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Lake Vegetation Management Plan

Big Elk Lake

Sherburne County, MN (#71-0141)

December 2021

Prepared by
James A. Johnson – Freshwater Scientific Services

Purpose & Context

This lake vegetation management plan has been created to guide Big Elk Lake homeowners and the Briggs Lake Chain Association (BLCA) in their work to protect and improve Big Elk Lake in Sherburne County, MN. Other agencies and groups have developed various plans and programs that will help to protect and improve the lake. These include:

Partners

(1) Sherburne County Soil & Water Conservation District (SWCD)
(2) Elk River Watershed Association
(3) Minnesota DNR Fisheries and Aquatic Invasive Species Programs
(4) Minnesota Pollution Control Agency (MPCA)
(5) Sherburne County Coalition of Lake Associations (SC COLA)

Plans

(1) Elk River Total Maximum Daily Load (TMDL) Project (2012)
(2) Sherburne County Local Water Management Plan (2018)

These partners and plans are an important part of protecting and improving the lake, but are generally focused on managing issues on a watershed-wide or regional scale. Consequently, they are not focused solely on Big Elk Lake and do not provide adequate guidance on some of the issues identified by BLCA and lakeshore homeowners (particularly for invasive species and aquatic plant management).

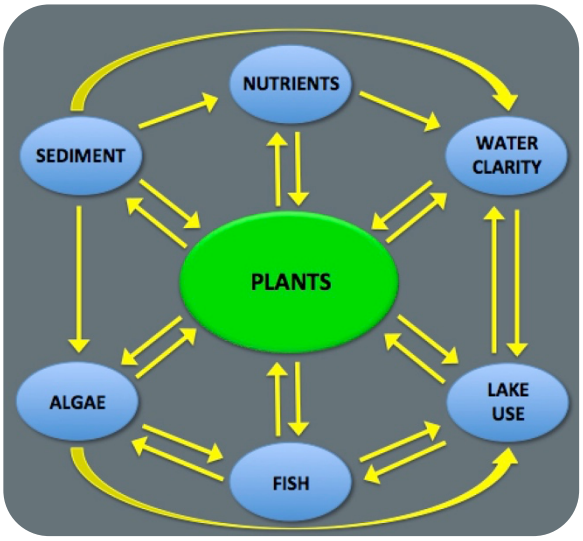
This plan has been designed to complement existing plans and programs by focusing on aspects of lake vegetation management that (1) directly impact lakeshore homeowners and how they use the lake, (2) are within the realm of influence of the lake association, and (3) are feasible given the financial and time limitations of homeowners and the BLCA. Furthermore, we have tried to keep this plan streamlined to make it easier to review, implement, and update items as needed. When possible, we have summarized or referenced supporting information from other sources rather than simply cutting and pasting large amounts of information into this document.

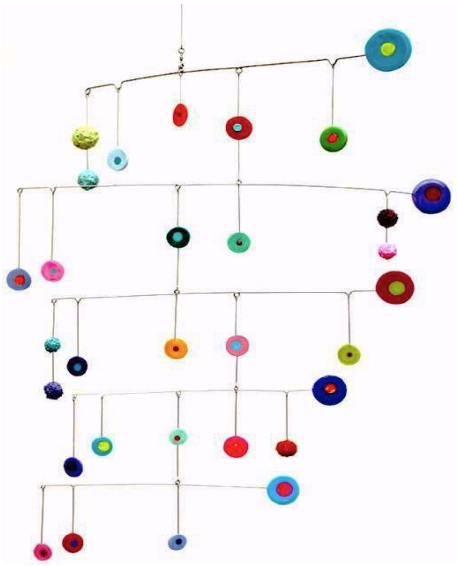
This plan should be thought of as a living document that adapts and grows in reaction to changes in the lake and its watershed. Accordingly, the homeowners and BLCA should adopt a schedule for reviewing and updating this plan.

Understanding Lake Management

Lakes are complex. The things that we try to affect with lake management, like water clarity, aquatic plant abundance, and fish populations, are closely tied to many other lake conditions. Like a hanging mobile with many dangling weights, these interconnected aspects of lakes are always shifting and maintaining a dynamic balance. If we remove one weight in a mobile, all of the other arms and weights bounce around and shift to new positions. Similarly, when we change one aspect of a lake, many other aspects of the lake will change until a new balance is achieved.

This complex and interconnected nature of lake ecology means that we need to think holistically to help us make the best management decisions, foster realistic expectations, and avoid undesirable consequences. To help foster this holistic thinking, each management item in this plan includes a list of contributing factors and possible impacts to other aspects of the lake. These should be considered and discussed before deciding on a course of action.





Summary of Lake Information

	Big Elk Lake
DOW#	71-0141
Morphometry	
Surface Area (acres)	357 [a]
Littoral Area (acres)	357 [a]
Max Depth (ft)	9 ft [a]
Mean Depth (ft)	5.4 [a]
Volume (ac-ft)	1,928 [a] / 1,540 [b]
Shoreline (mi)	3.5 [a]
Watershed	
Watershed Area	152,484 acres [b]
Watershed:Lake Area	425:1 [b]
Residence Time	1 to 60 days [b]
Lake Sediments	Sand/Gravel
Nutrient Loading [b]	
-Total P Load (lbs/yr)	21,500
-External P Load	17,430 (81%)
-Internal P Load	4070 (19%)
-No. of Septic Systems	unknown
-Est. % Failing	10-30%
Water Quality [b]	
-Secchi (ft)	1.0-2.5
-Total P (ppb)	100-300
-Chl-a (ppb)	50-90
Listed as Impaired	Yes (Nutrients, Bio)
Trend [b]	Slight Improvement

[a] Minnesota DNR Lakefinder
[b] Elk River Watershed TMDL Report (2012)

Fishery [a,b] (see 2009 DNR Fishery Survey Report in the supporting materials)

Walleye (primary management)
Northern Pike (secondary management)
Black Crappie
Bluegill
White Sucker
Yellow Perch
Pumpkinseed
Common Carp
Black Bullhead

Stocked with walleye and northern pike from 1960–1980, with additional private walleye stocking in 2009 [b]

"Walleye are not stocked in Big Elk Lake and the population is sustained through natural reproduction presumed to occur within the Elk River." – *2009 DNR Fisheries Survey Report* [a]

Despite the very low abundance of aquatic plants in Big Elk Lake, the fishery appears to be self-sustaining. This suggests that many of the fish species may be using the Elk River as supplemental spawning, feeding, and overwintering habitat. This connection to the river is likely a critical factor for maintaining the fishery in the lake.

Elk River is listed as having elevated mercury in fish tissue[c]. Although fish from Big Elk have not been tested, it is very likely that fish in the lake also have elevated mercury levels. Fish consumption guidelines should be considered.

Aquatic Plants [b]

Very low plant coverage reported in past DNR surveys

Plant Species Present in Big Elk Lake:

Eurasian watermilfoil (Invasive; first found in 2020)
Curlyleaf pondweed (Invasive)
Coontail
Bushy pondweed
Sago Pondweed
White waterlily
Cattail

Aquatic Plant Surveys:

Fisheries staff from the Minnesota DNR conducted nearshore plant surveys (transect-based) on Big Elk Lake in 1986, 1999, and 2009. There is no record of a point-intercept plant survey for the lake.

AIS Searches & Delineation Surveys:

Freshwater Scientific Services has conducted annual, late-summer, lakewide searches for aquatic invasive species (AIS) since 2016, with an additional early-summer delineation survey for Eurasian watermilfoil in 2021 to provide guidance on management and permitting.

[a] Minnesota DNR Lakefinder
[b] Elk River Watershed TMDL Report (2012)
[c] Sherburne County Local Water Management Plan (2018)

Management Planning Process

Recommended Annual Planning & Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Review & Update List of Lake Issues/Goals												
Select Priority Issues & Assign Planning Groups												
Review Supporting Materials & Assess Need for Additional Information/Monitoring												
Review Management Options & Goals for Selected Issues												
Select Management Action (or no-action)												
Implement Actions												
Monitor Outcomes (surveys/observations)												
Evaluate Management Actions (did it work?)												
Get Feedback from Homeowners (any new issues?)												

Prioritized List of Lake Issues Related to Aquatic Plants in Big Elk Lake

Priority	Issue	Details	Impact	Uses Impaired	See Page
1	Eurasian Watermilfoil	First found in 2020, EWM has only been found along the southern shore, but appears to be spreading to the west	June-Sept	Potential to impair Access, Boating, Waterski/Tubing, Swimming, Aesthetics	8
2	Preventing New AIS Infestations	Enhance prevention strategies; Early Detection/Rapid Response Planning	Year-Round	Boating, Waterski/Tubing, Swimming, Fishing, Aesthetics	11
3	Curlyleaf Pondweed	Although not currently a problem, CLP has been found in the lake and could increase in abundance in the future	April-June	Boating, Waterski/Tubing, Swimming, Fishing, Aesthetics	13
4	Protect/Promote Diverse Native Plant Community	Very low abundance of native aquatic plants	May-Sept	Fishing, Aesthetics	15
5	Low Water Clarity	Planktonic algae reduces water clarity; max depth of plant growth limited by light	June-Sept	Fishing, Swimming, Aesthetics	17
6	Invasive Carp	Carp may destroy aquatic plants, increase internal phosphorus load, increase turbidity, and reduce water clarity	Year-Round	Fishing, Swimming, Aesthetics	19

1 – Eurasian Watermilfoil: Context

Description of Problem:
Eurasian watermilfoil (EWM, *Myriophyllum spicatum*) was first reported in Big Elk Lake in 2020. Altough it has only been found growing sparsely along the southwern shore, it showed some signs of expanding to the west in 2021. EWM is an invasive aquatic plant that can form dense areas of surface-matted growth in the summer and early fall. Areas of dense growth can shade out native aquatic plants, reduce the quality and variability of habitat for fish, and impair boating and swimming in EWM beds. Given the very sparse native plant growth in the lake, the EWM may actually provide some benefit to the lake by providing fish habitat. However, given how shallow the lake is, EWM may be able to grow throughout the lake if it is able to receive adequate light.

EWM spreads within and between lakes primarily through the transport of plant fragments. Even small pieces of EWM stem can grow into mature plants. Established EWM plants form a root-ball in the sediment that sends up new stems each spring. For this reason, any management that does not remove or kill the roots will only provide temporary control. Furthermore, cutting and harvesting can create many EWM fragments and hasten the spread throughout a lake. For this reason, herbicide is usually the preferred method of controlling EWM.

Contributing Factors:
Given that EWM was first reported only recently in the lake (2020), it is very likely that this infestation will expand to additional areas of the lake if not managed. Water clarity appears to be limiting the maximum depth of EWM growth in the lake; increased water clarity resulting from reduced nutrient loading or the introduction of zebra mussels could lead to expansion of EWM into deeper areas.

Possible Side-Effects of Management:

On Other Plants:

(1) Aggressive management of EWM with auxin-mimic herbicides (such as 2,4-D, triclopyr, and procellacor) may impact water lilies and native milfoil in the vicinity of treatment
(2) Areas that support dense EWM likely have fertile sediments. If EWM is successfully controlled, homeowners should expect to see some areas of dense native plants in the treated areas; the goal is not to kill all plants, but to promote a diverse native plant community that will help to improve water clarity and provide good fish habitat.
(3) Given the very low abundance of native plants in Big Elk Lake, any herbicide treatments would not be expected to dramatically impact native plant abundance.

On Fish Population:

(1) Removal of large plant beds can expose small and newly hatched fish to greater predation (nowhere to hide)
(2) Fewer plants to support prey for small and newly hatched fish
(3) Dense EWM may lead to stunted growth of panfish due to reduced predation and greater competition for food, and may favor a shift to bass over other gamefish; bass are better at feeding in dense plant beds

On Water Clarity:

(1) Barren sediment may support filamentous algae growth in the spring and can be more easily stirred up by waves and boats leading to greater internal nutrient loading
(2) Fewer plants to compete with algae for nutrients

1 – Eurasian Watermilfoil: Management

Management Goals:

Short-Term

(1) Aggressively manage the isolated area of EWM along the southern shore to prevent spread within the lake
(2) Control any areas of dense EWM to minimize impairment of lake uses
(3) Minimize impacts to native plants near treated areas (not currently a major concern)

Long-Term

(4) Prevent the expansion of EWM in the lake
(5) Achieve some degree of long-term control to reduce the need for future treatments

Potential Management Actions:

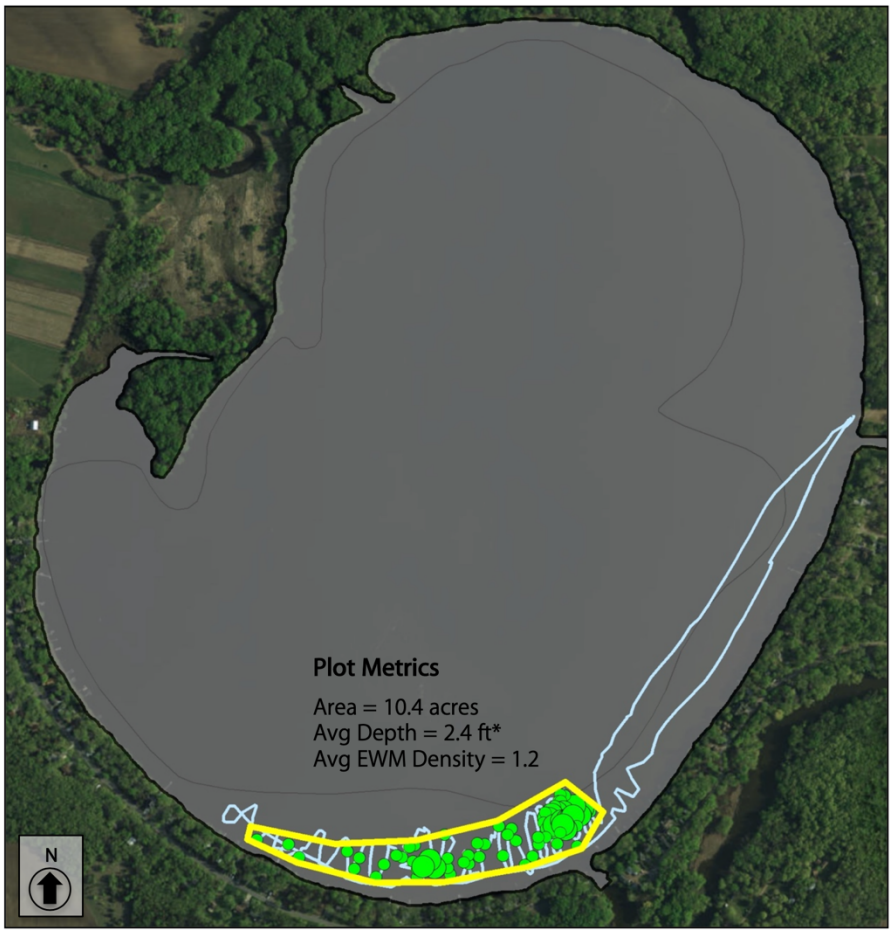
(1) Treat with Herbicide (up to 15% of littoral area, ~53 acres)
- **a.** *2,4-D*: Generally effective on non-hybridized EWM and fairly inexpensive
- **b.** *Triclopyr*: More expensive than 2,4-D; may be more effective on hybrid milfoil
- **c.** *Procellacor*: Newer herbicide that is thought to work better in small plots; used to treat Big Elk in 2021. Also touted as being more gentle on native plants than other similar herbicides.
- **d.** *Fluridone*: For whole-lake treatments, requires a variance permit and very long contact time (months). Thbis is not recommended given the amount of flow-through experienced in Big Elk Lake.

(2) Harvesting: Not recommended – would likely spread EWM fragments within the lake
(3) Hand-Pulling: Given the current abundance of EWM in Big Elk, this could be a good option. However, hand-pulling in 2020 did not appear to control EWM in the lake – likely due to low visibility and very firm sediments that made pulling more difficult. Any hand pulling should occur before the plants begin producing fragments (mid-summer), and care must be taken to remove all roots. Removal of only the above-ground portion of EWM plants will prevent herbicide damage to the plant (herbicide will not get to the roots), and any remaining roots will likely resprout the following spring.
(4) Biocontrol: Not recommended – although milfoil weevils have been shown to effectively reduce EWM in some lakes, results are very unpredictable and should be considered only as an experimental option. Research has shown that panfish predation on weevils can be very high, leading to low weevil numbers. Furthermore, Big Elk Lake may not have enough milfoil to support a population of weevils.
(5) Do nothing: Not recommended – without management, EWM will almost certainly persist and spread in Big Elk Lake. Although this could provide some needed habitat for fish, it would also potentially impair navigation and other lake uses.

Monitoring:

(1) Delineation Survey: Before permitting a treatment, the DNR requires a delineation survey to map out potential treatment areas. For EWM, these surveys are generally conducted in June. However, your AIS Specialist may also accept a late-summer or early-fall survey to plan treatments for the following year. In some cases, the DNR may also accept delineations from previous years if the treatment areas are not changed. Contact your AIS Specialist to discuss their survey requirements for a permit.
(2) Genetic Testing: If EWM treatments are not providing effective control, you should consider having the EWM plants in your lake tested to see if they are hybrid milfoil.
(3) Point-Intercept Plant Survey: Consider conducting a lake-wide point-intercept plant survey roughly every 3-5 years to track changes in the plant community.

Big Elk Lake (#71-0141)
Eurasian Watermilfoil Delineation Survey: July 16, 2021



Eurasian Watermilfoil

Surveyed Path (kayak)

Proposed Management Plot

EWM Density (1-3)
1
2
3

Note:
Water level in the lake was very low at the time of the survey. To ensure proper herbicide dosing, the hired herbicide applicator should reassess the mean depth in the plot prior to treatment. Furthermore, if water remains low, the applicator may need to use a small boat, as we were unable to launch our survey boat due to very low water levels.

Surveyed: July 16, 2021
Method: Visual, Rake, Sonar
Surveyor: JA Johnson
Certified Lake Manager
www.NALMS.org

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EWM Management Timeline

	J	F	M	A	M	J	J	A	S	O	N	D
Peak EWM Impact												
Apply for Permit												
Delineation Survey												
Herbicide Treatment												

2 – Preventing New AIS: Context

Description of Problem:
As of 2020, Big Elk Lake supported invasive common carp and two species of aquatic invasive plants; curlyleaf pondweed (CLP) and Eurasian watermilfoil (EWM). At this time, we are not aware of any other aquatic invasive species (AIS) in the lake. There are many invasive species threatening MN lakes (visit dnr.state.mn.us for the latest details), but zebra mussels, starry stonewort, and flowering rush likely pose the greatest threat to Big Elk Lake. Visit www.dnr.state.mn.us/invasives and www.maisrc.umn.edu for the latest details on these invasives and other emerging threats.

Zebra mussels have been spreading to new lakes in MN at an alarming rate. Given the proximity of Big Elk Lake to infested lakes in the metro and the rapid increase in the number of infested lakes over the past few years, it is very possible that the lake has already been exposed or will be exposed to zebra mussels in the coming years.

Starry stonewort is a macroalgae that grows like a bushy aquatic plant. This invasive plant has currently only been found in a handful of MN lakes, but has a propensity for forming extremely dense plant beds that displace native plants, impair lake use, and severely alter lake ecosystems.

Flowering Rush is an emergent plant that can form very dense beds in nearshore areas.

Contributing Factors:
(1) Proximity to infested waters
(2) Public boat launch and popularity as a fishing destination

Prevention Strategies
(1) Boat Launch Inspectors: The MNDNR hires launch inspectors, but these DNR inspectors cover only a small percentage of the state's boat launches, with a focus on very popular launch sites. Additional inspections are generally provided by lake volunteers or people hired by counties or individual lake groups. Many counties offer funding to assist lakes in hiring launch inspectors. The BLCA should consider contacting the county to discuss increasing inspections at the public boat launches. Funding assistance for this may be available from Sherburne County http://www.sherburneswcd.org/ais-grant-program.html
(2) Lake Service Providers (LSP): The MNDNR has a certification program for any business or professional that moves equipment between lakes www.dnr.state.mn.us/lsp/index.html. This certification program ensures that these businesses have been trained on AIS prevention rules and laws. The BLCA should educate their lakeshore homeowners to make sure they are only hiring certified LSP's to install or remove docks, move boat lifts, transport boats, treat their lakeshore, or any other professional lake service.
(3) Clean, Drain, Dispose: www.dnr.state.mn.us/invasives/preventspread_watercraft.html Although it is easy to blame outsiders for bringing new invasive species to a lake, lake residents can be an unwitting source of new infestations as well. Any lake residents who visit other lakes should be sure to clean their boat or equipment to remove any visible plants or debris, drain any water from bilge areas, ballast tanks, livewells, and bait buckets; dispose of unused bait, and dry the equipment for at least 5 days before returning it to your lake (21 days for lifts and docks brought in from other lakes).

The above strategies are designed to prevent new invasives from entering your lake, but it is also important to monitor the lake for new invasives so that they can be found early and managed aggressively to prevent establishment and expansion in the lake. This process is commonly called **Early Detection & Rapid Response**.

2 – Preventing New AIS: Early Detection/Rapid Response

Goals:

(1) Detect any new AIS before it can become established in the lake
(2) Be prepared to rapidly respond to any newly found infestation

Early Detection

(1) Conduct periodic inspections to search for new AIS in the lakes, with a focus on boat launch sites and resident boat lifts/docks. These are the most common locations where new AIS are found. Volunteers can be a great first line of defense, but trained AIS professionals should be incorporated to maximize the likelihood of detecting any new infestation. Funding for AIS monitoring and prevention may be available from Sherburne County http://www.sherburneswcd.org/ais-grant-program.html

(2) Inform lakeshore homeowners of new AIS so that they will know if they see one. Additionally, provide them with a BLCA contact to report any suspicious findings or to ask questions. Consider including this information in newsletters and on your website. Funding assistance for this may be available from Sherburne County (see link above).

(3) Periodically check the MN Infested Waters List to stay apprised of any new infestations in nearby lakes. www.dnr.state.mn.us/invasives/ais/infested.html

Rapid Response

If you suspect that you have found a new AIS in Big Elk Lake:

(1) Note or mark the location of the suspected AIS: GPS coordinates, float, or description
(2) Take a photo of the suspected AIS
(3) Contact your DNR AIS Specialist http://www.dnr.state.mn.us/invasives/ais/contacts.html

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Christine.Jurek@state.mn.us

Be prepared to send photos, GPS locations (or a detailed description of the location). The DNR will typically send a staff member to visit the site and verify whether the site is infested with a new AIS.

If the DNR verifies that you have a new AIS infestation:

(1) Contact Sherburne County SWCD to inquire about assistance (staff, guidance, or funding). We highly recommend that this step be addressed prior to finding any new infestation.
(2) Contact your lake surveyor/consultant to discuss monitoring and management options
(3) Develop a specific management plan for the new AIS in cooperation with with the DNR, County, and your lake consultant
(4) Solicit bids for any planned monitoring or treatments
(5) Notify lakeshore homeowners and organize an emergency LID meeting to go over the plan and solicit funds from stakeholders for management. If possible, BLCA should maintain an emergency AIS response fund to allow them to move quickly on new AIS.
(6) Post temporary signage at the launch announcing the newly found infestation and request permanent signage from the DNR
(7) Apply for any necessary DNR AIS control permits
(8) Implement the management plan for the new AIS as soon as is feasible
(9) Follow up with periodic monitoring in and around the managed site to determine if the management was effective or if additional management is needed.

3 – Curlyleaf Pondweed: Context

Description of Problem:
Curlyleaf pondweed (CLP, *Potamogeton crispus*) is an invasive aquatic plant that can form dense areas of surface-matted growth in the mid to late spring. Areas of dense growth typically shade out native aquatic plants, reduce the quality and variability of habitat for fish, and impair boating and swimming in beds of dense CLP. Furthermore, CLP naturally dies off in June, leaving large areas barren of plants and releasing nutrients into the water as the dead plants decay.

In most Minnesota lakes CLP acts as an annual plant, sprouting from turions (reproductive buds) during the cold-water periods in the fall and spring of each year. As the water warms in the spring, CLP sprouts grow rapidly, produce new turions, and then naturally die off in mid June, depositing new turions to the lake sediment. When buried, these turions can remain dormant for at least 5 to 10 years. This means that although treatments can kill newly-sprouted CLP and prevent the production of new turions, CLP management requires multiple years of treatment to reduce the extent and abundance of CLP in a lake.

Currently, CLP does not grow densely in Big Elk Lake. However, if water clarity were to increase or carp reduced, there is some potential for CLP to expand and grow to nuisance density.

Contributing Factors:
Sediment texture, water clarity, and possibly carp activity appear to limit CLP growth in the lake. Curlyleaf is widespread in the upper three lakes in the Briggs Chain, but the sediments in Big Elk Lake are much firmer (sand and rock). In general, sandy sediments do not support dense CLP growth as much as softer organic sediments. Although CLP tends to dominate in lakes with poor water clarity, the clarity in Big Elk is particularly bad. If the lake experienced a slight increase in water clarity, CLP may begin to expand. If carp population was reduced (via management or naturally), CLP may also expand.

Possible Side-Effects of Management:

On Other Plants:

(1) Aggressive management of CLP may also reduce other native pondweeds growing in the vicinity of treated areas. Early spring treatments provide an additional degree of selectivity by killing the CLP before many native plants sprout.
(2) Many lakes treated with endothall herbicide experience substantial increases in coontail and Elodea.

On Fish Population:

(1) Removal of large plant beds can expose small fish to greater predation
(2) Fewer plants to support food/prey for small and newly hatched fish

On Water Clarity:

(1) In untreated lakes with severe CLP infestations, natural die-off can release nutrients and lead to increased algae growth.
(2) Barren sediment in treated areas may support filamentous algae growth in the spring
(3) Fewer plants to compete with algae for nutrients

3 – Curlyleaf Pondweed: Management

Management Goals:

Short-Term

(1) Control any substantial areas of dense CLP to minimize impairment of lake use
(2) Reduce CLP biomass and the amount of nutrients released when CLP naturally dies off
(3) Minimize impacts to native plants in the vicinity of treated areas

Long-Term

(4) Prevent the expansion of CLP in the lake by preventing the production of new turions
(5) Reduce the abundance of turions in the lake sediment to decrease the potential for dense CLP growth and the need for future treatments
(6) Promote the reestablishment of diverse native plants in the treated areas

Potential Management Actions:

(1) Treat with Herbicide (up to 15% of littoral area)
- **a.** *Endothall*: Applied when water temperature is between 50° and 60°F. May not be as effective on smaller plots (<2 acres) due to herbicide dispersion. May impact native pondweeds.
- **b.** *Diquat:* Less expensive than endothall and less selective (kills many plants). Applied when water temperature is between 50° and 60°F to kill CLP before most native plants sprout. Good for smaller plots where endothall may fail.
- **c.** *Galleon+Endothall*: Mixture of herbicides that works best for large plots >20 acres. Galleon very effective on CLP and is thought to cause less damage to native pondweeds than endothall or diquat. Only a few applicators offer this.
- **d.** *Fluridone*: Only used for whole-lake treatments; requires a variance permit, additional monitoring, and careful planning to prevent harming native plants. This is not a viable option for Big Elk Lake given the high amount of flow-through from the river.

(2) Harvesting: Not recommended – can effectively remove biomass and substantial number of turions, but not as effective as herbicides; DNR allows up to 50% of littoral area to be harvested. Due to the shallowness of Elk Lake, a harvester may not be able to access areas near shore where most of the curlyleaf grows.

(3) Hand-Pulling or Cutting: Only feasible for isolate small patches in shallow water.

(4) Do Nothing: Given the low amount of CLP in Big Elk Lake, this is likely the best option for now. Given the low amount of native plant growth in the lake, any small areas of CLP may be providing more benefit (fish habitat) than harm to the lake. If CLP abundance increases substantially in the future, the other options listed above should be considered to prevent impairment of lake use and increased internal nutrient loading.

Monitoring:

(1) Delineation Survey: Before permitting a treatment, the DNR requires a delineation survey to map out potential treatment areas. For CLP, pretreatment surveys are conducted in April/May and posttreatment surveys (if desired) in June. The DNR may honor delineations from previous treatments if the treatment areas are not changed. Contact your AIS Specialist to discuss their survey requirements for a permit.

(2) Point-Intercept Plant Survey: The BLCA should consider conducting a lake-wide point-intercept plant survey roughly every 3-5 years to track changes in the plant community.

4 – Protect/Promote Native Plants: Context

Description of Problem:
Currently, there is very little plant growth in Big Elk Lake. This is likely due the very low water clarity, firm sandy sediments, and possibly carp activity in the lake. Low water clarity means that plants do not get enough light to survive, firm sediments may hold less nutrients than softer sediments, and carp eat or uproot plants while looking for food and can also increase turbidity which further blocks light. In addition, aggressive management of CLP and EWM with herbicides can also impact native plants in the vicinity of the treated plots.

Contributing Factors:
(1) Periods of very low water clarity – limits the depth to which plants can grow and may favor invasive plants that are more able to grow to the surface where light is abundant.
(2) Large areas of sandy/rocky sediments – may not support dense native plant growth
(3) Invasive common carp – uproot native aquatic plants while foraging for food
(4) Aggressive management of CLP or EWM – may harm native plants in vicinity
(5) Motorboat prop-scour and waves can uproot beds of native plants

Diverse native plants are a great benefit to lakes. They anchor sediments, compete with algae, and provide a rich diversity of habitat for fish and wildlife. Shallow lakes like Big Elk tend to exist in one of two states: (1) an algae-dominated state with few rooted plants, or (2) a plant-dominated state with clearer water and abundant plant growth. Big Elk is in a persistent algae-dominated state. If water clarity was increased or carp were managed in the lake, the lake may flip into a plant-dominated state. For this reason, the BLCA should carefully consider which of these two shallow lake states would be more desirable and manage the lake accordingly. Overall, a plant-dominated state is of greater value for fish and wildlife, but may not be the best for other lake uses. Based upon the status of the fishery in the lake, it appears that fish in Big Elk Lake may also use the Elk River for spawning and feeding habitat.

Possible Side-Effects of Management:

On Plants:
(1) Abundant and diverse native plants are more resilient to disturbance and may slow the expansion of invasive plants within the lake

On Fish Population:
(1) Abundant and diverse native plants will provide high quality habitat that will be capable of supporting a wider range of fish sizes and species by providing spawning areas, feeding and hiding areas for small/newly-hatched fish, and hunting grounds for predator fish
(2) Very dense plant growth can stunt the growth of panfish by decreasing predation (better hiding places). This can lead to more numerous but smaller panfish due to competition for food among the smaller fish.

On Water Clarity:
(1) Diverse native plant communities help to increase water clarity by anchoring lake sediments, competing with algae for nutrients, and providing hiding places for zooplankton that graze on algae.

4 – Protect/Promote Native Plants: Management

Management Goals:

(1) Protect areas of floating/emergent plants
(2) Promote greater native plant diversity through plantings (DNR permit required)
(3) Limit damage to native plants when treating CLP and EWM
(4) Educate lakeshore homeowners about the benefits of the native plants in the lake and on shore

Potential Management Actions:

(1) Reduce the abundance of carp in the lake. This would be a large undertaking that is likely beyond the means of the BLCA. Carp would likely reestablish in the lake from the river and connected waterbodies (Briggs Chain).
(2) Improve water clarity: This too is likely beyond the control of BLCA, as the water quality in Big Elk is largely driven by infow from the lake's large watershed. The Elk River Watershed TMDL provides much greater detail on the potential to improve water clarity in the lake. If interested, the BLCA should partner with the county to implement the TMDL plan.
(3) Transplant native plants from nearly lakes (DNR permit required)
(4) Promote native shoreline plantings with education and possible funding assistance. The BLCA has programs in place to educate homeowners on shore plantings that could be implemented on Big Elk Lake.
(5) Plan Treatments Carefully: Work with your consultant and applicator to minimize herbicide damage to natives when targeting invasive plants
(6) Do Nothing: If the homeowners and BLCA prefers the current algae-dominated state, then this is a viable option.

Monitoring:

(1) Point-Intercept Plant Survey: The BLCA should consider conducting a point-intercept plant survey roughly every 3-5 years to document changes in the diversity and abundance of native plants throughout the lake.

5 – Low Water Clarity: Context

Description of Problem:
Water clarity is particularly poor Big Elk Lake (listed as impaired). This poor water clarity is likely driven primarily by inflowing nutrients from the large Elk River watershed. Additionally, carp in the lake may further degrade water clarity by uprooting plants, stirring up sediment, and mobilizing phosphorus that fuels algae growth. The factors that drive the poor water clarity in the lake are largely beyond the control of the homeowners or BLCA. However, you should stay apprised of the ongoing TMDL process (Elk River Watershed Association / MPCA) and consider opportunities to collaborate with the partners listed on page 2 to improve water clarity.

Contributing Factors:

(1) Large upstream watershed dominated by agriculture
(2) Turf fertilizers, soil erosion, and failing septic systems in shoreland areas
(3) Possible internal recycling of phosphorus in the lake due to periodic lake stratification, sediment resuspension, carp, and curlyleaf die-off
(4) Possible non-algal turbidity due to high carp activity
(5) Any future infestation by zebra mussels could increase water clarity (filter out algae), but would have other undesirable impacts on the lake and its fishery

Possible Side-Effects of Management:

On Plants:

(1) Low water clarity reduces the penetration of light into the water, limiting the depth to which plants can grow. Conversely, increases in water clarity can allow plants to expand into deeper areas of a lake. Any substantial increase in water clarity would likely have an effect on the extent of plant beds in the lake. BLCA should familiarize themselves with the concept of shallow lake ecology and stable states (see supporting materials)
(2) If water clarity improves, and invasive CLP and EWM are not controlled, it is possible that these invasives would rapidly expand into deeper areas of the lakes. This could lead to a substantial increase in the proportion of the lake impaired by surface-matted plants.

On Fish Population:

(1) Water clarity can affect which fish do well in a lake. Visual predators like pike, walleye, and bass do better in clearer water, whereas bottom feeders like carp and bullhead tend to dominate in murky lakes.

5 – Low Water Clarity: Management

Management Goals:

(1) Reduce the severity and frequency of planktonic algae blooms
(2) Minimize the potential for sediment resuspension by wind, carp, and motorboats

Note: Given the scale of the factors that are driving the poor water clarity in Big Elk Lake, it is likely beyond the means of the BLCA to improve water clarity on their own. However, the Elk River Watershed TMDL Program documents provide a detailed analysis of these factors and lay out goals and action items that could be implemented on a watershed scale. The BLCA should continue to work cooperatively with local, county, and state partners named in the TMDL plan to reduce the nutrient load to the lake. The options listed below represent items that could be implemented or supported by BLCA on a more local scale (directly to the lakes and shoreline properties). These items complement the watershed actions highlighted in the TMDL.

Potential Management Actions:

(4) **Reduce Nutrient Inflow to Lake:** (see TMDL for larger scale options)
    a. **Promote Responsible Lawn-Care Practices:** P-free fertilizer, no fertilizing right before a rain, seed or sod areas of bare dirt to reduce soil erosion, keep grass clippings and leaves off of streets.
    b. **Promote Shoreline Buffers:** Vegetated buffers have much deeper roots than turf grass and can intercept nutrient runoff from nearshore areas. Check with Sherburne County SWCD to see if there are assistance grants available for establishing buffers.
    c. **Promote Septic System Maintenance:** It appears that all of the homes on Big Elk Lake have subsurface sewage treatment systems (SSTS). The TMDL estimates that between 10% and 30% of those are failing, leading to increased nutrient inflow to the lake. Homeowners should be reminded to maintain their septic systems for optimal performance.
(5) **Reduce Internal Phosphorus Cycling**
    a. **Sediment Phosphorus Inactivation:** Large-scale application of alum or similar compound can be applied to reduce phosphorus release from sediments. This would be very expensive and would not reduce the substantial amount of external nutrient inflow from the watershed. Furthermore, Big Elk Lake may be too shallow to benefit from such a treatment (may not consistently stratify)
    b. **Curlyleaf Pondweed Control:** Control of CLP in the early spring when the shoots are small can limit this release of phosphorus, and long-term reductions in CLP abundance may lead to some reduction of planktonic algae growth in the later spring. Currently, there is not enough CLP in the lake to have much of an impact, but if CLP increased in the future, this item could be revisited.
(6) **Reduce Sediment Resuspension**
    a. **Protect/Promote Native Plants** in shallow areas to anchor sediments
    b. **Limit Motorboat Speed** to slow-no-wake in shallow areas with soft sediments
    c. **Reduce Common Carp** abundance (likely very difficult given connection to river)
(7) **Do nothing:** Without action, the water clarity in the lakes will likely remain the same or degrade further. Other organizations are working to improve water quality in the Elk River Watershed, but the BLCA should remain engaged with agencies and stakeholders to ensure that these plans are pursued, funded, and implemented.

Monitoring:

(1) **Document Impairment:** The BLCA should ensure that water clarity and chemistry data are being collected, and consider collecting secchi transparency readings as a part of the Citizen Lakes Monitoring program at the MPCA.

6 – Invasive Common Carp: Context

Description of Problem:
The DNR has documented the presence of commmon carp in Big Elk Lake and the connected Elk River. However, the level of infestation by carp is not well documented. Research by the University of Minnesota suggests that abundant plants can persist in carp-infested lakes when carp density is kept below 25 lbs per acre, but when carp density reaches about 90 lbs/acre, the carp can severely reduce plants in a lake and have major impacts on water clarity and fish habitat. Furthermore, the same researchers have found that abundant bluegill populations suppress carp populations by eating their eggs.

Based upon the low abundance of plants in Big Elk Lake, it is possible that carp are numerous and having a substantial impact on the lake. Additional observations by lakeshore homeowners during the spring carp spawn would be helpful in assessing whether carp are a problem in the lake; lakes with high carp numbers tend to have many carp splashing around in shallow areas during the spawning period.

Contributing Factors:

(1) Big Elk Lake does not generally support a large population of bluegill. Abundant bluegill populations have been shown to devouring carp eggs and keep carp populations in check.

Possible Side-Effects of Management:

On Plants:

(1) If the carp population is reduced, native plants may become more abundant and widespread in the lake. Conversely, if the carp population remains the same or increases, native plants will have a hard time establishing.

On Fish Population:

(1) Carp can destroy native plant beds and stir up lake sediments. These impact reduce the availability of quality habitat for native fishes, reduce water clarity, and can favor a shift away from visual predator fish (northern, musky, bass) and toward more abundant bottom feeders (bullhead).

On Water Clarity:

(1) If the carp population is reduced, there may be some increase in water clarity. Conversely, if carp increase in the future, they would likely decrease water clarity by removing plants, stirring up lake sediments, and mobilizing sediment nutrients that would fuel algae growth and keep the lake in an algae-dominated state.

6 – Invasive Common Carp: Management

Management Goals:

(1) Maintain low abundance of carp in the chain of lakes (below 25 lbs/acre)
(2) Maintain abundant bluegill population by protecting habitat and preventing winterkill

Potential Management Actions:

Note that these may not be effective due to possible migration of carp from the connected Elk River.

(1) Carp removal (netting): Removal by tagging, locating, and netting (through ice or using baited corrals)
(2) Prevent bluegill winterkill by tracking winter oxygen levels and aerating if necessary
(3) Do nothing: Without action, the carp population will likely remain the same or increase.