Beecher Lake EWM Control Project
Phase II – Final Report

(AIS Control Grant # ACEI-172-15)

Chuck Druckrey
Marinette County Land Information Department
Land & Water Conservation Division
June 2020

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Beecher Lake EWM Control Project
Phase II – Final Report

Introduction

Beecher Lake is located in the Township of Beecher (T36N,R20E,S28) in Marinette County, Wisconsin. The lake actually consists of two separate lake basins, Beecher Lake and Upper Lake, connected by a narrow channel. Locally the combined lakes are referred to as Beecher Lake. The lakes drain to the Pike River, an Outstanding Resource Water and State designated Wild River.

The Upper Lake basin covers 21 acres with a maximum depth of 18 feet. The Beecher Lake basin covers 35 acres with a maximum depth of 47 feet. A dam on the outlet of Beecher Lake maintains a head of six feet and controls the water level in both lake basins (figure 1). Water quality is typically good with moderate to darkly stained water and relatively low phosphorus concentrations. A water quality study conducted in 1996-97 found the lakes consistently in the mesotrophic range.

Beecher Lake is heavily developed with 68 private homes on the shore. One public boat launch with parking is maintained by the Town of Beecher along with a public park and swimming beach on the north shore of the lake. Additional public access is available at the dam. Boating pressure is light and consists primarily of non-motorized craft and smaller fishing boats. Since neither lake basin is 50 acres in size Wisconsin law designates both as "slow-no-wake" lakes.

Beecher Lake Protection & Rehabilitation District

The Beecher Lake Protection & Rehabilitation District (Beecher Lake District) was formed by resolution of the Town of Beecher Board of Commissioners in 2000 to provide for the protection and improvement of Beecher and Upper Lakes. The Lake District includes all waterfront property owners on Beecher and Upper Lakes. The impetus for forming the Lake District was primarily to allow for the control of aquatic plants, which grow densely in

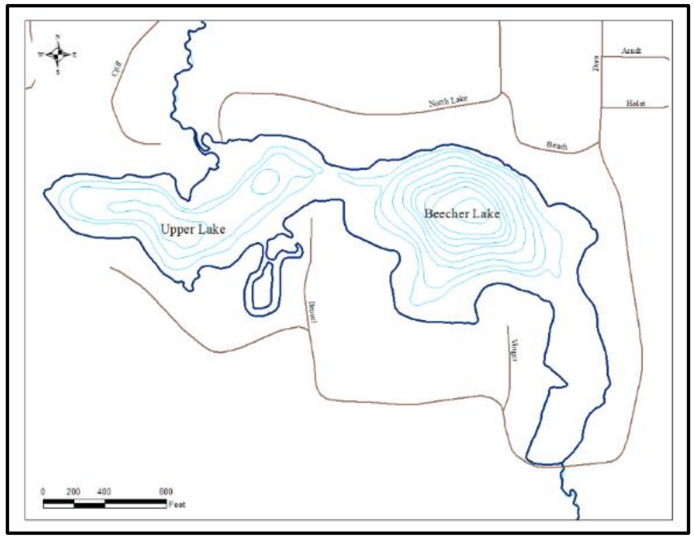

Figure 1. Beecher and Upper Lakes.

the shallow waters of Beecher Lake. Early efforts focused on harvesting aquatic plants. Since the discovery of Eurasian watermilfoil (*Myriophyllum spicatum*), the District has worked closely with the Wisconsin DNR and Marinette County Land & Water Conservation Division (LWCD) to manage exotic species.

Aquatic Plant Community

Beecher Lake has a well-developed, diverse, and much-studied aquatic plant community. Between 2008 and 2019 there have been 3 partial-lake and 8 whole-lake aquatic plant surveys. During this period, the average floristic quality index was 35.0. Maximum rooting depth varies considerably from year-to-year based on the volume of tannin stained runoff from the lakes 2,800-acre watershed. Over the last 11 years, the maximum rooting depth has ranged from 6 to 11 feet with an 8.5-foot average.

Exotic Species

Eurasian Water Milfoil (EWM) was discovered in Beecher Lake in June 2007 and verified by the Freckman Herbarium at UW-Stevens Point. A cursory survey of the lake in October 2007 found that EWM was primarily limited to the Beecher Lake basin with moderate to dense stands covering more than 6.5 acres. Genetic testing in 2008 and 2014 indicated that EWM was not hybridized despite the presence of both northern watermilfoil (*M. sibericum*) and whorled watermilfoil (*M. verticillatum*) in the lake.

Aquatic Invasive Species Planning

The Beecher Lake District received a Wisconsin DNR AIS Planning Grant in March 2008 to develop an aquatic invasive species management plan to address the newly discovered EWM infestation. Concurrent with EWM planning efforts the District worked with the DNR and Marinette County LWCD to treat EWM in the spring of 2008 and 2009 with mixed results. An in-depth discussion of all EWM management efforts including herbicide use is found on page 11.

The WDNR approved Aquatic Plant Management Plan for Beecher Lake was completed in January 2010. The plan calls for selective control of EWM and protection and restoration of the native plant community. Specific aquatic plant management recommendations included modification of the Beecher Lake dam to allow for periodic winter drawdown of Beecher and Upper Lakes to achieve long-term EWM control and targeted aquatic herbicide applications to manage EWM in deep water. In the interim, the plan recommended the use of early-season herbicide treatment with 2,4-D to selectively control EWM, surveying the lake for milfoil weevils (*Euhrychiopsis lecontei*), and hand pulling EWM as appropriate.

Beecher Lake AIS Control Project (Phase I)

An Aquatic Invasive Species Control Gant (ACEI-073-10.1) was awarded to the Beecher Lake District in 2010 with the goal of implementing the recently approved aquatic plant management plan for Beecher and Upper Lakes.

The proposal laid out a four-year multi-faceted strategy to prevent Eurasian water milfoil domination in Beecher Lake and preserve the diverse aquatic plant community. The approved EWM management strategy included a winter drawdown to evaluate its effectiveness as a management tool, the judicious use of selective aquatic herbicides, hand-pulling isolated plants, and the use of biocontrol agents where applicable. Routine aquatic plant monitoring was included to track changes in the frequency and density of EWM and evaluate impacts to the native plant community.

Winter water level drawdown attempt

The Beecher Lake dam consists of a fixed weir spillway with a width of 24.5 feet. There are no gates or valves for water level control. Water level manipulation was completed using siphons made from 6-inch pvc pipe and fittings available at most hardware or plumbing supply stores (figure 2). A single siphon tube was installed in Beecher Lake in the summer of 2010 to demonstrate proof-of-concept. The test was successful and the siphon operated for two weeks without interruption.

Figure 2. 6-inch siphons created using off-the-shelf plumbing supplies.

A full drawdown of the lake using four siphon tubes was attempted in September 2010. Good progress was made, and a two-foot water level change was achieved in three weeks. Unfortunately, a late season storm dropped nearly 4.5 inches of rain on the surrounding area and the lake quickly refilled. The drawdown attempt was abandoned on October 5, 2010.

A second drawdown was attempted in 2011 with the installation of four siphons on August 27. The water level fell rapidly and the lake level reached 5.0 feet below full pool by early October (figure 3). Unfortunately, the drawdown failed to achieve the expected water level reduction in the Beecher and Upper Lake basins. The Beecher Lake dam is located on Beecher Creek approximately 1,300 feet downstream from the lakes natural outlet. While the siphons did lower the water level near the dam, a build-up of sediment in the creek bed between the dam and the lake prevented the main body of the lake from draining sufficiently. A survey of the dewatered lakebed in December showed that the water level near the dam was 5 feet below full pool while 1,300 feet upstream, the water level in the main body of Beecher and Upper Lakes was only 2.5 feet below full pool.
On December 28, 2011, the siphons were removed and the lake was allowed to begin refilling. Water levels rose slowly throughout the winter, returning to normal before ice-out in the spring of 2012.

Figure 3. View of Beecher Lake near the dam following a "complete" drawdown.

Results and discussion of the partial winter drawdown

Although the siphons were effective during warm weather, they were difficult to maintain during the winter as the pipes became encased in ice and frozen mud. While continuous flow prevented ice formation inside the pipes, any interruption in flow during sub-zero weather allowed the intake pipes to freeze solid in a matter of hours often rupturing the pipes and valves. These factors severely limit the utility of siphons for winter drawdown purposes.

The winter of 2011/12 was also exceptionally warm with less than three inches of frost penetration prior to the accumulation of insulating snow cover. As a result, EWM control was unacceptable in most areas of the lake. In fact, it appears that a non-lethal drawdown may have stimulated EWM growth. A detailed aquatic plant survey conducted after the drawdown showed a 94% increase in the frequency of EWM, from 41.6% to 80.7%. The one exception was the south arm of the lake near the dam where the drawdown was complete and the sediment was exposed for a much longer period. In this area EWM control was nearly complete and recolonization was slow. While the results were promising, winter drawdown was abandoned as a management tool until the factors limiting its use could be resolved.

Whole-lake 2,4-D treatments

After failing to achieve sufficient water level reduction, and in the face of rapidly expanding EWM in both lake basins, a whole-lake herbicide treatment using 2,4-D was conducted in 2012 resulting in generally poor EWM control. A second whole-lake treatment conducted in 2013 also resulted in poor EWM control. A detailed discussion of herbicide management efforts and results is found on page 11.

Beecher Lake AIS Control Project (Phase II)

The Beecher Lake EWM Control Project (Phase II) was approved in 2015 to address factors identified in the initial AIS control project that were impeding winter water level drawdowns.

Goals and Objectives

The goal of the project was to make the necessary changes to allow for the effective use of periodic winter drawdown as the primary EWM management tool in Beecher and Upper Lakes, implement an integrated aquatic plant management strategy that reduces reliance on aquatic herbicides, and protect/restore the native plant community. The following objectives were identified for advancement of this goal:

1. Install a drainpipe and valve system through the Beecher Lake dam to allow for water level manipulation.

2. Dredge a channel from the dam to the Beecher Lake basin for the purpose of achieving the maximum 5-foot drawdown of Beecher and Upper Lakes.

3. Conduct periodic winter drawdown(s) for the control of EWM.

4. Conduct enhanced manual harvesting of EWM as appropriate.

5. Reduce or eliminate the need for aquatic herbicides for EWM control in Beecher and Upper Lakes.

6. Evaluate EWM control methods for efficacy and effect on the native plant community.

7. Update the long-range integrated AIS management strategy to control EWM while protecting the native plant community.

8. Prevent future AIS invasions of Beecher and Upper Lakes and prevent the spread of EWM from Beecher and Upper Lakes to neighboring waters.

Beecher Lake dam modification

A low-level drain was engineered and installed in the spring of 2016. The drain consists of a single 10-inch diameter pvc pipe with two shutoff valves. The origin of the pipe is located in a sump excavated in the lakebed approximately 45 feet from the dam. The drainpipe and siphons were utilized in the fall of 2016 to draw the water level down in preparation for the channel dredging project.

Channel dredging

Channel dredging began on January 11, 2016 and was completed on February 6, 2017. LWCD staff were on-site throughout the project to oversee construction, check elevations, and document as-built conditions. The contractor worked at the lake for 14 days with several weather delays for heavy snow and unseasonably warm weather. The as-built channel location varied slightly from the planned location (figure 4) due to difficulties in accessing the center part of bay with heavy equipment.

Dredge spoils were disposed of on upland sites on two private properties near the lake according to the WIDNR approved dredging permit. Spoil piles were graded and seeded in July 2017.

Winter water level drawdown

Like previous winter water level drawdown attempts, the drawdown conducted for channel dredging was only effective at dewatering the south bay of the lake. Early and deep snow cover also drastically reduced frost penetration except along the west shore of the bay where snow and ice were stripped from the lakebed to increase frost penetration in preparation for the dredging operation.

The first complete winter drawdown of the lake was completed in the winter of 2017/2018 using the newly installed drain and three remaining siphons that were still in working order. The drawdown began on 9/2/16 and was complete by 10/28/16. The average drawdown rate was approximately 1-inch per day with the lake at full pool but slowed as head pressure decreased with declining lake elevation. The drainpipe was able to keep the lake level drawn down through most of the winter. Snowmelt and rainfall had nearly refilled the lake by April 2018 when the drainpipe was closed.

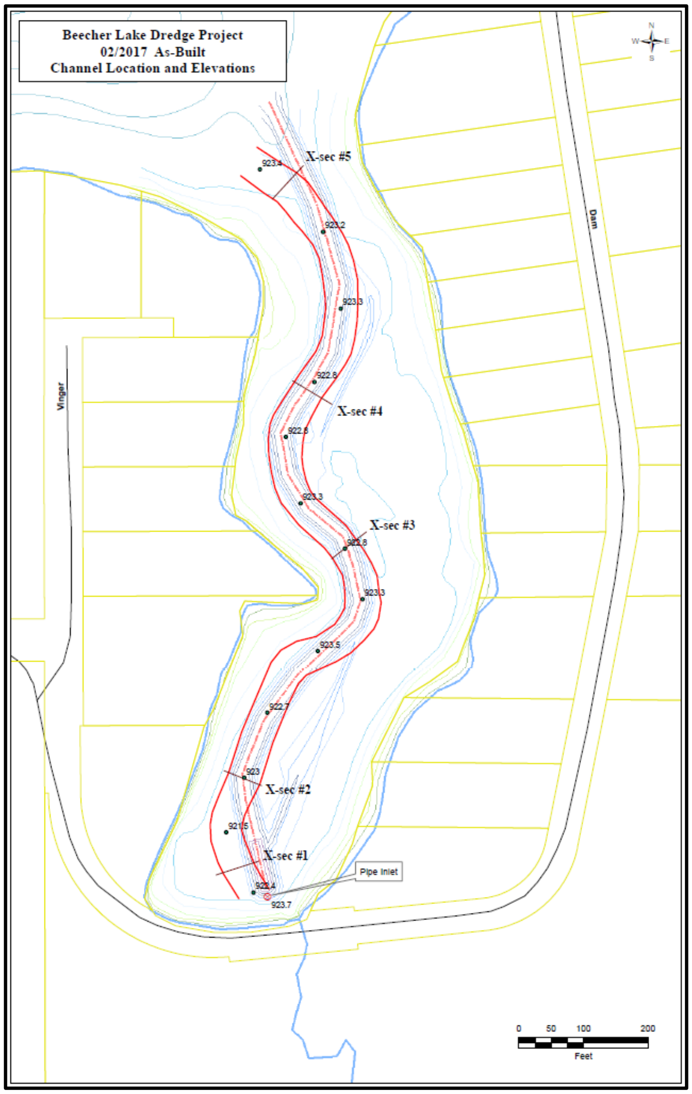

Figure 4. Dredged channel design and as-built location.

Herbicide spot treatment

The 2017/2018 winter drawdown resulted in excellent EWM control in most of the Beecher and Upper Lake basins. However, EWM control was poor on the west end of Upper Lake where groundwater seepage prevented sediment freezing. On June 4, 2019, 0.8-acres on the west end of Upper Lake was treated using Agristar 2,4-D Amine 4. The treatment area was enclosed using curtain wall barriers developed by the LWCD to slow herbicide dissipation rates (figure 5). The herbicide was applied at a concentration of 4.0 ppm and the curtain wall barriers were in place for 48 hours. A study of herbicide enclosure effectiveness conducted on Thunder Lake in 2019 (AIS grant #ACEI22719) showed that barriers are effective at preventing herbicide dissipation from the treatment site and resulted in improved EWM control within the enclosed area.

Manual/DASH Harvesting

The grant proposal called for using Diver Assisted Suction Harvesting (DASH) as appropriate during the grant period. DASH is very labor intensive and generally appropriate for harvesting scattered plants and small colonies to prevent the spread of EWM. Unfortunately, the lack of significant EWM control through most of the project period precluded using DASH on Beecher Lake.

Several years of experience using DASH for EWM control also shows it is most efficient when used on lakes with good water clarity where EWM can be identified and mapped from the surface. The dark stained water of Beecher Lake makes finding scattered EWM difficult. As a result, DASH harvesting was not used as EWM management tool during the grant period.

Results and Discussion

Since its discovery in 2007, the Beecher Lake District has been working closely with the Wisconsin DNR and Marinette County LWCD to control EWM. During this period, EWM has spread aggressively

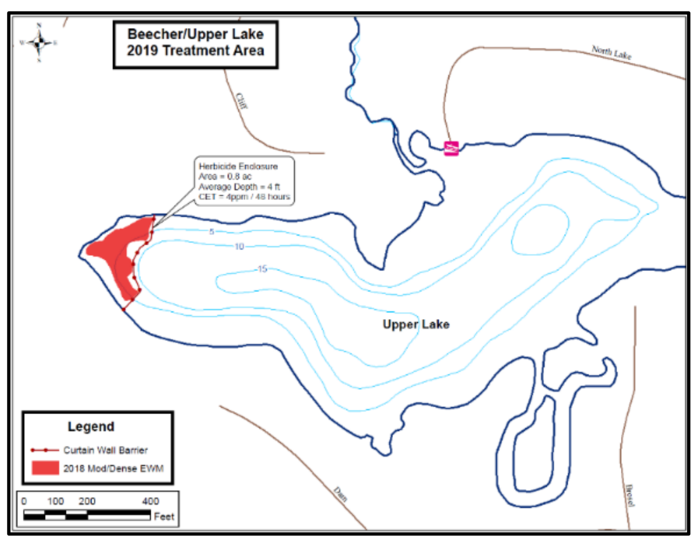

Figure 5. 2019 herbicide treatment area. An herbicide enclosure barrier was used to improve exposure time.

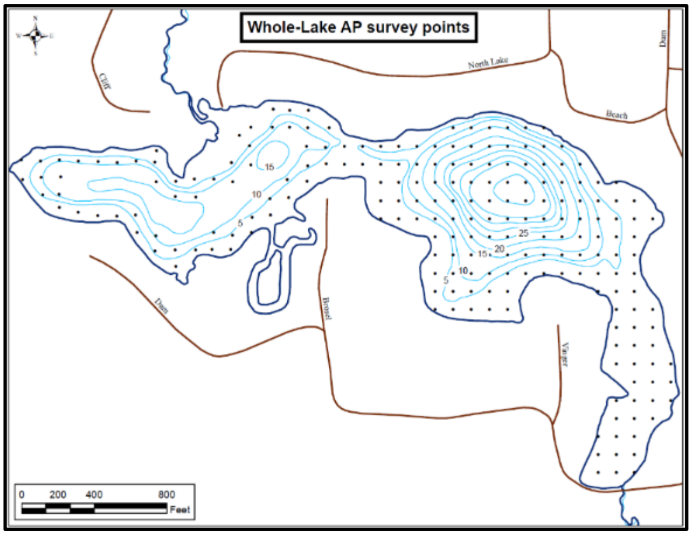

Figure 6. Beecher Lake point/intercept survey points for whole-lake aquatic plant surveys (30-meter spacing).

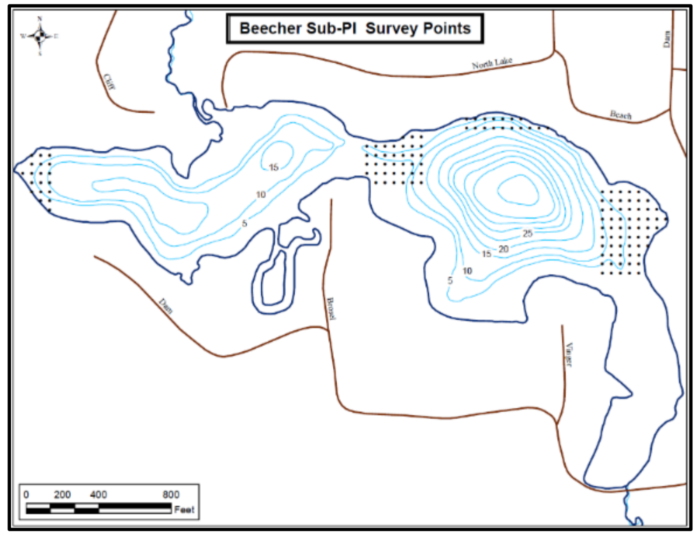

Figure 7. Beecher Lake point/intercept survey points for sub-PI aquatic plant surveys (15-meter spacing).

and has proven resistant to many management efforts. The following discussion of EWM management results includes all chemical and physical control efforts carried out since 2008 including those completed without AIS grant funding.

Aquatic plant surveys & survey methodology

Between 2008 and 2019, the Marinette County LWCD conducted eleven aquatic plant surveys on Beecher Lake to track the expansion of EWM and evaluate the numerous control efforts. Surveys conducted in 2008 and 2013-2019 used the same 30-meter grid point spacing (figure 6). The 2010-2012 plant surveys were done in four representative areas of the lake using a 15-meter point spacing (figure 7). While survey point spacing differed between years, the partial lake surveys covered representative areas of the lake. The number of sample points shallower than maximum depth of plant growth, native species count and floristic quality indices (FQI) of full and partial lake surveys were comparable (table 1).

All aquatic plant surveys were conducted according the Wisconsin DNR point/intercept sampling protocols. Data analysis was completed in Microsoft Excel and is reported in full in Appendix A. All frequency data is reported as a percentage of points shallower than the maximum depth of plant growth. Grid sample points and associated plant, depth, and

Beecher Lake AP Survey Statistics

Year	date	full or partial	n	n < max depth	Max Rooting Depth (ft)	# of Native Species	FQI
2008	08/04/08	full	177	134	11.0	31	38.1
2009	--	--	--	--	--	--	--
2010	08/10/10	partial	114	92	7.0	26	31.3
2011	08/03/11	partial	114	101	8.0	27	34.5
2012	08/22/12	partial	121	119	9.0	26	33.3
2013	07/18/13	full	211	140	10.0	30	33.2
2014	08/13/14	full	167	138	8.0	22	31.6
2015	08/20/15	full	164	140	9.5	25	32.4
2016	08/03/16	full	151	130	8.0	29	37.3
2017	08/23/17	full	153	134	8.0	27	39.1
2018	08/05/18	full	190	134	7.0	24	37.0
2019	08/21/19	full	149	132	6.5	28	37.4

Table 1. Beecher Lake aquatic plant survey statistics.

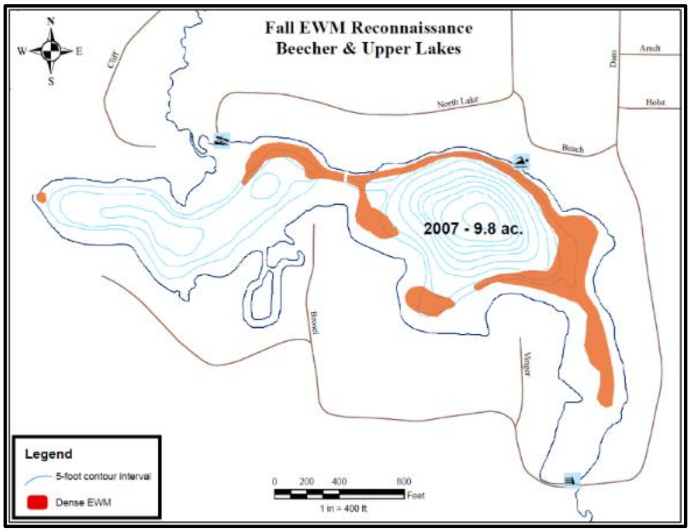

Figure 8. Fall 2007 EWM reconnaissance results. Moderate to Dense EWM covered 14.6 acres.

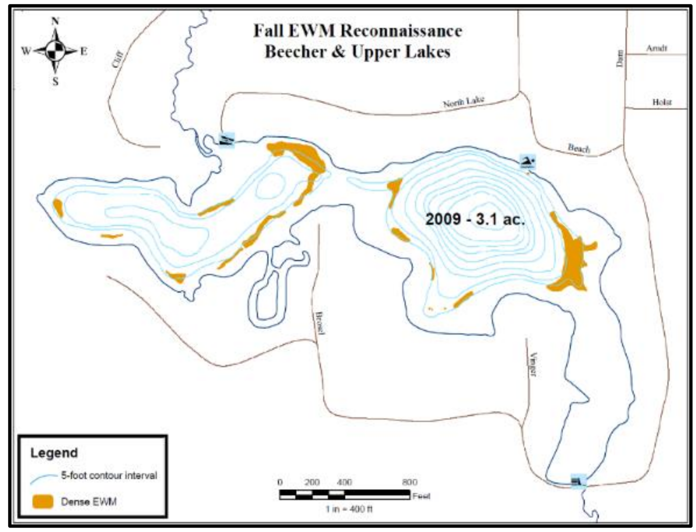

Figure 9. Fall 2009 EWM reconnaissance found 3.6 acres of moderate/dense EWM, a 55% reduction.

sediment data were mapped in a Geographic Information Systems (GIS) database.

History of EWM management efforts on Beecher Lake.

Since 2008, efforts to control EWM in Beecher Lake include several targeted herbicide treatments, two whole-lake herbicide treatments, several failed winter drawdown attempts, and one successful winter drawdown. A consecutive listing of EWM control efforts and a short discussion of individual results follows.

2008 – 2,4-D herbicide treatment

Detailed mapping in the fall of 2007 identified 14.6 acres of moderate/dense EWM encompassing much of the littoral zone of the Beecher Lake basin (figure 8). The area was treated on June 11, 2008 with Navigate 2,4-D at 100 lbs/ac. The treatment resulted in significant herbicide damage to EWM plants but poor control. A post-treatment aquatic plant survey found EWM at 38.1% of sample points. Post-treatment EWM reconnaissance mapping showed only a slight (12%) reduction in moderate/dense EWM.

2009 – 2,4-D herbicide treatment

Nearly all of the area treated in 2008 was treated again in late May 2009 with Navigate 2,4-D (12.9 acres). The application rate was increased to 150 lbs/ac in hopes of improving EWM control. No post-treatment aquatic plant survey was conducted in 2009 but EWM reconnaissance mapping showed a 55% reduction in moderate/dense EWM (figure 9).

2010 – 2,4-D herbicide treatment and winter drawdown attempt

In 2010 the Beecher Lake District received an AIS control grant (ACEI-073-10.1) to control EWM through targeted herbicide use and to evaluate the impact of winter water level drawdown on EWM and the native plant community.

Moderate/dense EWM covering 5.8 acres was treated in early May 2010 with Navigate 2,4-D at a rate of 150 lbs/ac with excellent results. Lake-wide, EWM frequency of occurrence fell to 7.6%, an 80% reduction from the most recent plant survey (2008).

A winter water level drawdown was attempted in the fall of 2010. The Beecher Lake Dam consists of a fixed crest weir with a head of 6 feet. Since the dam has no means of water level control, siphons were used to draw down the lake level. On September 11, 2010 four siphons were installed at the Beecher Lake Dam. By September 22, more than 20 inches of water had drained from the lake with little interruption of flow. Unfortunately, a 4-inch rainfall refilled the lake within a matter of days and the drawdown attempt was abandoned when it became clear the drawdown could not be completed in the permitted timeframe.

2011 - Winter drawdown attempt

Herbicides were not used in Beecher Lake in 2011 and EWM frequency of occurrence increased by nearly 82% in a single growing season.

Siphons were again installed on August 27, 2011 to conduct a winter drawdown for EWM control. The siphons worked as planned and a 4.9-foot water level reduction was achieved at the dam within 44 days. Unfortunately, unseasonably warm weather and early snow cover limited frost penetration to approximately 2.5 inches.

The 2011 winter drawdown also exposed some significant roadblocks to using water level drawdown as a EWM management tool on Beecher Lake. While the drawdown was successful in moving water over the dam it failed to achieve the expected water level reduction in the majority of Beecher and Upper Lakes. The Beecher Lake dam is located on Beecher Creek approximately 1,300 feet downstream from the lakes natural outlet. While the siphons did lower the water level near the dam, a build-up of sediment in the creek bed between the main body of the lake and the dam prevented the main body of the lake from draining sufficiently. A topographic survey of the lakebed showed that while the water level near the dam was 5 feet below full pool, the water level in the main body of Beecher Lake was only 2.5 feet below full pool.

The utility of using siphons to maintain a water level drawdown was also called into question. Although effective during warm weather, the siphons were difficult to maintain during the winter months as the pipes became encased in ice and frozen mud. In addition, while continuous flow prevented ice formation in the pipes, any interruption in flow during sub-zero weather allowed the intake pipes to freeze solid in a matter of hours, often breaking valves and fittings. These factors severely limit the utility of the siphons for winter drawdown purposes.

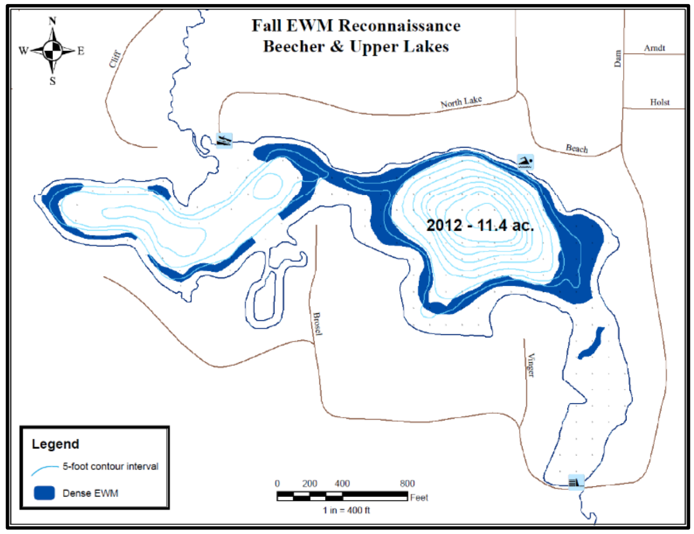

Figure 10. Fall 2012 EWM reconnaissance found 12.9 acres of moderate/dense EWM.

2012 – No EWM management efforts

In an effort to evaluate the effects of the previous winter drawdown, no aquatic herbicides were used in the spring of 2012. Unfortunately, as discussed above, unforeseen technical issues and uncooperative weather greatly reduced drawdown effectiveness. As a result, EWM frequency increased by 94%. EWM reconnaissance and mapping in the fall of 2012 showed most of the littoral zone of both lake basins supported dense milfoil growth (figure 10). The only exception was the south bay of the lake where the drawdown was nearly complete.

2013 – Whole-lake herbicide treatment

A whole-lake treatment using Dow DMA-4 2,4-D was conducted on May 17, 2013. Herbicide was applied to the entire littoral zone of both lake basins to achieve a lake-wide concentration of 335 ug/l (ppb). Monitoring sites were established at seven sites to monitor 2,4-D dissipation and degradation in a cooperative effort with the WDNR and US Army Corps of Engineers. Samples were collected at 1, 2, 3, 5, 8, 10, 15, and 22 days after treatment (DAT).

The Upper Lake basin mean herbicide concentration, 0 to 7 DAT was 232 ug/l. The Beecher Lake Basin mean herbicide concentration, 0 to 7 DAT was 377 ug/l. This indicates some flushing of herbicide from the Upper Lake basin into the Beecher Lake basin (figure 11).

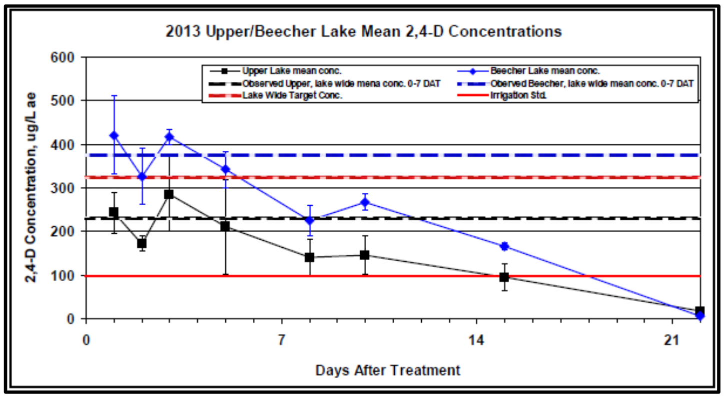

Figure 11. 2,4-D concentration monitoring results for the 2013 whole-lake treatment.

An aquatic plant survey conducted on July 18, 2013 showed a 69% reduction in EWM frequency. However, the results were not evenly distributed. EWM frequency in the Beecher Lake basin was 13.5% while the frequency in Upper Lake basin was 46%. Also, while the treatment was initially viewed as a success, EWM reconnaissance in September of 2013 showed a strong resurgence in EWM growth with moderate/dense EWM beds covering more than 9.6 acres of the lake and scattered plants throughout the littoral zone (figure 12).

2014 – Whole-lake herbicide treatment
A second whole-lake treatment was conducted on June 4, 2014 using Dow DMA-4 (liquid 2,4-D). The relatively late treatment date was the result of a late start to the growing season. The target herbicide concentration was increased to 375 ug/l to improve EWM control. Herbicide concentration monitoring was not conducted in 2014.

Post treatment aquatic plant survey results showed a 71% increase in EWM. As in 2013, differences in EWM frequency between lake basins was significant. EWM frequency in the Upper Lake basin was 82% while frequency in the Beecher basin was 20.5%. As in 2013, the whole lake treatment initially appeared successful but there was a similar resurgence of EWM late in the summer.

2015 – No EWM management efforts
Due to the poor success using aquatic herbicides, and the inability to conduct and maintain a winter water level drawdown, the Beecher Lake District did not conduct any EWM control measures in the spring/summer of 2015. As a result, EWM frequency increased to 72.3% in the Beecher Lake basin. An increase of 68%.

The Beecher Lake District received a second AIS control grant in 2015 (ACEI-172-15) to install a drainpipe with shutoff valve through the Beecher Lake Dam and dredge a channel in the lake to improve winter drawdown efficiency. A fall water level drawdown was attempted in 2015 in preparation for dam modifications and channel dredging. The water level was drawn down as much as possible but late fall rains again re-filled the lake and overwhelmed the capacity of the siphons.

2016 – No herbicide use –partial winter drawdown
No herbicides were used in 2016 as all management efforts were directed towards completing the dam modifications and channel dredging to improve winter drawdown efficiency. EWM frequency declined by 25% from the previous year. The reduction in EWM may be due to effects of the 2015/16 drawdown attempt as most of the reduction appeared to take place in very shallow areas of both lake basins and in the south bay where dewatering was nearly complete. The EWM decline was greater in the Beecher Lake basin (36.6%) than the Upper Lake basin (16.7%).

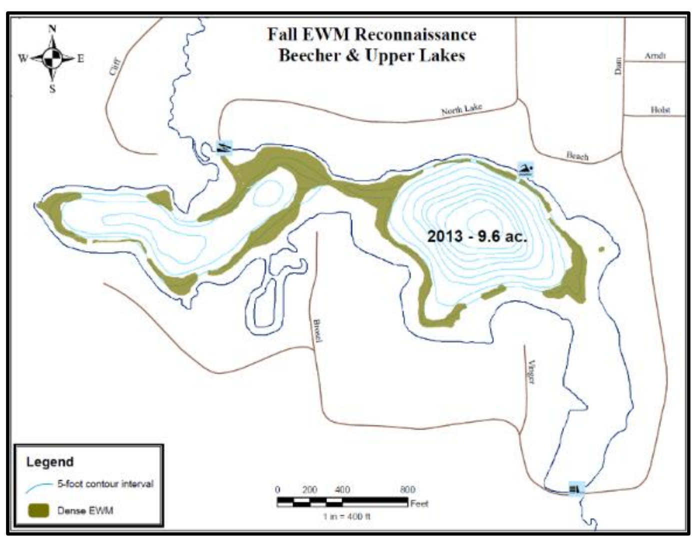

Figure 12. Fall 2013 EWM reconnaissance following whole lake 2,4-D treatments in 2012 and 2013.

The drainpipe and shutoff valve were installed in March 2016 and opened on September 3, 2016.
Three siphons were also installed to draw down the water level in preparation for the channel-dredging project.

The dredging contractor cleared the lakebed of ice and snow on January 11, 2017 to allow for frost penetration and create a haul road for heavy equipment. Channel dredging began on 1/13/17 and was completed 2/6/2017.

2017 – No herbicide use -partial winter drawdown for dredging
No herbicides were applied in 2017. The winter drawdown completed in 2016/17 for channel dredging was maintained through early February, allowing for some EWM control in shallow areas of both lake basins. EWM frequency declined by 17.7% from the previous year

2018 – Complete winter drawdown
The first complete winter drawdown of the lakes was completed in the winter of 2017/18 with excellent results. EWM frequency of occurrence fell to 8.7% in the Upper Lake basin and 2.3% in the Beecher Lake basin. Overall, there was an 88% reduction in EWM frequency.

2019 – Herbicide spot treatment
0.8-acres on the west end of Upper Lake was treated using Agristar 2,4-D Amine 4. The treatment area was enclosed using a herbicide enclosure barrier developed by the LWCD to slow herbicide dissipation rates (figure 13). Herbicide was applied at a concentration of 4.0 ppm and the barrier was left in place for 48 hours.

EWM control in the treatment area was acceptable. However, in the absence of widespread management efforts, EWM expanded by nearly 300% from the previous year. Frequency of occurrence was 21.3% in the Beecher Lake basin and 20.5% in the Upper Lake basin.

EWM response to herbicide use

Figure 13. Herbicide enclosure barrier being installed by LWCD staff.

Large-scale 2,4-D treatments have been conducted on Beecher Lake four times in a seven-year period with mixed results (figure 14). While not planned as whole-lake treatments, the 2008 and 2009 "spot treatments" resulted in lake-wide 2,4-D concentrations of 286 ug/l and 381 ug/l respectively. A much smaller (5.8 acre) treatment was conducted in 2010. Together, these herbicide treatments resulted in a dramatic decrease (78%) in EWM coverage, from 14.6 acres to 3.1 acres. Pre-treatment frequency data is not available, but post-treatment EWM frequency was 7.6% in 2010. Unfortunately, control was short-lived and EWM frequency rebounded to 80.7% in just two years.

Two planned whole-lake 2,4-D treatments conducted in 2012 and 2013 resulted in only moderate EWM control, from 80.7% occurrence to 42.8% occurrence. Again, within a year of the final treatment EWM frequency rebounded to 72.1%.

Overall, large-scale treatment of EWM with 2,4-D has been marginally successful and EWM recovery has been rapid. EWM resistance to 2,4-D has been reported with hybrid watermilfoil (*Myriophyllum spicatum x sibericum*) (Nault, 2016). However, genetic analysis of EWM in 2008 and again in 2014 did not indicate hybridization despite the existence of northern watermilfoil (*M. sibericum*) and whorled watermilfoil (*M. verticillatum*) in both lake basins.

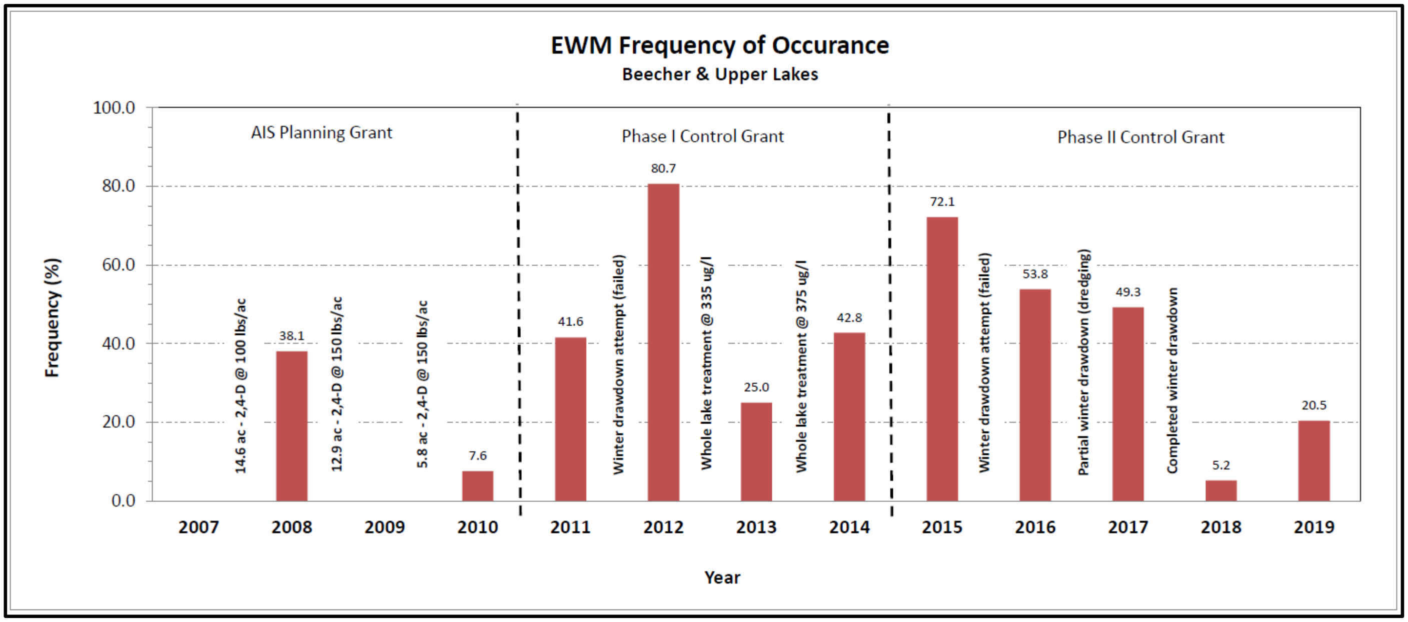

Figure 14. History of EWM management efforts on Beecher Lake and resulting EWM frequency.

Rapid herbicide degradation may be responsible for the apparent reduced efficacy of later whole-lake treatments. 2,4-D degradation occurs primarily through microbial activity, and studies have shown faster herbicide degradation in lakes with a history of frequent 2,4-D use (Nault 2017).

Dilution and water currents may also affect herbicide efficacy. A general trend of poor EWM control in the Upper Lake basin may be due to flushing of chemicals from the Upper basin into the Beecher basin due to inflow from Beecher Creek. Subsequent winter drawdowns also revealed areas of high groundwater inflow in areas of the Upper Lake basin which may result in herbicide dilution.

Herbicide effects on the native plant community

While the 2008 and 2009 herbicide treatments clearly affected the native plant community, The lack of a pretreatment aquatic plant survey makes it difficult to assign any significance to the changes or attribute them to the 2,4-D applications. Analysis of pre and post treatment aquatic plant survey data show that seven native species experienced statistically significant declines after the 2013 whole-lake treatment (table 2). In 2014 five native species experienced declines and two saw significant increases. By 2015 five native species increased in frequency while six declined. Native species that experienced the most significant and lasting declines include bushy pondweed, Fries pondweed, variable-leaf pondweed, stiff pondweed, and common bladderwort.

While it was not captured in the 2013-2015 aquatic plant data, there was a lake-wide decline in watershield following the 2008 & 2009 large scale 2,4-D treatments. Once the dominant floating-leaf plant in the lake, watershield almost disappeared by 2011. Even though floating-leaf vegetation is difficult to sample with point-intercept surveys, watershield frequency fell from 38.1% in 2008 to 5.9% in 2011.

EWM response to winter water level drawdown

The history of drawdown attempts on Beecher Lake is marked by early repeated failures to complete a drawdown and an inability to maintain the drawdown through the winter months. The earliest attempts to conduct a drawdown using only siphons were thwarted by heavy rainfall that exceeded the capacity of the siphons. The first drawdown attempt in 2011 was short-lived and was followed by an increase in EWM frequency from 41.6% to 80.7%, a 93%

Species		2013	2014	2015
Brasenia schreberi	Water shield	n.s.	+	+
Ceratophyllum demersum	Coontail	n.s.	n.s.	n.s.
Chara sp.	Musk grass	n.s.	n.s.	n.s.
Myriophyllum verticilatum	Whorled watermilfoil	n.s.	n.s.	+ + +
Najas flexilis	Bushy pondweed	- - -	- - -	- - -
Nitella sp.	Stonewort	n.s.	n.s.	n.s.
Nuphar variegata	Spatterdock	n.s.	n.s.	n.s.
Nymphaea odorata	White water lily	n.s.	n.s.	n.s.
Potamogeton amplifolius	Large leaf pondweed	n.s.	n.s.	n.s.
Potamogeton friesii	Frie's pondweed	- - -	- - -	- - -
Potamogeton gramineus	Variable pondweed	n.s.	- -	- - -
Potamogeton natans	Floating leaf pondweed	-	n.s.	n.s.
Potamogeton praelongus	White stem pondweed	n.s.	n.s.	n.s.
Potamogeton pusillus	Small pondweed	-	n.s.	n.s.
Potamogeton strictifolius	Stiff pondweed	- - -	- - -	- - -
Potamogeton zosteriformus	Flat-stem pondweed	-	n.s.	-
Utricularia gemniscapa	Twin-stemmed bladderwort	n.s.	n.s.	+ +
Utricularia gibba	Creeping bladderwort	n.s.	+	+ + +
Utricularia intermedia	Flat leaf bladderwort	n.s.	n.s.	+ +
Utricularia minor	Small bladderwort	n.s.	n.s.	n.s.
Utricularia purpurea	Large purple bladderwort	n.s.	n.s.	n.s.
Utricularia vulgaris	Common bladderwort	- -	- -	- -
# of species with significant increase		0	2	5
# of species with significant decrease		7	5	6

Table 2. Pearsons's chi-square analysis of pretreatment versus post-treatment frequency for all native species > 5% littoral frequency. Statistically significant changes indicated by the number of indicator signs (+ = P <0.05; ++ = P <0.01; +++ = P <0.001; n.s. = not significant).

increase. This followed a steep increase (447%) in 2010 and may just represent a rebound in the EWM population following a series of successful herbicide treatments in 2008 and 2009.

Partial winter drawdowns in 2015 and 2016 resulted in small reductions in EWM frequency (25% and 17.7% respectively). Both drawdowns resulted in complete dewatering of the south arm of the lake and a 2.5-foot drawdown of both lake basins, exposing approximately 14.6 acres of lakebed, or 42% of the littoral zone. The reduction in EWM frequency was most prominent in the south arm of the lake and the shallow west bay where dewatering was complete.

The first complete winter drawdown was completed in the winter of 2017-18, exposing approximately 29 acres of lakebed, or nearly 85% of the littoral zone. Despite heavy snow cover the drawdown resulted in a reduction of EWM from 44.3% to 5.2%, an 88% reduction in frequency (figure 15).

Longevity of winter drawdown effects on EWM

Between 2018 and 2019 EWM frequency increased from 5% to 20.5%. While this represents a dramatic rebound (294% increase), EWM frequency was still lower than the frequency following the 2013 and 2014 whole-lake herbicide treatments (25%). Two years after the first complete winter drawdown the longevity of EWM control is at least as good as the longevity of the earliest herbicide treatments and significantly better than the back-to-back whole lake treatments in 2013-14.

Studies of the effects of winter drawdown on EWM show that nuisance reduction is typically temporary. EWM recolonization is thought to be primarily a result of plant fragments from surviving plants. Nuisance conditions have been reported to reoccur within two to five years. Locally, winter drawdowns on High Falls Flowage and Peshtigo Flowage have resulted in excellent EWM control with nuisance relief lasting approximately three years (pers. knowledge).

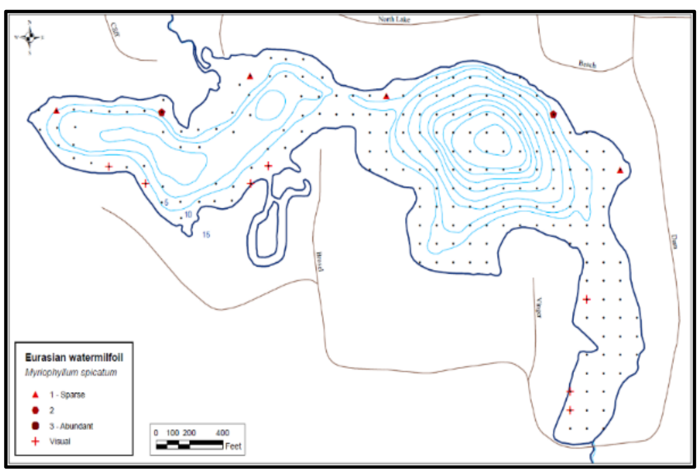

Figure 15. Aquatic plant survey map showing results for EWM following the 2017/18 winter drawdown.

Species		2018	2019
Brasenia schreberi	Water shield	- -	n.s.
Ceratophyllum demersum	Coontail	- -	- - -
Chara sp.	Musk grass	+ + +	+ + +
Myriophyllum verticilatum	Whorled watermilfoil	n.s.	+ + +
Najas flexilis	Bushy pondweed	n.s.	+ + +
Nitella sp.	Stonewort	n.s.	+ + +
Nuphar variegata	Spatterdock	n.s.	+ +
Nymphaea odorata	White water lily	-	n.s.
Potamogeton amplifolius	Large leaf pondweed	-	n.s.
Potamogeton friesii	Frie's pondweed	n.s.	n.s.
Potamogeton gramineus	Variable pondweed	n.s.	n.s.
Potamogeton natans	Floating leaf pondweed	n.s.	n.s.
Potamogeton praelongus	White stem pondweed	n.s.	+
Potamogeton pusillus	Small pondweed	n.s.	n.s.
Potamogeton strictifolius	Stiff pondweed	n.s.	n.s.
Potamogeton zosteriformus	Flat-stem pondweed	n.s.	n.s.
Utricularia gemniscapa	Twin-stemmed bladderwort	n.s.	+ +
Utricularia gibba	Creeping bladderwort	n.s.	n.s.
Utricularia intermedia	Flat leaf bladderwort	n.s.	+ +
Utricularia minor	Small bladderwort	n.s.	n.s.
Utricularia purpurea	Large purple bladderwort	n.s.	n.s.
Utricularia vulgaris	Common bladderwort	n.s.	+ +
# of species with significant increase		**1**	**9**
# of species with significant decrease		**4**	**1**

Table 3. Pearsons's chi-square analysis of pretreatment versus post-treatment frequency for all native species > 5% littoral frequency. Statistically significant changes indicated by the number of indicator signs (+ = P <0.05; ++ = P <0.01; +++ = P <0.001; n.s. = not significant).

Drawdown effects on the native plant community

The response of many native plants to winter drawdown has been described in several studies. Native plants in Beecher Lake generally followed the reported responses to winter drawdown. Table 3 lists native species that experienced statistically significant changes in frequency following the 2017 winter drawdown. In the first-year post-drawdown watershield, coontail, large-leaf pondweed, and white water lily experienced significant declines while muskgrass showed a significant increase. Two years after the drawdown only coontail had significantly lower frequency while nine native species showed significant increases in frequency. These include spatterdock water lily and whorled watermilfoil, both which are widely reported to decline in response to winter drawdown.

EWM Management Recommendations

Having successfully completed the dam modification and dredging portions of the grant, the main planning goal is to: **Update the long-range integrated AIS management strategy to control EWM while protecting the native plant community**.

Prior to 2017 the only management tool available to the Beecher Lake District was the periodic use of aquatic herbicides. While early results were promising, later treatments using 2,4-D were only marginally successful and control was short lived. The poor results may be due to rapid breakdown of herbicides or development of herbicide resistance in EWM in Beecher Lake.

The 2017 winter drawdown exposed nearly 85% of the littoral zone (figure 16), providing excellent control of EWM and at least two years of nuisance relief. Based on earlier drawdown attempts and knowledge of drawdown longevity in similar local waterways (Peshtigo River Flowages), it is likely that winter drawdowns will provide at least three years of nuisance relief. Early results also point to secondary benefits including a slight reduction in floating leaf vegetation (watershield and white water lily) and increases in low-growing species like stonewort, bushy pondweed, and bladderworts. In Beecher Lake stonewort and bushy pondweed tend to form dense growths that resist EWM re-infestation.

Winter drawdown for EWM control

Based on a review of EWM management efforts conducted in the Phase I & Phase II AIS Control Grants, the Beecher Lake District should conduct periodic winter water level drawdowns as the primary method of controlling EWM in Beecher and Upper Lakes.

Note that while the 2017 winter drawdown provided excellent EWM control, specific conditions must be

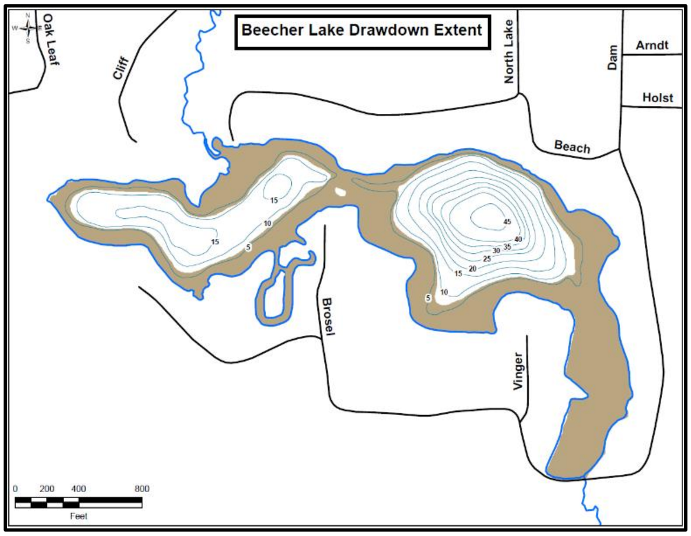

Figure 16. Approximate extent of exposed sediment during a maximum drawdown of Beecher Lake.

met for the practice to be effective. According to laboratory and field studies conducted by Lonergan (2014), EWM control requires exposing the plants root crowns to a temperature of -5 C (23 F) for 24 hours or longer with a slow thawing (> 12 h) of the root crown. While local winters are sufficiently cold and lengthy to result in EWM control, heavy snow-cover can effectively insulate the sediment from freezing temperatures. Lonergan also showed that desiccation (drying of the sediment) can kill EWM root crowns. To improve the chances of success, winter drawdowns should be completed by October to take advantage of desiccation and early snow-free cold weather. Drawdowns should also be maintained through the winter to increase the odds of achieving EWM control. If a winter drawdown fails to control EWM it should be repeated the following year.

A successful winter drawdown should be expected to provide three years of EWM control. With time EWM will re-invade most of the littoral zone. To be effective at controlling EWM and protecting the native plant community winter drawdowns will need to be repeated on a regular basis. The frequency of winter drawdowns should be based on nuisance levels of EWM. Generally, nuisance conditions occur when EWM frequency of occurrence exceeds 30%.

Beecher Lake dam modifications

The 2017 winter drawdown was completed using the newly installed drain pipe and the three 6-inch siphons, allowing for a drawdown rate of approximately 1-inch per day. A second drain pipe would eliminate the need to use siphons and will provide additional capacity to handle large rain events that are predicted to increase with continued global warming.

Herbicide use

In some areas of the lake spring seepage, flowing water, or depth may "protect" EWM from the effects of winter drawdown. In these areas herbicide use remains an option for controlling nuisance EWM.

With small treatment areas or in areas with high water exchange rates from groundwater input or flow it may be beneficial to use herbicide enclosure barriers. The Marinette County LWCD has pioneered the use of light-weight barriers that are easy to deploy and effective. The barriers reduce the amount of herbicide required and hold chemicals on-site to increase the concentration exposure time.

Careful consideration of active ingredients should be made, especially if EWM continues to resist control with 2,4-D. Other chemicals that are effective for EWM control include Diquat and Endothol, unfortunately both also control bushy pondweed, most bladderworts, and many of the native pondweeds found in Beecher Lake. For this reason treating large areas with these herbicides should be avoided. Any use of these or other broad-spectrum herbicides should be limited to areas where EWM is dominant and herbicide enclosure barriers should be used to reduce off-site impacts to native species.

Manual hand pulling & DASH harvesting

Manually pulling EWM can be an effective control measure if the roots are harvested along with the plant. Diver Assisted Suction Harvesting (DASH) speeds the process by using divers and a suction system to transport plants to the surface for disposal. Unfortunately, hand pulling is very labor intensive and best suited to harvesting scattered EWM. DASH harvesting works best where water clarity is good and EWM can be identified and marked from the surface.

Individual landowners may want to prolong the effects of winter drawdown or herbicide use by hand pulling plants as they invade swimming areas.

Currently limited staff time severely restricts the amount of DASH harvesting that can be accomplished using the county-owned DASH boat and controlling pioneer infestations has been prioritized over maintenance harvesting. The LWCD has been exploring alternate funding sources to increase the availability of DASH harvesting in the county.

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Appendix A

Aquatic Plant Survey Data

for

Beecher & Upper Lakes

2008 – 2019

Whole lake survey by C. Druckrey, M. Nault, A. Mikulyuk

8/4/2008

2008

Maximum rooting depth = 11 feet
FQI = 38.1
n=177

Scientific Name	Common Name	Combined Frequency	Combined Avg. rake fullness
Brasenia schreberi	Water shield	26.1	1.6
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	33.6	1.4
Chara sp.	Musk grass	59.7	1.9
Dulichium arundinaceum	Three way sedge		
Eleocharis acicularis	Hairgrass	2.2	1.0
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	6.7	1.1
Elodea nuttallii	Slender waterweed	0.7	1.0
Filamentous algae	Fillamentous algae	6.0	1.0
Freshwater sponge	Freshwater sponge	7.5	1.1
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	9.7	1.0
Myriophyllum sibericum	Northern water milfoil	1.5	1.0
Myriophyllum spicatum	Eurasian water milfoil	38.1	1.4
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	21.6	1.1
Nitella sp.	Stonewort	28.4	1.4
Nuphar variegata	Spatterdock	8.2	1.3
Nymphea odorata	White water lily	15.7	1.0
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	14.9	1.2
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed	1.5	1.0
Potamogeton foliosus	Leafy pondweed		
Potamogeton friessi	Frie's pondweed	0.7	1.0
Potamogeton gramineus	Variable pondweed	28.4	1.1
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed	4.5	1.0
Potamogeton natans	Floating leaf pondweed	2.2	1.0
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	7.5	1.0
Potamogeton pusilis	Small pondweed	22.4	1.2
Potamogeton strictifolius	Stiff pondweed	3.0	1.0
Potamogeton zosteriformis	Flat-stem pondweed	4.5	1.0
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush	4.5	1.0
Sparganium fluctuans	Floating leaf burreed	2.2	1.0
Stuckenia pectinata	Sago pondweed		
Typha sp.	Cattail		
Unknown Moss	Moss	27.6	1.3
Utricularia gemniscapa	Twin-stemmed bladderwort	1.5	1.0
Utricularia gibba	Creeping bladderwort	15.7	2.0
Utricularia intermedia	Flat leaf bladderwort	6.7	1.0
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	11.2	1.1
Vallisneria americana	Water celery		
Zosterella dubia	Water stargrass		

partial lake survey by C. Druckrey

8/10/2010

Maximum rooting depth = 7 feet

FQI = 31.3

n=114

Scientific Name	Common Name	2010 Combined Frequency	Combined Avg. rake fullness
Brasenia schreberi	Water shield	19.6	1.2
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	37.0	1.3
Chara sp.	Musk grass	64.1	**2.2**
Dulichium arundinaceum	Three way sedge		
Eleocharis acicularis	Hairgrass	3.3	1.3
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	5.4	1.2
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	6.5	1.2
Myriophyllum sibericum	Northern water milfoil	1.1	1.0
Myriophyllum spicatum	Eurasian water milfoil	7.6	1.1
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	41.3	1.4
Nitella spp.	Stonewort	9.8	1.0
Nuphar variegata	Spatterdock	3.3	1.7
Nymphea odorata	White water lily	33.7	2.2
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	27.2	1.2
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed		
Potamogeton foliosus	Leafy pondweed	1.1	1.0
Potamogeton friessi	Frie's pondweed		
Potamogeton gramineus	Variable pondweed	23.9	1.2
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed		
Potamogeton natans	Floating leaf pondweed	3.3	1.0
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	4.3	1.0
Potamogeton pusilis	Small pondweed	8.7	1.1
Potamogeton strictifolius	Stiff pondweed	7.6	1.0
Potamogeton zosteriformis	Flat-stem pondweed	8.7	1.1
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed		
Stuckenia pectinata	Sago pondweed	1.1	3.0
Typha sp.	Cattail		
Unknown Moss	Moss	8.7	1.8
Utricularia gemniscapa	Twin-stemmed bladderwort	2.2	1.0
Utricularia gibba	Creeping bladderwort	33.7	1.1
Utricularia intermedia	Flat leaf bladderwort	37.0	1.3
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort	5.4	1.0
Utricularia vulgaris	Common bladderwort	34.8	1.2

partial lake survey by C. Druckrey

8/3/2011

Maximum rooting depth = 8 feet

FQI = 34.5

n=114

Scientific Name	Common Name	2011 Combined Frequency	2011 Combined Avg. rake fullness
Brasenia schreberi	Water shield	5.9	1.2
Callitriche sp.	water starwort	1.0	3.0
Ceratophyllum demersum	Coontail	52.5	1.3
Chara sp.	Musk grass	30.7	1.6
Dulichium arundinaceum	Three way sedge		
Eleocharis acicularis	Hairgrass	3.0	1.0
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	5.9	1.0
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalondonta beckii	Water marigold	12.9	1.2
Myriophyllum sibiricum	Northern water milfoil	2.0	1.0
Myriophyllum spicatum	Eurasian water milfoil	41.6	1.4
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	42.6	1.2
Nitella sp.	Stonewort	51.5	1.8
Nuphar variegata	Spatterdock	5.9	1.0
Nymphaea odorata	White water lily	30.7	2.3
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	27.7	1.2
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed		
Potamogeton foliosus	Leafy pondweed		
Potamogeton friesii	Frie's pondweed	21.8	1.2
Potamogeton graminaeus	Variable pondweed	20.8	1.1
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed	1.0	1.0
Potamogeton natans	Floating leaf pondweed	4.0	1.3
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	5.9	1.0
Potamogeton pusillus	Small pondweed	9.9	1.0
Potamogeton strictifolius	Stiff pondweed	9.9	1.8
Potamogeton zosteriformis	Flat-stem pondweed	10.9	1.1
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed		
Stuckenia pectinata	Sago pondweed	5.0	1.2
Typha sp.	Cattail		
Unknown Moss	Moss	48.5	1.5
Utricularia geminiscapa	Twin-stemmed bladderwort	5.0	1.0
Utricularia gibba	Creeping bladderwort	33.7	1.1
Utricularia intermedia	Flat leaf bladderwort	50.5	1.3
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	7.9	1.3

Partial lake survey by C. Druckrey and Jake Budish

8/22/2012

Maximum rooting depth = 9 feet

FQI = 33.3

n=121

Scientific Name	Common Name	2012 Combined Frequency	2012 Combined Avg. rake fullness
Brasenia schreberi	Water shield	0.8	1.0
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	15.1	1.0
Chara sp.	Musk grass	38.7	1.3
Dulichium arundinaceum	Three way sedge		
Eleocharis acicularis	Hairgrass		
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	1.7	1.0
Elodea nuttallii	Slender waterweed		
Filamentous Algae	Fillamentous algae	1.7	1.0
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	0.8	1.0
Myriophyllum sibiricum	Northern water milfoil	3.4	1.0
Myriophyllum spicatum	Eurasian water milfoil	80.7	1.7
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	70.6	2.0
Nitella sp.	Stonewort	10.1	1.2
Nuphar variegata	Spatterdock	5.9	1.1
Nymphaea odorata	White water lily	16.8	1.5
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	10.1	1.3
Potamogeton diversofolius	Water-thread pondweed	0.8	1.0
Potamogeton epihydrus	Ribbon leaf pondweed	5.0	1.0
Potamogeton foliosus	Leafy pondweed		
Potamogeton fresii	Frie's pondweed	23.5	1.2
Potamogeton graminaeus	Variable pondweed	38.7	1.2
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed		
Potamogeton natans	Floating leaf pondweed	10.1	1.0
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	5.9	1.0
Potamogeton pusillus	Small pondweed	5.0	1.0
Potamogeton strictifolius	Stiff pondweed	10.9	1.2
Potamogeton zosteriformis	Flat-stem pondweed	9.2	1.2
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Spargaium fluctuans	Floating leaf burreed	0.8	1.0
Stuckenia pectinata	Sago pondweed	2.5	2.0
Typha sp.	Cattail		
Unknown Moss	Moss	0.8	1.0
Utricularia geminiscapa	Twin-stemmed bladderwort	1.7	1.0
Utricularia gibba	Creeping bladderwort		
Utricularia intermedia	Flat leaf bladderwort	0.8	1.0
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort		

Whole Lake survey. Upper Lake by C. Druckrey. Beecher Lake by B. Nordin and others

7/18/2013

Maximum rooting depth = 10 feet

FQI = 33.2

n=211

Scientific Name	Common Name	2013 Combined Frequency	Combined Avg. rake fullness
Brasenia schreberi	Water shield	5.7	1.3
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	16.4	1.3
Chara sp.	Musk grass	52.1	1.3
Dulichium arundinaceum	Three way sedge		
Eleocharis acccicularis	Hairgrass	0.7	2.0
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	1.4	1.0
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow	1.4	1.0
Megalodonta beckii	Water marigold		
Myriophyllum sibericum	Northern water milfoil	1.4	1.0
Myriophyllum spicatum	Eurasian water milfoil	25.0	1.4
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	12.1	1.1
Nitella sp.	Stonewort	7.9	1.5
Nuphar variegata	Spatterdock	2.1	1.3
Nymphaea odorata	White water lily	11.4	1.7
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	8.6	1.5
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed	5.0	1.0
Potamogeton foliosus	Leafy pondweed		
Potamogeton friesii	Frie's pondweed	0.7	2.0
Potamogeton gramineus	Variable pondweed	31.4	1.4
Potamogeton hilli	Hill's pondweed	2.9	1.3
Potamogeton illinoensis	Illinois pondweed	0.7	2.0
Potamogeton natans	Floating leaf pondweed	3.6	1.4
Potamogeton obtusifolius	Blunt-leaf pondweed	2.9	1.0
Potamogeton praelongus	White stem pondweed	5.7	1.3
Potamogeton pusillus	Small pondweed	0.7	1.0
Potamogeton strictifolius	Stiff pondweed		
Potamogeton zosteriformus	Flat-stem pondweed	2.1	1.7
Schoenoplectus acutus	Hardstem bulrush	0.7	1.0
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed		
Stuckenia pectinata	Sago pondweed	0.7	2.0
Typha sp.	Cattail		
Unknown Moss	Moss	3.6	1.0
Utricularia gemniscapa	Twin-stemmed bladderwort	1.4	1.0
Utricularia gibba	Creeping bladderwort	2.9	1.0
Utricularia intermedia	Flat leaf bladderwort	4.3	1.0
Utricularia minor	Small bladderwort	2.9	1.0
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	7.9	1.5

Whole lake survey by C. Druckrey

8/13/2014

Maximum rooting depth = 8 feet

FQI = 31.6

n=167

Scientific Name	Common Name	2014 Combined Frequency	Combined Avg. rake fullness
Brasenia schreberi	Water shield	8.0	1.3
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	29.0	1.5
Chara sp.	Musk grass	60.1	1.5
Dulichium arundinaceum	Three way sedge		
Eleocharis accicularis	Hairgrass		
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	4.3	1.0
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	2.2	1.0
Myriophyllum sibericum	Northern water milfoil		
Myriophyllum spicatum	Eurasian water milfoil	42.8	1.6
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	15.9	1.1
Nitella sp.	Stonewort	8.0	1.3
Nuphar variegata	Spatterdock	9.4	1.3
Nymphaea odorata	White water lily	16.7	1.5
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	15.2	1.2
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed	2.9	1.0
Potamogeton foliosus	Leafy pondweed		
Potamogeton friesii	Frie's pondweed		
Potamogeton gramineus	Variable pondweed	23.2	1.1
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed	7.2	1.0
Potamogeton natans	Floating leaf pondweed	8.0	1.5
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	6.5	1.2
Potamogeton pusillus	Small pondweed	6.5	1.0
Potamogeton strictifolius	Stiff pondweed		
Potamogeton zosteriformus	Flat-stem pondweed	5.1	1.1
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed		
Stuckenia pectinata	Sago pondweed		
Typha sp.	Cattail		
Unknown Moss	Moss	29.7	1.1
Utricularia gemniscapa	Twin-stemmed bladderwort	6.5	1.0
Utricularia gibba	Creeping bladderwort	5.1	1.0
Utricularia intermedia	Flat leaf bladderwort	5.8	1.0
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	8.7	1.1

Whole lake survey by C. Druckrey

8/20/2015

2015

Maximum rooting depth = 9.5 feet

FQI = 32.4

n=164

Scientific Name	Common Name	Frequency	Avg. rake fullness
Brasenia schreberi	Water shield	8.6	1.1
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	27.1	1.3
Chara sp.	Musk grass	48.6	1.3
Dulichium arundinaceum	Three way sedge		
Eleocharis accicularis	Hairgrass	4.3	1.0
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	1.4	1.0
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	6.4	1.1
Myriophyllum sibericum	Northern water milfoil	2.1	1.0
Myriophyllum spicatum	Eurasian water milfoil	72.1	1.7
Myriophyllum verticilatum	Whorled watermilfoil		
Najas flexilis	Bushy pondweed	45.7	1.5
Nitella sp.	Stonewort	12.9	1.0
Nuphar variegata	Spatterdock	7.1	1.0
Nymphaea odorata	White water lily	25.7	1.6
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	19.3	1.1
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed	2.9	1.0
Potamogeton foliosus	Leafy pondweed	4.3	1.3
Potamogeton friesii	Frie's pondweed		
Potamogeton gramineus	Variable pondweed	14.3	1.1
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed	0.7	1.0
Potamogeton natans	Floating leaf pondweed	10.0	1.1
Potamogeton obtusifolius	Blunt-leaf pondweed		
Potamogeton praelongus	White stem pondweed	9.3	1.0
Potamogeton pusillus	Small pondweed	2.1	1.0
Potamogeton strictifolius	Stiff pondweed		
Potamogeton zosteriformus	Flat-stem pondweed	2.1	1.0
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed		
Stuckenia pectinata	Sago pondweed	0.7	1.0
Typha sp.	Cattail		
Unknown Moss	Moss		
Utricularia gemniscapa	Twin-stemmed bladderwort	12.9	1.0
Utricularia gibba	Creeping bladderwort	12.9	1.0
Utricularia intermedia	Flat leaf bladderwort	10.0	1.1
Utricularia minor	Small bladderwort		
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	7.9	1.0
Vallisneria americana	Water celery		
Zosterella dubia	Water stargrass		

Whole lake survey by C. Druckrey

8/3/2016

2016

Maximum rooting depth = 8.0 feet

FQI = 37.3

n=151

Scientific Name	Common Name	Frequency	Avg. rake fullness
Brasenia schreberi	Water shield	9.2	1.2
Callitriche sp.	water starwort		
Ceratophyllum demersum	Coontail	20.0	1.2
Chara sp.	Musk grass	60.8	1.4
Dulichium arundinaceum	Three way sedge		
Eleocharis accicularis	Hairgrass	7.7	1.2
Eleocharis palustris	Creeping spikerush		
Elodea canadensis	Common waterweed	4.6	1.3
Elodea nuttallii	Slender waterweed		
Filamentous algae	Fillamentous algae		
Freshwater sponge	Freshwater sponge		
Justica sp.	Water willow		
Megalodonta beckii	Water marigold	6.9	1.1
Myriophyllum sibericum	Northern water milfoil	2.3	1.0
Myriophyllum spicatum	Eurasian water milfoil	53.8	1.5
Myriophyllum verticilatum	Whorled watermilfoil	0.8	1.0
Najas flexilis	Bushy pondweed	60.0	1.3
Nitella sp.	Stonewort	13.8	1.4
Nuphar variegata	Spatterdock	11.5	1.0
Nymphaea odorata	White water lily	13.8	1.8
P. unk #1	Unk. pondweed		
Potamogeton amplifolius	Large leaf pondweed	10.0	1.1
Potamogeton diversofolius	Water-thread pondweed		
Potamogeton epihydrus	Ribbon leaf pondweed	1.5	1.0
Potamogeton foliosus	Leafy pondweed	3.1	1.0
Potamogeton friesii	Frie's pondweed		
Potamogeton gramineus	Variable pondweed	16.2	1.1
Potamogeton hilli	Hill's pondweed		
Potamogeton illinoensis	Illinois pondweed		
Potamogeton natans	Floating leaf pondweed	6.9	1.3
Potamogeton obtusifolius	Blunt-leaf pondweed	0.8	1.0
Potamogeton praelongus	White stem pondweed	9.2	1.1
Potamogeton pusillus	Small pondweed	10.8	1.0
Potamogeton strictifolius	Stiff pondweed	6.2	1.0
Potamogeton zosteriformus	Flat-stem pondweed	3.1	1.0
Schoenoplectus acutus	Hardstem bulrush		
Schoenoplectus subterminalis	water bulrush		
Sparganium fluctuans	Floating leaf burreed	2.3	1.0
Stuckenia pectinata	Sago pondweed	0.8	1.0
Typha sp.	Cattail		
Unknown Moss	Moss		
Utricularia gemniscapa	Twin-stemmed bladderwort	3.1	1.0
Utricularia gibba	Creeping bladderwort	6.9	1.0
Utricularia intermedia	Flat leaf bladderwort	15.4	1.1
Utricularia minor	Small bladderwort	11.5	1.0
Utricularia purpurea	Large purple bladderwort		
Utricularia vulgaris	Common bladderwort	9.2	1.1
Vallisneria americana	Water celery		
Zosterella dubia	Water stargrass		

Whole lake survey by C. Druckrey

8/23/2017

2017

Maximum rooting depth = 8.0 feet

FQI = 39.1

n=153

Scientific Name	Common Name	Frequency	Avg. rake fullness
Brassenia schreberii	watershield	20.9	7.6
Ceratophylum demersum	coontail	44.0	15.9
Chara sp	muskgrass	3.7	1.4
Dulichium arundinaceum	three-way sedge		
Eleocharis accicularis	needle spikerush	8.2	3.0
Eleocharis palustris	creeping spikerush	3.0	1.1
Elodea canadensis	common waterweed	0.7	0.3
Equisetum fluvitale	water horsetail	0.7	0.3
Megalodanta beckii	water marigold	0.7	0.3
Myriophyllum sibericum	northern watermilfoil	0.7	0.3
Myriophyllum spicatum	Eurasian water-milfoil	49.3	17.8
Myriophyllum verticilatum	whorled watermilfoil		
Najas flexilis	bushy pondweed	18.7	6.8
Nitella sp	stonewort	11.9	4.3
Nuphar variegata	spatterdock pond lily	4.5	1.6
Nymphea odorata	white water lily	21.6	7.8
Potamogeton amplifolius	large-leaf pondweed	6.0	2.2
Potamogeton epihydrus	ribbon-leaf pondweed	1.5	0.5
Potamogeton foliosus	leafy pondweed		
Potamogeton graminaeus	variable pondweed	26.1	9.5
Potamogeton natans	floating-leaf pondweed	6.0	2.2
Potamogeton obtusifolius	blunt-leaf pondweed	9.7	3.5
Potamogeton praelongus	white-stem pondweed	2.2	0.8
Potamogeton strictifolius	stiff pondweed	1.5	0.5
Potamogeton zosteriformis	flat-stem pondweed		
Saggiteria sp.	arrowhead sp.	0.7	0.3
Sparganium chlorocarpum	short-stemmed bur-reed	0.7	0.3
Sparganium fluctuans	floating-leaf burreed	4.5	1.6
Stuckenia pectinata	sago pondweed		
Utricularia gemniscapa	twin-stemmed bladderwort	3.7	1.4
Utricularia gibba	creeping bladderwort	1.5	0.5
Utricularia intermedia	flat-leaf bladderwort	9.7	3.5
Utricularia minor	small bladderwort	7.5	2.7
Utricularia vulgaris	common bladderwort	6.0	2.2

Whole lake survey by C. Druckrey & B. Nordin

8/5/2018 **2018**

Maximum rooting depth = 7.0 feet

FQI = 37.0

n= 190

Scientific Name	Common Name	Frequency	Avg. rake fullness
Brassenia schreberii	watershield	7.5	1.0
Ceratophylum demersum	coontail	22.4	1.1
Chara sp	muskgrass	42.5	1.1
Eleocharis accicularis	needle spikerush	9.7	1.0
Equisetum fluvitale	water horsetail	0.7	1.0
Megalodanta beckii	water marigold	0.7	1.0
Myriophyllum sibericum	northern watermilfoil	4.5	1.2
Myriophyllum spicatum	Eurasian water-milfoil	5.2	1.3
Myriophyllum verticilatum	whorled watermilfoil	1.5	1.0
Najas flexilis	bushy pondweed	29.9	1.1
Najas guadalupensis	southern niad	6.7	1.0
Nitella sp	stonewort	7.5	1.0
Nuphar variegata	spatterdock pond lily	11.9	1.0
Nymphea odorata	white water lily	9.7	1.4
Potamogeton amplifolius	large-leaf pondweed	0.7	1.0
Potamogeton epihydrus	ribbon-leaf pondweed	1.5	1.0
Potamogeton foliosus	leafy pondweed	0.7	1.0
Potamogeton graminaeus	variable pondweed	23.1	1.1
Potamogeton natans	floating-leaf pondweed	2.2	1.0
Potamogeton pusillus	small pondweed	3.7	1.0
Schoenoplectus subterminalis	water bullrush	3.7	1.2
Sparganium fluctuans	floating-leaf burreed	0.7	1.0
Utricularia gibba	creeping bladderwort	5.2	1.0
Utricularia intermedia	flat-leaf bladderwort	18.7	1.6
Utricularia minor	small bladderwort	11.2	1.2
Utricularia vulgaris	common bladderwort	7.5	1.2

Whole lake survey by C. Druckrey & B. Devine

8/21/2019

Maximum rooting depth = 6.5 feet

FQI = 37.4

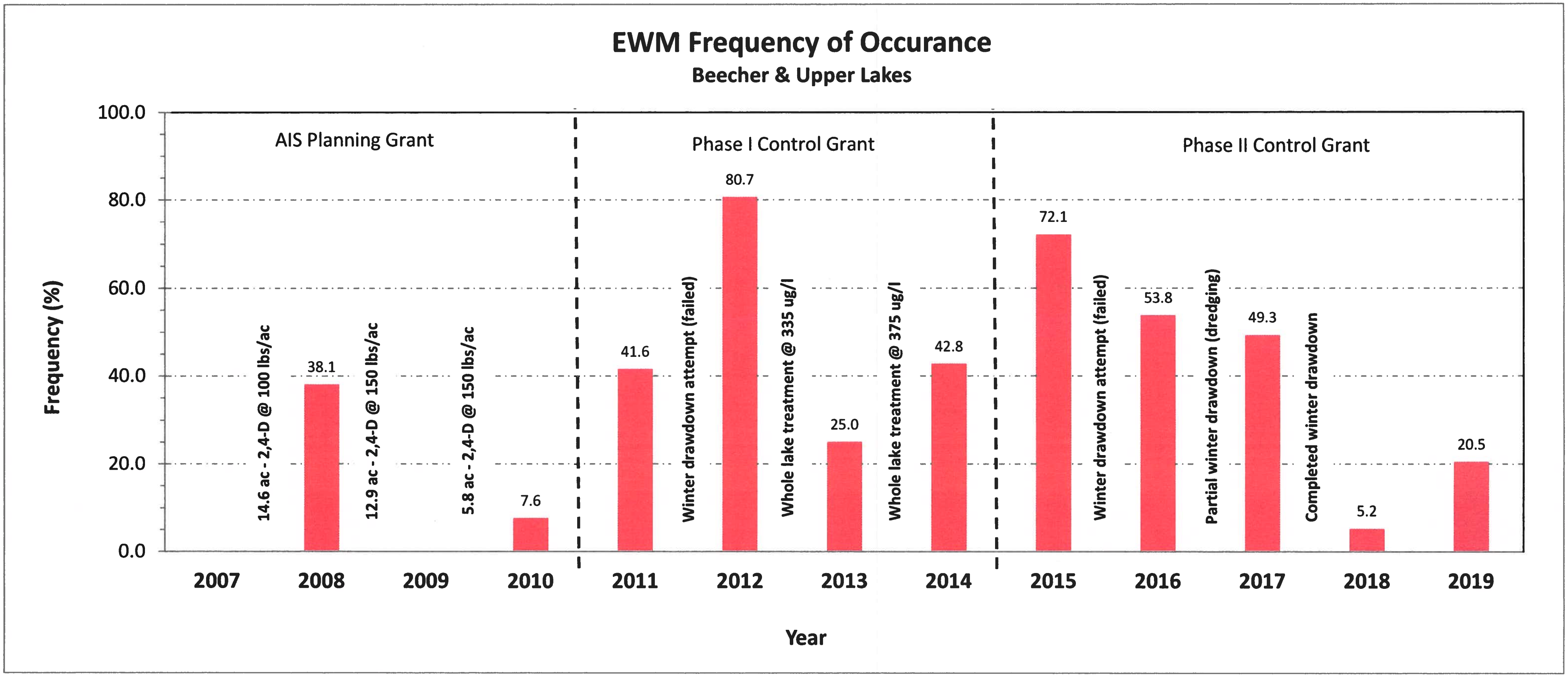
2019

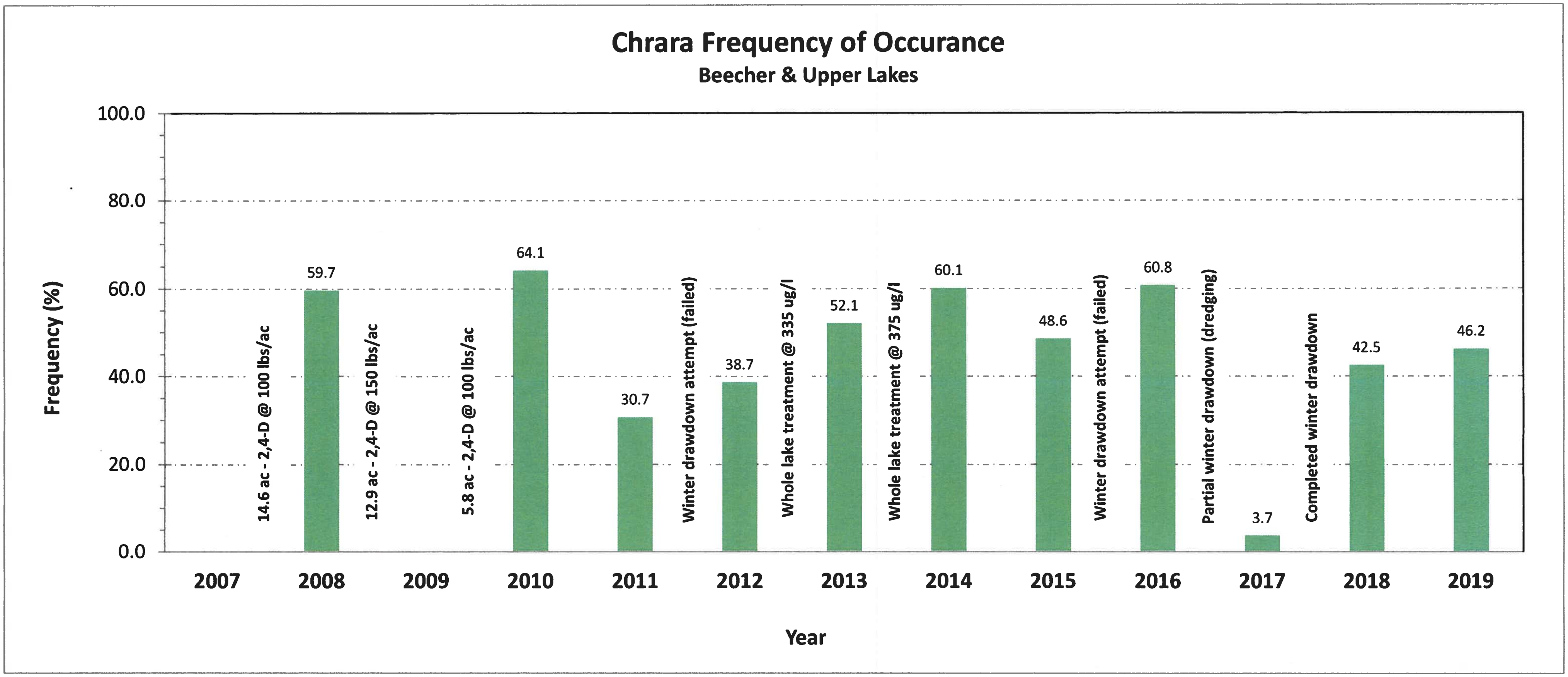
n= 149

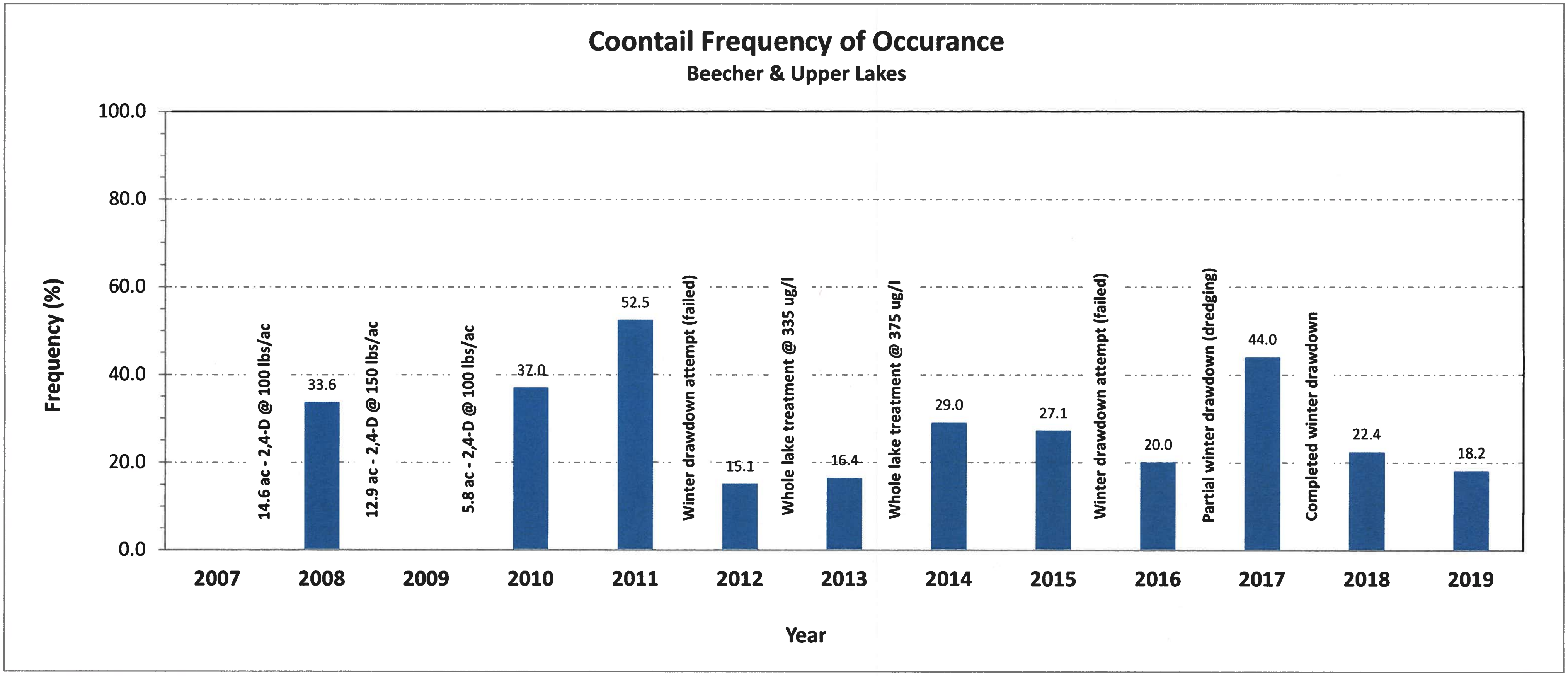
Scientific Name	**Common Name**	**Frequency**	**Avg. rake fullness**
Brassenia schreberii	watershield	10.9	1.1
Ceratophylum demersum	coontail	17.4	1.3
Chara sp	muskgrass	44.2	1.2
Dulichium arundinaceum	three-way sedge	0.7	1.0
Eleocharis accicularis	needle spikerush	2.9	1.0
Megalodanta beckii	water marigold	2.2	1.0
Myriophyllum sibericum	northern watermilfoil	3.6	1.0
Myriophyllum spicatum	Eurasian water-milfoil	19.6	1.1
Myriophyllum verticilatum	whorled watermilfoil	13.0	1.3
Najas flexilis	bushy pondweed	46.4	1.2
Nitella sp	stonewort	32.6	1.3
Nuphar variegata	spatterdock pond lily	17.4	1.1
Nymphea odorata	white water lily	15.9	1.3
Potamogeton amplifolius	large-leaf pondweed	1.4	1.0
Potamogeton epihydrus	ribbon-leaf pondweed	7.2	1.0
Potamogeton foliosus	leafy pondweed	0.7	1.0
Potamogeton graminaeus	variable pondweed	17.4	1.1
Potamogeton natans	floating-leaf pondweed	2.9	1.0
Potamogeton pusillus	small pondweed	2.2	1.0
Potamogeton strictifolius	stiff pondweed	4.3	1.0
Potamogeton zosteriformis	flat-stem pondweed	1.4	1.0
Sparganium emersum	stemless bur-reed	1.4	1.0
Sparganium fluctuans	floating-leaf burreed	3.6	1.0
Stuckenia pectinata	sago pondweed	0.7	1.0
Utricularia gemniscapa	twin-stem bladderwort	17.4	1.0
Utricularia gibba	creeping bladderwort	2.9	1.0
Utricularia intermedia	flat-leaf bladderwort	23.9	1.1
Utricularia minor	small bladderwort	13.8	1.0
Utricularia vulgaris	common bladderwort	17.4	1.1

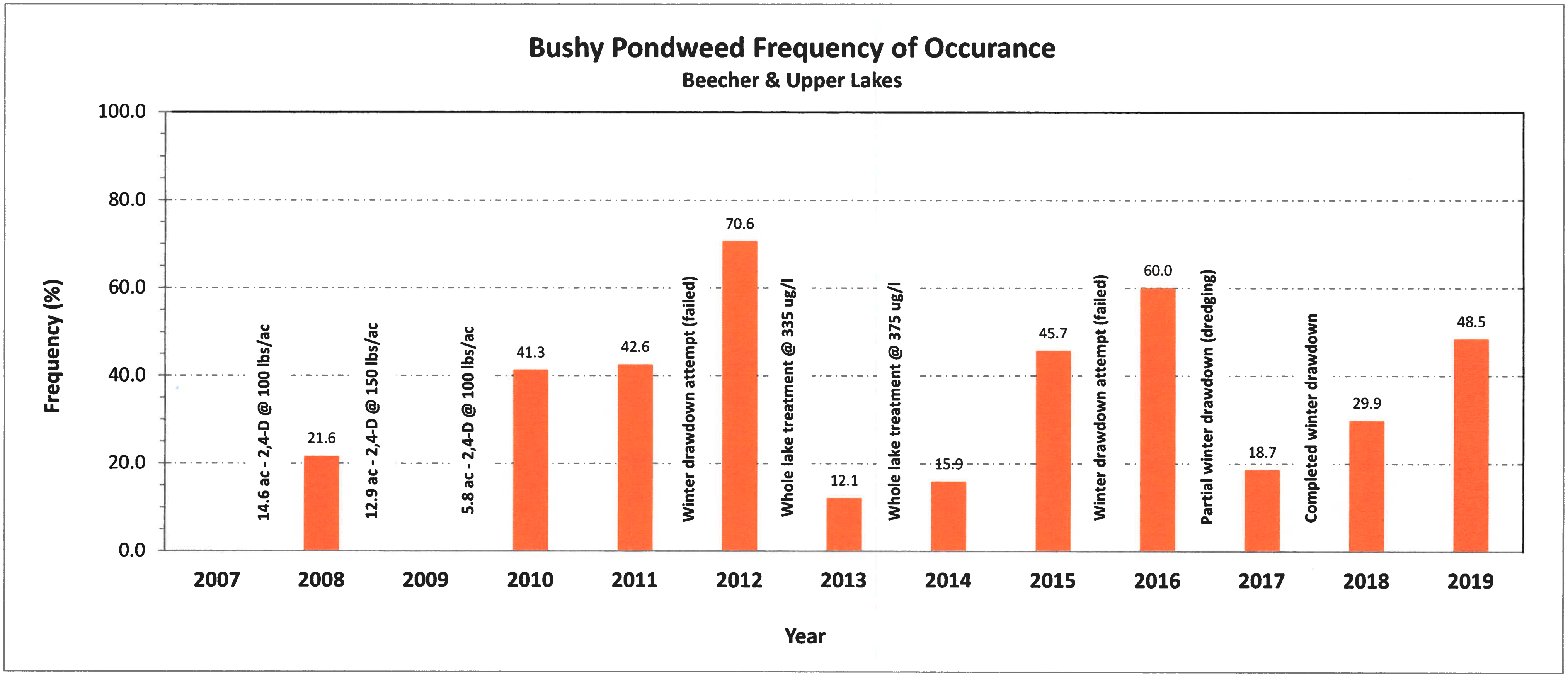
Beecher & Upper Lakes

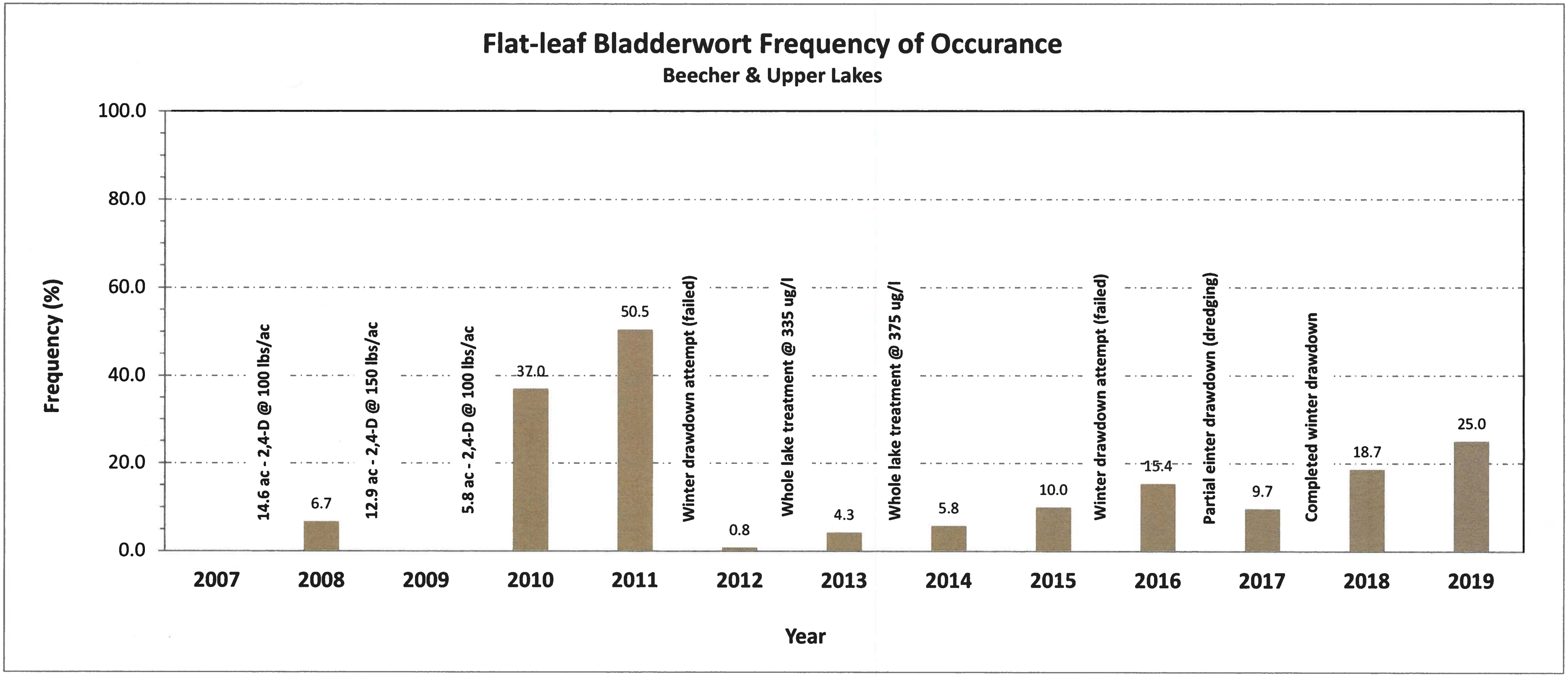
Scientific Name	Common Name	2007 Frequency	2008 Frequency	2009 Frequency	2010 Frequency	2011 Frequency	2012 Frequency	2013 Frequency	2014 Frequency	2015 Frequency	2016 Frequency	2017 Frequency	2018 Frequency	2019 Frequency
Brasenia schreberi	Water shield		26.1		19.6	5.9	0.8	5.7	8.0	8.6	9.2	20.9	7.5	11.4
Callitriche sp.	water starwort					1.0								
Ceratophyllum demersum	Coontail		33.6		37.0	52.5	15.1	16.4	29.0	27.1	20.0	44.0	22.4	18.2
Chara sp.	Musk grass		59.7		64.1	30.7	38.7	52.1	60.1	48.6	60.8	3.7	42.5	46.2
Dulichium arundinaceum	Three way sedge													0.8
Eleocharis accicularis	Hairgrass		2.2		3.3	3.0		0.7		4.3	7.7	8.2	9.7	3.0
Eleocharis palustris	Creeping spikerush											3.0		
Elodea canadensis	Common waterweed		6.7		5.4	5.9	1.7	1.4	4.3	1.4	4.6	0.7		
Elodea nuttallii	Slender waterweed		0.7											
Equisetum fluvitale	Water horsetail											0.7	0.7	
Freshwater sponge	Freshwater sponge		7.5											
Justica sp.	Water willow							1.4						
Megalodonta beckii	Water marigold		9.7		6.5	12.9	0.8		2.2	6.4	6.9	0.7	0.7	2.3
Myriophyllum sibericum	Northern water milfoil		1.5		1.1	2.0	3.4	1.4		2.1	2.3	0.7	4.5	3.8
Myriophyllum spicatum	Eurasian water milfoil		38.1		7.6	41.6	80.7	25.0	42.8	72.1	53.8	49.3	5.2	20.5
Myriophyllum verticilatum	Whorled watermilfoil										0.8		1.5	13.6
Najas flexilis	Bushy pondweed		21.6		41.3	42.6	70.6	12.1	15.9	45.7	60.0	18.7	29.9	48.5
Nitella sp.	Stonewort		28.4		9.8	51.5	10.1	7.9	8.0	12.9	13.8	11.9	7.5	34.1
Nuphar variegata	Spatterdock		8.2		3.3	5.9	5.9	2.1	9.4	7.1	11.5	4.5	11.9	18.2
Nymphaea odorata	White water lily		15.7		33.7	30.7	16.8	11.4	16.7	25.7	13.8	21.6	9.7	16.7
P. unk #1	Unk. pondweed													
Potamogeton amplifolius	Large leaf pondweed		14.9		27.2	27.7	10.1	8.6	15.2	19.3	10.0	6.0	0.7	1.5
Potamogeton diversofolius	Water-thread pondweed						0.8							
Potamogeton epihydrus	Ribbon leaf pondweed		1.5				5.0	5.0	2.9	2.9	1.5	1.5	1.5	7.6
Potamogeton foliosus	Leafy pondweed				1.1					4.3	3.1		0.7	0.8
Potamogeton friesii	Frie's pondweed		0.7			21.8	23.5	0.7						
Potamogeton gramineus	Variable pondweed		28.4		23.9	20.8	38.7	31.4	23.2	14.3	16.2	26.1	23.1	18.2
Potamogeton hilli	Hill's pondweed							2.9						
Potamogeton illinoensis	Illinois pondweed		4.5			1.0		0.7	7.2	0.7				
Potamogeton natans	Floating leaf pondweed		2.2		3.3	4.0	10.1	3.6	8.0	10.0	6.9	6.0	2.2	3.0
Potamogeton obtusifolius	Blunt-leaf pondweed							2.9			0.8	9.7		
Potamogeton praelongus	White stem pondweed		7.5		4.3	5.9	5.9	5.7	6.5	9.3	9.2	2.2		
Potamogeton pusillus	Small pondweed		22.4		8.7	9.9	5.0	0.7	6.5	2.1	10.8		3.7	2.3
Potamogeton strictifolius	Stiff pondweed		3.0		7.6	9.9	10.9				6.2	1.5		4.5
Potamogeton zosteriformus	Flat-stem pondweed		4.5		8.7	10.9	9.2	2.1	5.1	2.1	3.1			1.5
Schoenoplectus acutus	Hardstem bulrush							0.7						
Schoenoplectus subterminalis	water bulrush		4.5										3.7	
Sparganium emersum	stemless bur-reed											0.7		1.5
Sparganium fluctuans	Floating leaf burreed		2.2				0.8				2.3	4.5	0.7	3.8
Stuckenia pectinata	Sago pondweed				1.1	5.0	2.5	0.7		0.7	0.8			0.8
Typha sp.	Cattail													
Unknown Moss	Moss		27.6		8.7	48.5	0.8	3.6	29.7					
Utricularia gemniscapa	Twin-stemmed bladderwort		1.5		2.2	5.0	1.7	1.4	6.5	12.9	3.1	3.7		18.2
Utricularia gibba	Creeping bladderwort		15.7		33.7	33.7		2.9	5.1	12.9	6.9	1.5	5.2	3.0
Utricularia intermedia	Flat leaf bladderwort		6.7		37.0	50.5	0.8	4.3	5.8	10.0	15.4	9.7	18.7	25.0
Utricularia minor	Small bladderwort							2.9			11.5	7.5	11.2	14.4
Utricularia purpurea	Large purple bladderwort				5.4									
Utricularia vulgaris	Common bladderwort		11.2		34.8	7.9		7.9	8.7	7.9	9.2	6.0	7.5	18.2


EWM Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
AIS Planning Grant
Phase I Control Grant
Phase II Control Grant
14.6 ac - 2,4-D @ 100 lbs/ac
38.1
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 150 lbs/ac
7.6
41.6
Winter drawdown attempt (failed)
80.7
Whole lake treatment @ 335 ug/l
25.0
Whole lake treatment @ 375 ug/l
42.8
72.1
Winter drawdown attempt (failed)
53.8
Partial winter drawdown (dredging)
49.3
Completed winter drawdown
5.2
20.5
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year

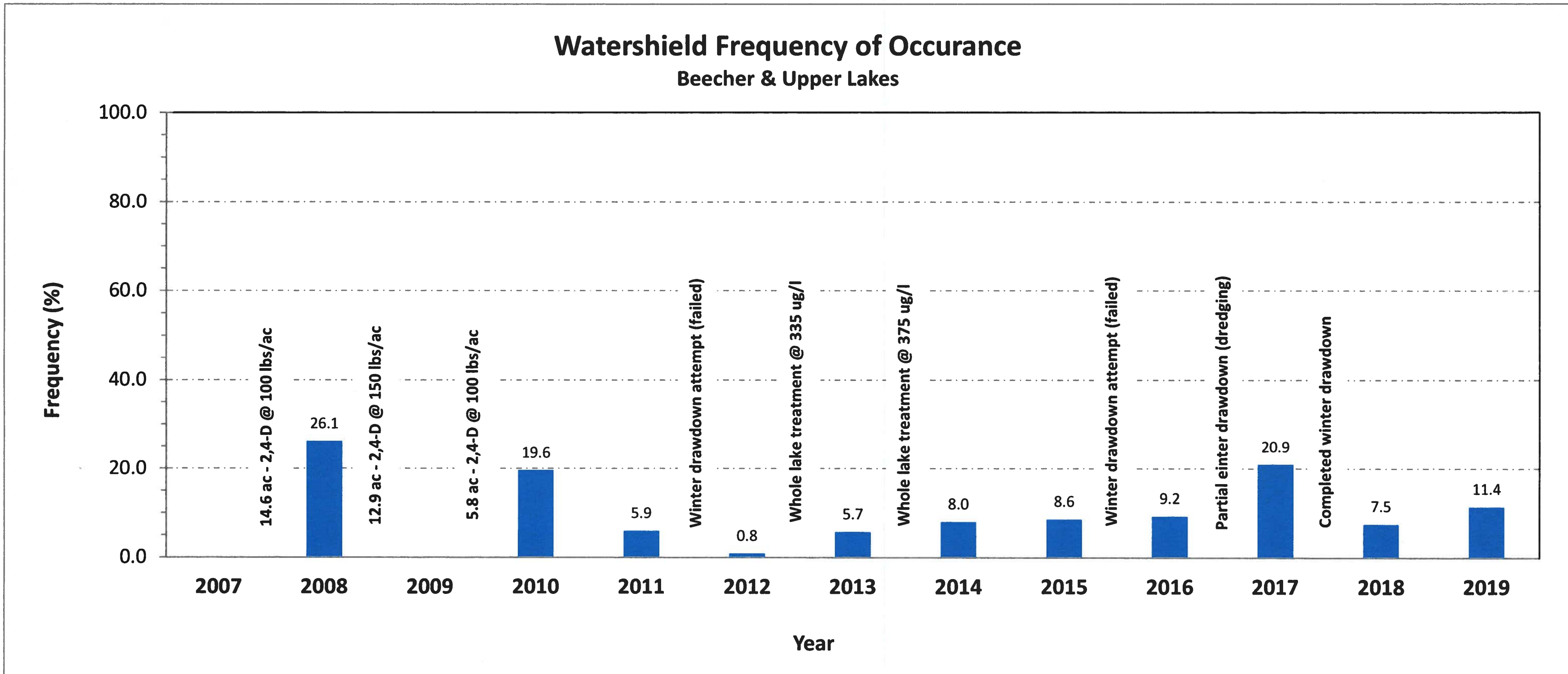

Chrara Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
14.6 ac - 2,4-D @ 100 lbs/ac
59.7
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 100 lbs/ac
64.1
30.7
Winter drawdown attempt (failed)
38.7
Whole lake treatment @ 335 ug/l
52.1
Whole lake treatment @ 375 ug/l
60.1
48.6
Winter drawdown attempt (failed)
60.8
Partial winter drawdown (dredging)
3.7
Completed winter drawdown
42.5
46.2
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year


Coontail Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
14.6 ac - 2,4-D @ 100 lbs/ac
33.6
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 100 lbs/ac
37.0
52.5
Winter drawdown attempt (failed)
15.1
Whole lake treatment @ 335 ug/l
16.4
Whole lake treatment @ 375 ug/l
29.0
27.1
Winter drawdown attempt (failed)
20.0
Partial winter drawdown (dredging)
44.0
Completed winter drawdown
22.4
18.2
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year


Bushy Pondweed Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
14.6 ac - 2,4-D @ 100 lbs/ac
21.6
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 100 lbs/ac
41.3
42.6
Winter drawdown attempt (failed)
70.6
Whole lake treatment @ 335 ug/l
12.1
Whole lake treatment @ 375 ug/l
15.9
45.7
Winter drawdown attempt (failed)
60.0
Partial winter drawdown (dredging)
18.7
Completed winter drawdown
29.9
48.5
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year



Flat-leaf Bladderwort Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
14.6 ac - 2,4-D @ 100 lbs/ac
6.7
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 100 lbs/ac
37.0
50.5
Winter drawdown attempt (failed)
0.8
Whole lake treatment @ 335 ug/l
4.3
Whole lake treatment @ 375 ug/l
5.8
10.0
Winter drawdown attempt (failed)
15.4
Partial einter drawdown (dredging)
9.7
Completed winter drawdown
18.7
25.0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year


Watershield Frequency of Occurance
Beecher & Upper Lakes
Frequency (%)
100.0
80.0
60.0
40.0
20.0
0.0
14.6 ac - 2,4-D @ 100 lbs/ac
26.1
12.9 ac - 2,4-D @ 150 lbs/ac
5.8 ac - 2,4-D @ 100 lbs/ac
19.6
5.9
Winter drawdown attempt (failed)
0.8
Whole lake treatment @ 335 ug/l
5.7
Whole lake treatment @ 375 ug/l
8.0
8.6
Winter drawdown attempt (failed)
9.2
Partial einter drawdown (dredging)
20.9
Completed winter drawdown
7.5
11.4
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year