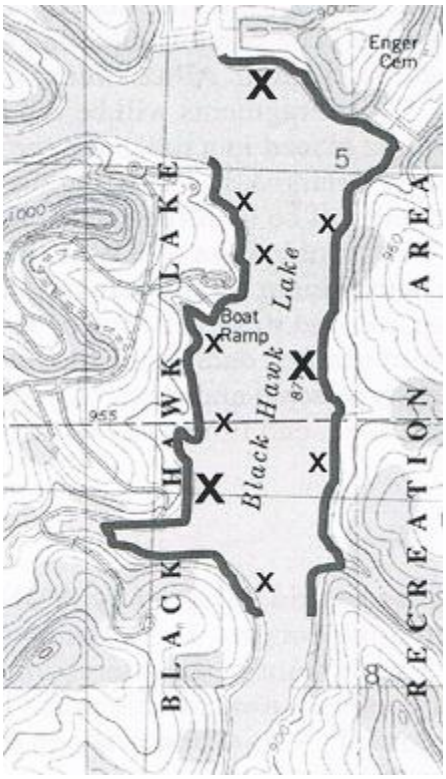
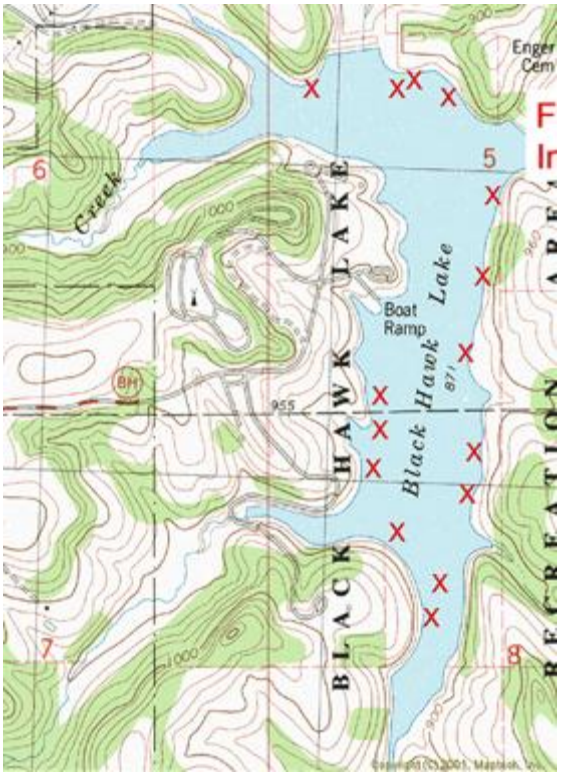


Fig. 10. Blackhawk L EWM distribution post-treatment, June 2007. Red X's where EWM found.



UHI conducted a post-treatment EWM survey around the entire lake (Fig. 10). Water clarity was optimum with the Secchi exceeding 20 feet. Polarized glasses were used to reduce glare. The survey showed significant reduction of colonies within the two areas of highest EWM densities, the pontoon mooring area and near the left "dry" dam. However, additional colonies were observed north of the pontoon mooring area, near the mouth of Otter Creek bag, and along the entire east shore. Colonies were not observed with the bays, perhaps due to dense growths of both macrophytes and filamentous algae.

UHI conducted an experimental manual harvest of EWM along the east shoreline from the pontoon mooring area north for 270 feet. UHI harvested all observed EWM colonies using a long pole rake. Non-target species were returned and any floating EWM fragments were collected with a dip net. A large mesh bag and spring scale was used to weight the wet biomass of plants collected from that area. Excess water was removed by swinging the mesh bag vigorously in the air. 7-1/2 lbs (wet weight) of EWM was collected (Fig. 11).

Fig. 11. EWM manually harvested, 2007.

UHI instructed Blackhawk Lake employees how to identify EWM and conduct manual harvesting of wisdely dispersed colonies around the lake. Given the widely dispersed status of the EWM invasion, manual harvesting is recommended as a follow up to chemical control.

The preliminary Aquatic Plant Management Plan was revised based on the experience in 2007. The final plan, "Eurasian Watermilfoil Control and Aquatic Plant Management Plan for Blackhawk Lake" was completed in September, 2007.

The September, 2007 APM plan recommended the following and provided procedures for each:

1. Manually remove the widely dispersed EWM colonies using two person crews operating from a rowboat. A long pole rake should be used to uproot EWM and dip nets used to collect floating fragments. Efforts to remove EWM should be quantified to track the future status of the exotic in the lake. Quantified included harvesting hours, locations, EWM color counts and wet weight biomass. Manual harvesting efforts should encompass the entire shoreline and post-eradication surveys performed either in the fall or early the following spring. This information should be summarized annually.
2. If chemical treatments are needed, 2,4-D applications should be conducted during early spring or fall when IWM is more vulnerable than other native plants. Granular applications are recommended given the widely dispersed growth of EWM. Individual colonies can be targeted for optimum control while minimizing effects on non-target species.
3. SCUBA uprooting or root-crown cuttings are viable options where deeper off-shore colonies are found. Offshore EWM growths in water deeper than 12 ft have been minimal so far.
4. Preserve the current status of native aquatic plant communities in Blackhawk Lake that provide outstanding fish and wildlife habitat.
5. Implement a Clean Boats, Clean Waters watercraft inspection program and install signs.

2008 Results

Heavy rains during the spring resulted in flooding and very turbid water. The lake did not have the usual spring – early summer clear phase. The average spring Secchi transparency was 5.1 feet (Table 2). Visual and rake surveys of aquatic plants were conducted by DFS Conservation Consulting (DFS CC) found no EWM. Few other plants were found. There was mostly sago pondweed and coontail in the shallower water.

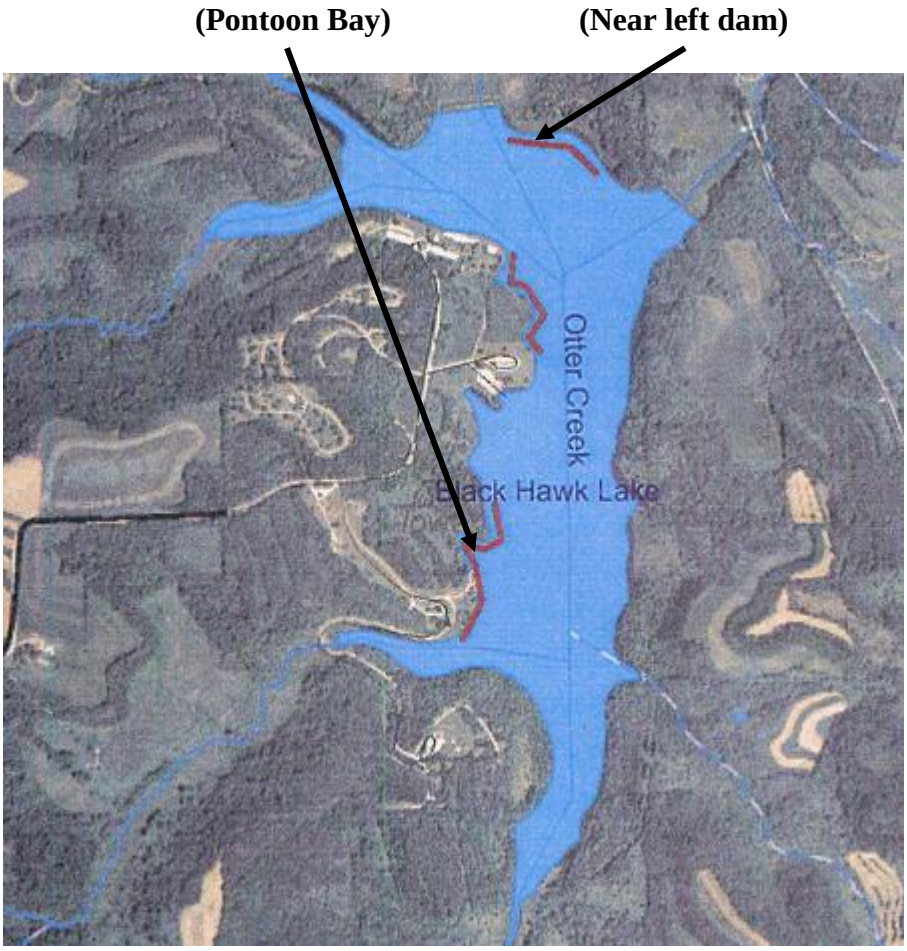
Table 2. Blackhawk L Mean Secchi Clarity by Season 2006-2012

Year	Mean spring—mid summer Secchi (ft)	Mean mid summer—fall Secchi (ft)
2006	20.2	10.8
2007	19.7	5.5
2008	5.1	14.2
2009	20.6	6.2
2010	19.8	4.5
2011	24.2	3.6
2012	7.7	3.7

2009 Results

Visual and rake surveys for EWM were conducted by DFS CC in May and June, 2009 (Fig 12). The water was clear, with a mean Secchi clarity of 20.6 feet from spring-midsummer (Table 2). Small EWM colonies were found in Pontoon Bay, near the left (dry) dam, and along the east shoreline in 6-12 feet of water. The colonies were interspersed with coontail, sago pondweed, curly-leaf pondweed. *Ranunculus* (water buttercup) was abundant in the shallower areas of Pontoon Bay and other parts of the lake. *Heteranthera dubia* (water stargrass) was common in the summer.

Fig. 12. Distribution of EWM in Blackhawk Lake, June 2009



On June 26, 2009, Susan Graham of WDNR snorkeled and hand pulled EWM, while DFS CC and staff from Blackhawk Lake collected the plants in nets and placed them in the boat for disposal on shore (see photos Fig. 13). This was done in Pontoon Bay and near the left (dry) dam, just south of the sand ridge (Fig. 12). The Secchi clarity was excellent for the task (17 feet). In Pontoon Bay, the EWM was scattered among other plants (mostly coontail, sago pondweed, and elodea), so complete removal of the EWM was not possible. There were distinct patches of EWM near the left dam (just south of the sand ridge) that were manually removed. This effort was much more successful in removing all the EWM. There was thick growth of curly leaf pondweed, coontail, sago pondweed, elodea, water buttercup, and other plants on the sand ridge, but no EWM was found there.

The plants collected weighed approximately 45 lbs wet weight. They were disposed in the garbage.

Fig. 13. Photos of EWM and manual control efforts in Blackhawk L, June 26, 2009.

EWM interspersed with other plants, Pontoon Bay

Colony of EWM littoral area just south of left dam.

Snorkeling to remove colonies of EWM

Collecting EWM with net, Blackhawk

EWM on rake

Harvested EWM

Because EWM remained in Pontoon Bay and areas along the east shoreline (Fig.12), the Blackhawk Lake Recreation Area applied for an Aquatic Plant Management permit to apply granular 2, 4-D (Navigate) to treat those areas. By the time the 2,4-D was received, however, the EWM had senesced and was no longer evident.

2010 Results

Visual and rake surveys by DFS CC on May 28 and June 9, 2010 found large amounts of EWM (approximately 5 acres) in the sand ridge spawning area just south of the left dam and extending toward the beach and concession area on the northeast shore (Fig. 14). The excellent water clarity (24 feet) made it easy to survey (see photos, Fig. 15). Patches were also found in Pontoon Bay.

Fig. 14. Distribution of EWM in Blackhawk L, June 9, 2010

Fig. 15. Photos of EWM, Blackhawk L, May 28 & June 9, 2010.

EWM and curly-leaf pondweed on sand ridge

EWM and curly-leaf pondweed on sand ridge

EWM on rake.

Scattered colonies of EWM, Pontoon Bay

The Blackhawk Lake Recreation Area obtained an Aquatic Plant Management (APM) permit to apply 2,4-D (Navigate) granular to treat the EWM. On June 14, 2010, licensed applicator Bradd Sims, with the help of WDNR staff and DFS CC treated the sand ridge area with granular Navigate, concentrating on areas where colonies were evident within the green lines. This treatment was at a rate of approximately 50-55 lbs/acre. (See green line in Fig. 16).

On June 16, 2010, buoys were placed along the core area. Buoy GPS readings are represented by the green stars. The area inside the red treatment line is just under 1.25 acres. It was treated with 3.5 bags (175 lbs) of granular 2,4-D. The fringe area (that area between the red and yellow lines) was treated with 3 bags. This put both of these areas in the 195 lb/acre range when combined with the June 14 treatment (Table 3). The remaining ½ bag was used for spot treatment just north of the core area. This is outlined by the dark blue line in Fig. 16. The plants treated on June 14 were already showing signs of turning brown and weakening.

Fig. 16. Areas treated with 2,4-D, Blackhawk L June 14 and 16, 2010

Table 3. Blackhawk Lake Application Rates for EWM Treatment, June 14 & 16, 2010

EWM treatment 2010	Application rate lbs/acre 2,4-D		
Treatment area	**6/14/2010**	**6/16/2010**	**Total**
Between green & yellow lines (2.25 acres)	55	0	55
Between yellow & red lines (1.25 acres)	55	120	175
Within red line (1.25 acres)	55	140	195
Within blue line (0.25 acre)	55	88	144

Subsequent visual and rake surveys in 2010 by DFS CC found no visible EWM.

On November 19, 2010, John Skogerboe of the U.S. Army Corps of Engineers, Bill Ratajczyk of Applied Biochemists, and DFS CC conducted a visual and rake survey of Blackhawk Lake (Fig. 17). Applied Biochemists was interested in doing some research with early spring treatments using their new triclopyr product, Navitrol. No EWM was found, but water stargrass and water buttercup were present in the shallower areas, along with abundant coontail, sago pondweed, and some curly-leaf pondweed. Applied Biochemists was interested in doing some research with early spring treatments using their new triclopyr product, Navitrol.

Fig. 17. Visual and rake survey of plants in Blackhawk L, Nov. 19, 2010.


Coontail on rake


Sago pondweed on rake


*Ranunculus (*water buttercup)

DFS CC discussed using Blackhawk Lake as a demonstration site for application of triclopyr herbicide to control EWM with John Skogerboe of the U.S. Army Corps of Engineers, Bill Ratajczyk of Applied Biologists, and Susan Graham and Tim Asplund of DNR. Native plants such as water stargrass, which is common in shallower areas, and coontail found throughout the littoral zone are not as susceptible to triclopyr as to 2,4-D.

2011 Results

In anticipation of the spring 2011 EWM treatment with triclopyr, the Blackhawk Lake Recreation Area submitted an APM permit application to WDNR. Upon review, it was discovered that the endangered Northern Cricket Frog was found within 1 mile of the lake, so the application required special review. Documentation of the proposed treatment areas and the herbicide to be used were submitted to WDNR's Endangered Resources Program. Following much discussion, it was determined that an incidental take application was not needed because the triclopyr salt was being used. Because the concern also affected planned dredging of Pontoon Bay, an official Northern Cricket Frog survey was done. None were found.

A visual and rake survey for EWM conducted by DFS CC on May 10, 2011 found no EWM. Curly-leaf pondweed was common to abundant in 4 – 12 feet of water. Water buttercup was actively growing in some areas in 3-5 feet of water. Mostly senescent sago pondweed and coontail was found in 3-10 feet of water, but they were beginning to grow.

John Skogerboe of the U.S. Army Corps of Engineers and DFS CC conducted a point-intercept aquatic plant survey of Blackhawk Lake on June 4, 2011 (see photos, Fig. 18). The visibility was excellent, with a Secchi disk transparency of 20 – 25 feet and calm conditions. No EWM was found in the sand ridge area where it was abundant in 2010, nor in Pontoon Bay where it was common in 2009 and 2010f. There was a small patch of EWM on the edge of the southern (Otter Creek inlet) bay. This was harvested using a rake.

Curly-leaf pondweed was abundant with almost 100% occurrence in 6-12 feet of water. Coontail was dominant in the shallower bays. In deeper areas, coontail was senescent and just beginning to turn green. In areas 2- 6 feet in depth, water buttercup and water stargrass were beginning to grow. Patches of *Potomogeton foliosus, Chara*, elodea and sago pondweed were also found.

Fig. 18. Blackhawk L Aquatic Plant Survey, June 4, 2011

Curly-leaf pondweed in 8-10' water on sand ridge

Curly-leaf pondweed, coontail in NE (Narveson) Bay

Elodea, water stargrass, narrow-leaf in Pontoon Bay

Curly-leaf & water buttercup in Pontoon Bay

EWM colony found S (Otter Cr) bay

Table 4. Blackhawk L 2011 APS Survey Summary

Summary of Blackhawk Lake Point Intercept Survey	
	4 June 2011
Species	% Occurrence
Myriophyllum spicatum	3
Potamogeton crispus	36.3
Ceratophyllum demersum	26.2
Elodea canadensis	3.7
Potamogeton foliosus	8.8
Ranunculus longirostris	11
Scirpus validus	1.2
Stukenia pectinata	9.8
Zosterella dubia	6.7
Chara sp	3.7
No Plants Present	60.4
All species	39.6
Native species	34.8
Mean number of species/sample point	1.08
Mean number of native species/sample point	0.71

Follow-up visual and rake surveys by DFS CC did not find any EWM in 2011. Narrow leaved and sago pondweed was abundant in the sand ridge area and in 6-12' of water. Water stargrass and water buttercup were common in shallower areas. By July 21, Secchi clarity was reduced to 5 ft and in August and Sept. it was at 3 feet.

2012 Results

Visual and rake boat surveys for EWM conducted by DFS CC at least monthly from March – October, 2012 found no EWM (see photos, Fig.19).

2012 was an unusual year weather-wise, and the lake responded differently than usual. There was an early warm spring, then a period of cool and windy weather, and a hot, dry summer. This resulted in early growth of aquatic plants and algae, lake turnover twice in the late spring/summer, early plant senescence, and a blue-green algae bloom. There was no spring very clear water phase as is normally the case. The average Secchi from spring-midsummer was 7.7 feet, and 3.7 feet from midsummer-fall (Table 2)

On March 29 and May 23, curly leaf pondweed was abundant in 6 – 12 feet of water. Sago pondweed and coontail were common. Water buttercup was actively growing in 3-5 feet of water in many areas. The Secchi was 8.5 feet on April 29 and 12 feet on May 23, which is the clearest it got all summer. There was no very clear water phase from May to early July as is usually the case (Table 2).

By June 3, the curly-leaf pondweed was already senescing (it usually does not do so until mid-July). There was abundant coontail and sago pondweed in 6 – 12 feet of water. In shallower areas, water buttercup, *Elodea*, *Chara*, and water stargrass were present. Fishermen reported the lake turned over twice in June following cool and windy weather. This brought available phosphorus to the surface to promote the growth of algae. (The management plan based on the DNR Phase I and 2 planning grants conducted from 2004 to 2006 predicted this would happen because of an unstable thermocline due to the bottom withdrawal).

The curly-leaf pondweed was mostly gone, the sago pondweed was senescing, and coontail was abundant on the sand ridge on June 25. Coontail, elodea, water buttercup, *Chara*, and water stargrass were common in Pontoon Bay. Small green algae were visible in the water, affecting the transparency, which was only 7.5 feet.

On July 20, following a hot, dry period, a blue green algae bloom created a “paint slick” near the boat rental dock and beach area. Water Quality Advisory signs were posted at the concession area and office.

The Secchi was 4 feet on August 14. There was a strong hydrogen sulfide (rotten egg) smell by the right dam, indicating that anaerobic water was being discharged downstream with the bottom withdrawal.

By October 23, no plants were found in the bays, where normally coontail, elodea, and sago pondweed are usually still common at that time of year. This raises a concern that there may not be as many plants in the spring that will compete against EWM, and it may make a comeback.

New invasive species signs were posted at the boat landing by Southwest Badger Resource Conservation and Development Council in 2012.

Fig 19 . Blackhawk Lake Photos, 2012

Curly-leaf pondweed sand ridge 5-23-12

Sago pondweed & coontail sand ridge 5-23-12

Curly-leaf pondweed 5-23-12

Aquatic plants sand ridge 5-23-12

Aquatic plants pontoon bay 5-23-12

Aquatic plants Pontoon Bay 5-23-12

Chinese mystery snails on beach 5-23-12

Aquatic plants near beach 5-23-12

Aquatic plants boat landing dock 5-23-12

Water buttercup Pontoon Bay 6-25-12

Water buttercup Pontoon Bay 6-25-12

Sago pondweed sand ridge 6-25-12

Secchi disk clarity 6-25-12

Plants Pontoon Bay 6-25-12

Aquatic plants on the sand ridge 7-20-12

Coontail sand ridge 7-20-12

Blue green algae beach 7-20-12

Blue green algae boat rental 7-20-12

Secchi transparency 7-20-12

New aquatic invasives sign 8-14-12

Plants-boat landing 8-14-12

By boat rental dock 8-14-12

Summary of Results by Year

The distribution, treatment, and results by year are summarized in Table 5.

Table 5. Blackhawk L EWM Distribution, Treatment, and Results by Year.

Year	Distribution of EWM Before Treatment	Treatment Methods	Distribution of EWM after Treatment
2006	**June (Fig. 4 & 5)** -2 pioneer colonies on NNW side near left dam -10 x 10 & 15 x 29 ft circumference in 10 - 15 ft of water -Later found near Pontoon mooring Bay on SSE side	**June** -EWM colonies hand pulled/root crowned by scuba diver & harvested. -Abundant coontail & other plants made uprooting difficult.	**Late July** -Several colonies in pontoon mooring area on SW side of lake. -Other colonies scattered along E & W shorelines.
2007	**April-pre-treatment (Fig. 9)** -Larger colonies in areas of pioneer infestation. -New colonies along E & W shores -GPS located, total of ~3 acres	**May (Fig 9 & 11)** -Spot treatment of individual EWM colonies along E & W shores with granular 2,4-D. -Rate up to 195 lbs/acre for spot treatment; 67 lbs/acre for whole 3 acres) Manually harvested ~7.5 lbs along 270 ft of E shoreline.	**June-post-treatment (Fig. 10)** -Significant reduction in areas of highest density and where spot treated. -Many new colonies found.
2008	¨ Little EWM found by visual/rake surveys. ¨ Decreased plant diversity. ¨ Primarily coontail & sago pondweed.	-Very turbid from heavy spring rains. -No treatment	-Visual/rake surveys found no EWM for remainder of summer.
2009	**May (Fig 12)** -Visual/rake surveys found EWM in vicinity of pioneer infestation, in pontoon mooring bay & scattered along E shore.	**June (Fig. 13)** -Hand pulled by snorkeler & harvested approx. 45 lbs wet weight in Pontoon Bay & near left dam. -EWM colonies in pontoon mooring bay difficult to remove - interspersed with other plants. -Colonies near left dam distinct & more easily removed.	**July** -No colonies in area of original infestation near left dam. -Several colonies in pontoon mooring bay. -Some scattered colonies small colonies along E shore.

2010	**June (Fig. 14 & 15)** -EWM abundant on sand ridge near left dam -In 8-13 ft water -Colonies in pontoon mooring bay interspersed with other plants.	**June (Table 3 and Fig 16)** -Treated 5 acres of the sand ridge with up to 195 lbs/acre granular 2,4-D.	**July (Fig 17)** -Visual/rake surveys found EWM senescing or absent on sand ridge -No EWM found in later summer or in Nov.
2011	**June (Table 4 & Fig. 18)** -Point-intercept aquatic plant survey -Only 1 small colony observed in S. bay	**June** -Planned to apply triclopyr if found because of sensitivity of water stargrass and coontail to 2,4-D. Not done. -Manually harvested small colony with rake	**July/August** -Visual/rake surveys found no EWM remainder of summer.
2012	**May/June (Fig. 19)** -Visual and rake surveys found no EWM.	-None	-Visual/rake surveys found no EWM remainder of summer.

Water Quality Data

Blackhawk Lake was monitored by DFS CC biweekly for Secchi disk transparency and in April or May, June, July, and August for total phosphorus and in June, July, and August for chlorophyll-a. The Secchi disk clarity is summarized by year and season in Table 2.

Table 6 summarizes the water quality data and calculated trophic state indices by year and season. The seasons are spring-midsummer (Spr = April – July 15) vs midsummer-fall (Sum = July 16 – Sept. 15). The trophic state of Blackhawk Lake is usually mesotrophic in spring and slightly eutrophic from mid-summer-fall. Mesotrophic lakes have good clarity, few problems with algae blooms, and sufficient oxygen to support fish to deeper depths. Eutrophic lakes have reduced clarity, fewer, more nuisance type algal species, oxygen depleted bottom waters, and often have abundant aquatic plants. Blackhawk Lake is considered the best quality lake in southwestern Wisconsin, especially in the spring.

Table 6. Comparison of water quality and Trophic State Index (TSI) by year and season, Blackhawk L.

Year	Secchi (ft)	Total Phosphorus (mg/l)	Chlorophyll (ug/l)	TSI Secchi	TSI TP	TSI Chl	Ave. TSI	Classification
2006 Spr	20.2	22	5.7	37	51.7	45	45	Mesotrophic
2006 Sum	10.8	23.5	19	43	52.3	56	50	Borderline Mesotrophic/ Eutrophic
2007 Spr	19.7	12	1.9	34	47	39	40	Borderline Oligotrophic/Mesotrophic
2007 Sum	5.5	38	28.8	53	55	58	55	Eutrophic
2008 Spr	5.1	54	6.93	57	59	49	55	Eutrophic

2008 Sum	14.2	17.5	5.6	43	50	46	46	Mesotrophic
2009 Spr	20.6	14		31	59		45	Mesotrophic
2009 Sum	6.2	28.3	20.8	44	53	54	50	Borderline Mesotrophic/ Eutrophic
2010 Spr	19.8	13.5	4.0	33	48	45	42	Mesotrophic
2010 Sum	4.5	20.6	21.2	47	50	54	50	Borderline Mesotrophic/ Eutrophic
2011 Spr	24.2	40		31	57		44	Mesotrophic
2011 Sum	3.6	26.6	20.5	53	52	56	54	Eutrophic
2012 Spr	7.7	21		48	52		50	Borderline Mesotrophic/ Eutrophic
2012 Sum	3.7	37	21.5	54	56	57	56	Eutrophic

Discussion

The distribution and abundance of EWM in Blackhawk L varies from year to year and season to season with clarity. EWM was found in June of the years with greatest spring Secchi disk clarity (e.g. 2006, 2007, 2009 and 2010). Only a few small colonies of EWM were found in 2008 when the water was very turbid in the spring (average of 5 ft. clarity) due to heavy rains and flooding. No EWM was found in 2012 when the spring clarity averaged 7 feet . EWM is generally not found in later summer in the turbid water after curly-leaf pondweed senesces in midsummer and transparency is reduced by planktonic algae growth.

In spring, curly-leaf pondweed is abundant and coontail and sago pondweed are common in depths of 4-12 ft. In shallower areas, native plants (e.g. water buttercup, elodea, coontail, Chara, water stargrass) blanket the bottom. Filamentous algae also covers the plants in late spring-summer. The abundant curly-leaf pondweed, filamentous algae, and native plant growth in the deeper water and lush native plant growth in shallow water in spring and summer compete with EWM and help to prevent its spread. There is a relatively small littoral zone with steep slopes around most of lake; larger shallow bays have lush growth of thick with plants in spring helps prevent the spread of EWM.

Manual harvesting of EWM in spring of 2007 and 2009 worked well when there were small distinct colonies of EWM concentrated in an area. However, it was an intensive, time consuming process, especially when the EWM was interspersed with other plants. New colonies were found in the areas harvested and other areas following the manual harvesting.

In 2007, treatment with 2,4-D granular at rates up to 195 lbs/acre in areas of greater abundance (left dam near sand ridge and Pontoon Bay) significantly reduced the population in those areas. Spot treatments with an effective rate of 67 lb/acre were successful in treating some areas along the shoreline. However, new colonies were found post-treatment.

In 2010, 5 acres of abundant EWM on the sand ridge on the NNW side at rates of up to 195 lbs/acre successfully controlled the EWM. It was not found there the remainder of the summer.

Distribution and abundance of EWM in Blackhawk L varies from year to year and season to season with clarity. EWM was found in June of the years with greatest spring clarity (e.g. 2006, 2007, 2009 and 2010). Only a few small colonies of EWM were found in 2008 when the water was very turbid in the spring due to heavy rains and flooding. EWM is generally not found in later summer in the turbid water after curly-leaf pondweed senesces in midsummer, releases nutrients to feed the growth of algae, and clarity is reduced by the algae growth.

2012 was an unusual year weather-wise, and the lake did not respond as it normally does. There was an early warm spring, then a period of cool and windy weather, and a hot, dry summer. This resulted in early growth of aquatic plants and algae, lake turnover twice in the late spring/summer, early plant senescence, and a blue-green algae bloom.

Time and Cost of Monitoring, Surveys, and Treatment

The annual cost for EWM surveys, manual removal, and treatment by year is summarized in Table 7.

Table 7 . Blackhawk Lake, cost of surveys and treatment, 2006 - 2012

Year	Monitor/EWM Survey			EWM Manual Rem			EWM Herbicide Treatment			
	Consult Hours	$	Vol Hours	Consult Hours	$	Vol Hours	Consult Hours	$	Vol Hours	Permit/ Herbicide
2007	21.5	$860		4	$160		18.5	$740		$121.75 permit fee 200 lbs 2,4-D = $833
2008	26.25	$445								
2009	18.25	$365		8	$160	16				
2010	18.25	$370					8	$160	16	$170 permit fee 400 lbs 2,4-D = $1,810
2011	26	$520					4	$80		
2012	20	$400	49							

The costs for manual removal versus herbicide application at Blackhawk Lake are shown in Table 8.

Table 8. Blackhawk L. Cost of Manual Removal vs Herbicide					
	Manual Removal		Herbicide		
	2007	2009	2007	2010	
Total Hours (incl volunteer)	4	24	18.5	24	
Labor *	$120	$720	$555	$720	
Cost of permit/ herbicide			$956	$1,980	
Total cost	$120	$720	$1,511	$2,700	
Acres	0.5	1.5	3	5	
Cost per acre	$240	$480	$504	$540	
* At $30/hr (consultant 2007 @ $40/hr, consultant 2008-12 @ $20/hr)					

The equalized costs per acre for manual removal in 2009 ($480) compared to herbicide treatment in 2007 ($504) and 2010 ($540) are not that different. Manual removal works best where there are smaller, distinct colonies of EWM to be harvested and the water is very clear. The main advantage of manual removal is that chemicals are not required. Manual removal involves more people making a personal investment of their time in protecting the lake. The intensive involvement of volunteers is a disadvantage for Blackhawk Lake because the manual removal requires much more coordination with use of volunteers. Since the land around Blackhawk Lake is publicly owned, there is no property owner's association to draw from for the volunteers.

The advantage of herbicide treatments are that they can be done in one day, a much larger area can be covered, and the treatment would only require the certified operator and one volunteer. The herbicide treatment is most practical and effective for larger areas, although it can work by spot application of the granular form for larger colonies.
If there are native species that are especially sensitive to the herbicide (i.e. 2,4-D) such as water stargrass (found in shoreline areas in 2-6 feet of water in summer) and coontail (found throughout the littoral area), the herbicide treatment should be done in early spring. Or a herbicide that doesn't affect these sensitive species, such as Triclopyr, should be used. Manual removal could also be used in those areas (although this is difficult in the shallower areas where water stargrass is found in Blackhawk Lake because the EWM is scattered and interspersed with other plants).

There are new label directions for 2,4-D granular that calculate the amount to be used by the acre-feet of water to be treated. A maximum of 10.8 lbs of 2,4-D per acre-foot per application is allowed. Since the EWM on the sand ridge was in 5-10 feet of water, with an average depth of 8 feet, the maximum treatment rate would be 86.4 lbs/acre – a much lower dosage than the 200 lbs/acre allowed in 2010. With that in mind, the treatment should be done in early spring before the EWM reaches the surface. A second application more than 21 days is allowed after the initial application may be needed.

Conclusions

- Rapid response to pioneer infestations of EWM has reduced its spread in Blackhawk L.
- Manual harvesting worked best during the spring-midsummer clear water phase of the lake to remove distinct EWM colonies that are located in small areas. However, if the colonies were interspersed with other plants or there were colonies scattered in many locations, manual removal became difficult and time consuming. If all colonies were not removed, they spread to other parts of the lake.
- Spot treatment with 2,4-D was effective on smaller colonies of EWM. However, colonies that were not treated were found in other parts of the lake post-treatment. Spring treatment with 2,4-D granular at near maximum application rates was effective in controlling EWM in a 5 acre area where it was abundant and interspersed with other plants.
- No EWM was found in the area treated in June 2010 for the remainder of that year and the following 2 years.
- Weather that affects water clarity influences EWM distribution and abundance at Blackhawk Lake. An abundance of the non-native curly-leaf pondweed in early spring and native plants in shallower areas until late summer helps to compete with EWM. Decreased transparency following die off of curly-leaf pondweed which releases nutrients for algae blooms likely also hinders its growth in later summer.
- The key to controlling the pioneer EWM infestation at Blackhawk L was diligent monitoring, particularly in early spring, followed by rapid response with manual removal and/or appropriate chemical treatment.

Recommendations for Future Monitoring and Control of EWM at Blackhawk Lake

EWM control efforts have been successful to date, but EWM will continue to remain a threat. It is highly recommended that the Cobb-Highland Recreation Commission continue to diligently monitor EWM in the lake, and rapidly respond to discovery of any infestations. Like any other maintenance required for upkeep of the park, maintenance of the lake is required to continue to make it a desirable place to visit and protect the lake's quality, usability, and economic value.

Funds should be budgeted annually to monitor, prevent and control the spread of EWM. Resources recommended for future monitoring and control of EWM at Blackhawk Lake are summarized in Table 9.

The Commission should apply for a DNR AIS Education, Prevention and Planning grant to continue monitoring and education. The grant would pay 75% of the costs up to $10,000. In-kind match can be used for the 25% local share. A draft workplan and cost estimate for this grant is found in Table 10. The proposed timetable for the grant is 5 years. Applications are due by August 1, 2013 for projects beginning in April, 2014.

The Commission should consider applying for a DNR Clean Boats/Clean Waters grant for watercraft inspections/education at the boat landing. This grant would pay 75% up to $4,000. In-kind match can be used for the 25%. Applications are due by August 1, 2013 for projects beginning in April, 2014.

The Commission and Blackhawk Lake staff should also pursue opportunities to educate the public and school groups, such as those from Highland, about EWM and other factors that affect lake quality and engage them in activities to help protect the lake. Some of these activities might include sponsoring workshops and training volunteers to identify EWM and serve as first responders in notifying of infestations and helping with EWM removal.

Involving the Friends of Blackhawk Lake could also provide support for EWM monitoring and control as well as other lake and park projects.

Table 9.				
BLACKHAWK L RECOMMENDED ANNUAL EWM CONTROL BUDGET				
Recommended Action	**Who**	**Cost**	**Total**	
Planning/Coordination/Reporting/	Consultant	10 hrs @$20/hr	$200	
Training	BHL Staff/Volunteers	4 hrs		
EWM Surveys/Monitoring	Consultant	22 hrs @ 20/hr	$440	
	BHL Staff/Volunteers	20 hrs		
Manual Removal	Consultant/Snorkeler/Scuba Diver	14 hrs @ $20/hr	$280	
	BHL Staff/Volunteers	14 hrs @ $20/hr		
Herbicide Treatment	Permit fee		$150	
	Herbicide	MINIMUM = 4		
		50 lbs bags 2,4-D	$1,000	
		x $250/bag		
	Licensed applicator	8 hrs @ $40/hr	$320	
	Assistant	8 hrs x $20/hr	$160	
			_____	
Recommended Annual Budget			**$2,550**	
for EWM Monitoring/Treatment				

Table 10.

DRAFT DNR AIS EDUCATION/PREVENTION/PLANNING GRANT (4/1/14 for 5 yrs))

Action	Who	Annual Schedule	Annual State	Annual Local	State Total	Local Total
Project Planning/	Consultant	1/1 - 12/31	$400.00		$1,500.00	
Coordination/Reporting	(20 hrs x $20/hr)					
Training of staff/volunteers	Consultant		$160.00		$640.00	
for Surveys/Monitoring	(8 hrs x $20/hr)					
EWM Surveys/Monitoring	Consultant	5/1-9/30	$720.00		$3,600.00	
	(36 hrs x $20/hr)					
	BHL staff/volunteers	5/1-9/30		$240.00		$1,200.00
	(20 hrs x $12/hr)					
	GPS/rakes	Once		$300.00		$300.00
	Boat rental	5/1 - 9/30		$450.00		$2,250.00
	(30 hrs x $15/hr)					
AIS education kiosk at	BHL	Once	$600.00		$600.00	
Boat Landing						
Workshops/Field Trips/	Consultant (teaching/training)	1/1 - 12/31	$360.00		$1,800.00	
Projects	(18 hrs x $20/hr)					
	BHL staff	1/1 - 12/31		$96.00		$480.00
	(8 hrs x $12/hr)					
Watercraft Inspections/	Consultant (teaching/training)	5/25 - 9/30	$160.00		$640.00	
Education at Boat Landing	(8 hrs @ $20/hr)					
(Memorial Day, 4th of July,	BHL Staff/Volunteers	5/25 - 9/7		$864.00		$4,320.00
Labor Day weekends)	3 days x 2 staff x 8 hr x 3x =					
	144 hrs x $12/hr=1728					
Grant Total						
- Repeating costs			**$1,860.00**	**$2,900.00**	**$9,300.00**	**$8,450.00**
- One time cost			**$600.00**	**$300.00**	**$600.00**	**$300.00**
			$2,460.00	**$3,100.00**	**$9,900.00**	**$8,750.00**

Sharing Results

A poster summarizing the Blackhawk Lake Early Detection/Rapid Response results for 2006 – 2012 was prepared and presented at the North American Lake Management Society's International Symposium on Lake and Watershed Management, Nov. 7 – 9, 2012 in Madison, WI. Laura Sefton of UW-Platteville won the best student poster award for it. The poster is being displayed in the Blackhawk Lake office.

A power point presentation "Successful Eurasian watermilfoil Control at Blackhawk Lake, Iowa Co, WI" was presented in the "Citizen Response to AIS Discoveries" at the Wisconsin Lakes Convention April 11, 2013 in Green Bay, WI. Laura and Donna Sefton also participated in a panel discussion on invasive species control.

A final project summary and recommendations were presented to the Cobb-Highland Recreation Commission on May 8, 2013. Laura Sefton is also preparing a technical paper on the project for publication in a journal.

References

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