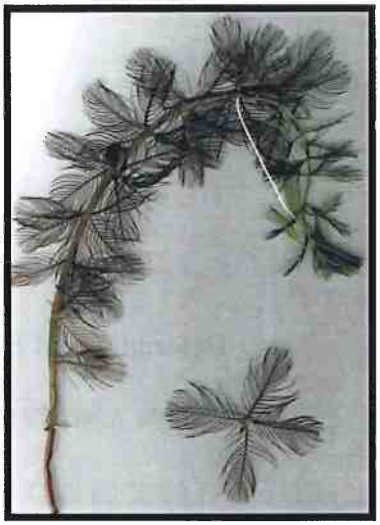
Scanned + emailed to KL 12/21/22

Eurasian water-milfoil (*Myriophyllum spicatum*) Late Summer Bed Mapping Survey Tomahawk Lake - WBIC: 2501700 Bayfield County, Wisconsin

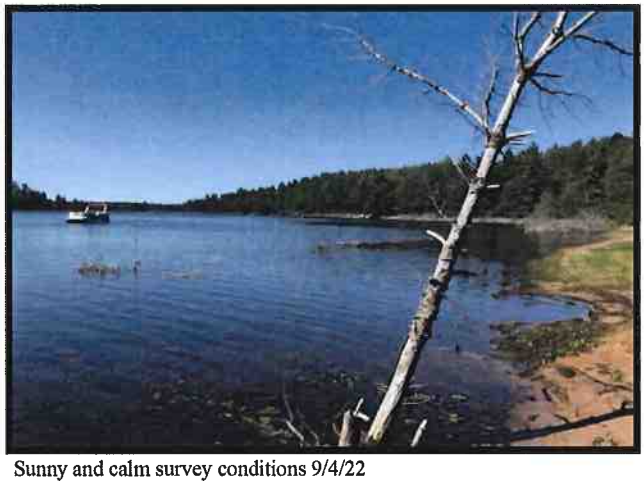
Dense canopied EWM in Tomahawk Lake's east bay - 9/4/22



Eurasian water-milfoil (Berg 2007)

Project Initiated by:

The Town of Barnes – Aquatic Invasive Species Committee and the Wisconsin Department of Natural Resources



Sunny and calm survey conditions 9/4/22

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
September 4, 2022

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION:

Tomahawk Lake (WBIC 2501700) is a 131-acre stratified seepage lake on the west-central edge of Bayfield County, Wisconsin in the Town of Barnes (T45N R9W S20). It reaches a maximum depth of 42ft on the south side of the southern basin and has an average depth of approximately 13ft. The lake is mesotrophic in nature with Secchi readings from 2000 to 2014 (the most recent year data was available) averaging 13.1ft (WDNR 2022). This good water clarity produced a littoral zone that extended to at least 15.0ft in the summer of 2022. The bottom substrate is predominately sand along the shoreline, but this gradually transitions to sandy muck at most depths over 6ft (Figure 1) (Holt et al. 1971).

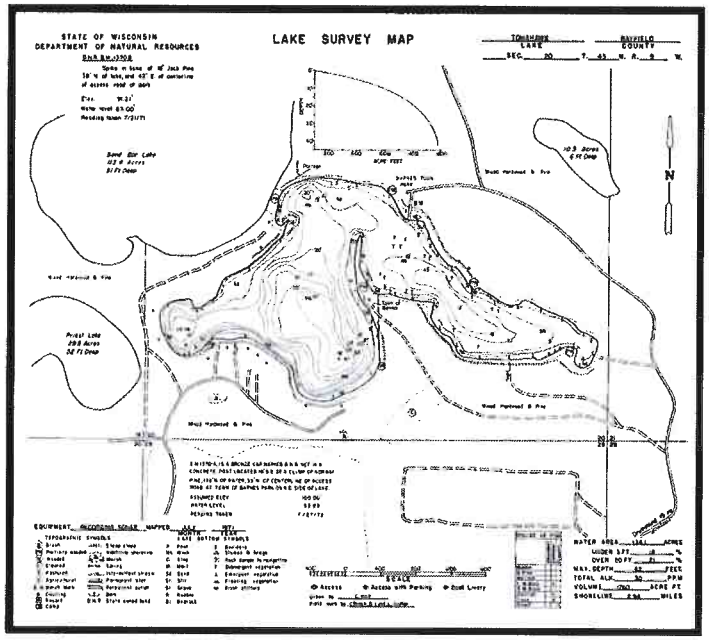


Figure 1: Tomahawk Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) is an exotic invasive plant species that is a growing problem in the lakes and rivers of northwestern Wisconsin. Now present in 13 different Bayfield County waterbodies (WDNR 2022), the Town of Barnes Aquatic Invasive Species Committee (TOB) and the Wisconsin Department of Natural Resources (WDNR) first confirmed EWM in Tomahawk and Sand Bar Lakes in the fall of 2004. Because the lakes are so similar (and even connected at high water), WDNR and Army Corp of Engineer (ACE) biologists decided they would initially serve as test (Tomahawk) and control (Sand Bar) lakes for a variety of treatments regimes as shareholders decided how to best fight the infestation. Over the next several years, the lakes would become a true case study as managers used different types of herbicides singly and in combination; tried them at varying concentrations; and conducted both bed and whole-lake applications. To assess the impacts of these treatments (or the lack there of in the case of Sand Bar) on both EWM and the lakes' native macrophytes, WDNR and ACE biologists conducted annual macrophyte surveys on Tomahawk from 2006 to 2015 and on Sand Bar from 2007 to 2015. However, due to budget cuts and a lack of staffing, these surveys were discontinued after the July 2015 survey at which time the TOB took over primary responsibility for the management of the lakes.

In 2016, the TOB built and began using a suction harvester as part of an integrated approach to managing EWM. Since the most recent herbicide application – a whole-lake treatment with 2, 4-D (Shredder Amine 4) that occurred on May 15, 2017 – the "Barnes Aquatic Invasive Species Sucker" or BAISS has been the only EWM management on the lakes. To see how these control efforts were holding up, we were asked by the TOB and the WDNR to complete full point-intercept surveys of all macrophytes and compare those results to the last WDNR surveys from 2015. The 2018 surveys found no sign of EWM on Sand Bar Lake and only a floating fragment near the public landing on Tomahawk Lake. Unfortunately, although the 2019 survey found that the BAISS continued to keep EWM at undetectable levels on Sand Bar, EWM was spreading rapidly along Tomahawk's northern shoreline. The 2020 and 2021 surveys found that harvesting was no longer keeping up with EWM's expansion in Tomahawk and barely keeping up in Sand Bar. This prompted the TOB, under the direction of Lake Education and Planning Services, LLC (LEAPS – Dave Blumer), to apply for a permit to chemically treat areas along the north shoreline of Tomahawk Lake in 2022. Although no formal pre/posttreatment surveys were done, it was requested that we conduct a late summer EWM bed mapping survey to assess the impact of the treatment and allow for future active management decisions. This report is the summary analysis of that survey conducted on Tomahawk Lake on September 4, 2022.

METHODS:

Eurasian Water-milfoil Bed Mapping Survey:

During the survey, we searched the visible littoral zone of the lake. By definition, a "bed" was determined to be any area where we visually estimated that EWM made up >50% of the area's plants, was generally continuous with clearly defined borders, and was canopied or close enough to being canopied that it would likely interfere with boat traffic. After we located a bed, we motored around the perimeter taking GPS coordinates at regular intervals. We also estimated the rake density range and mean rake fullness of the bed (Figure 2), the range and mean depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none** – easily avoidable with a natural channel around or narrow enough to motor through/**minor** – one prop clear to get through or access open water/**moderate** – several prop clears needed to navigate through/**severe** – multiple prop clears and difficult to impossible to row through). These data were then mapped using ArcMap 9.3.1, and we used the WDNR's Forestry Tools Extension to determine the acreage of each bed to the nearest hundredth of an acre. Because the goal of the survey was to identify all areas of the lake with significant EWM, we also mapped "high density areas" where EWM plants were continuous but didn't meet all of the other "bed" criteria.

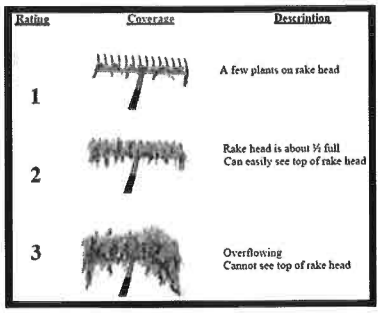


Figure 2: Rake Fullness Ratings (UWEX 2010)

RESULTS:

Treatment Areas:

The three treatment areas along the lake's north shoreline totaled 2.99 acres (2.28% of the lake's total surface area) (Table 1). Treatment occurred over three days so the limnocurtain could be moved with each successive treatment (Figure 3) (Appendix I). Applications occurred on June 10, June 13, and June 16 with Northern Aquatic Services (Dale Dressel - Dresser, WI) applying 2,4-D (Amine 4) at a target rate of 4ppm (42.46 total gallons).

Table 1: Spring Eurasian Water-milfoil Treatment Summary
Tomahawk Lake – Bayfield County, WI
June 10, 13, and 16, 2022

Date	Final Treatment Area (acres)	Chemical, Rate, and Total Volume
6/10/22	1.01	2,4-D Amine 4 – 4ppm – 14.34 gallons
6/13/22	1.14	2,4-D Amine 4 – 4ppm – 16.19 gallons
6/16/22	0.84	2,4-D Amine 4 – 4ppm – 11.93 gallons
Total	**2.99**	**2,4-D Amine 4 – 4ppm– 42.46 gallons**

Figure 3: Approximate June 2022 EWM Treatment Areas - Limnocurtain Deployment

Eurasian Water-milfoil Bed Mapping Survey:

On September 4, 2022, we searched 8.3km (5.2 miles) of transects throughout the lake's visible littoral zone (Figure 4). We had mostly sunny skies and calm winds, but we were only able to see down 6-7ft as the water was "milky". This meant small plants in deeper water were potentially missed. Despite these limitations, we immediately found scattered plants growing in the treatment areas along the northwest/north-central shorelines (Figure 5) (Appendix II). Raking in deeper areas also produced scattered plants, and members of the BAISS team that we talked to confirmed that EWM was regrowing in deeper water in areas where we couldn't see the bottom. In total, we mapped six areas covering 3.96 acres (3.02% of the lake's surface area) (Table 2). The smallest, Beds 1-3, were each <0.10 acre and occurred within the core of the treatment area. The largest, Bed 6, covered 3.51 acres and dominated the eastern tip of the "handle".

.

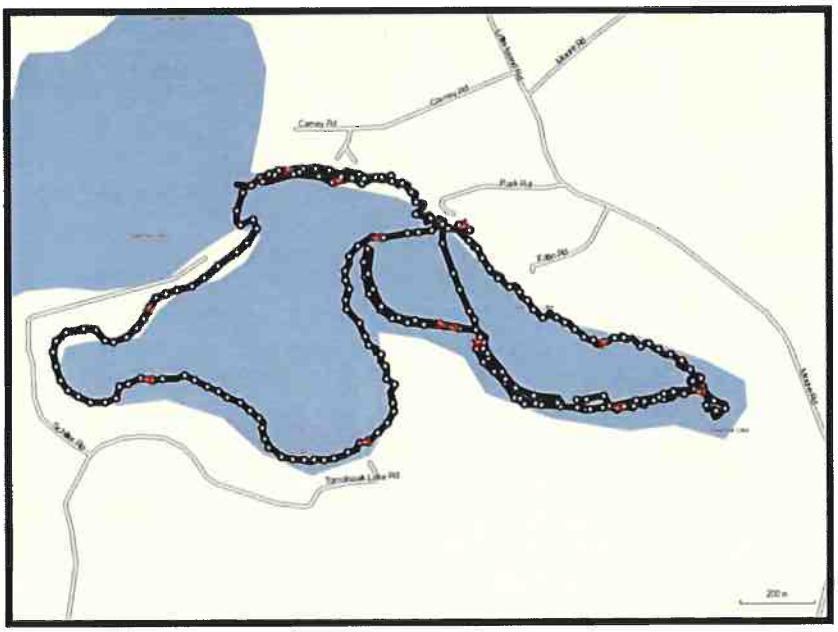


Figure 4: September 4, 2022 EWM Littoral Zone Survey – GPS Tracks

Table 2: Late Summer Eurasian Water-milfoil Bed Mapping Summa
Tomahawk Lake – Bayfield County, WI
September 4, 2022

Bed Number	2022 Acreage	Rake Range and Mean Rake Fullness	Depth Range and Mean Depth	Canopied	Navigation Impairment	2022 I
Bed 1	0.07	1-3; 2	2-5; 4	Near	Minor	Plants severely burned but
Bed 2	0.05	1-3; 3	2-5; 4	Near	Minor	Plants severely burned but
Bed 3	0.09	1-3; 3	4-7; 5	Near	Minor	Plants severely burned but
Bed 4	0.12	1-3; 2	1-5; 4	Near	Minor	Plants slightly burned but
Bed 5	0.12	1-3; 1	1-5; 4	Near	Minor	Plants slightly burned but
Bed 6	3.51	<<<1-3; 2	1-6; 5	Yes	Moderate	Canopied in bay – subcanc
Total	**3.96**					

Descriptions of Eurasian Water-milfoil Beds and High-Density Areas:

Bed 1 – Eurasian water-milfoil was highly variable on the northwest edge of the treatment area (Figure 5). Although Bed 1 was moderately dense, the narrowness of the total bed likely meant it would have only been a minor impairment.

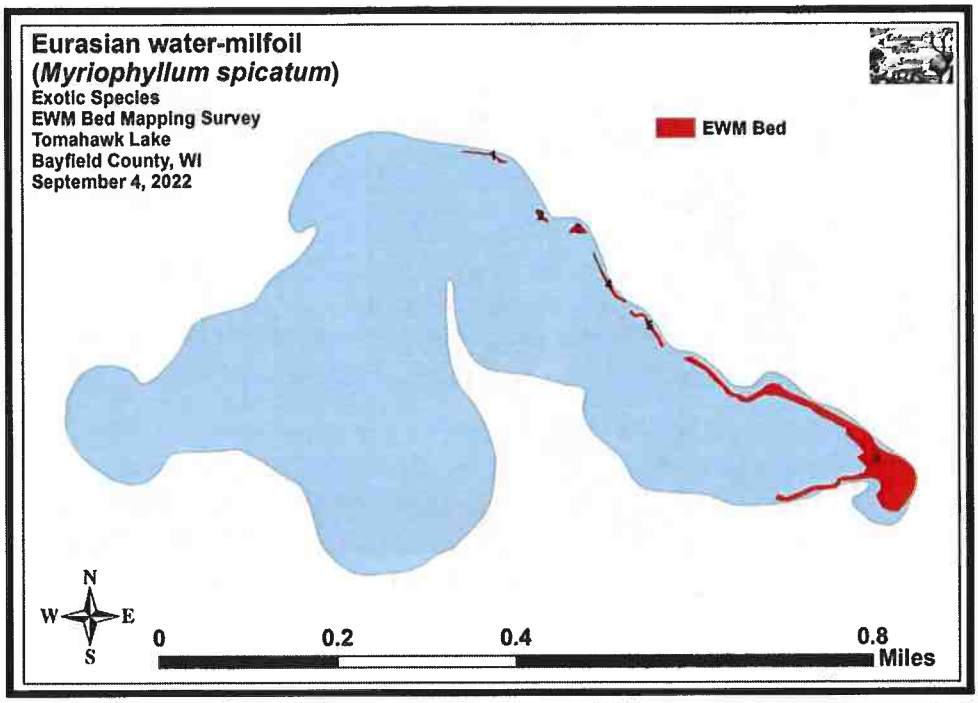


Figure 5: Eurasian Water-milfoil Bed Map – September 4, 2022

Beds 2 and 3 – These beds were also relatively narrow and likely wouldn't have caused more than a minor impairment. Unfortunately, it appeared the majority of plants in these areas survived the treatment despite having been severely burned. We observed new shoots throughout and almost all were shown to be regrowing from large root crowns (Figure 6).

Beds 4 and 5 – These beds were on the far eastern edge of the treatment area. None of the plants seem to have been killed, and they were only slightly burned as they were brown on the tips but were already regrowing. Due to the bed's narrowness, they were likely only a minor impairment.

Bed 6 – This bed started just outside of the northeastern end of the treatment area, continued into the eastern bay, and then wrapped around the southeastern shoreline. On the north shoreline, the bed was similar to Beds 4 and 5 – narrow and only a minor impairment. The eastern bay would likely cause severe impairment (Figure 7), but the area that was dense and canopied was relatively small. Along the southeastern shoreline, EWM was largely restricted to the immediate shoreline, and, as we moved to the west, plants became less and less common before disappearing altogether.

Figure 6: Typical Regrowing EWM from Severely Burned Root Crowns – Beds 2 and 3 Near the Public Landing

Figure 7: Dense Canopied EWM in the Eastern Bay – Bed 6

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Eurasian water-milfoil continues to occupy only a small percentage of Tomahawk Lake's surface area, but it is widely-established making eradication an unrealistic expectation. With this in mind, continuing to work to control its spread in the most cost-effective manner possible, while simultaneously minimizing its impact on the lake's aquatic ecosystem will likely continue to be important goals for the Town of Barnes moving forward.

For unknown reasons, the 2022 treatment appears to have been relatively unsuccessful. EWM levels certainly declines, and most impairment seems to have been eased. However, the majority of mature plants with well-established root balls appeared to have survived and immediately started to regrow. Because the treatment did not reduce levels back to something the BAISS could easily keep up with, it is likely that another herbicide treatment or extensive manual removal will be needed in 2023. In addition to any future management, a decision on how much monitoring will be needed in 2023, if any, is a conversation that needs to take place. Ultimately, the TOB, LEAPS, and the WDNR will have to decide on a future course of action.

LITERATURE CITED

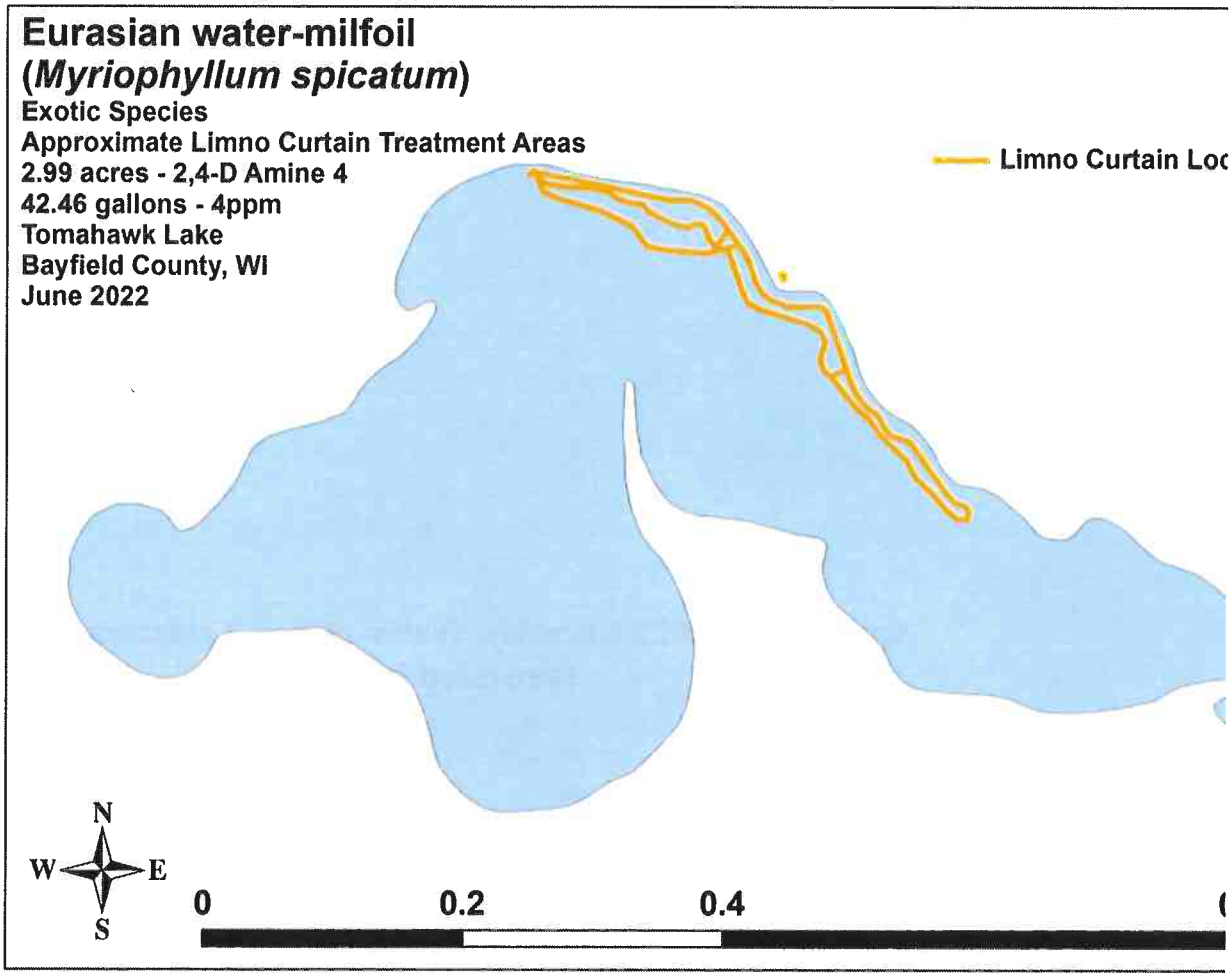
Holt, C., C. Busch, G. Lund, and L. Sather. 1971. Tomahawk Lake Bathymetric Map. http://dnr.wi.gov/lakes/maps/DNR/2501700a.pdf (2022 September).

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2022 September).

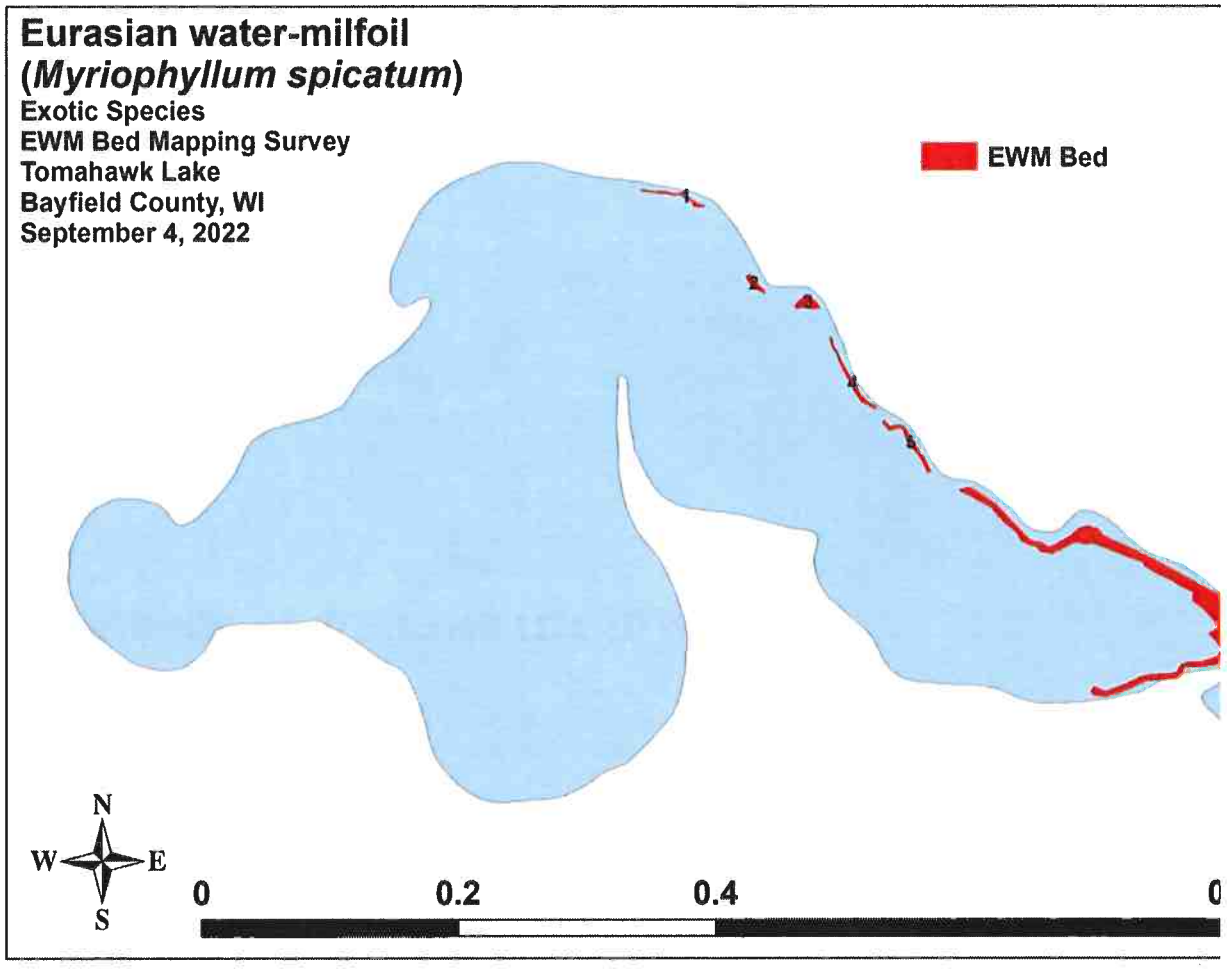
WDNR. [online]. 2022. Wisconsin Lakes Citizen Monitoring Data for Tomahawk Lake – Bayfield County. Available from https://dnr.wi.gov/lakes/waterquality/Station.aspx?id=043119 (2022 September).

WDNR. [online]. 2022. Wisconsin Lakes Information – Tomahawk Lake – Bayfield County. https://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2501700 (2022 September).

Appendix I: 2022 Eurasian Water-milfoil Treatment Areas Map (Provided by LEAPS)

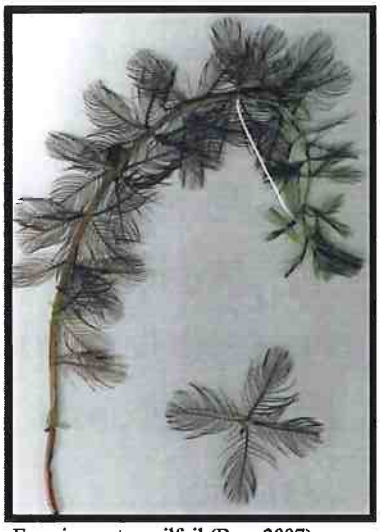

Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Approximate Limno Curtain Treatment Areas
2.99 acres - 2,4-D Amine 4
42.46 gallons - 4ppm
Tomahawk Lake
Bayfield County, WI
June 2022
Limno Curtain Loc
N
W
E
S
0
0.2
0.4

Appendix II: 2022 Eurasian Water-milfoil Bed Map


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
EWM Bed Mapping Survey
Tomahawk Lake
Bayfield County, WI
September 4, 2022
EWM Bed
N
W
E
S
0
0.2
0.4

Eurasian water-milfoil (*Myriophyllum spicatum*) Late Summer Bed Mapping Survey Sand Bar Lake - WBIC: 24924900 Bayfield County, Wisconsin

EWM among the dead jack pine along Sand Bar Lake's shoreline - 9/4/22



Eurasian water-milfoil (Berg 2007)

Project Initiated by:

The Town of Barnes – Aquatic Invasive Species Committee and the Wisconsin Department of Natural Resources

Very sparse vegetation on Sand Bar Lake – 9/4/22

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
September 4, 2022

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION:

Sand Bar Lake (WBIC 2494900) is a 127-acre stratified seepage lake on the west-central edge of Bayfield County, Wisconsin in the Town of Barnes (T45N R9W S19/20). It reaches a maximum depth of 49ft on the east side and has an average depth of approximately 25ft. The lake is oligotrophic in nature with Secchi readings from 2000 to 2013 (the most recent year available) averaging 17.7ft (WDNR 2022). This good water clarity produced a littoral zone that extended to approximately 19ft in the summer of 2022. The bottom substrate is predominately sand along the shoreline, but this gradually transitions to sand with a thin top layer of muck at most depths over 6ft (Figure 1) (Holt et al. 1972).

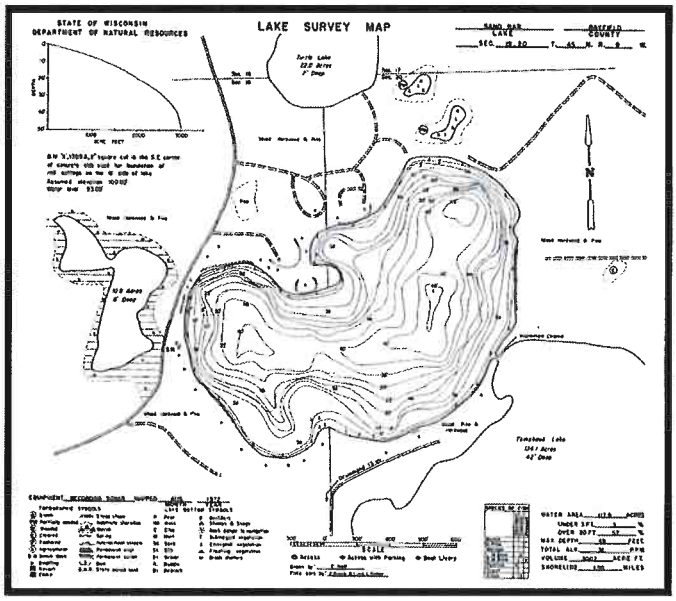


Figure 1: Sand Bar Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) is an exotic invasive plant species that is a growing problem in the lakes and rivers of northwestern Wisconsin. Now present in 13 different Bayfield County waterbodies (WDNR 2022), the Town of Barnes Aquatic Invasive Species Committee (TOB) and the Wisconsin Department of Natural Resources (WDNR) first confirmed EWM in Tomahawk and Sand Bar Lakes in the fall of 2004. Because the lakes are so similar (and even connected at high water), WDNR and Army Corp of Engineer (ACE) biologists decided they would initially serve as test (Tomahawk) and control (Sand Bar) lakes for a variety of treatments regimes as shareholders decided how to best fight the infestation. Over the next several years, the lakes would become a true case study as managers used different types of herbicides singly and in combination; tried them at varying concentrations; and conducted both bed and whole-lake applications. To assess the impacts of these treatments (or the lack there of in the case of Sand Bar) on both EWM and the lakes' native macrophytes, WDNR and ACE biologists conducted annual macrophyte surveys on Tomahawk from 2006 to 2015 and on Sand Bar from 2007 to 2015. However, due to budget cuts and a lack of staffing, these surveys were discontinued after the July 2015 survey at which time the TOB took over primary responsibility for the management of the lakes.

In 2016, the TOB built and began using a suction harvester as part of an integrated approach to managing EWM. Since the most recent herbicide application – a whole-lake treatment with 2, 4-D (Shredder Amine 4) that occurred on May 15, 2017 – the "Barnes Aquatic Invasive Species Sucker" or BAISS has been the only EWM management on the lakes. To see how these control efforts were holding up, we were asked by the TOB and the WDNR to complete full point-intercept surveys of all macrophytes and compare those results to the last WDNR surveys from 2015. The 2018 surveys found no sign of EWM on Sand Bar Lake and only a floating fragment near the public landing on Tomahawk Lake. Unfortunately, although the 2019 survey found that the BAISS continued to keep EWM at undetectable levels on Sand Bar, EWM was spreading rapidly along Tomahawk's northern shoreline. The 2020 and 2021 surveys found that harvesting was no longer keeping up with EWM's expansion in Tomahawk and barely keeping up in Sand Bar. This prompted the TOB, under the direction of Lake Education and Planning Services, LLC (LEAPS – Dave Blumer), to apply for a permit to chemically treat areas along the north shoreline of Tomahawk Lake in 2022. Although no treatment occurred on Sand Bar Lake, it was requested that we conduct a late summer EWM bed mapping survey to assess the current levels of EWM and allow for future active management decisions. This report is the summary analysis of that survey conducted on Sand Bar Lake on September 4, 2022.

METHODS:

Eurasian Water-milfoil Bed Mapping Survey:

During the survey, we searched the visible littoral zone of the lake. By definition, a "bed" was determined to be any area where we visually estimated that EWM made up >50% of the area's plants, was generally continuous with clearly defined borders, and was canopied or close enough to being canopied that it would likely interfere with boat traffic. After we located a bed, we motored around the perimeter taking GPS coordinates at regular intervals. We also estimated the rake density range and mean rake fullness of the bed (Figure 2), the range and mean depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none** – easily avoidable with a natural channel around or narrow enough to motor through/**minor** – one prop clear to get through or access open water/**moderate** – several prop clears needed to navigate through/**severe** – multiple prop clears and difficult to impossible to row through). These data were then mapped using ArcMap 9.3.1, and we used the WDNR's Forestry Tools Extension to determine the acreage of each bed to the nearest hundredth of an acre. Because the goal of the survey was to identify all areas of the lake with significant EWM, we also mapped "high density areas" where EWM plants were continuous but didn't meet all of the other "bed" criteria.

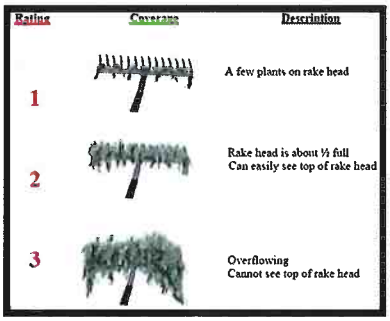


Figure 2: Rake Fullness Ratings (UWEX 2010)

RESULTS:

Eurasian Water-milfoil Bed Mapping Survey:

During our point-intercept surveys from 2018-2020, EWM was almost undetectable in the lake and there were no places that could be called "beds" or even "high density areas". Our 2021 survey found EWM at three points all of which were located along the eastern shoreline adjacent to the "channel" to Tomahawk Lake. Away from this area, we didn't see any evidence of EWM.

On September 4, 2022, we searched 11.8km (7.3 miles) of transects throughout the lake's visible littoral zone (Figure 3). We had mostly sunny skies and calm winds, but we were only able to see down 6-7ft as the water was "milky". This meant small plants in deeper water were potentially missed. Despite these limitations, we immediately noted floating EWM fragments and found plants and clusters of plants were establishing among the dead jack pines around much of the lake (Figure 4) (Appendix I). In total, we mapped eight areas covering 1.21 acres (0.95% of the lake's surface area). The smallest, Bed 2, was just 0.02 acre, while the largest, Bed 7, covered 0.32 acre (Table 1).

.

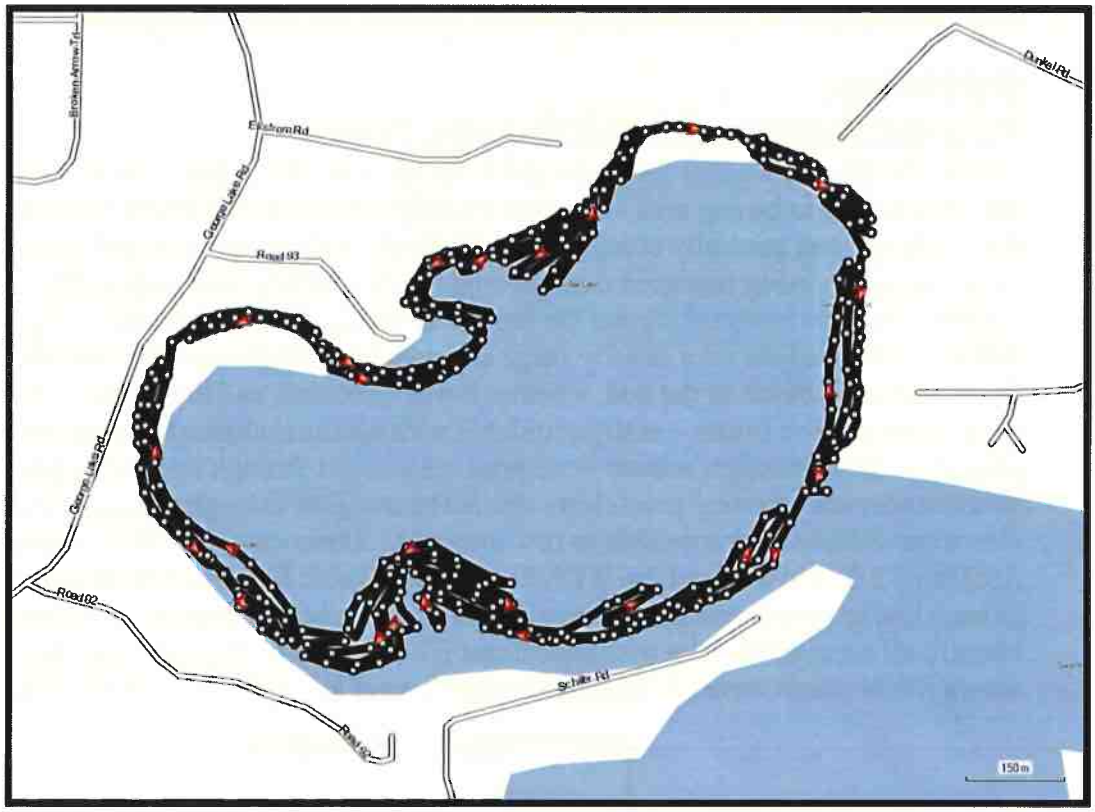


Figure 3: September 4, 2022 EWM Littoral Zone Survey – GPS Tracks

Table 1: Late Summer Eurasian Water-milfoil Bed Mapping Summa
Sand Bar Lake – Bayfield County, WI
September 4, 2022

Bed Number	2022 Acreage	Rake Range and Mean Rake Fullness	Depth Range and Mean Depth	Canopied	Navigation Impairment	2022 I
Bed 1	0.20	<<<1-2; <1	1-5; 3	Yes	None	Nearly continuous EWM g
Bed 2	0.02	<<<1-2; <1	1-5; 3	Yes	None	Clusters among dead jack
Bed 3	0.15	<<<1-2; <1	1-5; 3	Yes	None	Scattered clusters in dead j
Bed 4	0.10	<<<1-2; <1	1-5; 3	Yes	None	Scattered clusters in dead j
Bed 5	0.09	<<<1-1; <<<1	1-6; 4	Near	None	Scattered single plants thro
Bed 6	0.16	<<<1-3; 1	1-6; 4	Yes	None	Small beds expanding and
Bed 7	0.32	<<<1-3; 1	1-6; 4	Near	None	Small beds starting to expa
Bed 8	0.17	<<<1-3; 2	1-6; 4	Yes	None	Plants starting to expand b
Total	**1.21**					

Descriptions of Eurasian Water-milfoil Beds and High-Density Areas:

"Beds" 1-5 – None of these areas were true beds; rather, each was a nearly continuous ribbon of scattered plants and clusters. In each case, Eurasian water-milfoil was almost exclusively confined to the immediate shoreline (Figure 4) where it was growing among dead Jack pines (*Pinus banksiana*) that had been killed by rising lake levels after decades of low water (Figure 5). Because EWM were imbedded in these "flooded forests", none of these "high density areas" were an impairment to navigation.

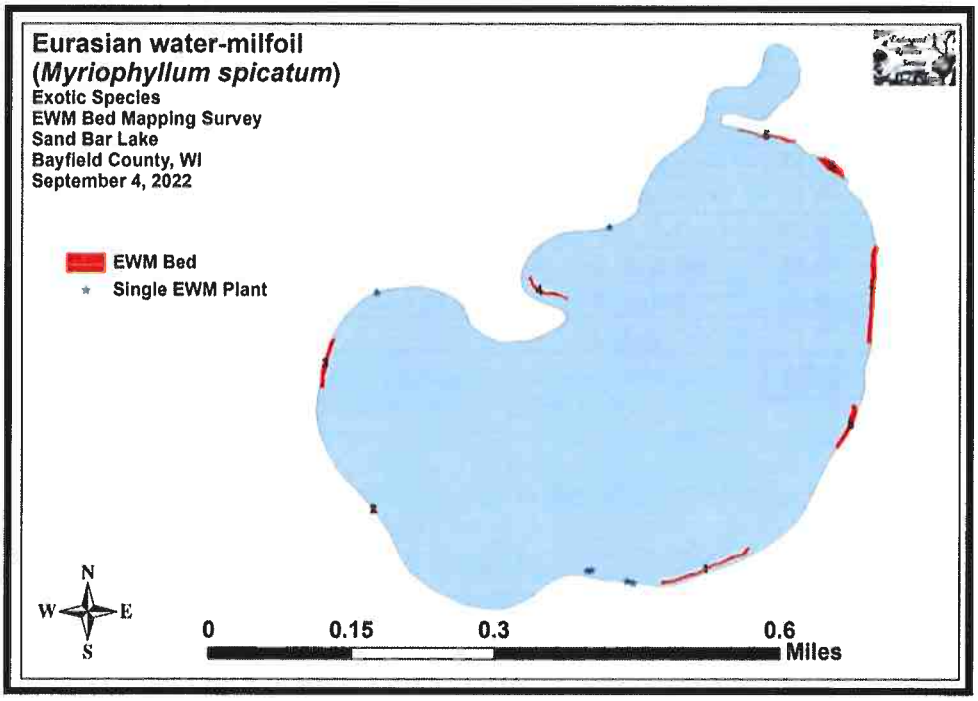


Figure 4: Eurasian Water-milfoil Bed Map – September 4, 2022

Beds 6 and 7 – Both of these low-density beds were beginning to exit the ring of dead pines. However, due to their proximity to the trees and the shoreline, neither was likely to be an impairment.

Bed 8 – This bed near the channel to Tomahawk Lake was the worst area on Sand Bar. We found dense patches of canopied EWM were beginning to expand beyond the ring of dead pines, and individual plants were spreading into deeper water. Although still not an impairment to navigation, wave action was causing the plants growing in open water to break apart, and we saw a concentration of floating fragments throughout this area. Interestingly, especially in this area, we noticed that beyond 7-10ft, the majority of the lake had no vegetation (Figure 6). This may account for the unusually poor water clarity we observed during the survey.

Figure 5: Canopied EWM Growing among Dead Jack Pines – 9/4/22

Figure 6: Typical Lack of Vegetation in Water Deeper than 7ft – 9/4/22

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Eurasian water-milfoil continues to occupy only a small percentage of Sand Bar Lake's surface area, but it is widely-established making eradication an unrealistic expectation. With this in mind, continuing to work to control its spread in the most cost-effective manner possible, while simultaneously minimizing its impact on the lake's aquatic ecosystem will likely continue to be important goals for the Town of Barnes moving forward.

The BAISS lost containment of EWM on Sand Bar Lake in 2022, and the current inaccessibility of most plants will make manual removal challenging to impossible due to the danger of air hoses becoming entangled in the dead trees. Although it is unlikely that the beds will become a navigation impairment in 2023, the widespread establishment of EWM around the lakeshore likely means these areas will continue to expand. Whether this constitutes a need for active management in 2023 needs to be discussed. Likewise, there should be a decision made on how much monitoring, if any, will be needed in 2023. Ultimately, the TOB, LEAPS, and the WDNR will have to decide on a future course of action.

LITERATURE CITED

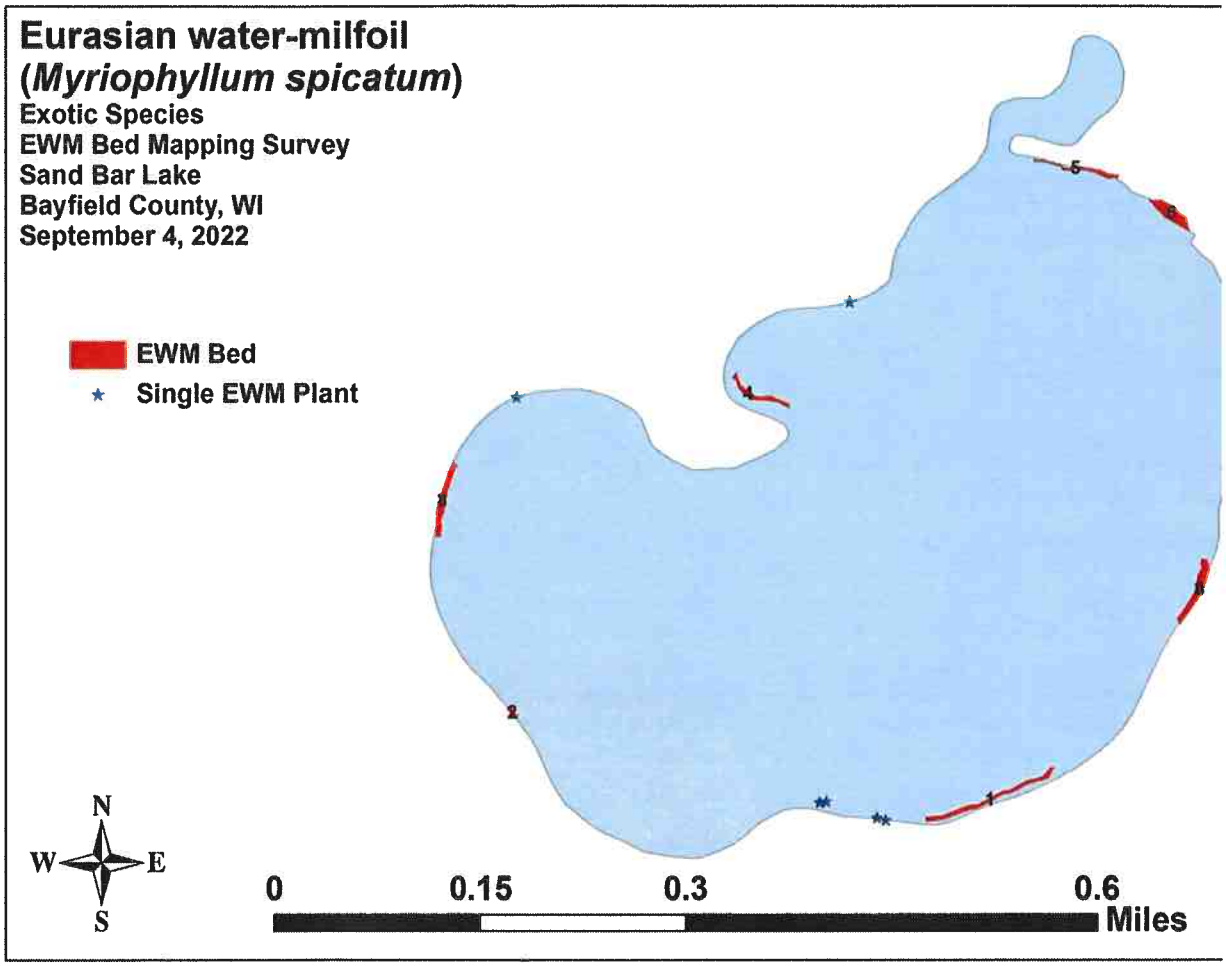
Holt, C., C. Busch, G. Lund, and L. Sather. 1972. Sand Bar Lake Bathymetric Map. http://dnr.wi.gov/lakes/maps/DNR/2494900a.pdf (2022 October).

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2022 September).

WDNR. [online]. 2022. Wisconsin Lakes Citizen Monitoring Data for Sand Bar Lake – Bayfield County. Available from https://dnr.wi.gov/lakes/waterquality/Station.aspx?id=043118 (2022 October).

WDNR. [online]. 2022. Wisconsin Lakes Information – Sand Bar Lake – Bayfield County. https://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2494900 (2022 October).

Appendix I: 2022 Eurasian Water-milfoil Bed Map


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
EWM Bed Mapping Survey
Sand Bar Lake
Bayfield County, WI
September 4, 2022
EWM Bed
Single EWM Plant
N
W
E
S
0
0.15
0.3
0.6
Miles