Wisconsin Department of Natural Resources
Surface Water Grants Program
Aquatic Invasive Species
Grant # ACEI25721

Buckatabon Lakes Eurasian Watermilfoil Management Project

Upper and Lower Buckatabon Lakes - Vilas County, WI

2021 Annual Reporting

Submitted To:
Wisconsin Department of Natural Resources

And

Buckatabon Lakes Association, Inc.
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PROJECT LOCATION & OVERVIEW

Upper and Lower Buckatabon Lakes are connected waterways located in Conover Township, Vilas County, WI with 493 and 352 surface water acres respectfully. Upper Buckatabon has a maximum depth of 30 feet and Lower Buckatabon has a maximum depth of 16 feet. Both lakes are drainage lakes and complex two-story fisheries. Located in the Tamarack Pioneer River Watershed, land cover consists primarily of forests, wetlands and opens water. This watershed is ranked medium for non-point sources affecting lakes (WDNR). Aquatic invasive species known to occur on the Buckatabon Lakes include banded mystery snails, Chinese mystery snails, Eurasian watermilfoil, and yellow iris.

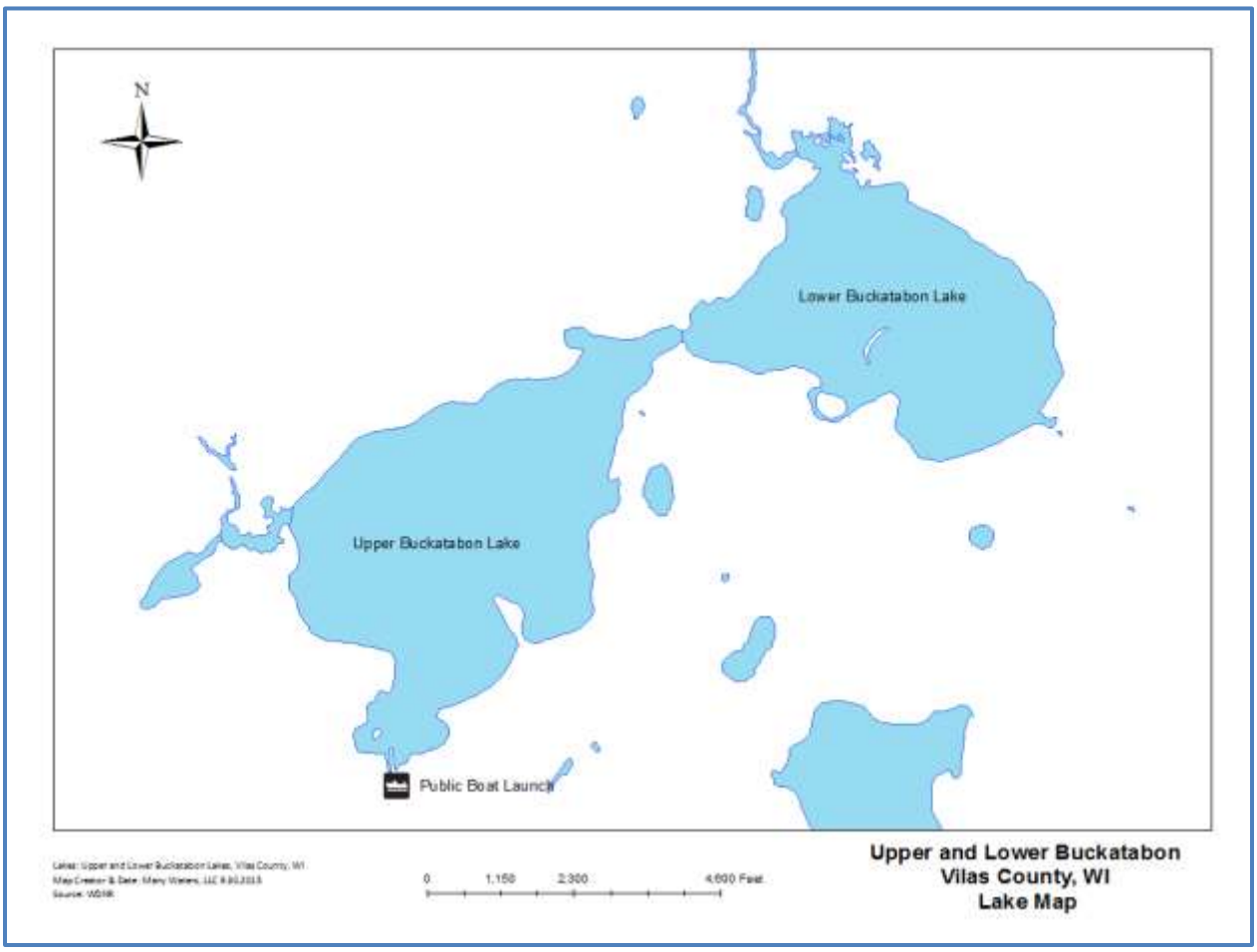
Buckatabon Creek flows into Upper Buckatabon from the north. This creek is a cool-cold headwater, macro-invertebrate natural community that supports a Class II trout stream. From the headwaters of Buckatabon Creek to the inlet of Upper Buckatabon, a substantial portion of property is public including State of WI Board of Commissioners of Public Lands, Wisconsin Department of Natural Resources (WDNR) and Vilas County Commercial Forestry Land. Upper Buckatabon has a floristic quality index[1] of 37.71 and a EWM frequency of littoral occurrence[2] of 3.85% (2021).

Lower Buckatabon is a shallow fertile lake. Wisconsin Valley Improvement Company owns and operates a dam at the southeast end of the lake, draining Buckatabon Creek to the Wisconsin River. The State of Wisconsin and State of Wisconsin Board of Commissioners of Public Lands owns property at the far north end of the lake. Lower Buckatabon has a floristic quality index of 36.28 and a EWM frequency of littoral occurrence of 0% (2019).

This report summarizes 2021 activities completed under the WDNR Aquatic Invasive Species Grant - Buckatabon Lakes EWM Control Project. With assistance from Golden Sands RC&D and VCLWCD, the Buckatabon Lakes Association (BLA) initiated a successful weevil-stocking program in 2020. Grant funds have given the BLA the ability in 2021 and 2022 to build on 2020 weevil rearing and stock efforts. In addition to weevil stocking and monitoring, this project includes EWM population monitoring and management with hand removal and DASH.

[1] Floristic Quality Index (FQI) measures the natural quality of a lake's aquatic plant community or nearness of the lake's plants to those seen in undisturbed conditions.

[2] Frequency of littoral occurrence of a species uses the results of a point intercept survey by taking the presence of a species on a rake sample divided by the total number of points sampled within the littoral zone.



EWM SEASONAL MONITORING

Aquatic invasive species (AIS) monitoring targets Eurasian watermilfoil but includes other aquatic and wetland invasive plant species. The first survey, timed during the first half of the growing season, reconfirms previous EWM locations to refine annual management strategies and monitors for EWM, mainly in shallow waters (Appendix A). The second survey, timed to capture EWM plants at or near their greatest annual growth potential occurs during the second half of the growing season and includes deeper waters and off shore locations where vegetation grows (Appendix A).

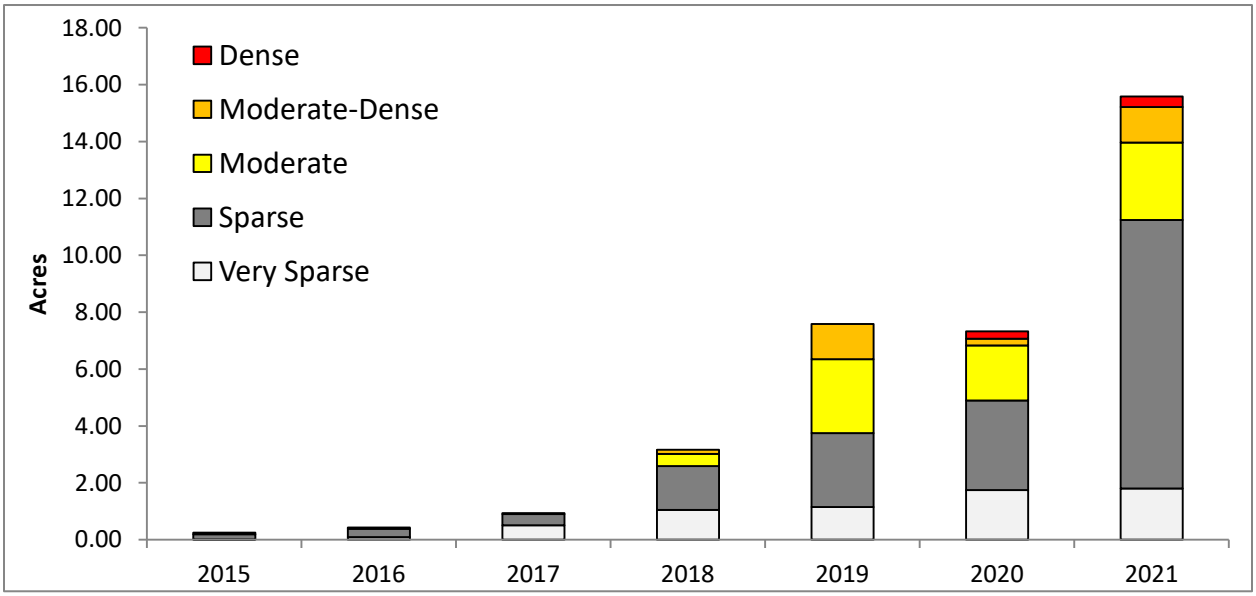
Monitoring efforts are qualitative in nature, meaning information collected describes the condition or population of the target AIS rather than relying on measured or quantitatively collected and calculated values. Smaller sites are geo-referenced with a GPS point and extent is determined by visually estimating coverage in foot-circumference. This is an observed estimate of exact extent, not footprint. On average, these sites are less than a 0.10 of an acre in size. Larger sites, typically greater than a 0.10 of an acre in size, are circumnavigated and extent in acres is calculated and represented on a map with a polygon.

The EWM population on the Buckatabon Lakes climbed from roughly 7 acres in 2020 to roughly 15.50 acres in 2021. Most of this increase occurred in Upper Buckatabon mainly along the eastern and southern shorelines. Most beds mapped consisted of sparse EWM with pockets of moderate to dense EWM observed mainly along the southern shoreline.

Table 1: *Change in EWM abundance from 2015-2021, Upper and Lower Buckatabon Lakes combined.*

EWM Abundance Estimate	2015	2016	2017	2018	2019	2020	2021
Very Sparse	0.02	0.10	0.50	1.05	1.15	1.75	1.80
Sparse	0.18	0.28	0.40	1.54	2.60	3.15	9.44
Moderate	0.05	0.05	0.03	0.43	2.61	1.93	2.72
Moderate-Dense	0.00	0.00	0.00	0.15	1.23	0.24	1.24
Dense	0.00	0.00	0.00	0.00	0.00	0.26	0.37
TOTALS (acres)	**0.25**	**0.43**	**0.93**	**3.17**	**7.58**	**7.33**	**15.58**

Figure 1: *Change in EWM abundance from 2015-2021, Upper and Lower Buckatabon Lakes combined.*



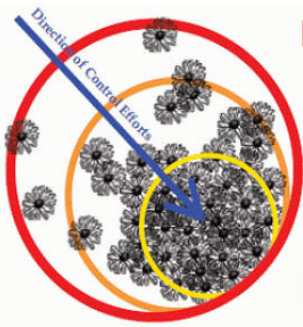
EWM MANAGEMENT

Goals for this two-year project are to (1) increase the abundance of the native milfoil weevil in Upper Buckatabon Lake and (2) limit the presence and spread of outlier EWM populations on Upper and Lower Buckatabon. The remaining regions not managed with manual removal or weevils are monitored and evaluation for population change.

To increase native milfoil weevil abundance, VCLWCD and the BLA reared and stocked weevils in 2021 and will again in 2022. Lake-wide weevil monitoring followed procedures detailed in the Biological Control of Eurasian Watermilfoil using the native milfoil weevil (Golden Sands, 2017). Weevil abundance monitoring within the stock beds followed Citizen Lake Monitoring Network procedures for native water milfoil weevil monitoring. A complete report of weevil rearing, stocking, and monitoring can be found in Appendix B.

The second goal of this project is to limit the presence and spread of outlier populations on Upper and Lower Buckatabon. Using an outward/in approach, priority sites for hand pulling and DASH include outlier and somewhat isolated sites working towards the core infestation. Data from the early season survey identified priority sites including all known EWM sites on Lower Buckatabon and priority sites on Upper Buckatabon near the boat launch, the channel to Lower, and select DASH sites on the north shore of Upper Buckatabon.

In 35.75 dive hours, 688 plants weighing approximately 103.75 pounds (wet weight) were removed from the dive priority sites. Roughly eleven DASH hours removed 184 cubic feet of EWM from three priority DASH sites on Upper Buckatabon (Appendix C).



Outliers – Highest priority

- Lowest density of infestation
- Goal = eliminate small, isolated infestations
- Prevent the reproduction and survival of outliers
- Monitor annually beyond the known infestation for new outliers
- Lowest level of commitment, resources and effort needed

Advancing Front

- Goal = control the advancing front and perimeter of core infestations
- Prevent the expansion of the core infestation

Core – Lower priority

- Highest density of infestation
- Goal = suppress the interior of core infestations
- Highest level of commitment, resources and effort needed

Note: Effective control may require the use of multiple control methods. Control efforts must be followed up by monitoring for new plants, regrowth, and flowering, generally within the same growing season. Monitoring should be done annually.

Adapted from www.dnr.wisconsin.gov

Proposed Management Methods
Manual Removal
Monitor & Evaluate/Manual Removal
Biological Control

N

Lower Buckatabon

Upper Buckatabon

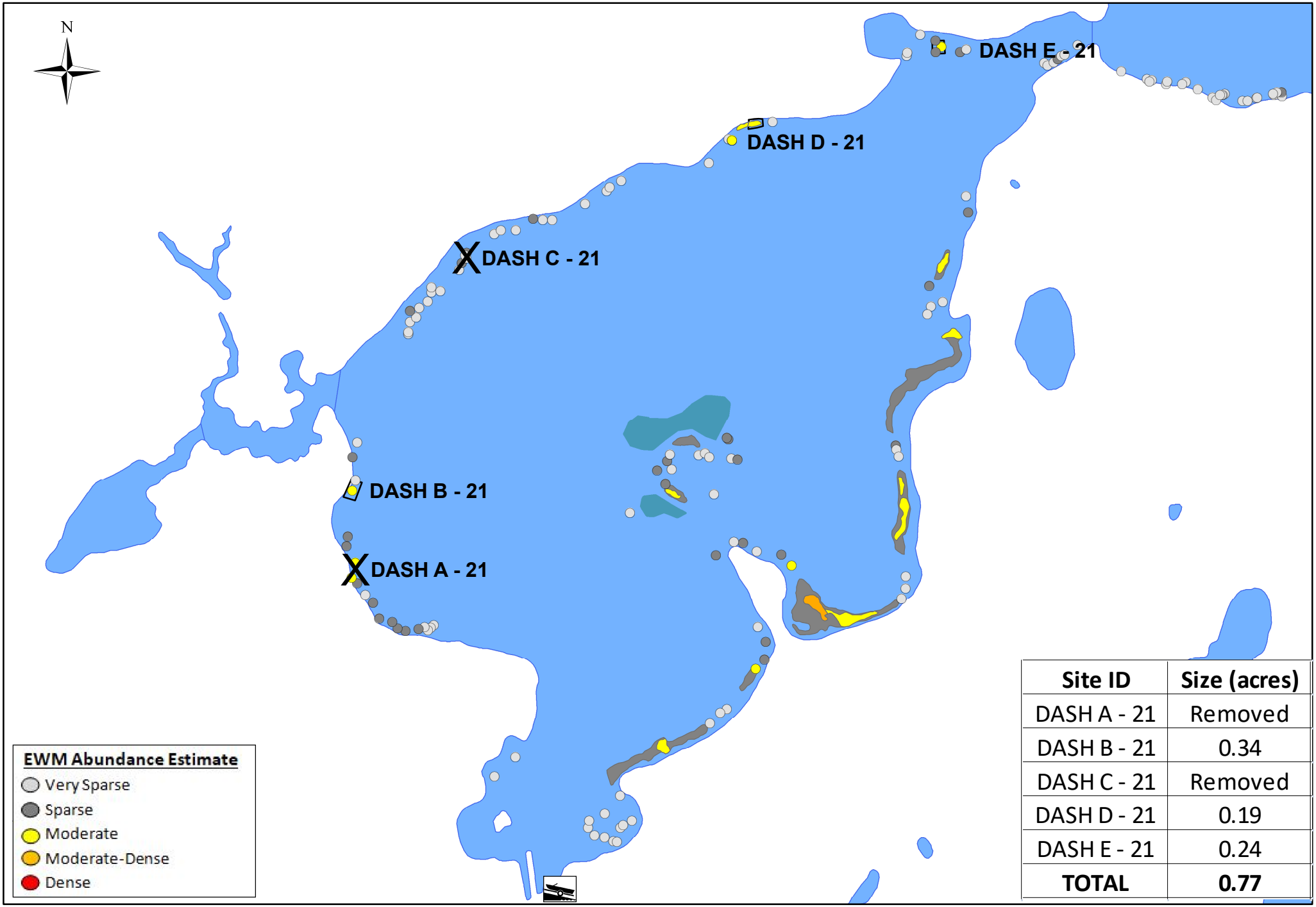
0 1,100 2,200 4,400 Feet

EWM Abundance Estimate

- Very Sparse
- Sparse
- Moderate
- Moderate-Dense
- Dense

Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 10.129.2020,Many Waters, LLC
Survey Date: 7.30.2020-8.12.2020
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2020

Buckatabon Lakes
Prioritized EWM Management Strategy
2021 & 2022



Site ID	Size (acres)
DASH A - 21	Removed
DASH B - 21	0.34
DASH C - 21	Removed
DASH D - 21	0.19
DASH E - 21	0.24
TOTAL	**0.77**

Lake: Lower Buckatabon, Vilas County, WI
Map Date & Creator: 07.07.2021,Many Waters, LLC
Survey Date: 06.8/9.2021/ DASH Sites Updated on 08/19/2021
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_DASH_2021

0 550 1,100 2,200 Feet

Upper Buckatabon - Vilas County, WI
Final DASH Sites - UPDATED 08/29/2021
2021

2022 MANAGEMENT STRATEGIES AND BEYOND

The 2022 management objectives, at outlined in the current WDNR grant, will be to continue to apply an integrated approach to EWM management using manual removal, biological control, and population monitoring to address a growing EWM population in Buckatabon Lakes. Using and outward-in approach, outlier populations will be managed with manual removal, whereas the core infestation will be stocked with native milfoil weevils.

The scope of work for 2022 under the current grant is defined within the priority regions on Upper and Lower Buckatabon Lakes. Management in 2021, limited the presence of EWM on Lower Buckatabon and somewhat maintained the presence of sparse outlier sites on Upper Buckatabon. The regions identified in the monitoring and evaluation, mainly along the eastern and southern shore areas are the primary source of EWM increase in Upper Buckatabon Lake in 2021. The current grant does not go beyond monitoring and evaluation in these specific regions, nor are their budgets within this grant to do so. Discussion with WDNR on what types of management would be appropriate for the current population of EWM on Upper Buckatabon Lake beyond this grant cycle is needed.

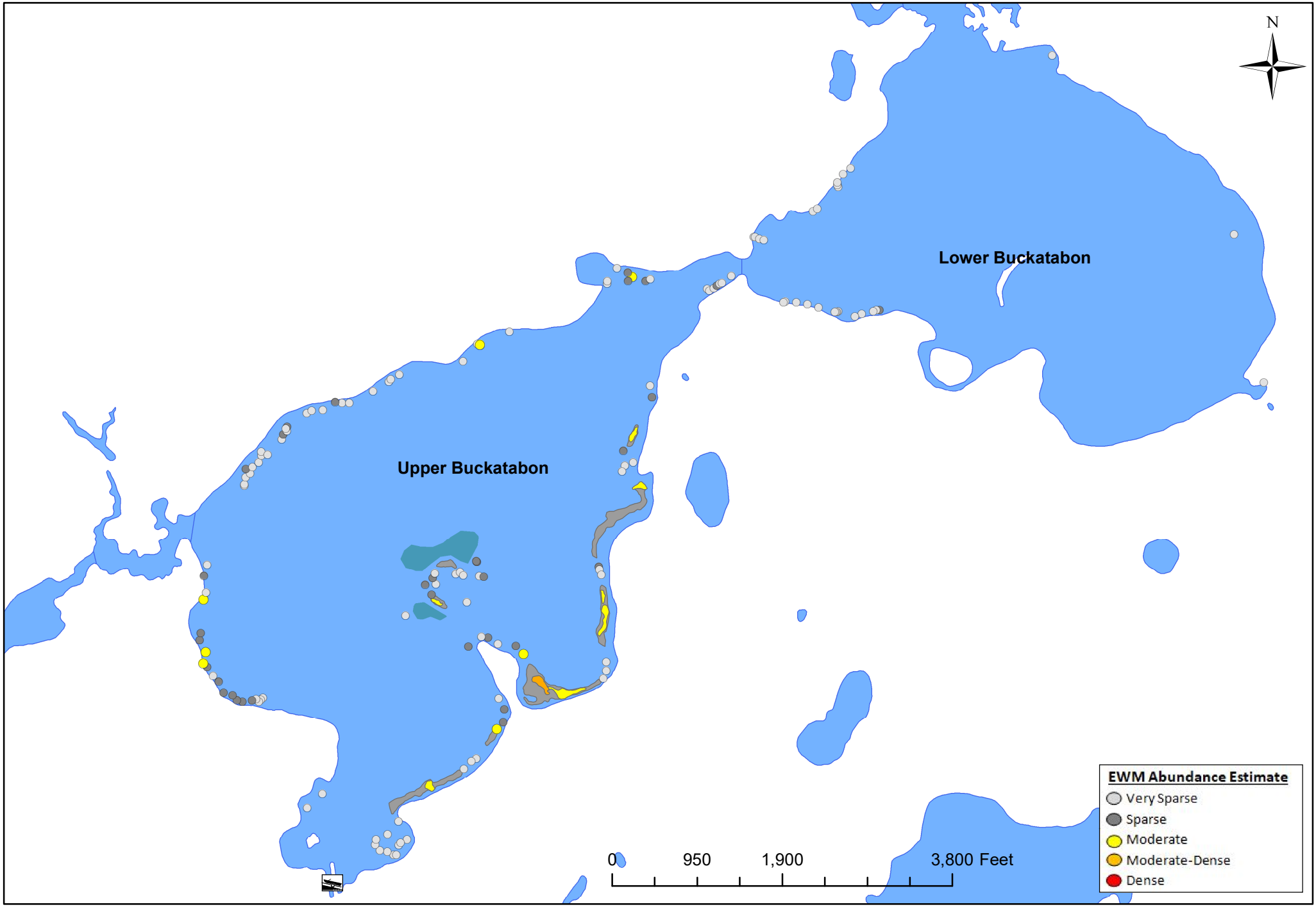
Some considerations include:

- Impacts to weevil populations depending on chosen management techniques
- Will management results in long-term control?
- Is the management targeting abundance, distribution or both?
- Is EWM causing recreational impairments and riparian use and access to the waterbody?
- Balance between non-target risks of proposed management with impairment and recreational nuisance caused by uncontrolled EWM populations
- Current conditions of EWM population lake-wide, is it expanding, contracting, or remaining stable?
- What steps are being taken to work towards reducing nutrient and other pollutants that may exacerbate aquatic plant growth?

Management of aquatic invasive species should benefit both the lake user and the ecological health of the waterway. Furthermore, management should use control techniques that support the best use of resources, are adaptive to address the population at the time following well-accepted best management practices. Having a nuisance issue impairing recreational use and access to the waterbody or a growing EWM population (perceived or data supported) that is clearly expanding across the waterbody are considerations when making decisions selecting control techniques, including the use of aquatic herbicides. Details on to the degree of when and how herbicides fit into the WDNR's principles of best-management practices specifically for Upper Buckatabon Lake will need clarification from WDNR. It is advised to consult with the WDNR regarding these questions regarding herbicide applicability and best management practices for herbicide options.

APPENDIX A

SEASONAL EWM MONITORING
2021



Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 06.17.2021,Many Waters, LLC
Survey Date: 6.8.21 & 6.9.21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_ES_2021

Buckatabon Lakes
Early Season - EWM Relocation Survey
2021

Lake: Upper Buckatabon Lake, Vilas County, WI
Map Date & Creator: 12/30/21, Many Waters, LLC
Survey Date: 8/19/21 & 9/13/21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2021

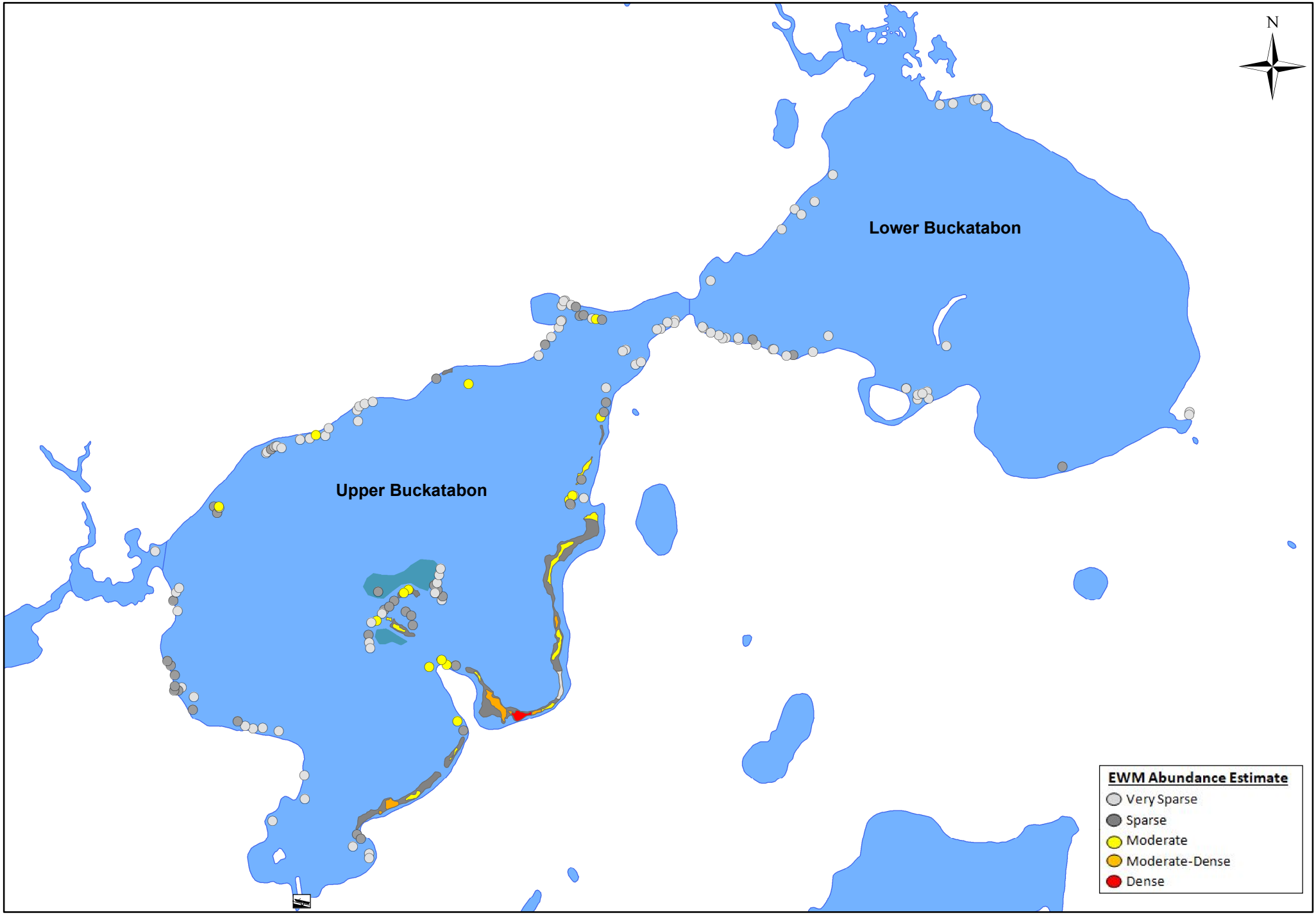
0 700 1,400 2,800 Feet

Upper Buckatabon Lake - Vilas County, WI
Mid/Late Season EWM Survey
2021

Lake: Lower Buckatabon Lake, Vilas County, WI
Map Date & Creator: 12/30/21, Many Waters, LLC
Survey Date: 8/19/21 & 9/13/21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2021

0 500 1,000 2,000 Feet

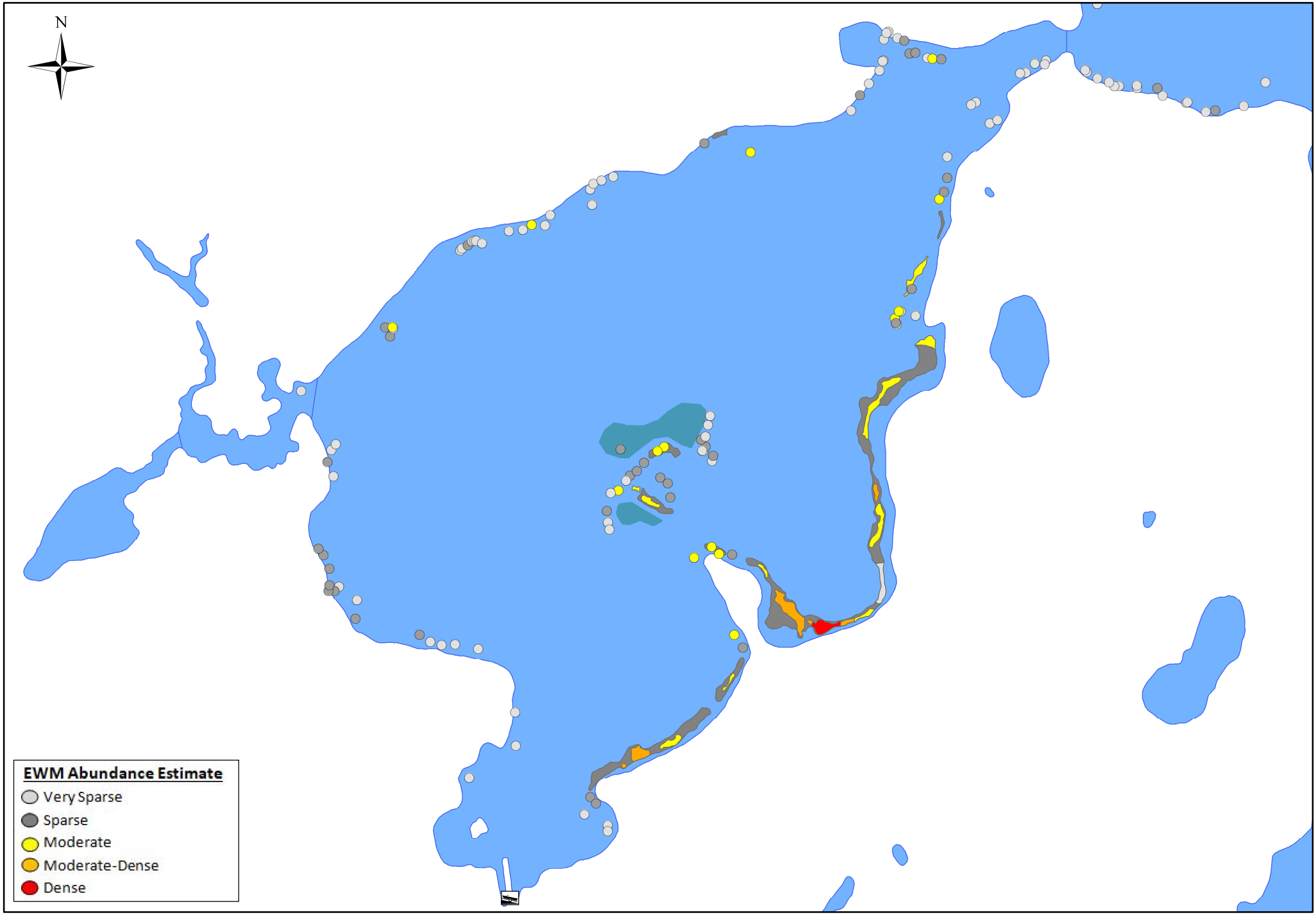
Lower Buckatabon Lake - Vilas County, WI
Mid/Late Season EWM Survey
2021



Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 12/30/21,Many Waters, LLC
Survey Date: 10/5/21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2021

0 1,000 2,000 4,000 Feet

Buckatabon Lakes - Vilas County, WI
End of the Year - EWM Locations
2021



Lake: Upper Buckatabon Lake, Vilas County, WI
Map Date & Creator: 12/30/21,Many Waters, LLC
Survey Date: 10/5/21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2021

0 700 1,400 2,800 Feet

Upper Buckatabon Lake - Vilas County, WI
End of the Year - EWM Locations
2021

Lake: Lower Buckatabon Lake, Vilas County, WI
Map Date & Creator: 12/30/21,Many Waters, LLC
Survey Date: 10/5/21
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2021

0 500 1,000 2,000 Feet

Lower Buckatabon Lake - Vilas County, WI
End of the Year - EWM Locations
2021

APPENDIX B

Weevil Rearing, Stocking, and Monitoring Reports

2021 Upper Buckatabon Lake Weevil Rearing & Stocking Report

3/10/2022

Report prepared by Cathy Higley, Lake Conservation Specialist, Vilas County Land & Water Conservation Dept.

Figure 1. An adult weevil found in rearing tanks during this project, and Tom Christensen in the canoe points out for snorkelers Cathy Higley and Shawn O'Connell more dense clumps of Eurasian watermilfoil.

Table 1. Weevil Stats at a Glance

Metric	2020 Pre-Weevil Stocking Baseline Data	2021 – 1 Year After 1 Weevil Stocking	Success Measure (Determine after 2023 stocking)
Lake-Wide Weevil density on EWM	0.19 weevils/stem	0.11 weevils/stem	n/a, but goal of 0.25-1.0 or greater
EWM % Littoral Frequency of Occurrence	2.84%	5.15%	n/a
EWM Average Rake Fullness	1.00	1.00	1.00
Acres of "dense" EWM in (Upper and Lower Buckatabon combined)	0.26 (3.5% of EWM polygons)	0.37 (2.4% of EWM polygons)	= or < 3.5% of EWM polygons
Lake-Wide Weevil Density on EWM & NWM combined	0.10 weevils/stem	0.07 weevils/stem	n/a
Lake-wide Weevil Density on NWM	0.06 weevils/stem	0.06 weevils/stem	n/a
Approx. Weevils Stocked	2,600	3,151	n/a
Donated labor from Buckatabon Lakes Association	67.3 hours	133.08 hours	n/a

Background

In 2015 the invasive aquatic plant Eurasian watermilfoil *Myriophyllum spicatum* (**EWM**) was verified on what is locally referred to Benson's Bay on Upper Buckatabon Lake in Vilas County, WI. Upper Buckatabon Lake is a 493 acre Two-Story Fishery Drainage lake. It is currently listed as Impaired for total phosphorus (Impaired Water 2018). Response efforts to the EWM included handpulling, diver assisted suction harvesting, and the formation of the Buckatabon Lakes Association (**BLA**) to coordinate lake management along with their lake consultant, Many Waters, LLC.

By 2019, the EWM was dense in some areas of Benson's Bay where water is 6-8 ft deep, and had spread to several other sites around the lake. A lake resident and active BLA member, Charlie Coventry, approached Vilas County Land & Water Conservation Department for assistance using native weevils as a biocontrol to manage the EWM. The use of weevils, *Euhrychiopsis lecontei* has been shown to be effective at managing EWM in some lakes, but this management technique is not effective in all lakes. Reasons for these differences are not well understood (Golden Sands 2016).

The Buckatabon Lakes Association is working to adopt an integrated pest management approach, and since the weevils are native and less costly than herbicide treatments, they were an attractive option. Because Benson's Bay had some dense EWM in a protected bay with AIS buoys already established, a nearby natural shoreline that would likely support hibernating weevils, and membership willing to pitch in with volunteer hours, this appeared an ideal opportunity for promoting weevils.

EWM may still be expanding in the Buckatabon Lakes. The lake consultant Many Waters, LLC has been mapping its extent in the lakes since 2015. There are points and polygons of EWM mapped along some areas of shoreline, but there are many areas where EWM is not yet detected. As time goes on, EWM may continue to spread. However, the hope is that with enough weevils EWM will not become dense and create nuisance areas.

Vilas County Land & Water's Invasive Species Strategic Management Plan supports efforts to adopt integrated pest management, and thus a partnership was created between BLA and Vilas County to try weevil stocking in Upper Buckatabon Lake.

Eurasian Watermilfoil Occurrence Data

EWM can be characterized in different ways. A high percent of EWM acres considered "dense" can reflect a nuisance level of EWM. EWM was mapped by Many Waters, LLC starting in 2015. The Mid/Late Season 2020 and 2021 Maps of EWM Occurrences is shown here for reference, courtesy of Many Waters, LLC.

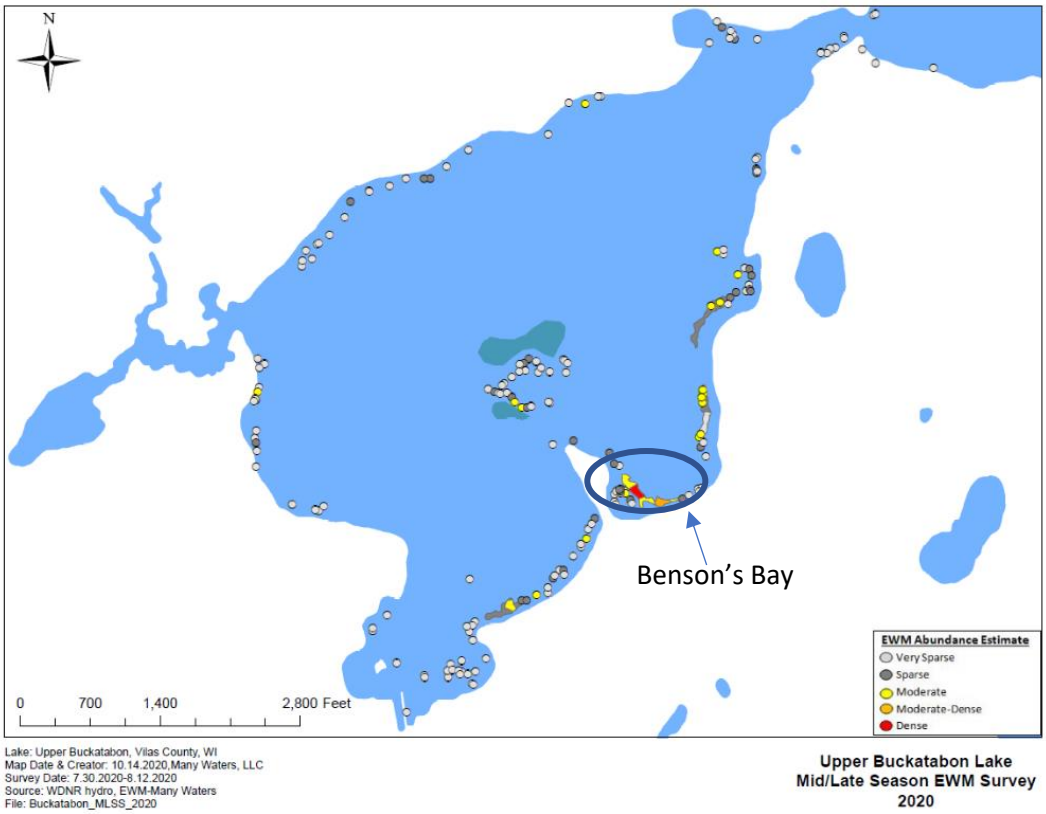


Figure 2. 2020 Upper Buckatabon Lake Mid/Late Season EWM Survey. Courtesy of Many Waters, LLC.

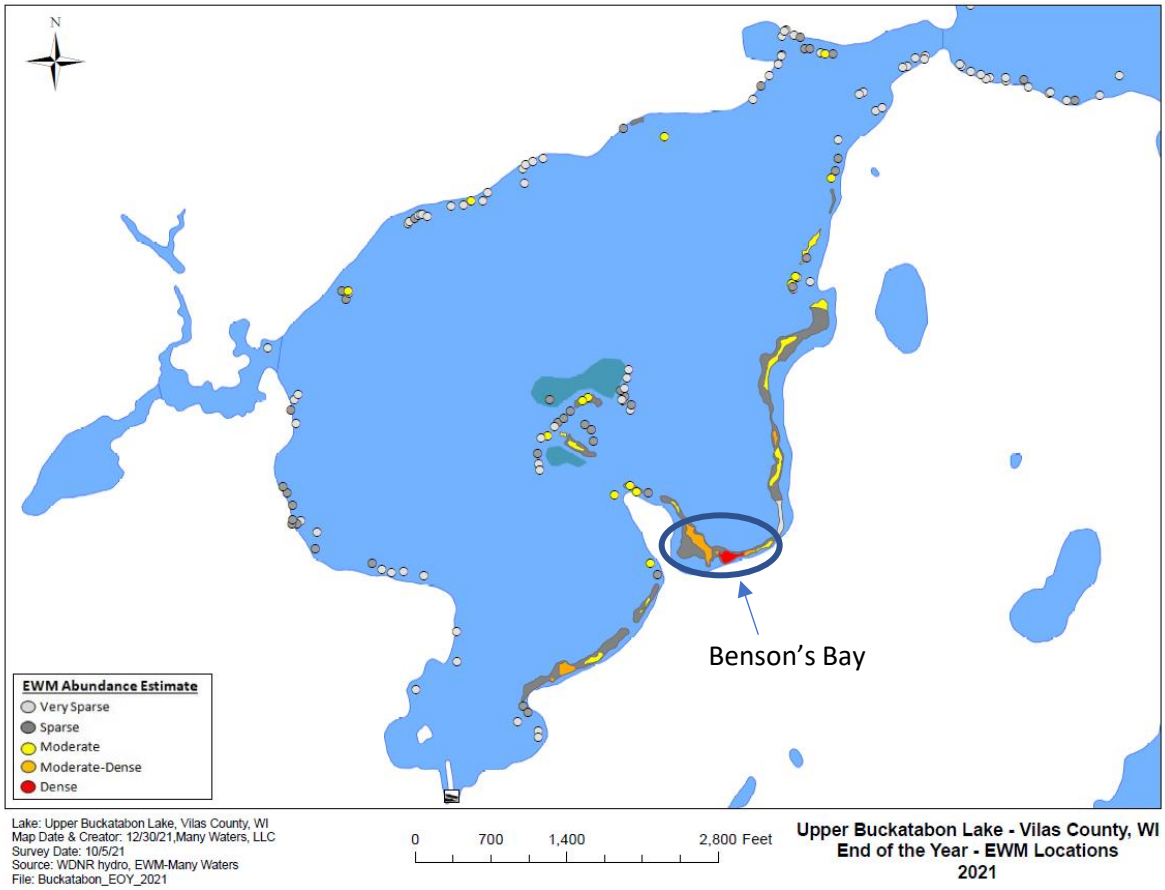


Figure 3. 2021 Upper Buckatabon Lake End of the Year EWM Survey. Courtesy of Many Waters, LLC.

It can be helpful to see how density and acreage changes from year to year by the following chart provided by Many Waters, LLC. Note that this chart includes data from Lower Buckatabon Lake, however the majority of EWM is found on Upper Buckatabon. In 2020 there were 0.26 acres, and in 2021 there were 0.37 acres of EWM were considered "dense" on both Upper and Lower Buckatabon.

Table 2. Change in EWM abundance from 2015-2021 on Upper and Lower Buckatabon Lakes. Courtesy of Many Waters, LLC.

EWM Abundance Estimate	2015	2016	2017	2018	2019	2020	2021
Very Sparse	0.02	0.10	0.50	1.05	1.15	1.75	1.80
Sparse	0.18	0.28	0.40	1.54	2.60	3.15	9.44
Moderate	0.05	0.05	0.03	0.43	2.61	1.93	2.72
Moderate-Dense	0.00	0.00	0.00	0.15	1.23	0.24	1.24
Dense	0.00	0.00	0.00	0.00	0.00	0.26	0.37
TOTALS (acres)	**0.25**	**0.43**	**0.93**	**3.17**	**7.58**	**7.33**	**15.58**

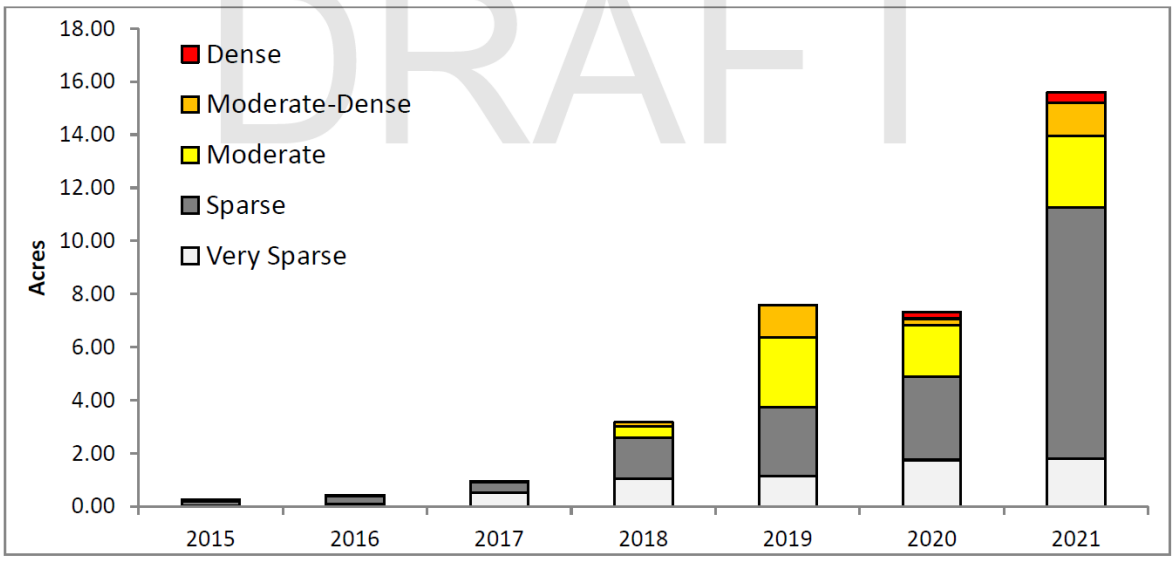


Figure 4. Change in EWM abundance from 2015-2021 on Upper Buckatabon and Lower Buckatabon Lakes. Courtesy of Many Waters, LLC.

Weevil & Eurasian Watermilfoil Densities

In order to determine if weevil stocking will be impactful, baseline data was collected July 21-July 27, 2020. An Aquatic Plant Point Intercept survey was completed using the DNR's standard point intercept grid, along with collecting two stems of EWM or northern watermilfoil where they were found at these points. The purpose of this method is to get a lake-wide statistically comparable measure of EWM frequency of occurrence as well as weevil densities, but it will not detect all occurrences of EWM and weevils. It will also give several other metrics such as species richness, floristic quality index, and other parameters that describe aquatic plant community quality. This protocol was repeated August 2 – August 10, 2021 to monitor lakewide weevil and Eurasian watermilfoil densities one year after the first weevil stocking. The

sampling followed procedures listed in the “Biological Control of Eurasian Watermilfoil” manual (Golden Sands, 2016). See Figure 5 for the 766 sites on Upper Buckatabon that were sampled.

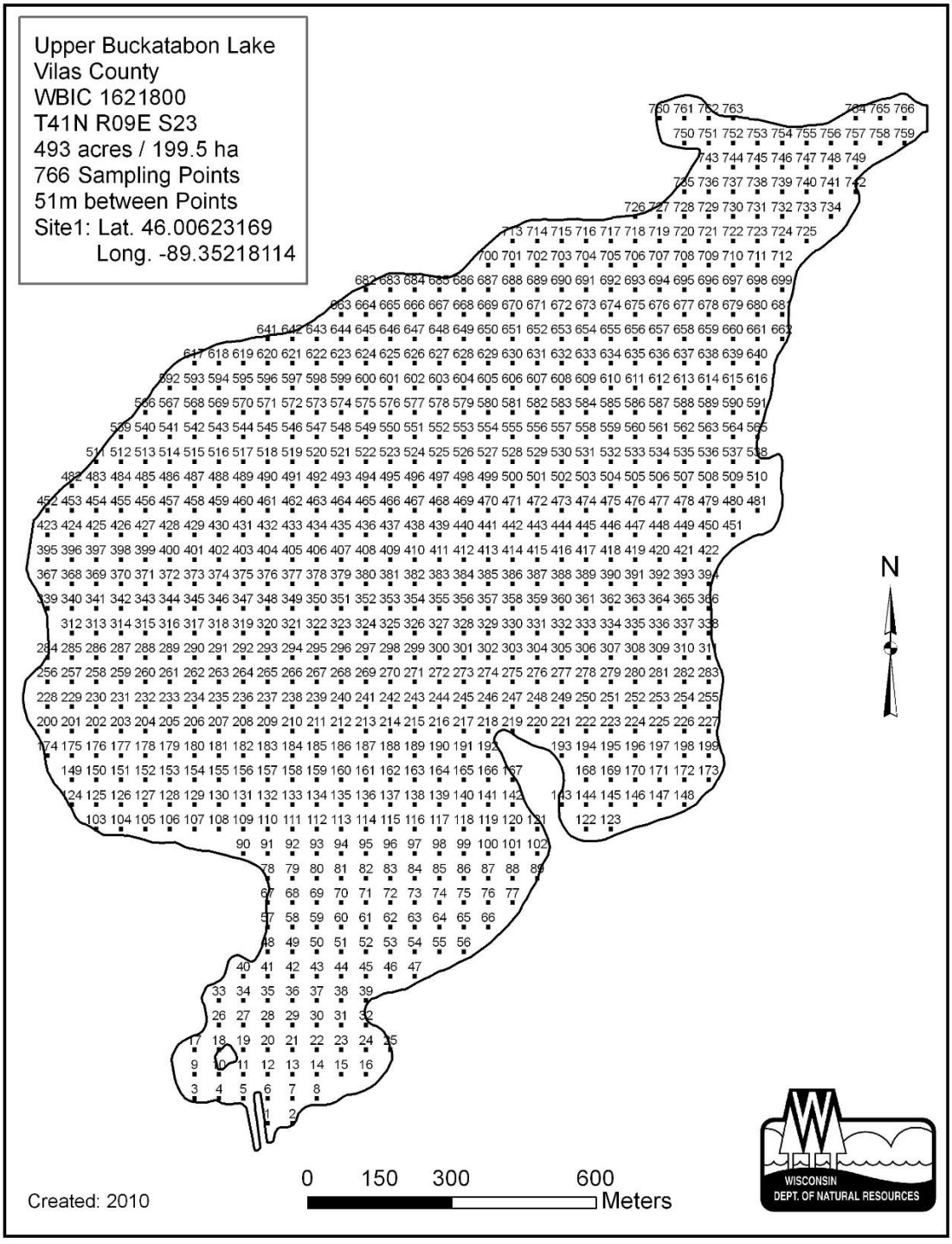


Figure 5. Aquatic Plant Point Intercept map. Courtesy WI DNR.

Total rake fullness for each site as well as individual species found was recorded as 1, 2, or 3 as described in Figure 6.

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

Figure 6. Cathy Higley processing plant samples from the Aquatic Plant Point Intercept survey; rake fullness rating descriptions. Photo courtesy of Emily Heald. Diagram courtesy of WI DNR.

Percent littoral frequency of occurrence reflects how likely it is to collect at least 1 stem of EWM at a sampling point where aquatic plants can grow on the lake. The middle of the lake does not support aquatic plants – it is too deep, so these points are not considered in this calculation.

Where EWM was found at each Point-Intercept sampling location, two 24 inch long stems were collected and preserved in ethanol. In 2021 Cathy Higley, after training and further mentoring from Amy Thorstenson of Golden Sands RC&D, counted all life stages of weevils found on the stems in order to get an estimate of lake-wide weevil density.

Because the native aquatic plant northern watermilfoil *Myriophyllum sibiricum* (**NWM**) is quite common on Upper Buckatabon and serves as another host plant for the weevils, stems of northern watermilfoil were also collected as they were encountered at each Aquatic Plant Point Intercept sampling site. However, in many instances two 24 inch stems of Northern watermilfoil could not be collected as it is often shorter than 24 inches. In these cases, shorter stems were collected.

Benson's Bay has been the focus area of the weevil project, and contained 8 Aquatic Plant Point Intercept survey sites where milfoil was found (4 EWM, 4 NWM, and 1 both). Of these, one 1 EWM and 1 NWM sample showed presence and/or evidence of weevils - one more site in Benson's Bay than the 2020 sampling showed.

Rearing Set Up

The Buckatabon Lakes Association (BLA) purchased cultured weevil stock from Golden Sands RC&D. Golden Sands was also able to hold the DNR NR 40 permit to transport and transfer the EWM used for this project as well as the DATCP Biocontrol permit. All cultured weevil stock were transferred onto EWM from Upper Buckatabon before arriving at the rearing site. BLA used four 100 gallon cattle troughs to raise weevils. Troughs were placed at Ronald and Barbara Schaefer's property. 305 weevils living in bundles of Upper Buckatabon EWM were divided among the four cattle troughs, so each trough received either 75 or 76 weevils. Seven fresh bundles of EWM from Upper Buckatabon were also added. Temperatures were monitored once or twice/day depending on weather conditions. Water temperatures are ideal at 84° F, but temps over 87° F are too hot; sustained temps of 93° F are lethal (Golden Sands 2016). BLA worked to keep water temperatures hospitable. Recorded temps ranged from 58° F to 81° F. On hot days shade covers were used in the afternoons; on cool days insulation board was placed over the tanks at night and removed the next morning. Time of checks varied with daily air temps. For example, on cool days the board insulation was on overnight and morning & night checks were needed to put on and remove the insulation. From trial and error in 2020, Vilas County Land & Water staff found this typically kept the water in the troughs about 5°F warmer at the early morning checks. On hot days, only afternoon checks were needed to put on shade cloth.

Figure 7. BLA volunteer Dan Benson helping to set up the 2021 weevil rearing site on Upper Buckatabon.

Some "extra weevils" were cultured by Golden Sands RC&D, and these 223 weevils were released directly into the release site on Benson's Bay over the 4th of July weekend.

Weevils were fed approximately every 21 days according to the "Biological Control of Eurasian Watermilfoil" manual (Golden Sands 2016). Volunteers from BLA and Vilas County Land &

Figure 8. Land & Water Staff snorkeling to collect EWM; BLA member Carolyn Barthel and her grandson cleaning and bundling EWM stems.

Water Staff snorkeled to collect and then process stems of EWM from Upper Buckatabon Lake. After collection, stems were then washed, trimmed, bundled, and weighted with a rock before being placed in troughs.

Figure 9. BLA volunteer Tom Christensen canoes weevil filled EWM bundles out to Vilas County Land & Water Staff snorkelers who attach them to existing EWM on the lake in Benson's Bay.

Weevil Releases

Using the average rate of return on weevil rearing in "Biological Control of Eurasian Watermilfoil" it is estimated that 3,151 weevils were released into Benson's Bay on August 19, 2021. EWM bundles containing weevils in all life stages were loaded into a canoe and snorkelers tied the bundles to existing EWM plants in Benson's Bay with jute twine. This method of snorkeling seems to reduce EWM fragmenting and worked well with the 6-8 ft water depths.

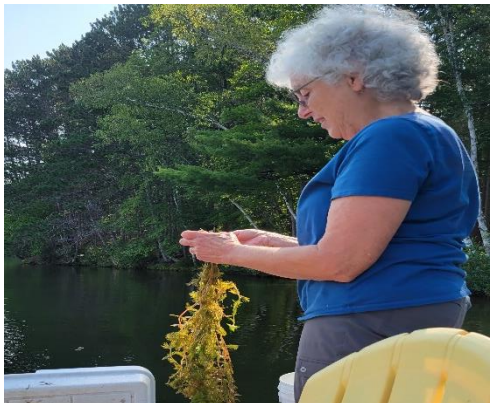


Figure 10. BLA volunteer Barb Benson removes rocks and rubber bands from the EWM bundles, replacing them with jute twine in preparation for releasing the weevils.

Results

The following table shows information pertinent to EWM management, and aquatic plant community. This table summarizes information on all aquatic vascular plants found during the point-intercept survey on Upper Buckatabon, except for the last two lines which refer to just the Eurasian watermilfoil and northern watermilfoil in the lake. "Sites" refer to the areas marked on the map in Figure 5.

Table 3. 2020-2021 Upper Buckatabon Aquatic Plant Point Intercept Survey Results

	2020	2021 & (2021 adjusted)
Total number of sites visited	328	582 (369)
Total number of sites with vegetation	189	232 (226)
Total number of sites shallower than maximum depth of plants	317	494 (369)
Frequency of occurrence (of all plants) at sites shallower than maximum depth of plants	59.62%	46.96% (61.25%)
Simpson Diversity Index	0.91	0.92 (0.92)
Maximum depth of plants (ft)	22.00	26.00 (22.00)
Average number of all species per site (shallower than max depth)	1.56	1.60 (2.12)
Average number of all species per site (veg. sites only)	2.62	3.40 (3.46)
Species Richness	35	33 (33)
Species Richness (including visuals)	39	39 (39)
Floristic Quality Index	36.51	37.72 (37.72)
Average Value of Conservatism	6.67	6.77 (6.77)
EWM % Frequency of Occurrence shallower than maximum depth of plants	2.84%	3.85% (5.15%)
NWM % Frequency of Occurrence shallower than maximum depth of plants	8.52%	8.10% (10.84%)

Sampling effort was increased in 2021 vs. 2020 due to an emphasis from DNR towards a preference on “oversampling” vs. “under-sampling”. In 2021 many sites were visited that were likely too deep to support vascular plant life in hopes of finding a few that could support plants. This did prove slightly fruitful as 6 additional sites out of the 254 extra sites deeper than 22 ft did, in fact, support vascular plant life. It is important to take this difference in effort into consideration when comparing the two years of data. Data appearing in parentheses were adjusted to maintain a 22 ft max depth of plants as in 2020 so data are more comparable between the two years. The following discussion points reference these data in parentheses.

Frequency of occurrence of all plants shallower than the maximum depth of plant growth was 59.62% in 2020, and 61.25% in 2021. This means that of all the areas shallower than 22 ft (adjusted max depth of plants for the lake) 59.62% contained plants in 2020; and 61.25% contained plants in 2021. These figures are fairly similar to each other.

The Simpson Diversity Index indicates how many different kinds of plants and how evenly distributed they are throughout a system on a scale of 0 (no diversity) to 1 (infinite diversity). The Upper Buckatabon Lake value showed very little change between the 2020 to 2021 of 0.91 and 0.92. This figure is quite high, indicating many different kinds of plants that are fairly evenly distributed.

At each site that contained plants, on average 2.62 different species were found in 2020. This is anecdotally on the middle-high end when compared to other lakes Vilas County Land & Water has surveyed. In 2021, this figure increased to 3.46, indicating and increased species count at each site.

Species Richness is a direct count of how many different species were collected during the Aquatic Plant Point Intercept survey. The Northern Lakes and Forest Region of WI average Species Richness is 13 (Nichols 1999). Upper Buckatabon Lake's Species Richness was 35 in 2020, and 33 in 2021. A few plants were not captured during the survey, but were visually found on the lake. Adding these "visuals" to the survey would give a Species Richness of 39 in both 2020 and 2021.

The Average Value of Conservatism reflects how sensitive the plants found are. For example, a disturbed lake would likely have a lower Average Value of Conservatism because most of the plants found there would likely be tolerant of less than ideal conditions. The Northern Lakes and Forests Region of WI average is 6.7 (Nichols 1999). Upper Buckatabon Lake had an Average Value of Conservatism of 6.67 in 2020, and 6.77 in 2021. These values are consistent with the area's average.

The Floristic Quality Index is a measure of how diverse and how sensitive the species found are. The Northern Lakes and Forests Region average is 24.3 (Nichols 1999). Upper Buckatabon Lake had a Floristic Quality Index of 36.51 in 2020, and similarly, 37.72 in 2021.

The EWM % frequency of occurrence (**%FOO**) shallower than the maximum depth of plants refers to how likely it is to collect at least 1 stem of EWM at an Aquatic Plant Point Intercept survey at a site shallower than the adjusted max depth of 22 ft deep. Upper Buckatabon had an EWM %FOO of 2.84% in 2020, and this figure had slightly increased in 2021 to be 5.15%. So out of every 100 rake samples in the littoral area of the lake, just over 5 sites will have EWM. This is considered quite low. Anecdotally, most lakes with nuisance EWM levels often report an EWM %FOO of 10% or higher. The % FOO for EWM is expected to increase over time as EWM expands its footprint around the lake, even if management options are working well.

The average rake fullness for EWM in both 2020 and 2021 was 1.0. As EWM expands its footprint around the lake, rake fullness may or may not change. The hope is that the weevils, along with the other methods of management, will be able to keep the EWM densities at lower levels. One component of determining success in the weevil project is to maintain an average total rake fullness of 1.0 for EWM.

Northern watermilfoil (**NWM**) %FOO information is also included here for reference. NWM %FOO on Upper Buckatabon was 8.52% in 2020, and 10.84% in 2021. In both years, NWM is at least twice the %FOO than that of EWM. It is important to mention that NWM is a native plant, and also serves as a host plant for the weevils.

The following table shows the lake-wide results of the weevil sampling on Upper Buckatabon Lake in 2020 and 2021. Within the table, weevil "presence" refers to finding adult weevils, larval weevils, weevil eggs, pupating weevils. Weevil "evidence" refers to finding blast holes where the weevils had emerged from stems after pupating. The average lake-wide weevil density is calculated by dividing the total number of present weevil life stages found by the total number of stems collected. See Appendices for raw data.

Table 4. 2020-2021 Upper Buckatabon Weevil Sampling Results

	Northern Watermilfoil		Eurasian Watermilfoil		Combined	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Number of sites where milfoil samples collected	26	40	8	14	34	51
Number of sites with weevils present or weevil evidence	3	13	5	4	8	17
% of sites with weevils present or weevil evidence	11.5%	32.5%	62.5%	29.6%	23.5%	33.3%
Average lake-wide weevil density (weevils/stem)	0.06	0.06	0.19	0.11	0.10	0.07

There is not comparable standardized weevil data for the Northern Lakes and Forests Region of WI like there is for the Aquatic Plant Point Intercept survey. The 2020 data showed an expected greater density of weevils on EMW stems than NWM stems. Typically, where NWM and EWM both occur, there is a tendency for weevils to shift their preference to EWM (Newman et. al. 1997). However, in 2021 there is a shift from weevil presence and evidence being documented more similarly throughout NWM and EWM sites and seem to now be found around the perimeter of the most of Upper Buckatabon Lake. This idea is reflected in the increased combined percent of sites with weevil presence or weevil evidence. This may be due to natural weevil migrations within the lake. Further years of sampling will determine if the weevils tend to be using NWM or EWM more consistently in Upper Buckatabon. See below for 2020 and 2021 weevil maps.

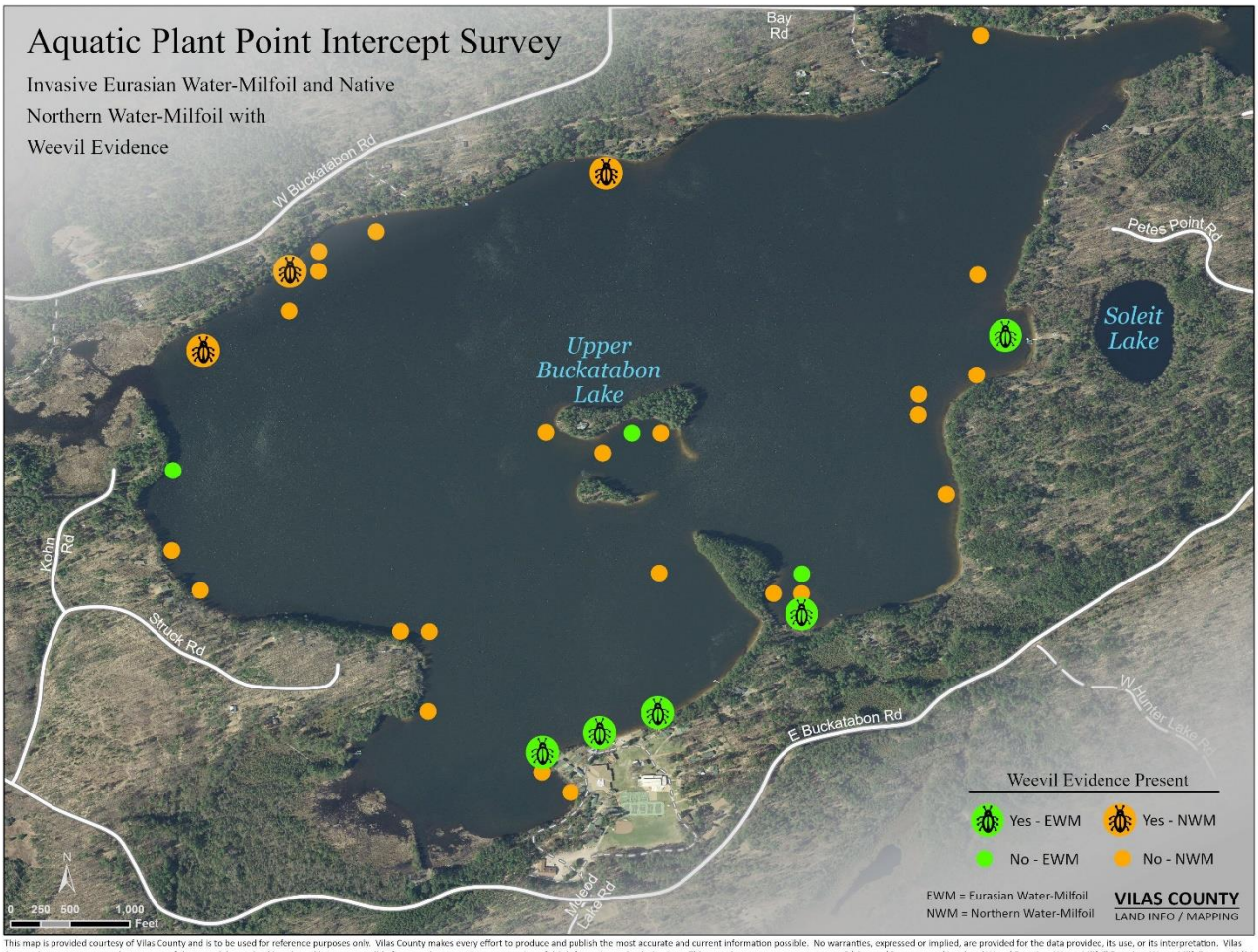


Figure 11. 2020 EWM and NWM stem sample sites where weevil presence or evidence was found and not found on Upper Buckatabon Lake.

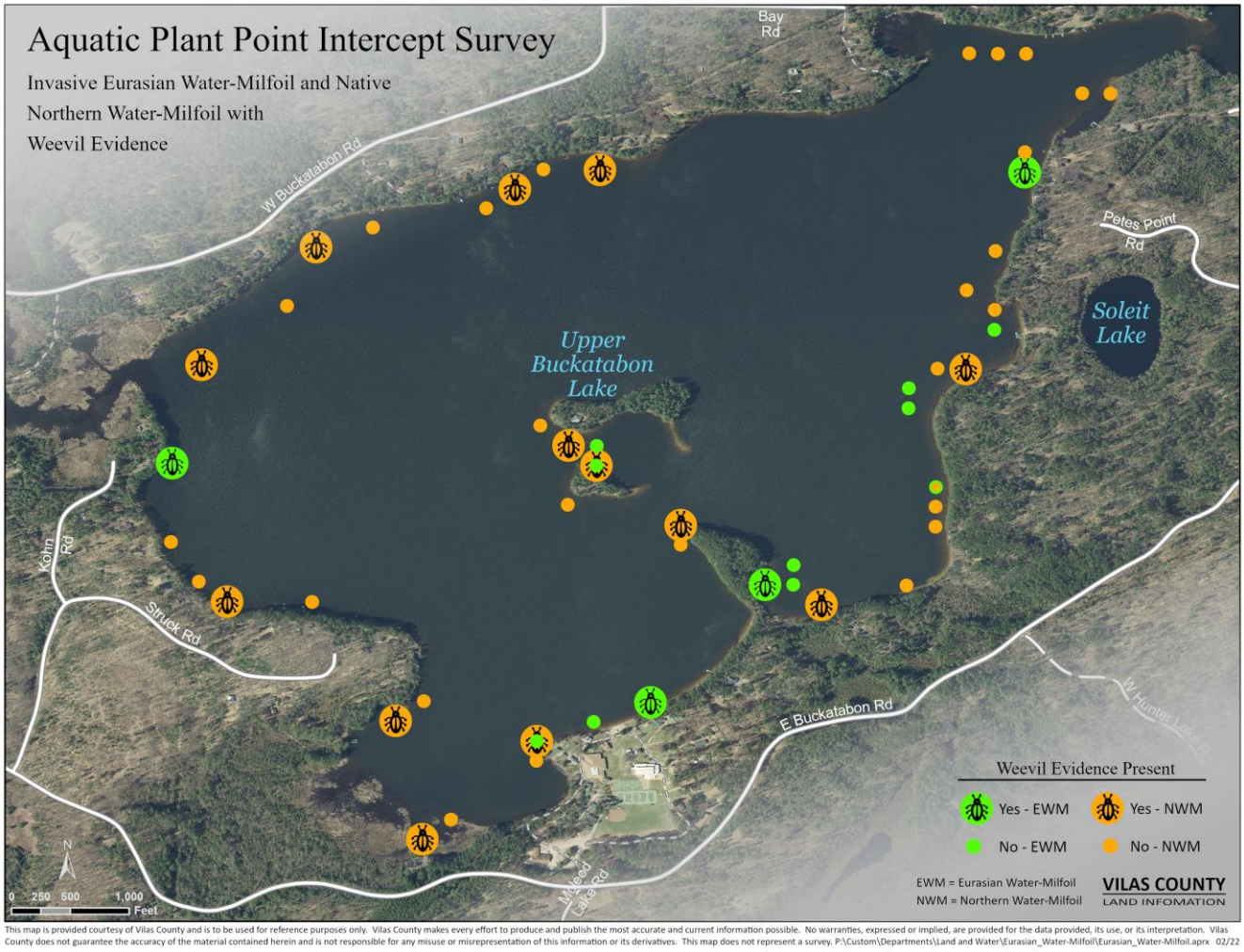


Figure 12. 2021 EWM and NWM stem sample sites where weevil presence or evidence was found and not found on Upper Buckatabon Lake.

<u>Plans for 2022 & Future Recommendations</u>

BLA has applied for and been awarded a grant to cover costs of 2021 and 2022 weevil culturing and replacement supplies. While the Schaefer property does serve as a somewhat "sunny site" and can function if needed in 2022, a site with more direct sun would be preferrable to increase weevil reproduction.

Vilas County Land & Water Conservation can continue to provide technical assistance similar to what was delivered in 2021: use of existing weevil supplies; volunteer coordination and communications; EWM food gathering and processing assistance; an aquatic plant point intercept survey; stocking assistance; weevil density counts on stem samples; and reporting. A 2022 memorandum of understanding between Vilas County Land & Water Conservation Committee and BLA will be in place during the 2022 field season.

As future planning continues, it is imperative to consider scientific data in appropriate perspectives. See Tables 3 and 4 summarizing the Aquatic Plant Point Intercept survey results and weevil sampling results. These data could reflect weevils may already be hard at work in Upper Buckatabon Lake, and that the aquatic plant community is not greatly disturbed. Control of EWM has been seen with weevil densities of 0.25-1.0 weevils/stem (Golden Sands 2016). Further stocking may help move EWM weevil densities closer to the 0.25 weevils per stem threshold. It will be important to track EWM and weevil density by repeating the weevil point-intercept survey as stocking continues.

There has been discussion of concerns with needing to create a navigation lane through the EWM in Benson's Bay where weevils were previously stocked in 2020 and 2021. Vilas County Land & Water would support this navigation lane. To minimize impacts to weevils, please consider doing the following:

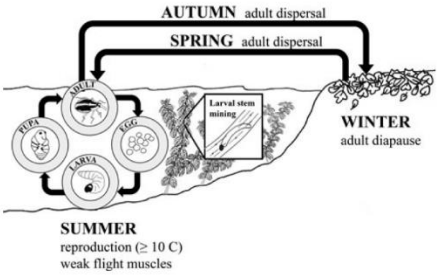


Figure 13. Life cycle of the milfoil weevil. Larvae spend most of their time feeding inside the stem, develop into pupae inside the stem, and then emerge as an adult. Adults will fly, swim, and raft to get to shore to overwinter. Figure by Havel et al 2017.

- GPS navigation lane boundaries and share with Vilas County Land & Water so weevils can be stocked outside this area in 2022.
- Weevils over-winter on land, so create the navigation lane early in the season. This way weevils are not already "moved in" when the EWM removals for the navigation lane occur. Late May – early June would be a good timeframe to start with shallower areas of 1-3 feet deep. Mid-June – early July would be a good time to make sure the deeper areas of 4-8 ft depths are cleared as those EWM plants would not reach the surface until later in the season.
- Once navigation lane is established, keep it open all season either by boat traffic or by repeated hand or DASH removals. DASH removals would require a DNR permit.
- Keep boat traffic and wakes outside the navigation lane to a minimum – weevils prefer calm waters.
- Continue to encourage landowners on Upper Buckatabon to maintain natural shorelines (un-mowed, unraked, not landscaped) to provide weevil overwintering sites.

There has also been discussion of the possibility of moving the weevil stocking site to between the two islands on Upper Buckatabon, and using Benson's Bay as a feeding site. While this could be an option if the navigation lane recommendations above are not workable, it would be preferred to keep the weevils stocking site consistent at Benson's Bay during all four years of stocking - impacts from weevils would be easier to track.

Lake-wide weevil densities on EWM in Upper Buckatabon were reported as 0.19 and 0.11 in 2020 and 2021, respectively. Weevils have been shown to be effective at controlling EWM at varying densities, between 0.25-1.0 weevils/stem (Golden Sands 2016). Havel et. al. looked at weevil densities within EWM beds (not lake-wide) and found that lakes in Northern Wisconsin that have had chemical treatments for EWM within the last 10 years had densities of weevils averaging 0.17 weevils/stem; lakes with EWM and no chemical treatments in the last 10 years average 0.79 weevils/stem; and lakes with no EWM but do have NWM average 0.22 weevils per stem (Havel et. al. 2017). It is not completely clear why lakes without recent chemical treatments tend to correlate with higher weevil densities. The lake-wide weevil densities on Upper Buckatabon are similar to lakes with chemical treatment, and since the

lake has never done and herbicide treatment, it is unclear why the weevil densities would be tracking lower. Further years of stocking may increase this figure.

The lake-wide weevil density for Upper Buckatabon may be a bit higher if only EMW beds were surveyed; and it may be helpful to also track an "EWM bed" weevil density, especially in Benson's Bay where the most impact is desired. This could be accomplished by following the Citizen Lake Monitoring Network's Native Water-Milfoil Weevil Monitoring Protocol (Maccoux 2007). If weevil densities are increasing in the bed that is stocked, the effort to rear weevils can be considered working. However, this would not be essential to determining the success of the weevil stocking as it was not listed as a success measure – the outcomes of the project are to maintain or decrease the density of EMW by its rake fullness and percent of dense acres.

Another recommendation is to ask a landowner to take photos of the same site on an EWM bed annually at peak abundance and flowering – sometime between August 5-15th. These annual photographs will help document if the plants are, over time, becoming too week to produce flowers or if the plants are no longer able to reach the surface. These photographs can give a qualitative idea if the weevil project is having an impact on the densest areas.

Success Measures

According to most research, weevils must be stocked for at least 3 years to see any noticeable impacts (Golden Sands 2016). BLA has indicated an interest in doing 4 years of stocking, with an end date in 2023. At that point, BLA along with Land & Water staff, Many Waters LLC, and WI DNR staff would determine if the project is successful.

The goal of weevil stocking is to maintain or decrease the nuisance level EWM. Weevil stocking will not eradicate EWM. In fact, as time goes on EWM littoral % frequency of occurrence may increase in spite of successful weevil stocking. However, it is expected that the % of EWM acres that are considered dense will be maintained or decrease where weevils are "doing their job". Total rake fullness of EWM should also be maintained.

The weevil stocking project will be considered a success if any are met by Aug 2023:

- EWM rake average fullness shows a maintenance trend compared to 2020 levels (2020 EWM rake fullness average was 1.0)
- % acreage of EWM "dense" polygons from EWM Mid/Late Season surveys show a maintenance or decreasing trend from 2020 to 2023 (= or < 3.5% of polygons)

Acknowledgements

It is our hope that this project honors the memory of Charlie Coventry who passed away in 2020 – his enthusiasm got this project up and running. So many volunteers offered their time and expertise in 2021 to make this project work. Special thanks go to Stephanie Attwood, Carolyn Barthel, Dan Benson, Brian Benson, Barb Benson, Karen Caruso, John Caruso, Tom Christensen, Holly Christensen, Sean Christensen, Donna Coventry, Gary Croisatiere, Peggy DeFrancheschi, Chris DeFranceschi, Cathy Ekberg, Justin Halpenny, Hayley Heller, Jim Kleiner, Suzanne Kleiner, Ian Pocklington, Carl Rockel, Amy Thorstenson, and Ken Whyte.

References

Artwich, Bill, and Barb Gajewski. "Buckatabon Lakes Eurasian Watermilfoil Control and Prevention Rapid Response Project." Upper and Lower Buckatabon Lakes, Conover, WI, 2020.

Artwich, Bill and Barb Gajewski. "Buckatabon Lakes Eurasian Watermilfoil Management Project." Upper and Lower Buckatabon Lakes – Vilas County, WI, 2021.

Golden Sands Resources Conservation & Development Council, Inc. "Biological Control of Eurasian Watermilfoil Using the Native Milfoil Weevil (Euhrychiopsis Lecontei): A Manual for Lake Groups and Lake Managers." Stevens Point, WI, Jan. 2016.

Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase. 2010. "Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications." Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010. Madison, Wisconsin, USA.

Havel, John E., Susan E. Knight, & James R. Miazga (2017): Abundance of milfoil weevil in Wisconsin lakes: Potential effects from herbicide control of Eurasian watermilfoil, Lake and Reservoir Management, DOI: 10.1080/10402381.2017.1334250. https://www.tandfonline.com/doi/full/10.1080/10402381.2017.1334250

"Impaired Water". *Upper Buckatabon Lake (Upper Buckatabon Lake),* Wisconsin Department of Natural Resources, 9/4/2018, https://dnr.wi.gov/water/impairedDetail.aspx?key=128692.

Maccoux, Aubrey. 2007. "Native Water-Milfoil Weevil Monitoring Protocol". Modified by Laura Herman, 2009. Aquatic Invasive Species Monitoring Manual – Citizen Lake Monitoring Network. May 2014. https://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/programs/CLMN/publications/Ch12-NativeWeevil.pdf

Nault, Michelle. 30 April 2020. "Aquatic Plant Management Research in Wisconsin". WI Department of Natural Resources. Spring AIS Coordinators Meeting.

Newman, Raymond M., et al. "Developmental Performance of the Weevil *Euhrychiopsis lecontei* on Native and Exotic Watermilfoil Host Plants." *Journal of the North American Benthological Society*, vol. 16, no. 3, [University of Chicago Press, Society for Freshwater Science], 1997, pp. 627–34, https://doi.org/10.2307/1468149.

Nichols, Stanley A. 1999. "Floristic Quality Assessment on Wisconsin Lake Plant Communities with Example Applications". Lake and Reservoir Management. 15:2, 133-141. DOI: 10.1080/07438149909353957.

APPENDIX C

2021 DASH Summary

Upper Buckatabon Lake EWM Removal Report 2021

PO Box 1134 Minocqua, WI 54548

Upper Buckatabon Lake EWM Manual Removal Summary 2021

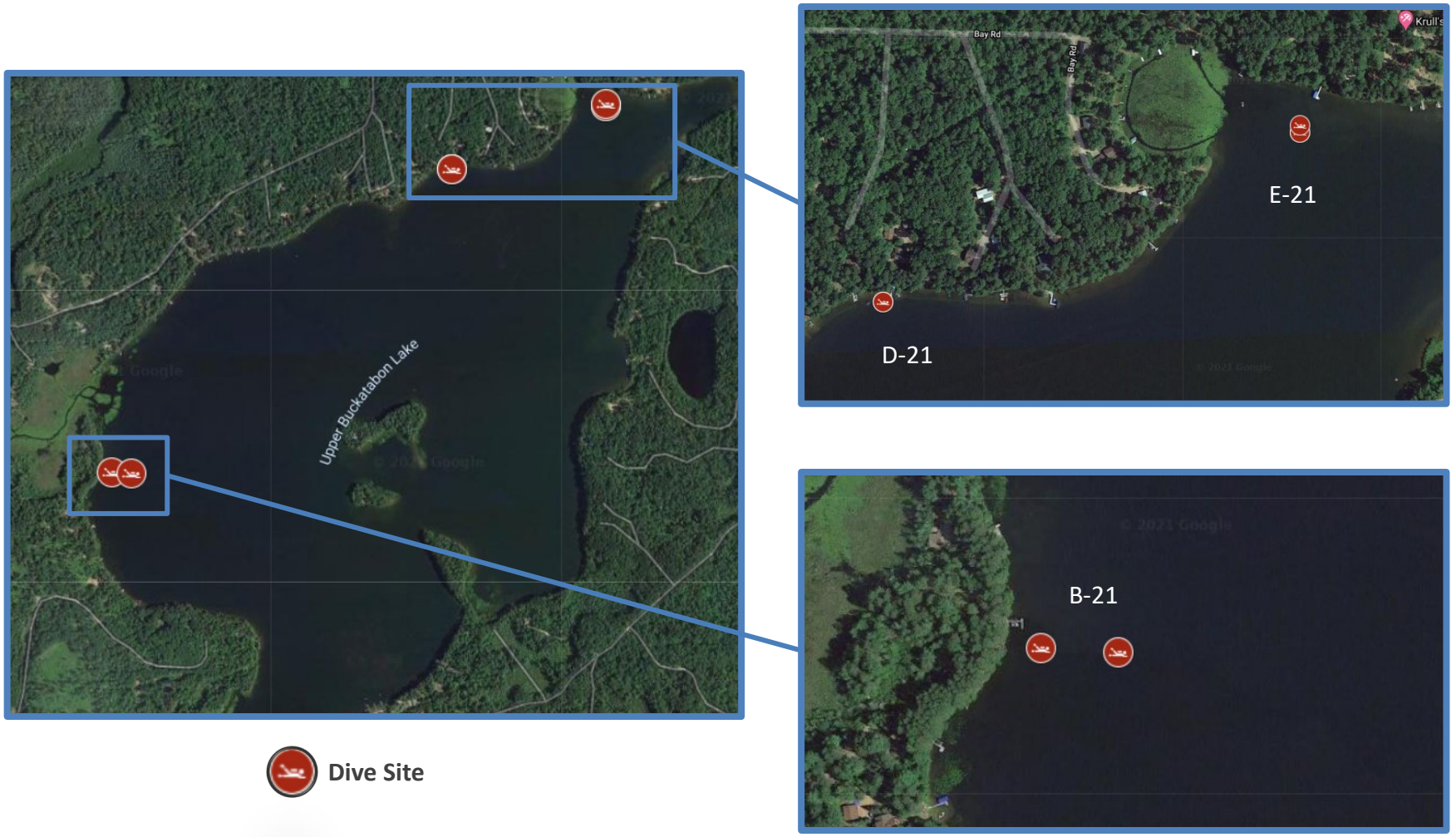
Dive Background: On September 1st and 2nd, Aquatic Plant Management LLC (APM) conducted 2 days of Diver Assisted Suction Harvesting (DASH) of Eurasian Watermilfoil (EWM) on Upper Buckatabon Lake in Vilas County, WI. The team, consisting of two divers, focused their efforts at 3 sites prioritized by the lake association. In total APM was able to remove **184.0 cubic feet of EWM** from Upper Buckatabon Lake.

Date	Weather Conditions	Water Temp (F)	Underwater Dive Time (hrs)	AIS Removed (cubic ft)
9/1/2021	Sunny	73	5.3	93.0
9/2/2021	Sunny	73	6.1	91.0
Grand Total			**11.3**	**184.0**

Dive Location	Avg. Water Depth	# of Dives	Underwater Dive Time	AIS Removed (cubic feet)
B-21	7.8	2	4.4	78.0
D-21	7.0	3	5.8	88.0
E-21	7.5	2	1.2	18.0
Grand Total	**7.4**	**7**	**11.3**	**184.0**

Dive Highlights and Recommendations: The dive team spent the bulk of their time at sites B-21 and D-21, where they removed 166 cubic feet of EWM. Overall, Upper Buckatabon Lake should take an Integrated Pest Management (IPM) approach and evaluate different strategies to manage the EWM population on the lake. Continued monitoring and management efforts are important to prevent the spread of EWM throughout Upper Buckatabon Lake.

Map of Upper Buckatabon Lake Dive Sites



Detailed Diving Activities

Date	Dive Location	Latitude Longitude	Underwater Dive Time (hrs)	AIS Removed (cubic ft)	AIS Density	Avg Water Depth (ft)	Native Species	Native By-Catch	Substrate Type
9/1/2021	E-21	46.02467 -89.33921	1.00	16.5	Surface Matting	7.5	Coontail	0.5	Sand
9/1/2021	D-21	46.02467 -89.33921	1.67	30.0	Surface Matting	6.0	Coontail	1.5	Organic/Sand
9/1/2021	E-21	46.02474 -89.33921	0.17	1.5	Highly Dominant	7.5	Coontail	0.0	Sand
9/1/2021	B-21	46.01508 -89.35782	2.42	45.0	Highly Dominant	7.0	Coontail	2.5	Organic/Sand
9/2/2021	B-21	46.01505 -89.35710	2.00	33.0	Surface Matting	8.5	Coontail	3.0	Organic
9/2/2021	D-21	46.02305 -89.34497	1.25	18.0	Surface Matting	7.5	Coontail	1.5	Organic/Sand
9/2/2021	D-21	46.02305 -89.34497	2.83	40.0	Surface Matting	7.5	Coontail	4.0	Organic/Sand
Total	**7**		**11.34**	**184.0**					