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

2022 Final Reporting

Submitted To:
Wisconsin Department of Natural Resources

And

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PROJECT LOCATION & OVERVIEW

Upper and Lower Buckatabon Lakes are connected navigable waterways located in Conover Township, Vilas County, WI. Situated in the Tamarack Pioneer River Watershed, land cover consists primarily of forests, wetlands and opens water. WDNR ranks this watershed medium for non-point sources affecting lakes. Buckatabon Creek flows into Upper Buckatabon from the north. This creek is a cool-cold headwater, macro-invertebrate natural community, supporting a Class II trout stream. From the headwaters of Buckatabon Creek to the to the outlet draining Lower Buckatabon into the Wisconsin River, a substantial portion of shoreline is public including State of WI Board of Commissioners of Public Lands, WDNR, Vilas County CFL, and Wisconsin Valley Improvement Company (WVIC). WVIC owns and operates a dam at the south end of Lower Buckatabon, draining Buckatabon Lakes into the Wisconsin River. Aquatic invasive species known to occur on the Buckatabon Lakes include banded mystery snails, Chinese mystery snails, Eurasian watermilfoil, and yellow iris.

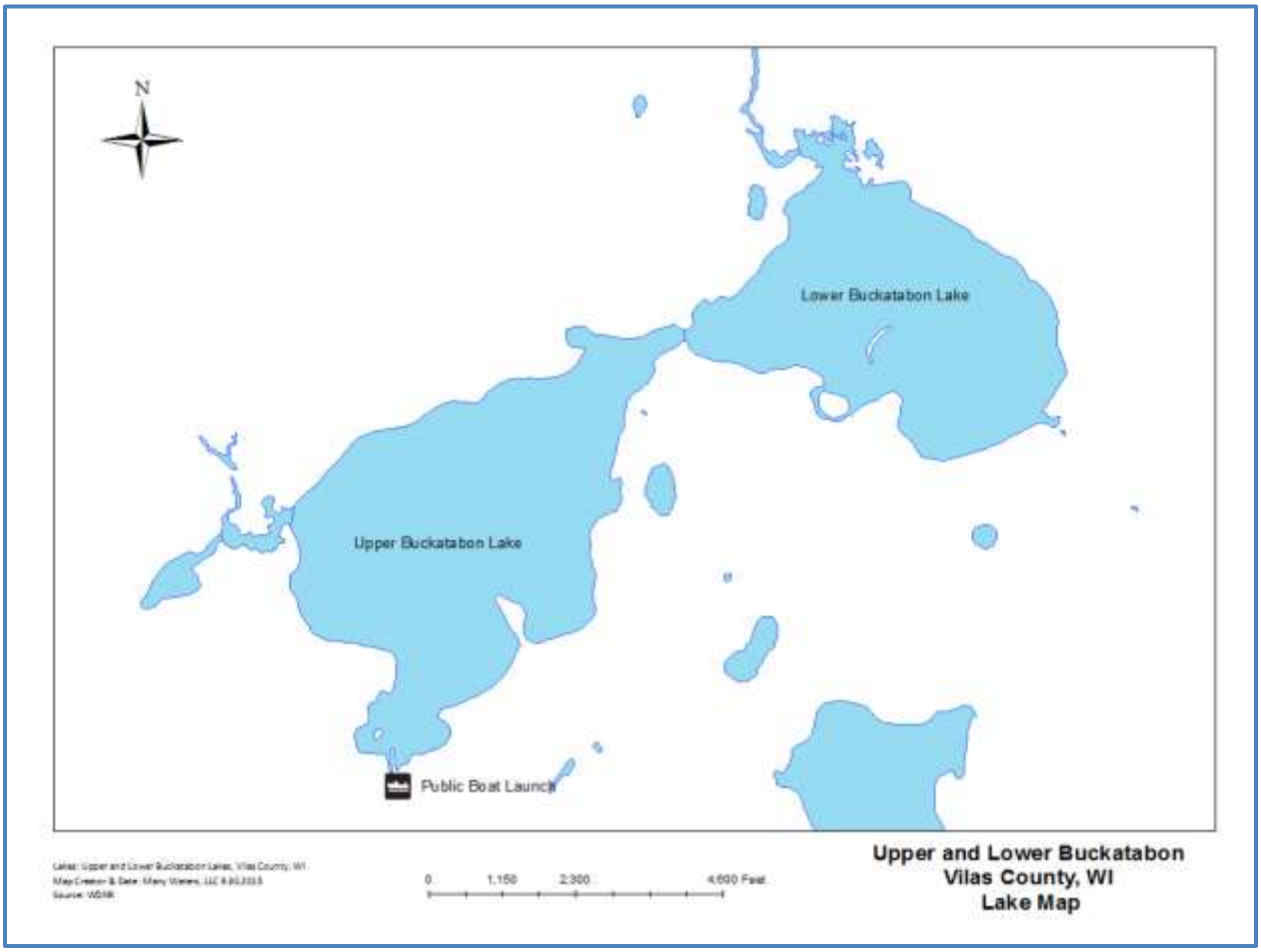
Upper Buckatabon is a 493-drainage lake, with a maximum depth of 30 feet. Upper Buckatabon is a complex two-story fishery and WDNR lists this lake impaired for total phosphorous. Upper Buckatabon has a floristic quality[1] of 37.71 and a EWM frequency of littoral occurrence[2] of 3.85% (2021).

Lower Buckatabon is a shallow lowland drainage lake, 352 acres in size with a maximum depth of 16 feet. Lower Buckatabon has a floristic quality index of 33.67 and a EWM frequency of littoral occurrence of <1% (2022). Historically, WDNR considered Lower Buckatabon a two-story fishery, until updated to a shallow lowland drainage lake in 2021. Under the historical two-story fishery classification, WDNR listed Lower Buckatabon impaired for total phosphorous, similar to Upper Buckatabon. Water quality standards for shallow lowland drainage lakes are different from for two-story fishery lakes and in 2021, total phosphorus sampling on Lower Buckatabon met water quality criteria using total phosphorous standards for shallow lowland drainage lakes. WDNR is proposing removal of Lower Buckatabon from their Impaired Waters List (WDNR Impaired Waters Search 11/22).

This report summarizes 2022 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 volunteer lead weevil-stocking program in 2020. Grant funds from this project gave BLA the ability to build on 2020 weevil rearing and stock efforts in 2021 and 2022. In addition to weevil stocking and monitoring, this project included EWM and native plant population monitoring and management with hand removal.

[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 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, monitors for EWM, confirming previous EWM locations and is used to refine annual management strategies (Appendix A). The second survey, timed to capture EWM plants at or near their greatest annual growth 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.

Both Upper and Lower Buckatabon Lakes saw an increase in EWM in 2022 compared to 2021. Most notable annual increase of EWM on Upper Buckatabon occurred along the southwest shore, whereas most notable annual increase on Lower Buckatabon occurred along the western shorelines adjacent to the channel connecting Upper and Lower Buckatabon. Based on the five-part abundance estimate, the largest increase on Upper Buckatabon occurred with "sparsely" mapped polygons. Slight increases to moderate, moderate-dense and dense abundances occurred on Upper Buckatabon. On Lower Buckatabon, the largest increase occurred on "very sparse" point based locations.

Table 1: *Change in EWM abundance from 2015-2022, Upper Buckatabon Lake.*

EWM Abundance Estimate	2015	2016	2017	2018	2019	2020	2021	2022
Very Sparse	0.02	0.10	0.50	1.04	0.90	1.66	1.77	1.43
Sparse	0.18	0.28	0.40	1.54	2.60	3.15	9.17	16.34
Moderate	0.05	0.05	0.03	0.43	2.61	1.93	2.72	2.98
Moderate-Dense	0.00	0.00	0.00	0.15	1.23	0.24	1.24	1.63
Dense	0.00	0.00	0.00	0.00	0.00	0.26	0.37	0.61
TOTALS (acres)	**0.25**	**0.43**	**0.93**	**3.15**	**7.33**	**7.24**	**15.28**	**22.99**

Figure 1: *Change in EWM abundance from 2015-2022, Upper Buckatabon Lake.*

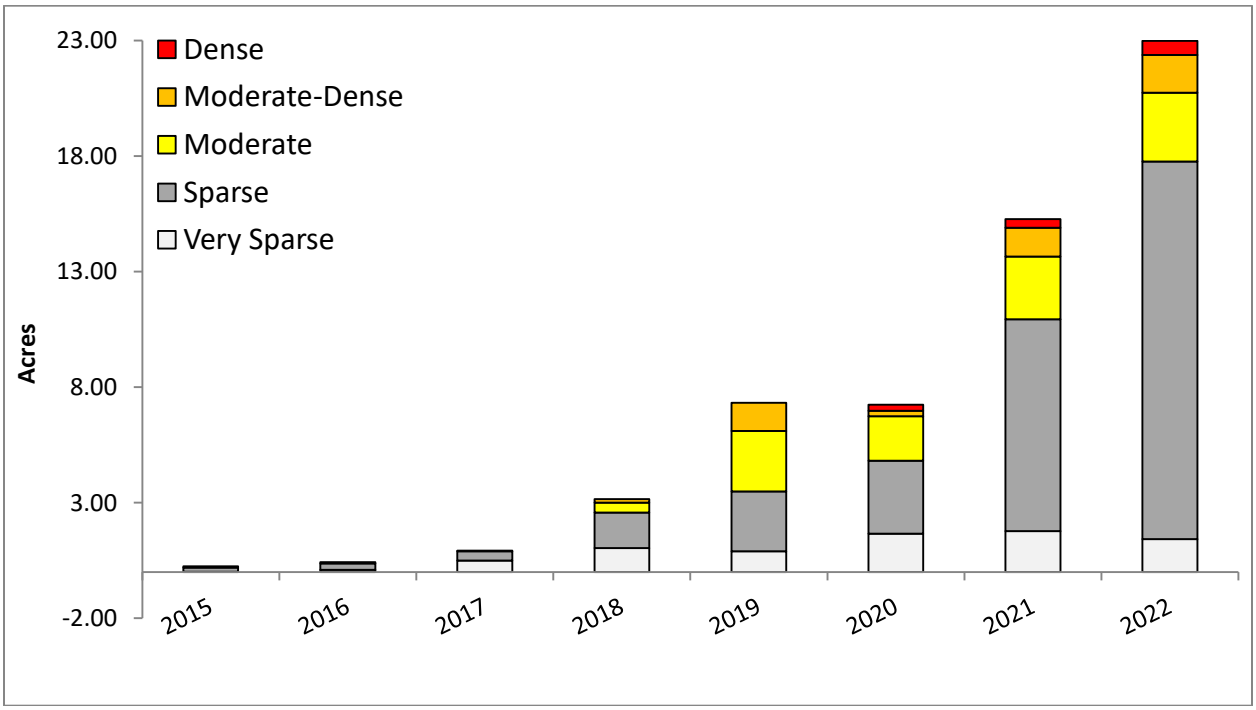
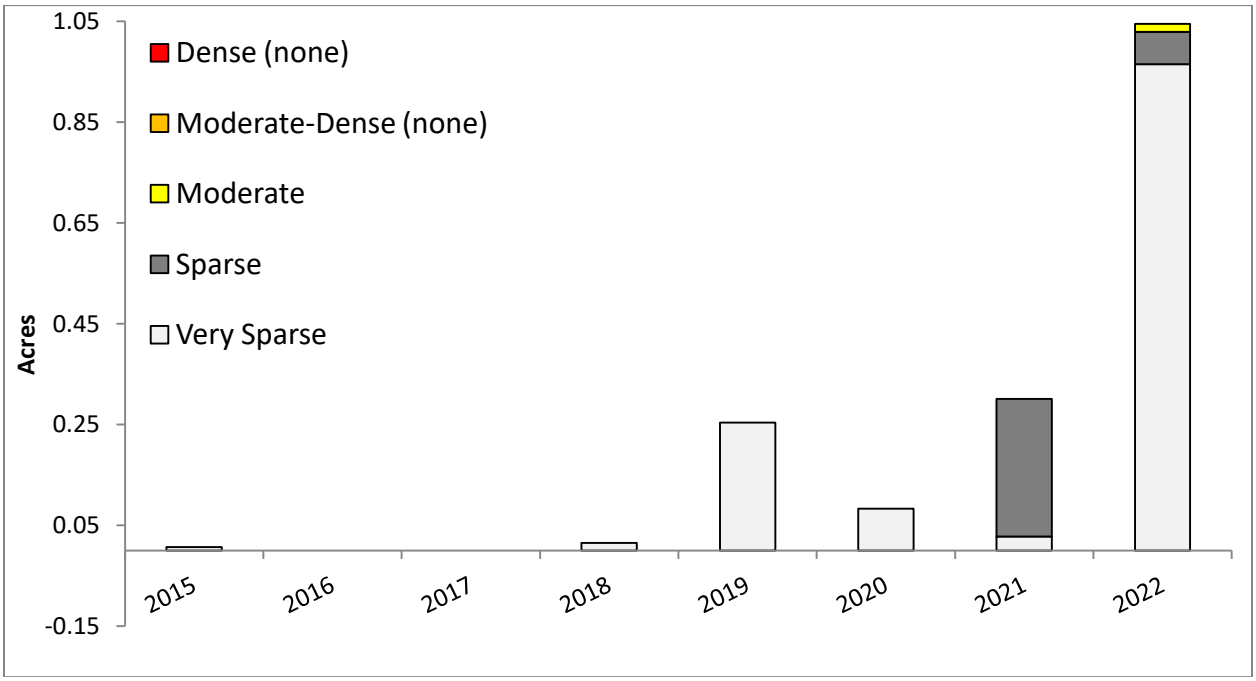


Table 2: *Change in EWM abundance from 2015-2022, Lower Buckatabon Lake.*

EWM Abundance Estimate	2015	2016	2017	2018	2019	2020	2021	2022
Very Sparse	0.01	0.00	0.00	0.02	0.25	0.08	0.03	0.97
Sparse	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.06
Moderate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Moderate-Dense (none)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dense (none)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS (acres)	**0.01**	**0.00**	**0.00**	**0.02**	**0.25**	**0.08**	**0.30**	**1.05**

Figure 2: *Change in EWM abundance from 2015-2022, Lower Buckatabon Lake.*



EWM MANAGEMENT

Goals for this two-year project were 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 were monitored and evaluated for population change.

To increase native milfoil weevil abundance, VCLWCD and the BLA reared and stocked weevils in 2020, 2021, and intended to repeat stocking efforts in 2022. In 2022, according to Golden Sands RC&D, who assisted in weevil rearing efforts and provided technical support, determined that weevil augmentation on Upper Buckatabon may have met density goals for adequate control of EWM in 2022. Food (EWM stocks) brought to Golden Sands to feed the rearing weevils had a very robust weevil density already. Two "food" sites on Upper Buckatabon were

evaluated; the historical site used in 2020 and 2021 between the islands, and EWM beds adjacent to weevil release site. Discussions amongst BLA, Vilas County LWCD, and Golden Sands RC&D determined not to take the "starter weevils" raised by Golden Sands RC&D in 2022 and rear them for release because removal of the food source (EWM) from Upper Buckatabon to feed the rearing weevils may remove existing weevils in the lake, countering benefit. No rearing of weevils by volunteers occurred in 2022, the "starter weevils" were released into the lake on July 1st[3]. A complete report of weevil rearing, stocking, and monitoring can be found in Appendix B.

The second goal of this project was to limit the presence and spread of outlier populations on Upper and Lower Buckatabon. Using an outward/in approach, priority sites for hand removal included outlier and somewhat isolated sites working towards the core infestation. Based on seasonal monitoring data, very few sites on Upper Buckatabon met the hand removal criteria. A few small sites adjacent to the boat landing on Upper Buckatabon were prioritized to minimized pathways of spread of EWM out of Buckatabon Lake, otherwise all hand removal efforts focused on Lower Buckatabon. In four days of snorkel pulling, a total of 31 cubic feet of EWM was removed (Appendix C). Staffing issues cut hand removal efforts short.

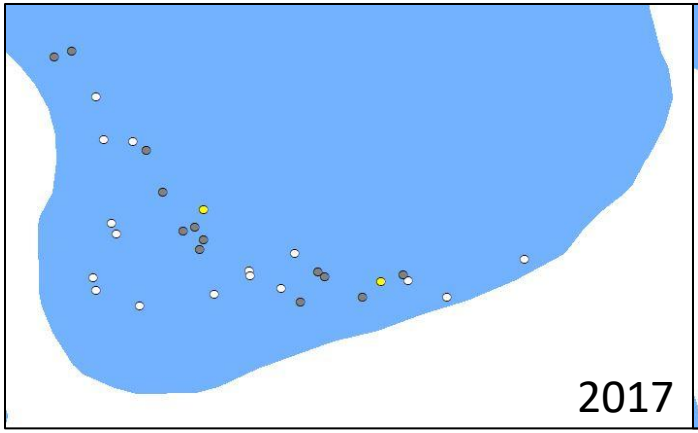
2023 MANAGEMENT STRATEGIES AND BEYOND

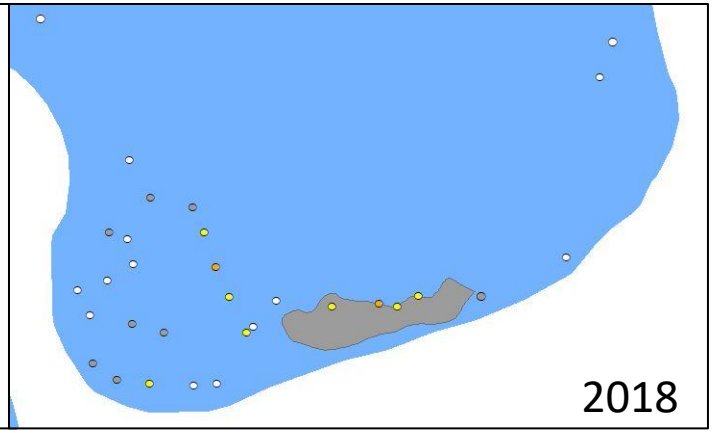
Since weevils met their density goals in year three (2022), 2023 efforts will focus on continued weevil monitoring in Upper Buckatabon and EWM population monitoring. Only light hand pulling is proposed for Upper Buckatabon to minimize pathways of spread of EWM out of Buckatabon Lake, these sites would be near the boat launch.

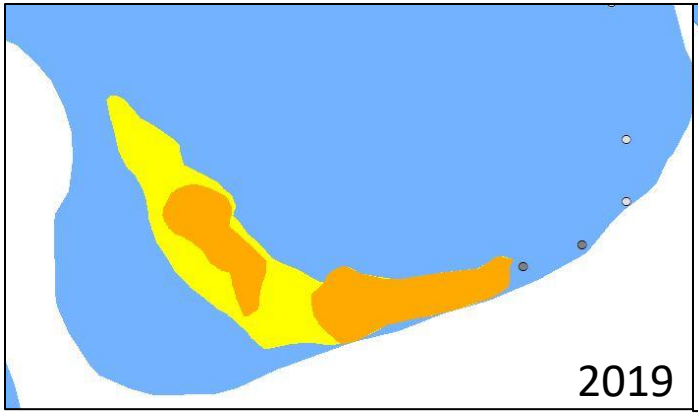
Proposed efforts on Lower Buckatabon will continue to monitor EWM populations and manage with hand removal. The EWM population on Lower Buckatabon is still considerably low, and management will target as much of the population as feasible aiming to reduce and/or sustain a low EWM population.

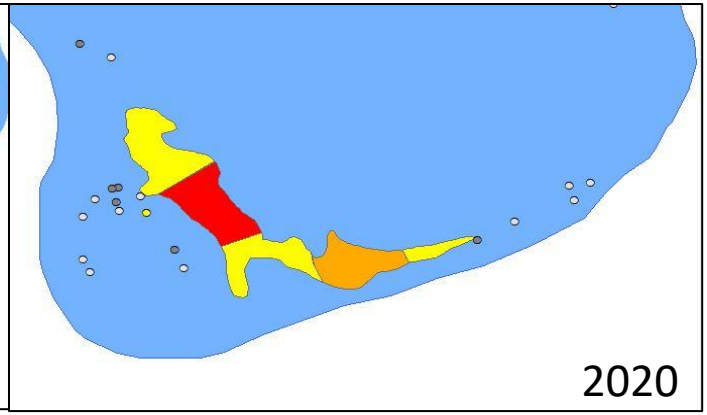
As mentioned above, based on 2022 monitoring data, most EWM sites on Upper Buckatabon are at levels beyond the reasonable use of hand pulling/DASH. Depending on the results of weevil monitoring in 2023, changes in strategy may be proposed. Management of aquatic invasive species should benefit both the 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.

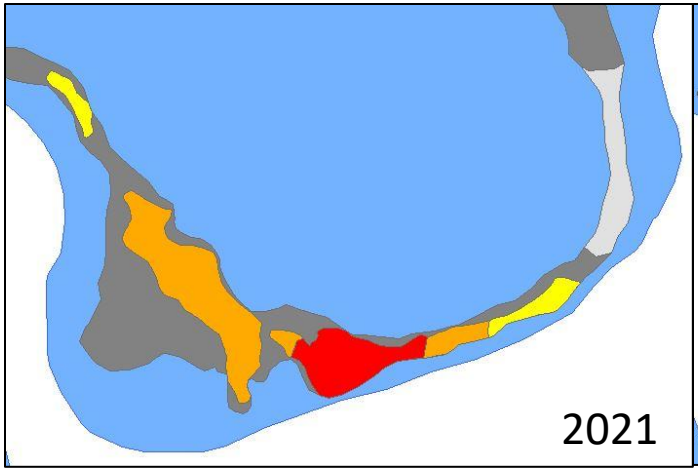
[3] Many Waters was not involved in these discussions and learned of the weevil release on July 6th 2022.

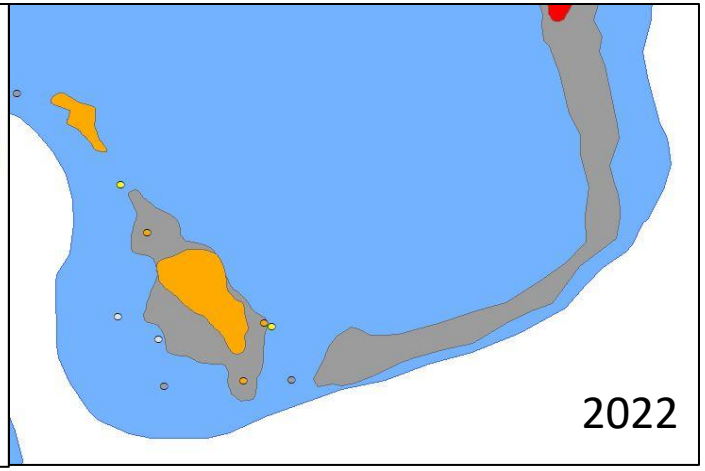












Change in EWM from 2017 -2022

Weevil Stocking Site -Southeast Bay of Upper Buckatabon Lake.

Weevils Stocked
2020 – 2,600
2021 3,151
2022 - 496

Abundance Estimate

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

NATIVE PLANT MONITORING – LOWER BUCKATABON

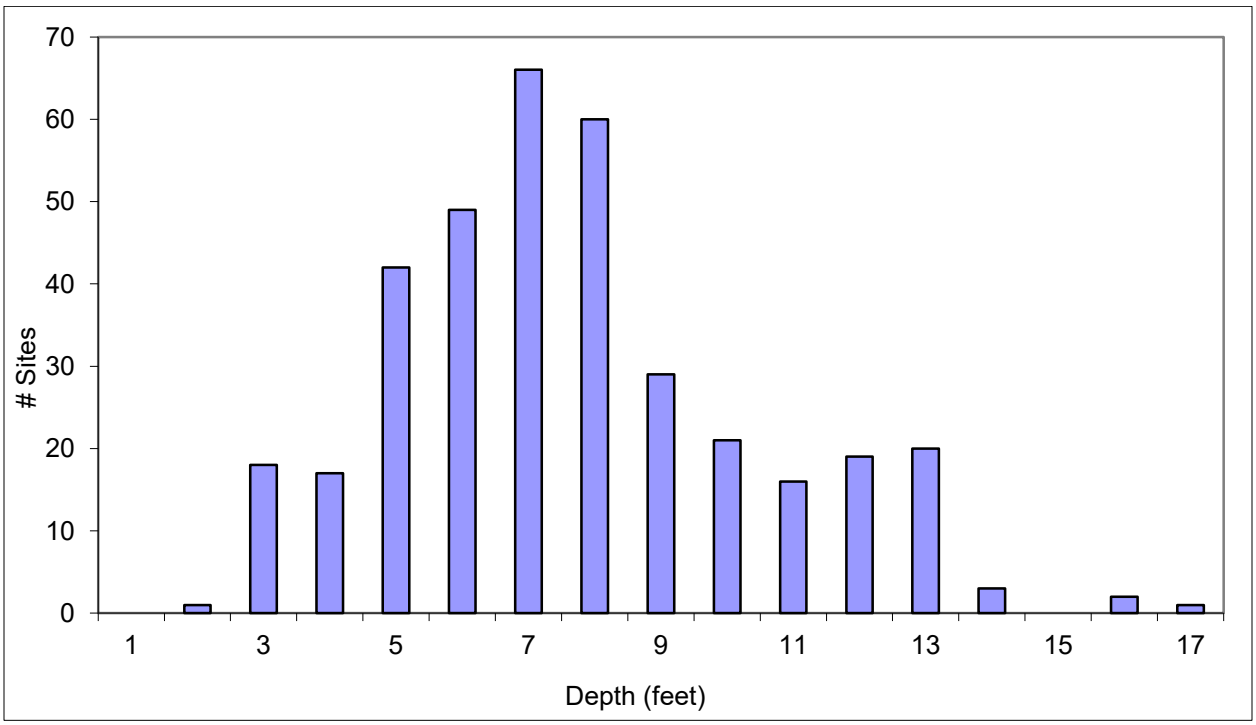
Assessing a lake's aquatic plants provides detailed information on the types and distribution of aquatic plants in a lake, useful to understanding habitat characteristics, ecosystem stability, and identify high quality sites. Furthermore, repeating this assessment provides comparisons of these data over time. These assessments follow WDNR Monitoring of Aquatic Plants in Wisconsin (2010) protocol, which uses a grid of predetermined points evenly spaced across the lake. These points are up-loaded into a GPS for field navigation. At each site, a double-sided rake lowered over the side of the boat collects a sample of aquatic vegetation. Each plant species on the rake is identified and the abundance or rake-fullness for the rake and each species is estimated. At each sampling site, water depth and sediment type are also recorded. Vilas County Land and Water Conservation Department completed a point intercept survey of Upper Buckatabon in 2022, more details on this survey can be found in Appendix B.

Point intercept surveys took place on July 27th and 28th 2022. The 2022 survey sampled 455 locations, identifying a total of 29 native aquatic plant species and one invasive plant species. Rake samples detected 28 native plants species and one invasive plant species, whereas the remaining species were visual observations (Table 3). Four additional species found during the survey not detected per the WDNR protocol include spiral fruited pondweed, floating leaf pondweed, water smartweed, and wild calla. Maximum depth of plant colonization occurred at 17 feet, with the majority of vegetated sites occurring between 5 to 8 feet (Figure 3). Total species detected per rake sample ranged from one to ten with an average of 1.60 species per rake sample. Additional point intercept surveys using the same methodology took place in 2010, 2015 and 2019.

Table 3: *Point intercept survey summaries for 2010, 2015, 2019, & 2022 - Lower Buckatabon.*

	2010	**2015**	**2019**	**2022**
Total number of sites visited	457	454	452	455
Total number of sites with vegetation	421	394	380	364
Total number of sites shallower than maximum depth of plants	454	448	433	454
Frequency of occurrence at sites shallower than maximum depth of plants	92	88	88	80
Simpson Diversity Index	0.80	0.77	0.82	0.81
Maximum depth of plants (ft)	16	15	15	17
Number of sites sampled using rake on Rope (R)	0	9	0	30
Number of sites sampled using rake on Pole (P)	457	445	452	425
Average number of all species per site (shallower than max depth)	1.9	1.6	2.0	1.61
Average number of all species per site (veg. sites only)	2.1	1.8	2.2	2.00
Average number of native species per site (shallower than max depth)	1.9	1.6	2.0	1.60
Average number of native species per site (veg. sites only)	2.1	1.8	2.2	1.99
Species Richness	29	25	28	29
Species Richness (including visuals)	34	33	29	30

Figure 3: *Number of sampling sites and depths of plant colonization – Lower Buckatabon, 2022.*



Floristic information summarized across all four surveys suggests Lower Buckatabon's aquatic plant community remains stable with slight variations in values across the measured parameters (Figure 4). Lower Buckatabon's floristic quality and diversity remains above the State and Northern Lake's Region average. Similar to floristic quality, the frequency and relative frequency of occurrence of the most common native aquatic plant species remains relatively stable with fern pondweed, coontail, and common waterweed being the most common species detected on Lower Buckatabon (Figures 5 & 6).

Figure 4: *Summary of Lower Buckatabon's floristic quality and diversity, 2010 – 2022.*

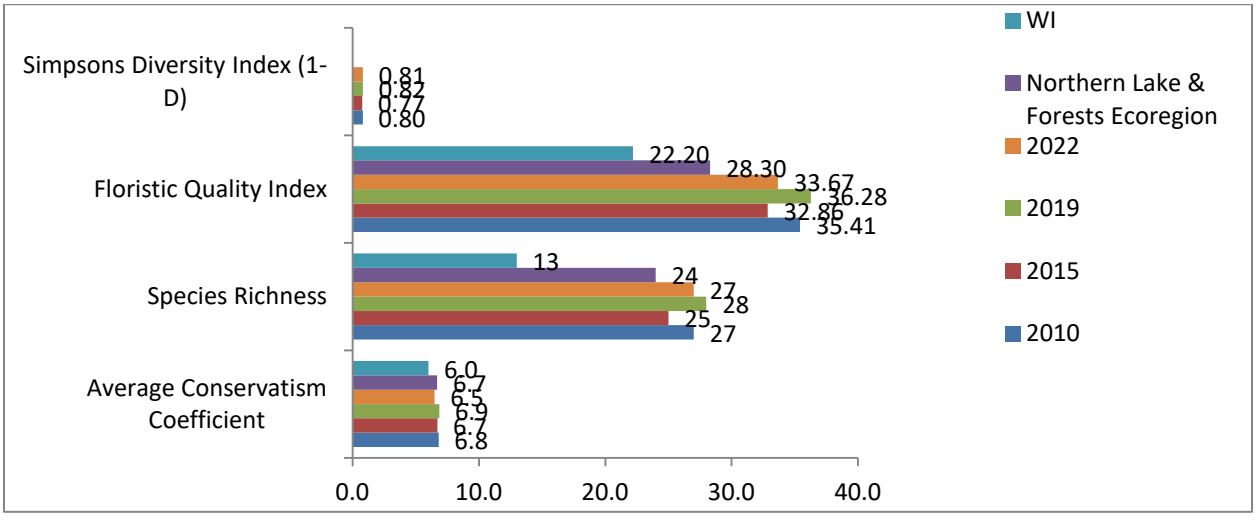


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Figure 5: *Frequency of littoral occurrence 2010 – 2022, Lower Buckatabon. Only species with 5% or greater occurrence shown.*

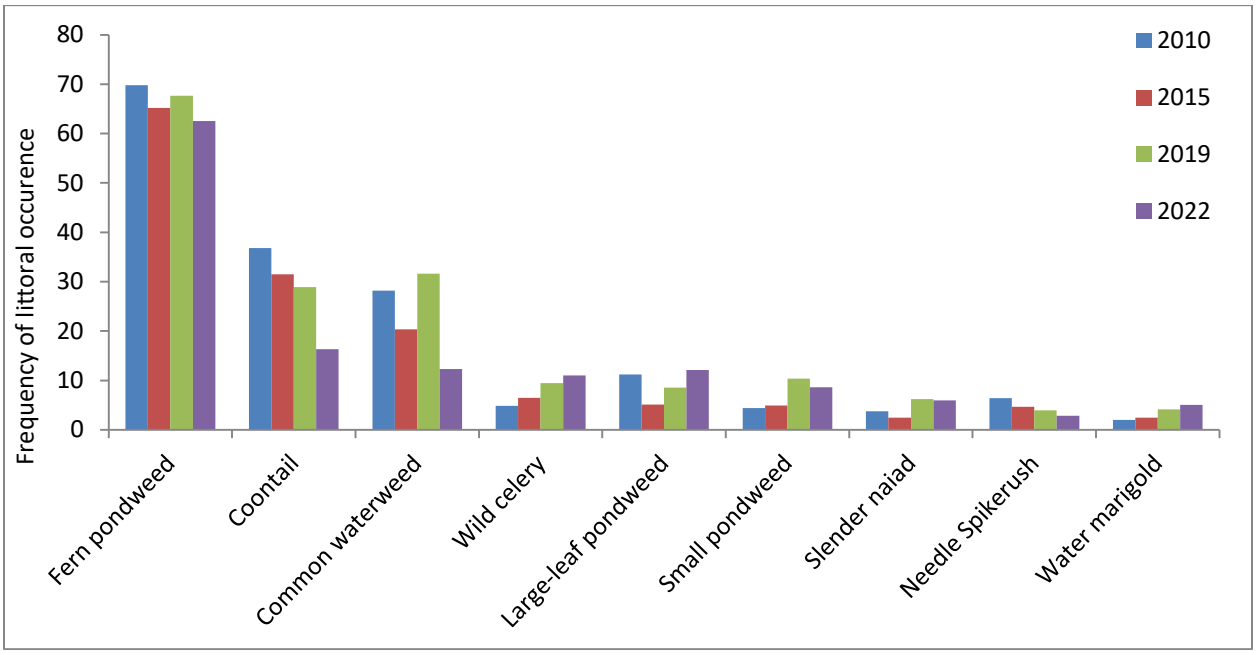
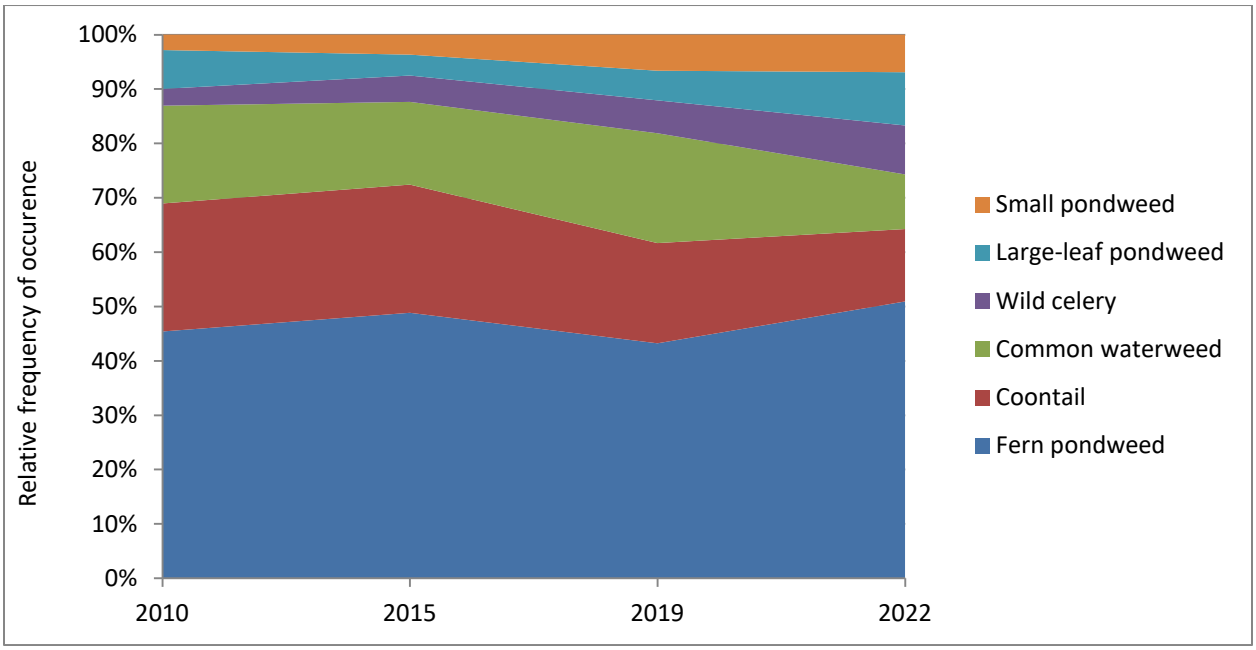
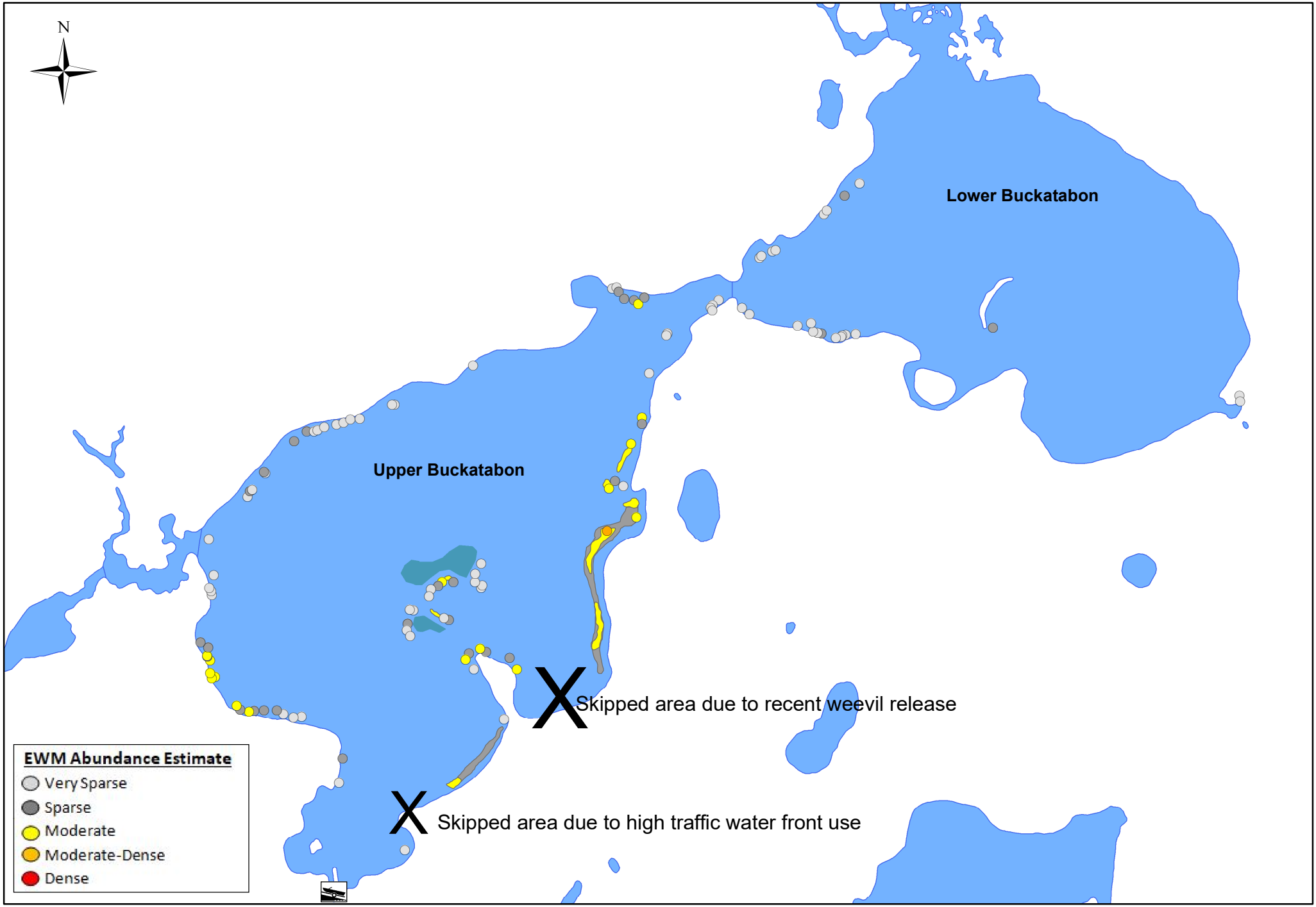


Figure 6: *Relative frequency of occurrence of aquatic plants 2010 – 2022, Lower Buckatabon. Only species with 5% or greater occurrence shown.*



APPENDIX A

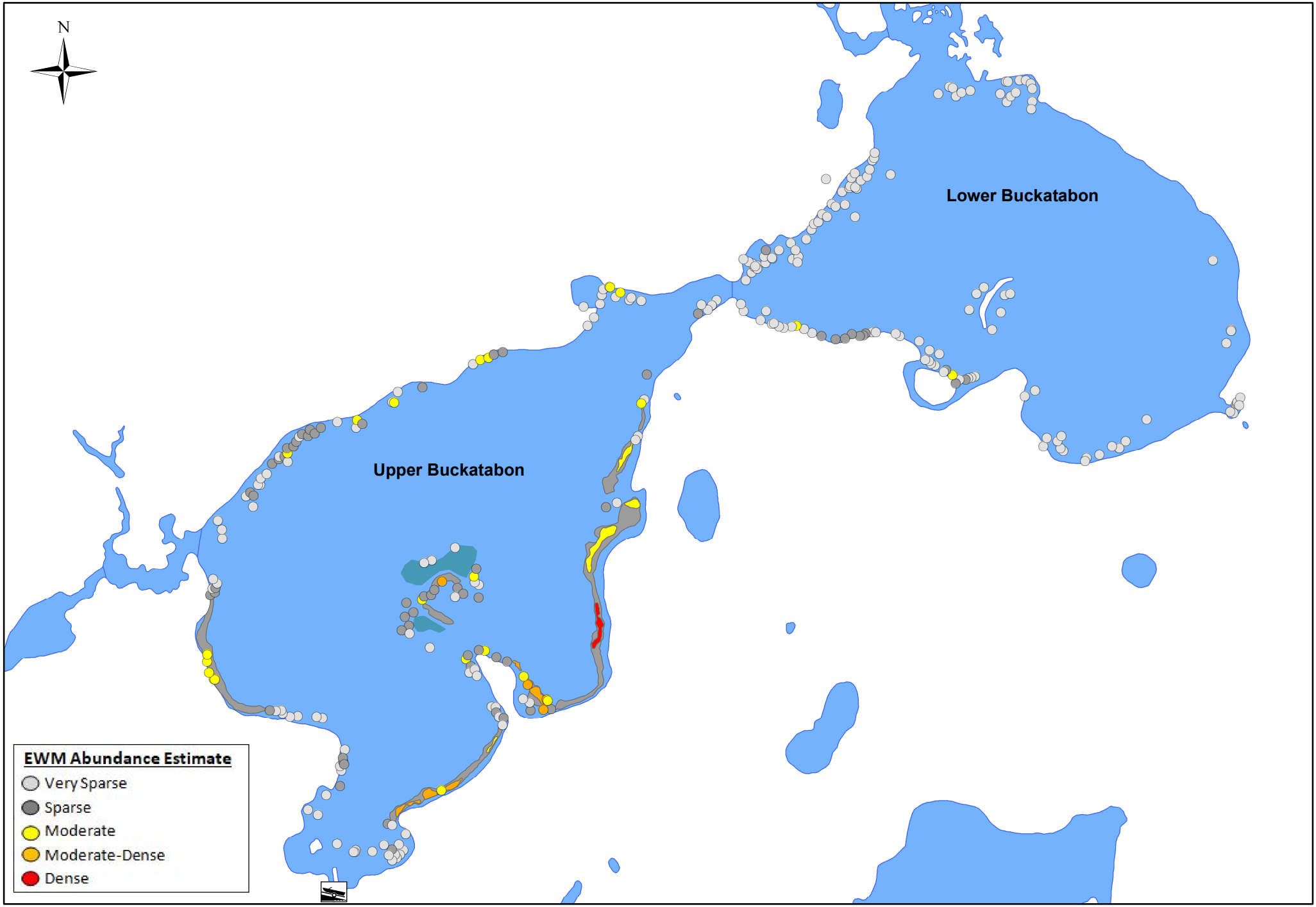
SEASONAL EWM MONITORING MAPS
2022



Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 1/17/2023, Many Waters, LLC
Survey Date: 6/7/22 & 7/6/22
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_ES_2022

0 1,000 2,000 4,000 Feet

Buckatabon Lakes - Vilas County, WI
Early Season EWM Survey
2022



Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 11/6/2022, Many Waters, LLC
Survey Date: 8/16/2022, 8/26/2022 & 10/1/2022
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2022

0 1,000 2,000 4,000 Feet

Buckatabon Lakes - Vilas County, WI
Mid/Late Season EWM Survey
2022

Lake: Upper Buckatabon Lake, Vilas County, WI
Map Date & Creator: 11/6/2022, Many Waters, LLC
Survey Date: 8/26/22 & 10/1/2022
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2022

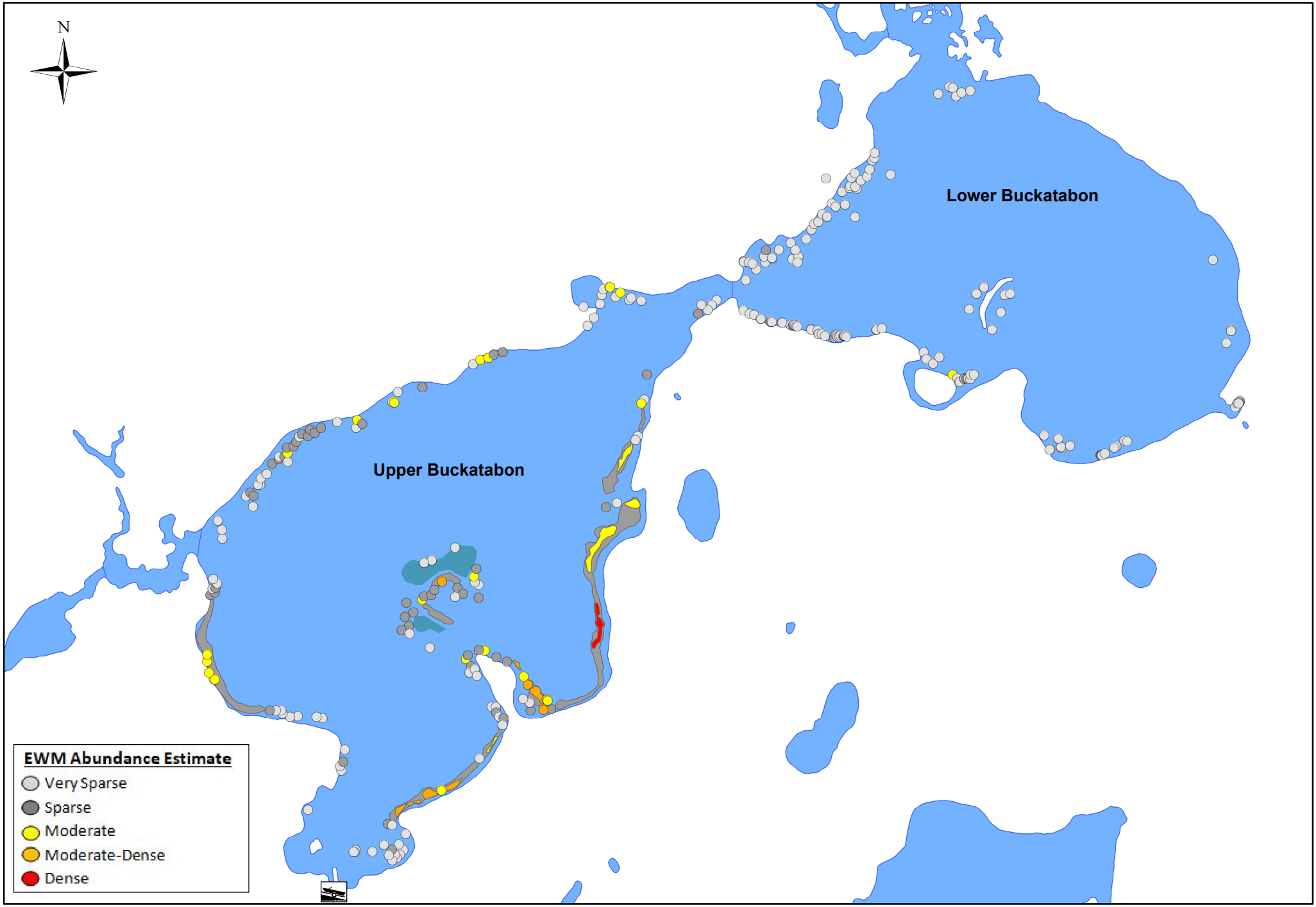
0 700 1,400 2,800 Feet

Upper Buckatabon Lake - Vilas County, WI
Mid/Late Season EWM Survey
2022

Lake: Lower Buckatabon Lake, Vilas County, WI
Map Date & Creator: 11/6/2022, Many Waters, LLC
Survey Date: 8/16/2022
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_MLSS_2022

0 500 1,000 2,000 Feet

Lower Buckatabon Lake - Vilas County, WI
Mid/Late Season EWM Survey
2022



Lake: Buckatabon Lakes, Vilas County, WI
Map Date & Creator: 11/6/2022, Many Waters, LLC
Survey Dates: 8/16/2022, 8/26/2022, 10/1/2022 & 10/14/2022
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2022

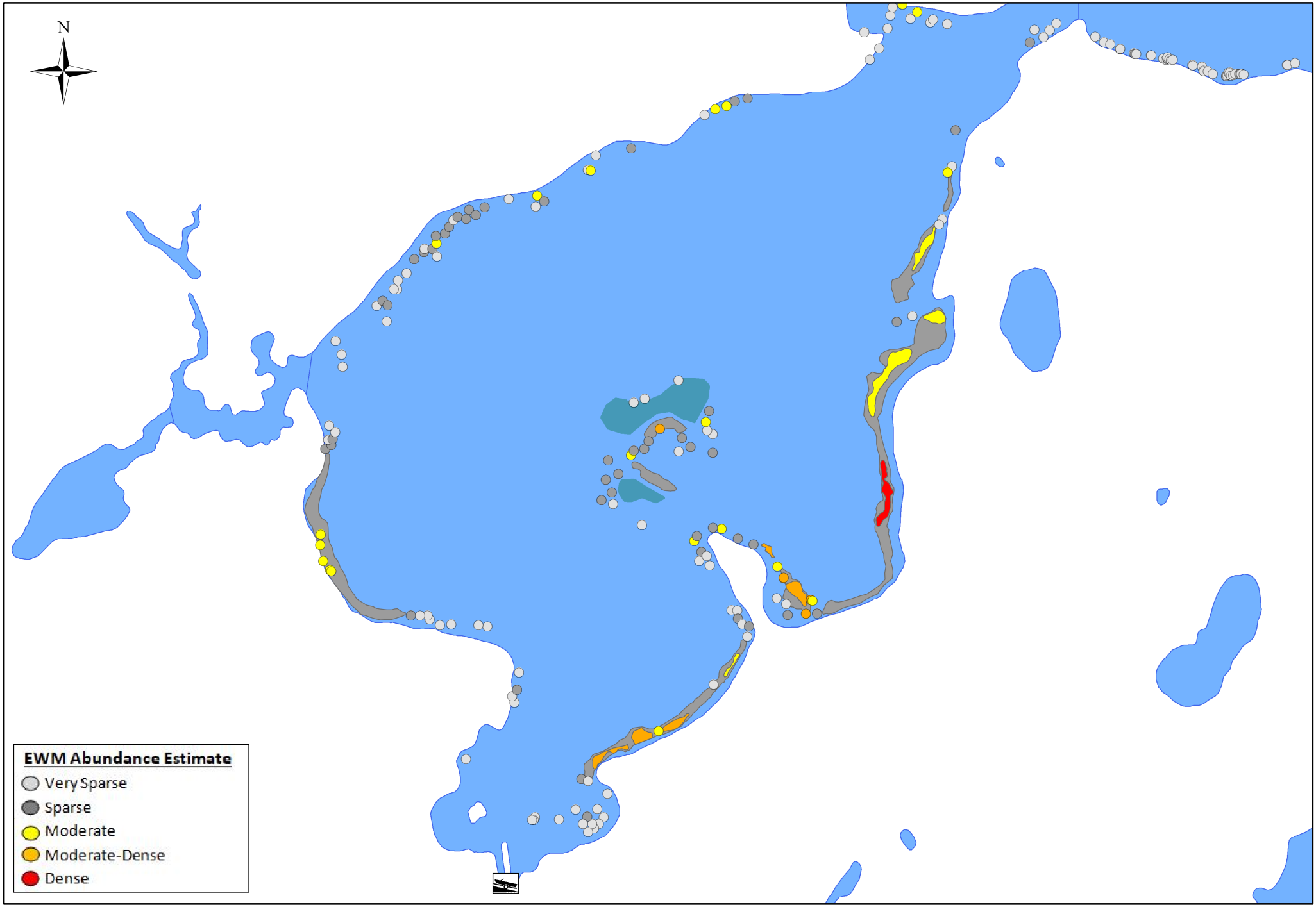
0 1,000 2,000 4,000 Feet

Buckatabon Lakes - Vilas County, WI
End of the Year EWM Locations
2022

Lake: Lower Buckatabon, Vilas County, WI
Map Date & Creator: 1/17/23, Many Waters, LLC
Survey Dates: 8/26/2022, 10/1/2022 & 10/14/22
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2022

0 500 1,000 2,000 Feet

Lower Buckatabon Lake - Vilas County, WI
End of the Year EWM Locations
2022



Lake: Upper Buckatabon, Vilas County, WI
Map Date & Creator: 1/17/23, Many Waters, LLC
Survey Dates: 8/16/22, 8/26/2022 & 10/1/2022
Source: WDNR hydro, EWM-Many Waters
File: Buckatabon_EOY_2022

0 700 1,400 2,800 Feet

Upper Buckatabon Lake - Vilas County, WI
End of the Year EWM Locations
2022

APPENDIX B

Weevil Rearing, Stocking, and Monitoring Reports

2022 Upper Buckatabon Lake Weevil Report

4/21/2023

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

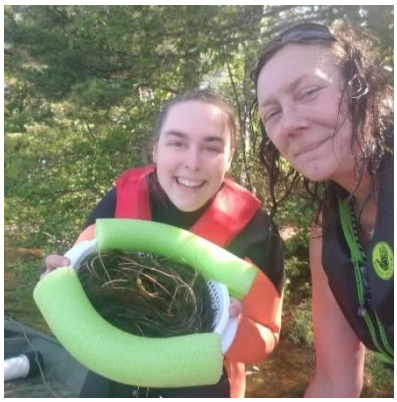


Figure 1. An adult weevil found in rearing tanks during this project in 2020; and Vilas County Land & Water staff Heidi Putnam & Amy Roedl harvesting Eurasian watermilfoil in 2022.

Executive Summary

Upper Buckatabon Lake Association has been working to manage invasive Eurasian watermilfoil (*Myriphyllum spicatum*) since it was found in 2015 in the Benson's Bay area. Diver assisted suction harvesting (DASH) along with rearing and stocking native weevils (*Euhrychiopsis lecontei*) in Benson's Bay have been the main methods of management to date. Weevils were stocked in 2020, 2021, and minimally stocked in 2022. The increasing in-lake population of weevils made rearing efforts counterproductive in 2022. In 2022, the annual point-intercept aquatic plant and weevil survey showed that weevil densities have increased to the lower threshold of levels of where it may be possible to affect management of EWM (Newman 2004). Where weevils are found on EWM, they averaged 1.5 weevils/stem. While the EWM littoral frequency of occurrence had increased to 6.92% as its footprint moves around the lake, the littoral total rake fullness of EWM had increased only slightly from 1.0 to 1.15. On the other hand, native plants & EWM considered together on Upper Buckatabon had increased from a rake fullness of 1.16 in 2021 to 1.63 in 2022. The mapping from Many Waters, LLC shows reductions in the EWM density in the main weevil stocking site of Benson's Bay in 2022. Weevils and/or weevil evidence were found on about 42% of EWM samples collected lake-wide during the point-intercept survey. Simpsons Diversity Index, Species Richness, Average Value of Conservatism, and Floristic Quality Index have all been increasing slightly from 2020-2022, suggesting a healthy aquatic plant community. Success measures include maintaining the EWM total rake fullness of 1.00 (exceeded slightly in 2022) and maintaining the acreage of "dense" EWM at 3.5% or less of the total EWM polygons (on track at 2.7% in 2022). Success of the weevil project will be determined in August 2023. In 2023, weevils should not be reared as it would be counterproductive at this stage. Instead, landowners around the lake should focus

efforts on maintaining natural shorelines and promoting Benson's Bay as a quiet weevil habitat area.

Table 1. Weevil Stats from Upper Buckatabon Lake

Metric	**2020 - Baseline**	**2021**	**2022**	**Success Measure (Determine after 2023)**
Lake-Wide Weevil density on EWM	0.19 weevils/stem	0.11 weevils/stem	0.28 weevils/stem	"Goal" of 0.25-1.0 or greater
Weevil density only at sites where weevils are present on EWM	0.5 weevils/stem	0.75 weevils/stem	1.50 weevils/stem	n/a
EWM % Littoral Frequency of Occurrence	2.84%	5.15%	6.92%	n/a
EWM Average Rake Fullness	1.00	1.00	1.15	1.00
% acres of "dense" EWM (Upper and Lower Buckatabon combined)	3.5% (0.26 acres)	2.4% (0.37 acres)	2.7% (0.61 acres)	= or < 3.5% of EWM polygons
Lake-Wide Weevil Density on EWM & NWM combined	0.10 weevils/stem	0.07 weevils/stem	0.19 weevils/stem	n/a
Lake-wide Weevil Density on NWM	0.06 weevils/stem	0.06 weevils/stem	0.03 weevils/stem	n/a
Approx. Weevils Stocked	2,600	223 + 3,151 = 3,374	496	n/a
Weevil Stocking Date	Aug 19, 2020	July 3, 2021 & Aug 19, 2021	July 1, 2022	n/a
Donated labor from Buckatabon Volunteers	67.3 hours	133.08 hours	26.5 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 listed as Impaired for total phosphorus (Impaired Water 2018). Response efforts to manage the EWM included handpulling, diver assisted suction harvesting, the formation of the Buckatabon Lakes Association (**BLA**), and the recent formation of the Upper and Lower Buckatabon Lakes Protection & Rehabilitation District.

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.

<u>Eurasian Watermilfoil Occurrence Data</u>

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, 2021, and 2022 Maps of EWM Occurrences are shown here for reference, courtesy of Many Waters, LLC.

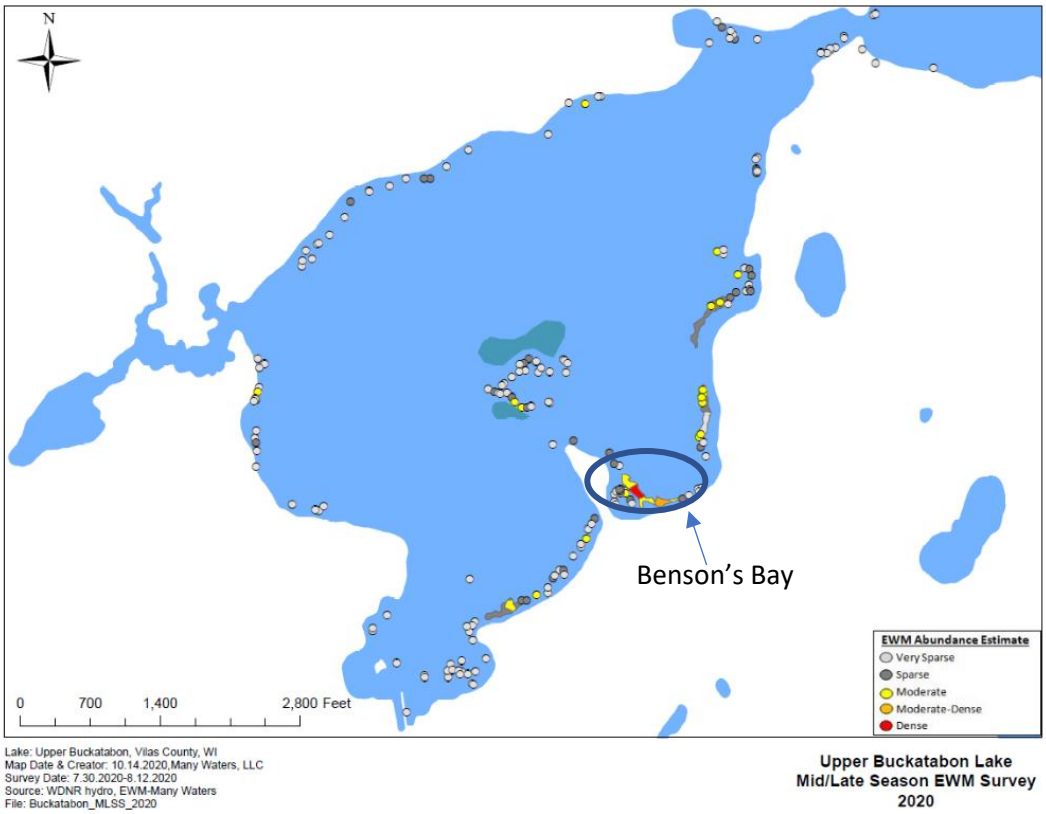


Figure 2. 2020 Upper Buckatabon Lake Mid/Late Season EWM Survey. Courtesy of Many Waters, LLC.

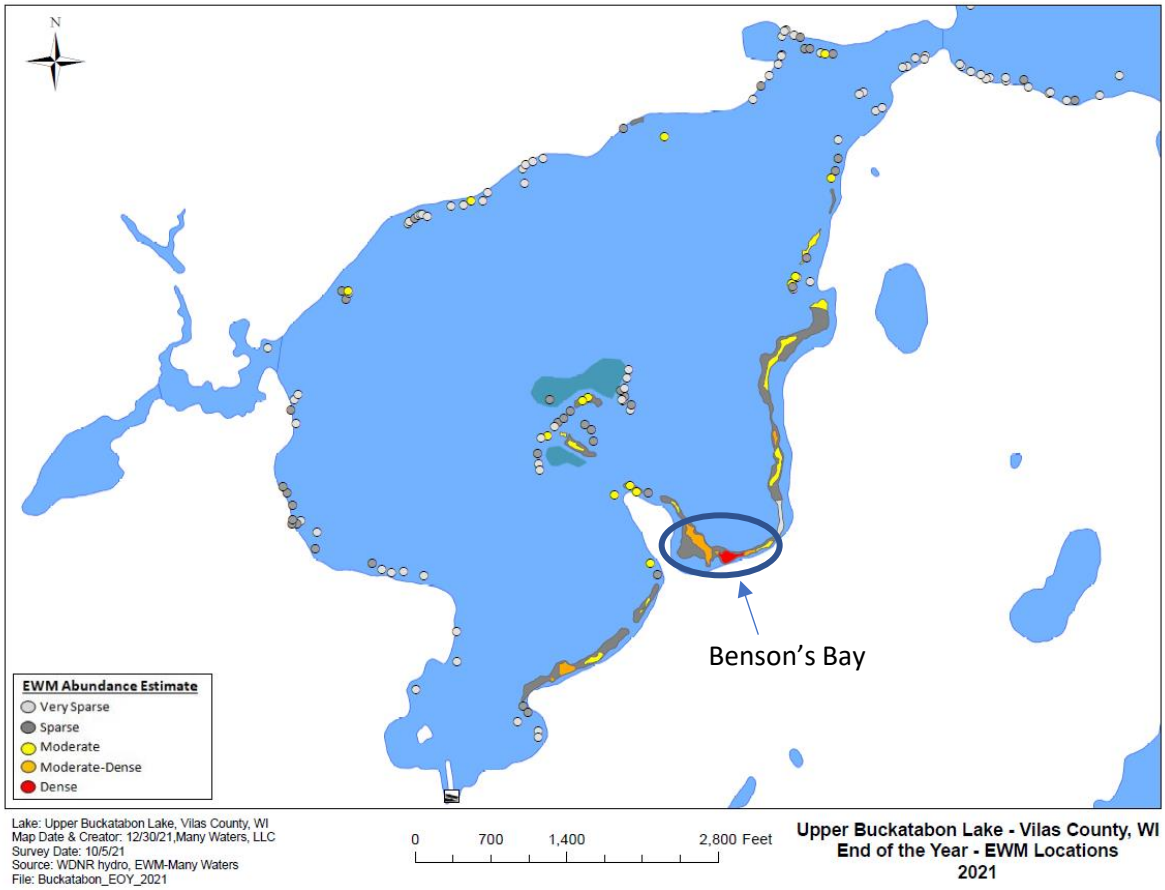


Figure 3. 2021 Upper Buckatabon Lake End of the Year EWM Survey. Courtesy of Many Waters, LLC.

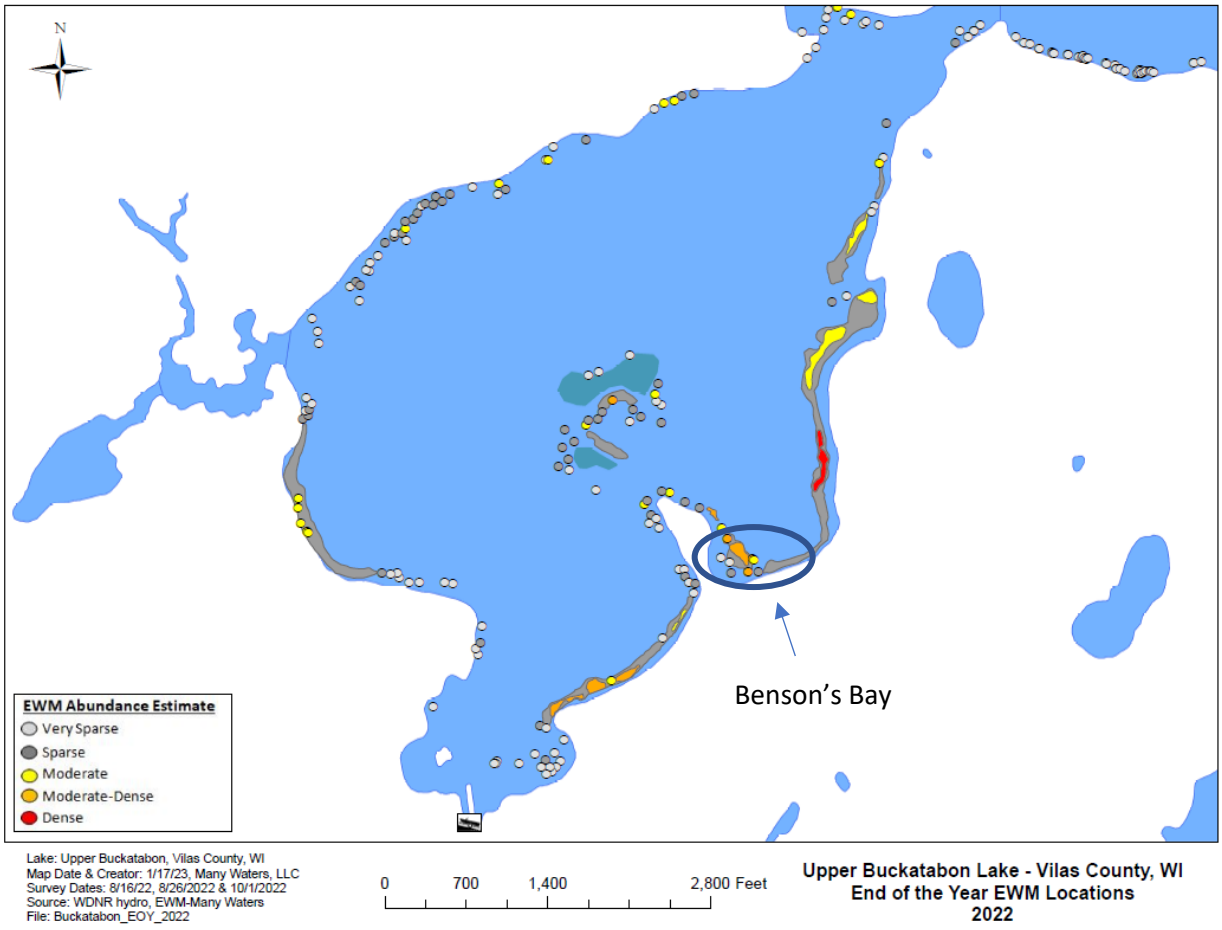


Figure 4. 2022 Upper Buckatabon Lake End of the Year EWM Survey. Courtesy of Many Waters, LLC.

It can be helpful to see how density and acreage change from year to year by the following chart provided by Many Waters, LLC. In 2020 there were 0.26 acres; in 2021 there were 0.37 acres; and in 2022 there were 0.61 acres of EWM were considered "dense" on Upper Buckatabon. In spite of the acreage of dense EWM increasing, the percentage of dense EWM acres remain low at 3.5%; 2.4%; and 2.7% from 2020-2022.

Table 2. Change in EWM abundance from 2015-2022 on Upper Buckatabon Lake. Courtesy of Many Waters, LLC.

EWM Abundance Estimate	2015	2016	2017	2018	2019	2020	2021	2022
Very Sparse	0.02	0.10	0.50	1.04	0.90	1.66	1.77	1.43
Sparse	0.18	0.28	0.40	1.54	2.60	3.15	9.17	16.34
Moderate	0.05	0.05	0.03	0.43	2.61	1.93	2.72	2.98
Moderate-Dense	0.00	0.00	0.00	0.15	1.23	0.24	1.24	1.63
Dense	0.00	0.00	0.00	0.00	0.00	0.26	0.37	0.61
TOTALS (acres)	**0.25**	**0.43**	**0.93**	**3.15**	**7.33**	**7.24**	**15.28**	**22.99**

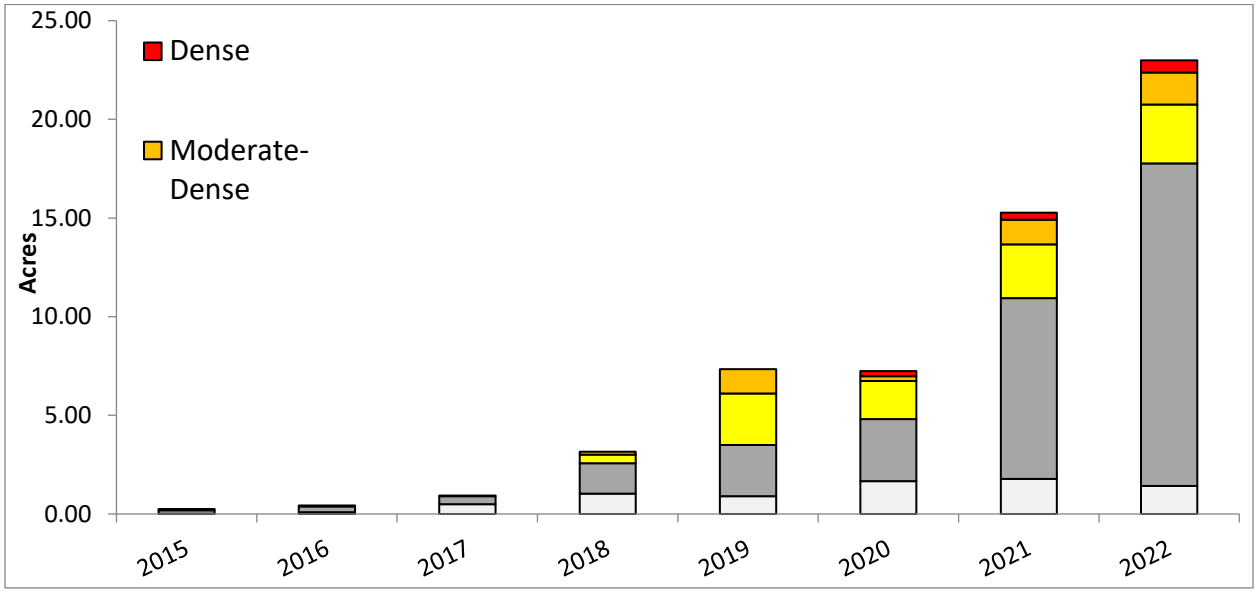


Figure 5. Change in EWM abundance from 2015-2022 on Upper Buckatabon Lake. Courtesy of Many Waters, LLC.

All weevils were stocked into Benson's Bay in 2020, 2021, and 2022. Estimates from all three years total 6,470 weevils were stocked. Therefore, it would make sense to see management results first in Benson's Bay. Many Waters mapped the EWM occurrence and density of Benson's Bay all three years, and the changes can be tracked in Figure 6.

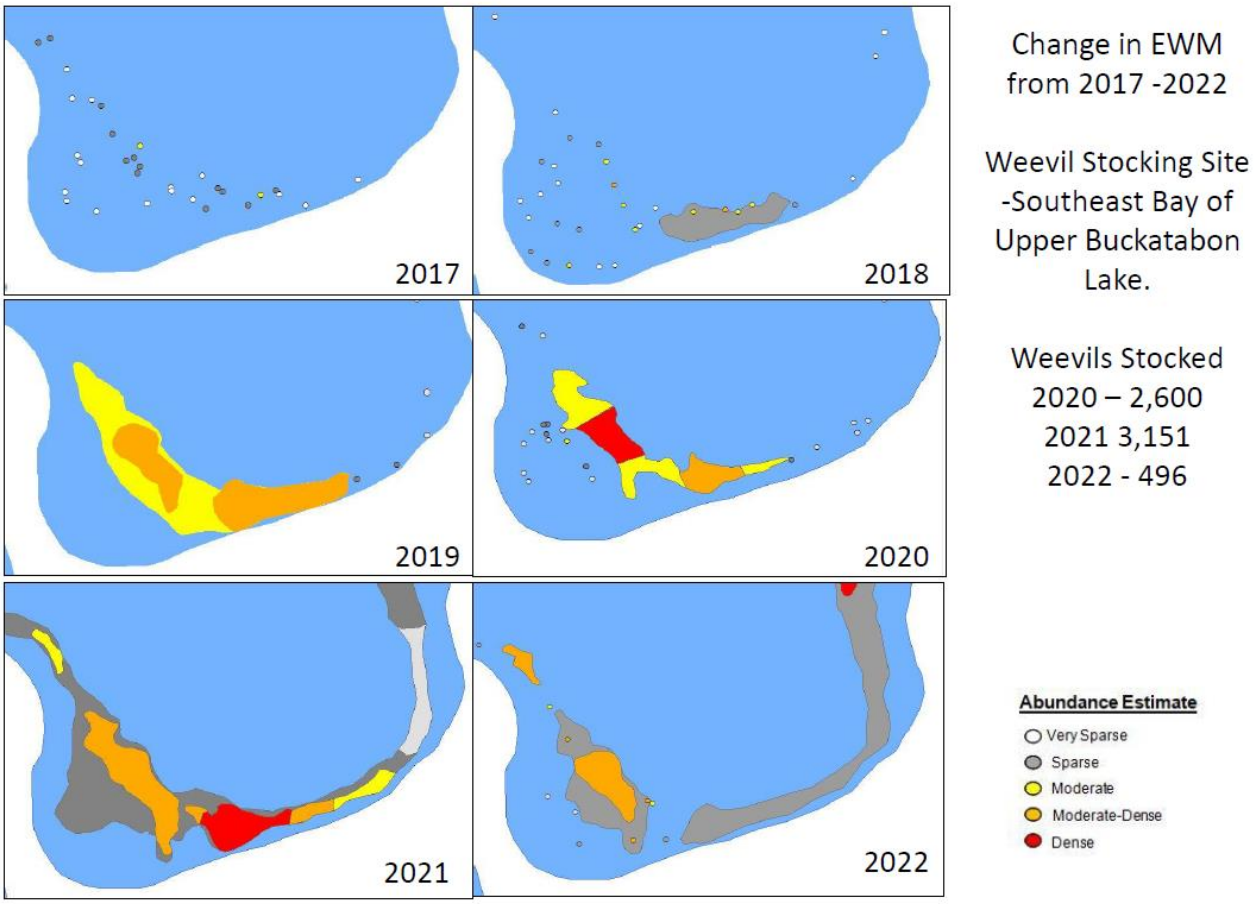


Figure 6. Change in EWM abundance from 2017-2022 in Benson's Bay, where all 6,470 weevils were stocked from 2020-2022. Courtesy of Many Waters, LLC.

<u>No Weevil Rearing in 2022</u>

The Buckatabon Lakes Association (BLA) was prepped and ready to rear weevils in 2022, as they had done in 2020 and 2021. However, as the gathering of healthy EWM stems for weevil food started, it became clear that the weevil density on the food stem collection sites in Upper Buckatabon was already quite high.

The process of rearing weevils necessitates that EWM stems be taken out of the target lake (in this case Upper Buckatabon Lake) as food and placed in the cattle troughs for rearing. This will avoid introducing EWM genetic strains or EWM hybrids from other

Figure 7. BLA volunteer Dan Benson helping to set up the 2021 weevil rearing site on Upper Buckatabon. These cattle troughs held the harvested EWM for rearing the weevils. This was discontinued in 2022 due to increased weevil density in food collection sites.

waterbodies when the weevils are released. To rear 4 troughs of weevils, 1,960 EWM stems are needed from the target lake; and would result in roughly 2,688 weevils to be stocked. If there are already weevils in the target lake, this process will inadvertently remove some weevils if they are on the EWM stems used for food. The ideal situation would be that an area free of weevils can be used as a food collection site, so no weevils are removed from the lake for the rearing process. However, this also needs to be balanced with effort needed to locate EWM food stems – a denser EWM area will mean less effort to search for the needed number of stems. In 2022, there were 2 areas considered good for food collection: between the islands and the outer lakeward edges of the Benson's Bay EWM beds.

The first round of about 70 EWM food stems was sourced between the islands on Upper Buckatabon and delivered to Golden Sands RC&D for culturing weevils in early June. These stems contained 103 weevils, equating to about 1.5 weevils/stem (Thorstenson 2022). This is a high density of weevils. It was determined that this area was not suitable for further collection:

1,960 stems needed for rearing x 1.5 weevils/stem = 2,940 weevils removed from lake for rearing food and possibly lost or killed during the cleaning and handling process

2,688 weevils to be stocked from rearing – 2,940 weevils removed from lake = 252 less weevils in lake

The second round of 60 EWM food stems were collected from the outer lakeward edges of Benson's Bay contained 130 weevils equating to 2.2 weevils/stem (Thorstenson 2022). This would also not be suitable for further food stem collection:

1,960 stems needed for rearing x 2.2 weevils/stem = 4,312 weevils removed from lake for rearing food and possibly lost or killed during the cleaning and handling process

2,688 weevils to be stocked from rearing – 4,312 weevils removed from lake = 1,624 less weevils in lake

It is important to note that the densities of weevils in the food stems are not representative of all EWM in the lake. Food stems must be at least 24 inches tall, clean, and healthy looking, not be covered in algae, and have a growing apical meristem. Ragged, algae-covered stems with the apical meristems missing are not collected for food because they are not preferred by female weevils for egg deposition (Golden Sands 2016). Because of this preference, it would make sense that the weevil densities on the "food-grade" EWM can be higher than the lake-wide or EWM bed weevil densities described later in this report.

Since there were no other places to efficiently collect the number of stems needed without inadvertently reducing the total number of weevils in Upper Buckatabon Lake, rearing was not done in 2022. The 496 weevils that were already cultured by Golden Sands RC&D were released into Benson's Bay on July 1, 2022.

Weevil Releases

Since weevils were not reared in 2022, only the 496 weevils referenced above were released into Benson's Bay on July 1, 2022 via snorkeling and tying bundles of Upper Buckatabon Lake-sourced EWM containing weevils to existing EWM stems in the lake.

Weevil & Eurasian Watermilfoil Density Sampling Methods

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 (**NWM**) where they were found at these points. The sampling followed procedures listed in the "Biological Control of Eurasian Watermilfoil" manual (Golden Sands, 2016), except for also collecting NWM stems for weevil counts. 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 lake-wide weevil and Eurasian watermilfoil densities one year after the first weevil stocking. This process was again repeated July 25-Aug 16, 2022. See Figure 8 for the 766 sites on Upper Buckatabon that were repeatedly sampled.

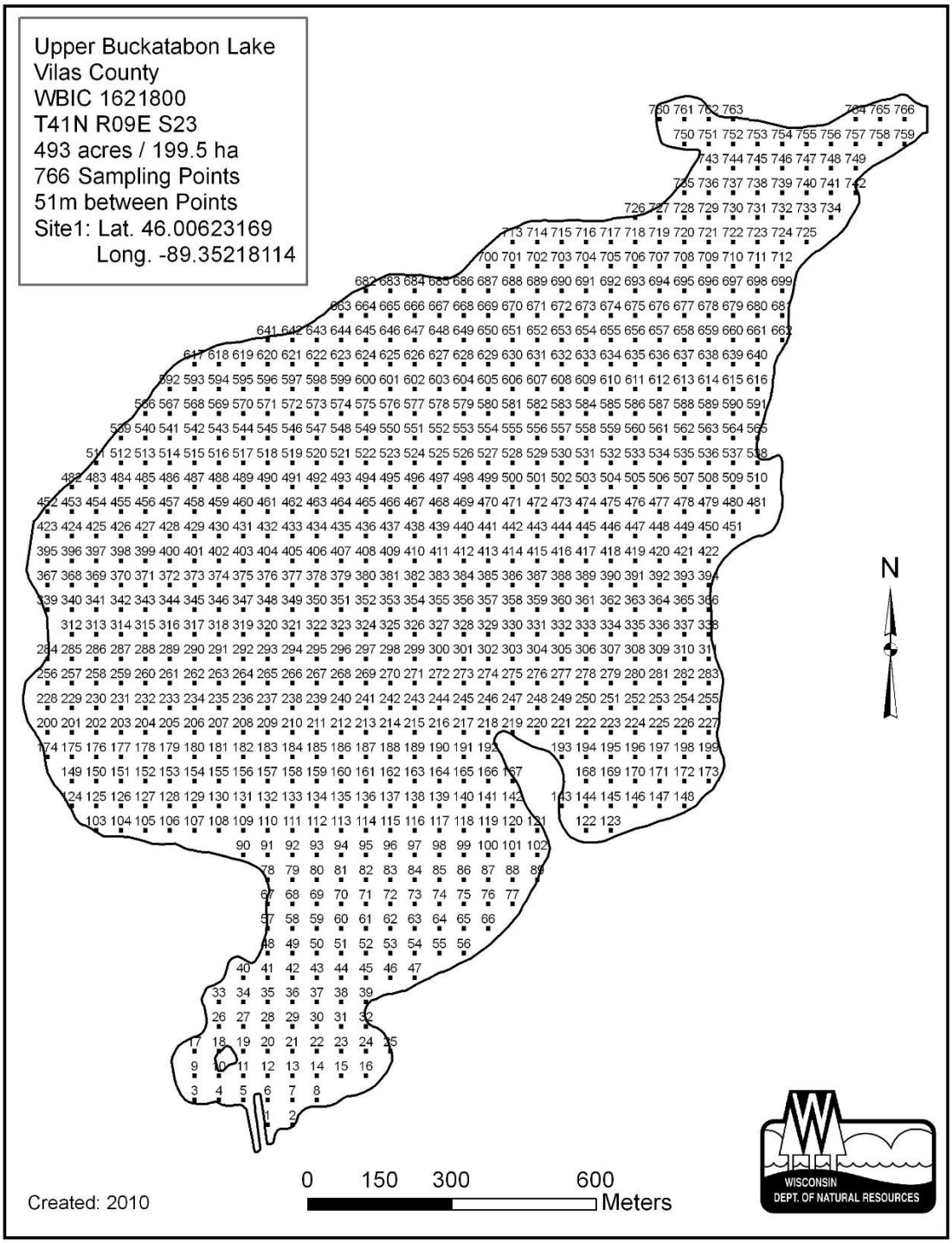
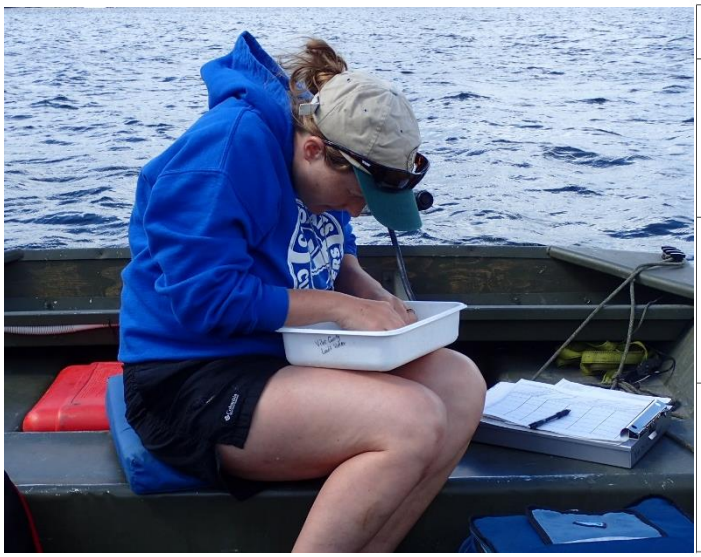


Figure 8. Aquatic Plant Point Intercept map. Courtesy WI DNR.



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 9. 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.

Total rake fullness for each site as well as individual species found was recorded as 1, 2, or 3 as described in Figure 9.

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. Because the native aquatic plant northern watermilfoil *Myriophyllum sibiricum* (NWM) is quite common on Upper Buckatabon and is the native host plant for the weevils, stems of NWM 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. In other cases, northern watermilfoil existed as 1 stem at a sampling location. In these cases, a sample could not be collected for the purpose of counting weevils.

In 2021 & 2022 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 to get an estimate of lake-wide weevil density.

Point Intercept Survey Results – Aquatic Plant Data

The following table 3 shows information pertinent to EWM management, and aquatic plant community. Table 3 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 sampling points marked on the map in Figure 8.

Table 3. 2020-2022 Upper Buckatabon Aquatic Plant Point Intercept Survey Results

	2020	2021 adjusted	2022
Total number of sites visited	328	369	495
Total number of sites with vegetation	189	226	211
Total number of sites shallower than maximum depth of plants	317	369	317
Frequency of occurrence (of all plants) at sites shallower than maximum depth of plants	59.62%	61.25%	66.56%
Average Rake Fullness (all species)	1.16	1.15	1.63
Simpson Diversity Index	0.91	0.92	0.93
Maximum depth of plants (ft)	22.00	22.00	22.00
Average number of all species per site (shallower than max depth)	1.56	2.12	2.46
Average number of all species per site (veg. sites only)	2.62	3.46	3.70
Species Richness	35	33	42
Species Richness (including visuals)	39	39	49
Floristic Quality Index	36.51	37.72	41.58
Average Value of Conservatism	6.67	6.77	7.03
EWM % Frequency of Occurrence shallower than maximum depth of plants	2.84%	5.15%	8.52%
NWM % Frequency of Occurrence shallower than maximum depth of plants	8.52%	10.84%	11.04%

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. 2021 data appearing in table 3 were adjusted to maintain a 22 ft max depth of plants as in 2020 so data are more comparable between the two years. The 2022 sampling efforts were much more in-line with the 2020 sampling effort, and again found a 22 ft max depth of plants.

Frequency of occurrence of all plants shallower than the maximum depth of plant growth was 59.62% in 2020; 61.25% in 2021; 66.56% in 2022. This indicates the percentage of all the sites shallower than 22 ft that contained plants. These figures are fairly similar to each other, however 2022 does show the most colonization of plants.

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. Values ranged from 0.91-0.93.

These figures are quite high, indicating many different species of plants that are fairly evenly distributed within the littoral area.

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; and in 2022 increased again to 3.70 species on average.

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; 33 in 2021; and 42 in 2022. 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; and 49 in 2022.

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; and 7.03 in 2022. 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. This number showed an increase in 2022 to 41.58, possibly reflecting more diverse and sensitive plants than previous years.

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 max depth of 22 ft deep. Upper Buckatabon had an EWM %FOO of 2.84% in 2020; in 2021 it slightly increased to be 5.15%; and in 2022 it slightly increased again to be 6.92%. So out of every 100 rake samples in the littoral area of the lake, just under 7 sites would have EWM. This is considered fairly low. The % FOO for EWM is expected to increase over time as EWM expands its footprint around the lake, even if management by weevils is working well.

The average rake fullness for EWM in both 2020 and 2021 was 1.0; but in 2022 it increased to 1.15. 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 go back to an average total rake fullness of 1.0 for EWM. It should be noted that total rake fullness for all plant species had increased in 2022, meaning that conditions for plant growth in general may have been better than normal in 2022.

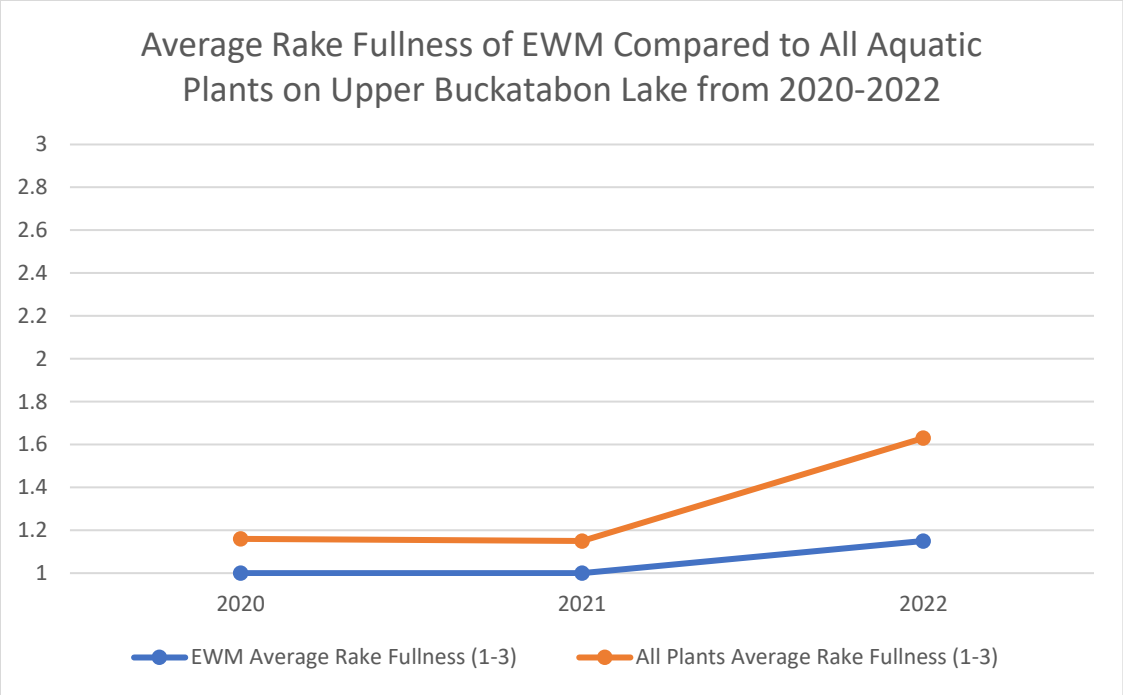


Figure 10. Total rake fullness of Eurasian watermilfoil in relation to total rake fullness of all aquatic plants by year sampled. Possible values range from 1-3 with 1 being least dense, to 3 being the most dense. See figure 9 for these descriptions.

Northern watermilfoil (**NWM**) %FOO information is also included here for reference. NWM is a native plant, and also serves as a host plant for the weevils. NWM %FOO on Upper Buckatabon was 8.52% in 2020; 10.84% in 2021; and 11.04% in 2022. In all 3 years, the NWM %FOO is more than that of EWM.

Point Intercept Survey Results – Weevil Data

Table 4 shows the lake-wide results of the weevil sampling on Upper Buckatabon Lake in 2020-2022. Within table 4, 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; as well as evidence of weevil feeding damage. 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. Note that the number of sites where NWM was found, plus the number of sites where EWM was found will not always equal the combined number of sites because sometimes NWM and EWM were found at the same site.

Table 4. 2020-2022 Upper Buckatabon Weevil Sampling Results. Weevil "evidence" refers to blast holes where weevils had emerged from stems after pupating or showed evidence of feeding damage.

	Northern Watermilfoil			Eurasian Watermilfoil			Combined		
	2020	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
Number of sites where milfoil samples collected	26	40	17	8	14	26	34	51	39
Number of sites with weevils present or weevil evidence	3	13	4	5	4	11	8	17	12
% of sites with weevils present or weevil evidence	11.5%	32.5%	23.5%	62.5%	29.6%	42.3%	23.5%	33.3%	30.8%
Average lake-wide weevil density (weevils/stem)	0.06	0.06	0.03	0.19	0.11	0.28	0.10	0.07	0.19

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; however, Jester et al. found that that the average natural population density in Wisconsin is approximately 0.65 weevils/stem (Jester et al 2000). Densities somewhere between 0.25 to 1.0 weevils/stem have been documented to produce a milfoil crash (Newman 2004). Data from all years show 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). Lake-wide weevil densities on EWM are highest in 2022 at 0.28 weevils/stem. This density is within the range that Newman references where it is possible for weevils to affect control of Eurasian watermilfoil, however it could take as much as 1.0 weevils/stem. The required density appears to vary from lake to lake (Newman 2004).

The lake-wide weevil density of 0.28 weevils/stem uses the total life stages of weevils found and is divided by the total number of EWM stems collected, even if weevils were not found at that site. It may also be useful to know the density of weevils only at sites where weevils occur. This calculation would be the total count of weevils in all life stages divided by the number of EWM stems collected from sites where weevils are present to understand the potential for localized control. In 2022 this would mean there are 1.5 weevils/stem at sites where weevils

are present in Upper Buckatabon Lake. This figure may be even more useful than the lake-wide density because EWM is still found in very sparse areas where it is newly colonizing on Upper Buckatabon. Sparse EWM typically does not provide good weevil habitat, so while it may be detected on the aquatic plant point intercept survey, weevils would likely not be present at these areas yet; nor would the EWM be considered to be at nuisance levels yet. As monitoring continues, currently sparse EWM areas may become more dense and locally-dense weevil populations may be found in response to the increased food source. See below for 2020, 2021, and 2022 weevil occurrence maps.

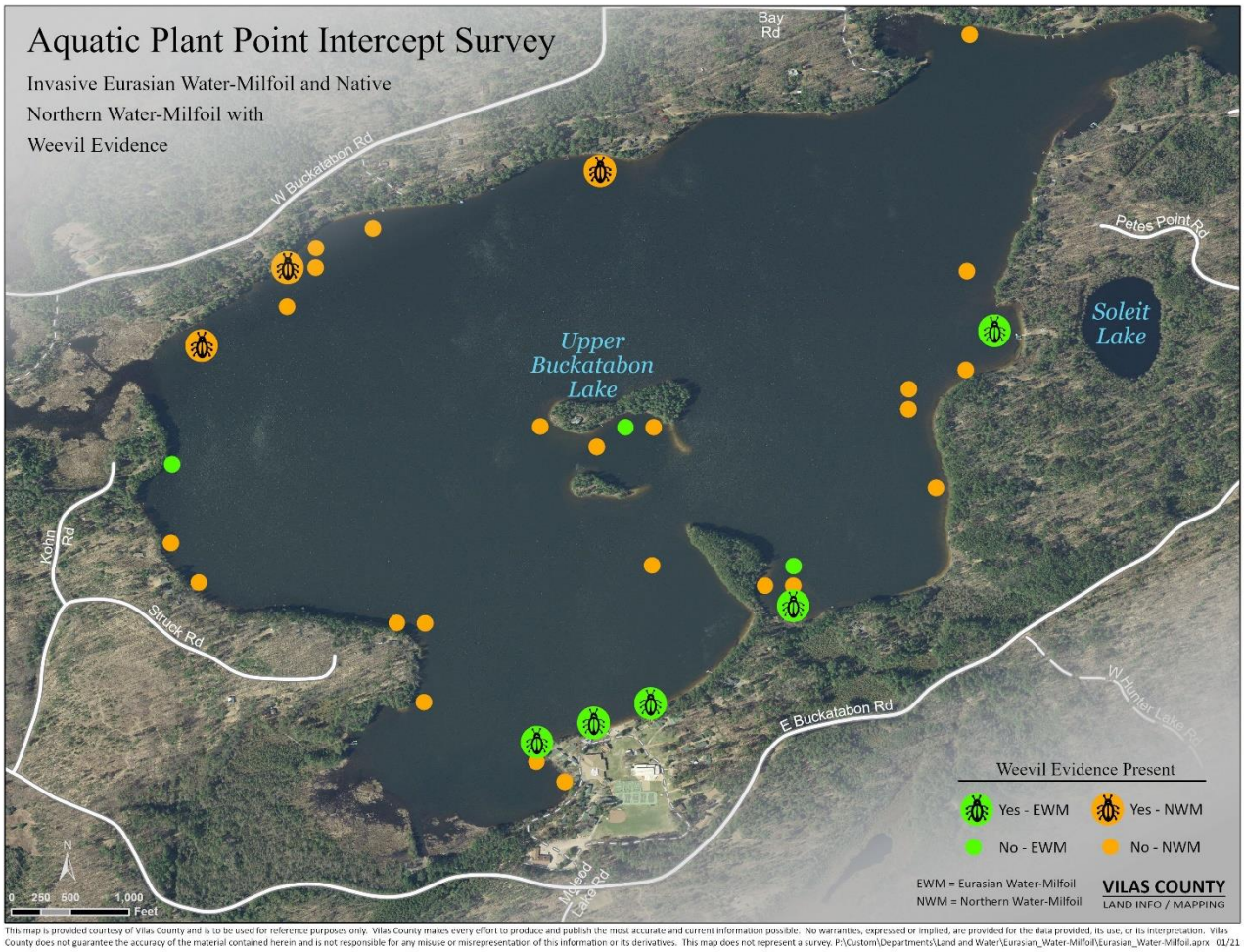


Figure 11. 2020 EWM and NWM stem sample sites where weevil presence or evidence was found and not found on Upper Buckatabon Lake.

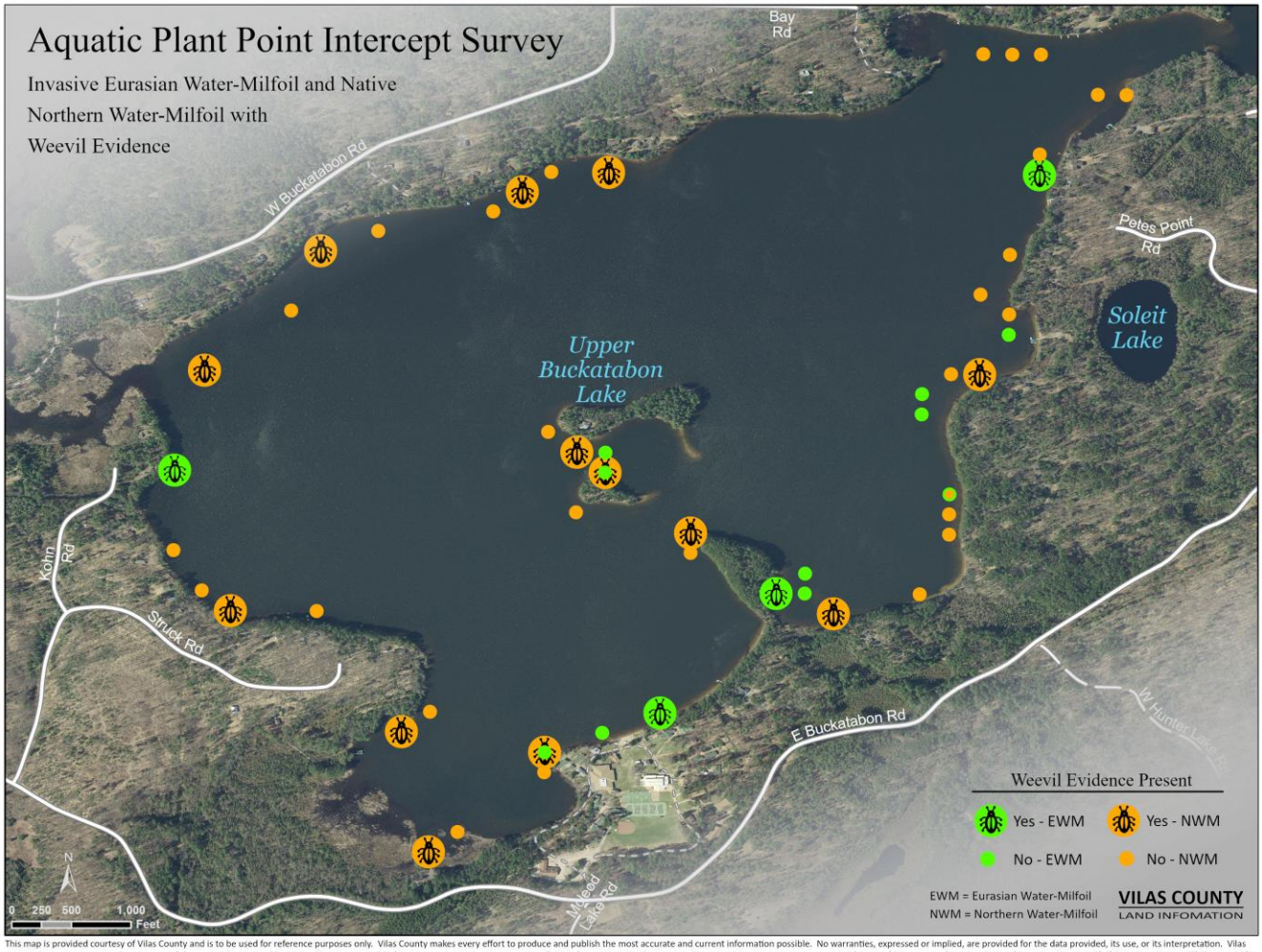


Figure 12. 2021 EWM and NWM stem sample sites where weevil presence or evidence was found and not found on Upper Buckatabon Lake.

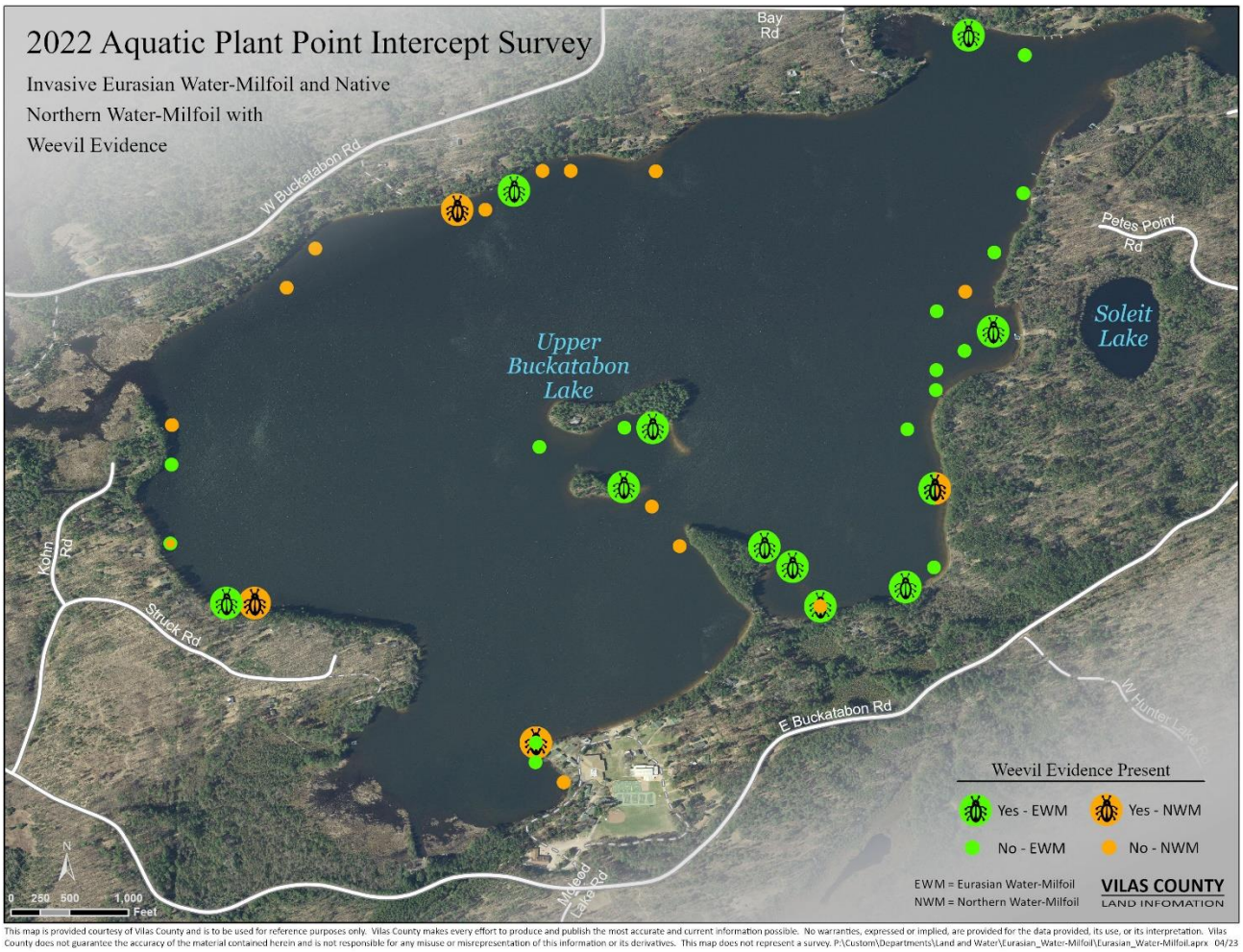


Figure 13. 2022 EWM and NWM stem sample sites where weevil presence or evidence was found and not found on Upper Buckatabon Lake.

Benson's Bay has been the focus area of the weevil project and in 2022 contained 5 aquatic plant point intercept survey sites where milfoil was found on EWM. Of these 5 sites, 4 samples contained weevils, and one did not contain weevils. For comparison, in 2020 and 2021 there was 1 EWM site showing weevil presence/evidence in Benson's Bay.

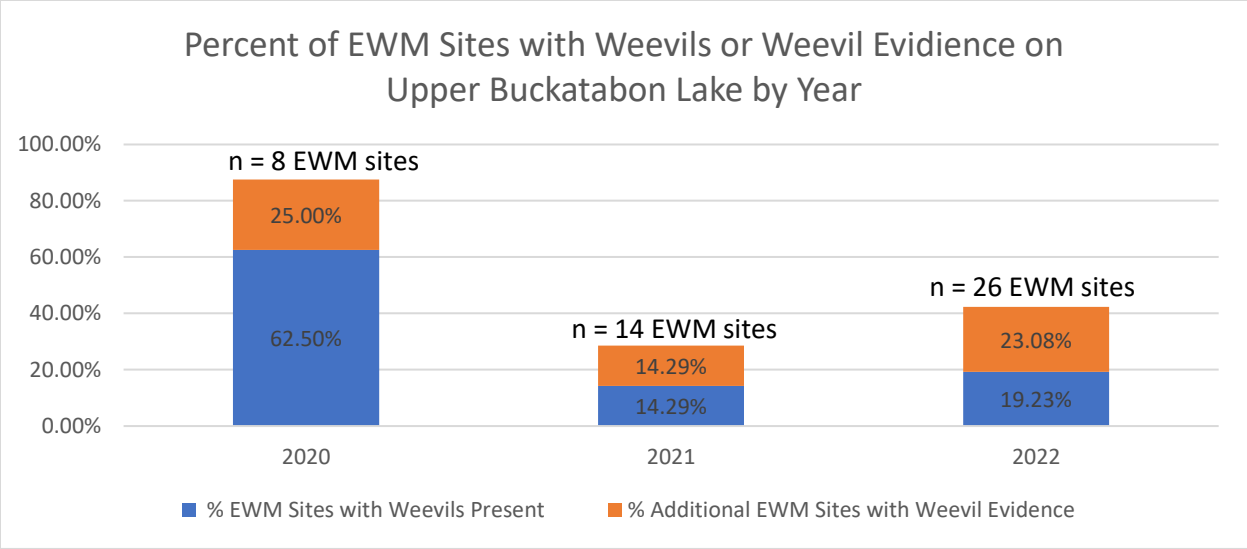


Figure 14. Percentage of EWM sites that had weevils or showed weevil evidence from 2020-2022.

Eurasian Watermilfoil Bed Weevil Monitoring

Lake-wide weevil density as determined by the aquatic plant point intercept survey method above can be used to determine weevil density regardless of where and how many EMW beds form from year to year. However, where weevil densities seem to matter the most is in the denser areas of Eurasian watermilfoil. For this reason, EWM bed-level weevil data collection began in 2022.

Protocols from the Citizen Lake Monitoring Network's Native Water-Milfoil Weevil protocols were used for this EWM bed-level survey (Maccoux 2007). Land & Water Staff used the 2021 End of Year Survey map created by Many Waters to locate the general area of 4 beds of EWM. For the purposes of this survey, beds would refer to "moderate" to "dense" polygons on the map. Since it is likely that the footprint of the EWM would change slightly since the map was created, staff visually located the boundaries of each EWM bed selected and picked 3 areas within each of the 4 EWM beds to sample. Ideally, these areas would have the first point be in the shallower water and the last point be in deeper water of the EWM bed, but in some cases the EWM bed was narrow and not practical to sample from shallow to deep. In these cases, transects were through the EWM bed, but more parallel to shore, with as much variation of depth as practical.

Following the protocols, 10 24-inch-long stems were collected at random at each transect point, 5 from either side of the boat. These stems were preserved in ethanol and assessed for all life stages of weevils. Each EWM bed had a total of 30 stems collected and was used to find an average number of weevils/stem in each EWM bed. See protocol example map below:

Figure 15. Citizen Lake Monitoring Native Water-Milfoil Weevil example transect map.

Table 5. Results of 2022 EWM Bed Weevil Survey on Aug 12, 2022.

EWM Bed	Transect Point	Location Description	Water Depth (ft)	Weevil Count	Weevil Evidence Present	Mean Weevil Density per EWM Bed
1	A	Benson's Bay	4.2	0	Yes	0.07
1	B	Benson's Bay	2.7	1	No	
1	C	Benson's Bay	4.8	1	No	
2	A	Between islands	2.7	0	Yes	0.13
2	B	Between islands	2.5	0	Yes	
2	C	Between islands	2.5	4	Yes	
3	A	Southwest of Soliet Lake	6.2	0	Yes	0.10
3	B	Southwest of Soliet Lake	3.3	3	Yes	
3	C	Southwest of Soliet Lake	3.9	0	No	
4	A	Camp Ramah	2.8	7	Yes	0.47
4	B	Camp Ramah	2.50	7	Yes	
4	C	Camp Ramah	2.8	0	Yes	

The EWM bed density counts can give information on very localized weevil densities and give an idea of what water depth weevils exist within an EWM bed at the time of sampling. Based on the EWM bed survey, the highest density of weevils was located offshore of Camp Ramah, while the lowest density of weevils was in Benson's Bay. For the EWM bed weevil counts, most weevils were found in water depth less than 3 ft, and deeper water sampling points may result in less weevils being detected.

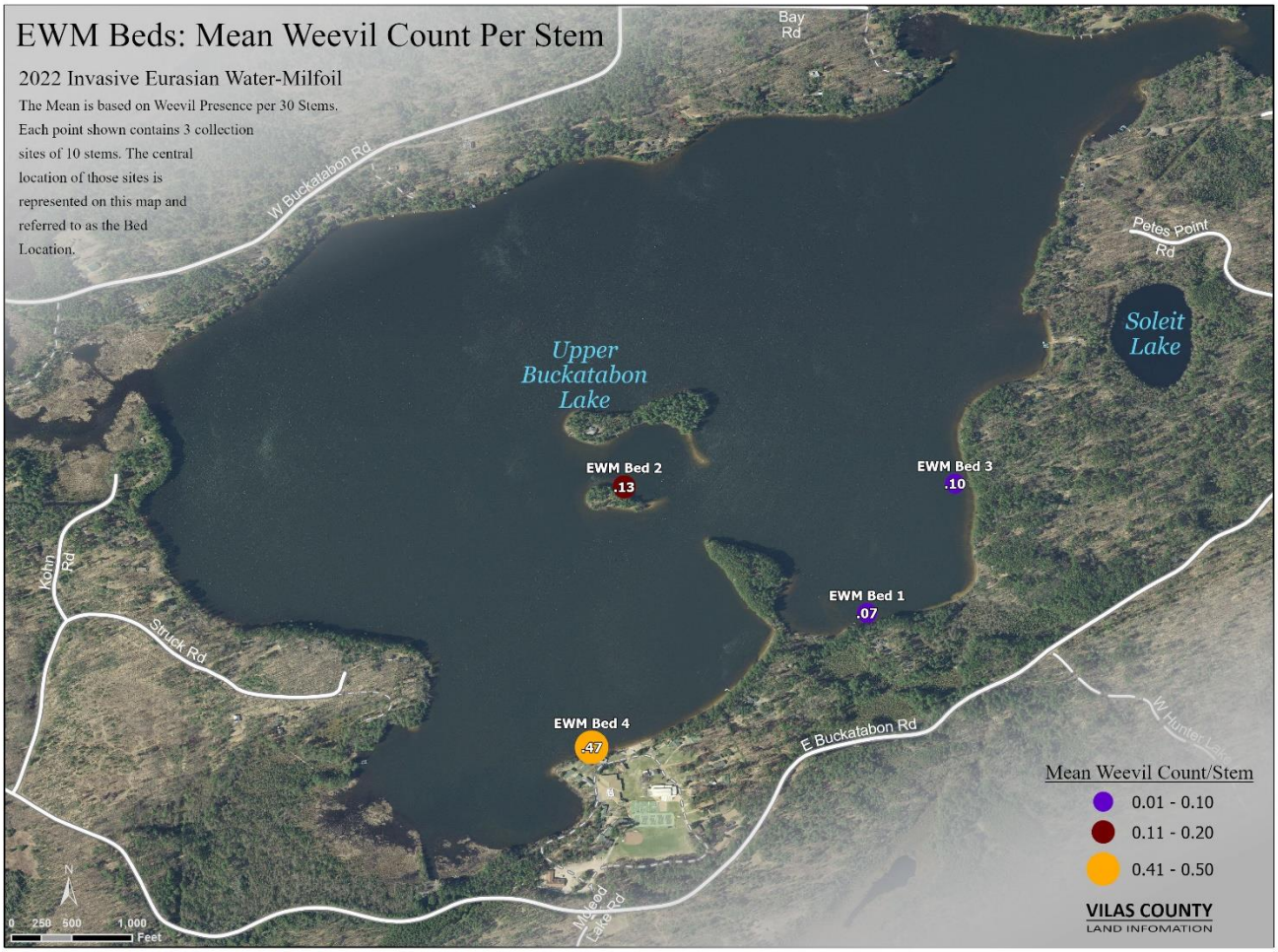


Figure 16. 2022 EWM bed weevil occurrences with mean weevil densities on Aug 12, 2022.

Other Observations

A stem burrowing insect that was not a weevil larva was found in a stem of northern watermilfoil from the samples collected on Upper Buckatabon. PJ Liesch, the Extension Entomologist from the Insect Diagnostics Lab was able to say the insect is a type of midge larvae, however, he could not confirm genus or species (Liesch 2023). Some midges are stem miners. Most often these midge stem miners build tubes in plant tissue to draw water and ingest diatoms, but others feed directly on leaves or other plant tissue (Balciunas 1982). It is unclear if the midge was consuming the stem tissue or simply using it as habitat. The exact location of this midge larvae was not recorded.

Figure 17. Midge larvae found inside a northern water milfoil stem on Upper Buckatabon, and the dissected stem where it was found. Notice the pinholes on the left side of the stem.

Further Discussion

As future planning continues, it is imperative to consider scientific data in appropriate perspectives. See Tables 3, 4, and 5 summarizing the aquatic plant point intercept survey results, weevil point intercept survey results, and EWM bed weevil sampling results. These data 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 (Newman 2004), and the aquatic plant point intercept survey showed a weevil density on EWM of 0.28 weevils/stem.

The map in figure 6 from Many Waters LLC also shows that EWM in the Benson's Bay area is becoming less dense in 2022 (as compared to years 2019-2021) during a year when overall, total rake fullness of aquatic plants in the lake had generally increased.

The weevil data from the point intercept survey and the EWM bed survey do not mesh. The aquatic plant point intercept survey did not detect weevils near Camp Ramah; and 4 of the 6 weevil sites were in Benson's Bay and contained 75% of all the weevils found. Because of this, one would expect the EWM bed survey to find a very low density of weevils near Camp Ramah, and a high density of weevils in Benson's Bay. But based on the results of the EWM bed survey, the highest density of weevils was located offshore of Camp Ramah, while the lowest density of weevils was in Benson's Bay. While the results of the 2 different types surveys do not reflect each other, considering the results together they may give a fuller picture of weevil activity in Upper Buckatabon Lake. Natural weevil movements may also play a part in these result differences. It is also possible that small location and date differences could yield very different results for weevil densities. It could be that the shape of the EWM beds could impact these result differences. For example, the Camp Ramah EWM bed is long and narrow and less likely to contain many sampling points from the aquatic plant point intercept survey. However, this bed was equally represented with the Benson's Bay EWM bed in the EWM bed survey, which is much more wide and more likely to contain more sampling points from the aquatic plant point intercept survey. EWM beds that are larger and in shallower water tend to have higher densities of weevils (Jester 2000).

Plans for 2023 & Future Recommendations

Due to the food collection sites having high densities of weevils in the usable EWM food stems, no weevil rearing should take place in 2023.

Vilas County Land & Water Conservation will provide one last year of assistance in 2023 that will be outlined in a memorandum of understanding between Upper and Lower Buckatabon Lakes Protection & Rehabilitation District and Vilas County Land & Water Conservation Committee. Vilas County Land & Water Conservation staff plan to do an aquatic plant point intercept survey along with weevil sample collection; sample EWM beds for weevils; process weevil density counts on stem samples; and create a 2023 weevil report.

Last year, a navigation lane was created through Benson's Bay via DASH harvesting. DASH does require a DNR permit. Benson's Bay is where all previous weevil stocking has occurred. If a navigation lane is desired in 2023, Vilas County asks to keep the following in mind:

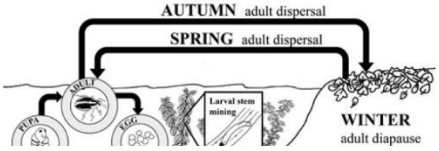


Figure 18. Life cycle of the milfoil weevil. Larvae spend most of their time feeding inside the stem, develop into pupae inside the stem, and then emerge as an adult. Adults will fly, swim, and raft to get to shore to overwinter. Figure by Havel et al 2017.

- 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 the navigation lane is established, keep it open all season either by boat traffic or by repeated hand or DASH removals.
- 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.

Lake-wide weevil densities on EWM in Upper Buckatabon were reported as 0.19 in 2020; 0.11 2021; and 0.28 in 2022. Weevils have been shown to be effective at controlling EWM at varying densities, between 0.25-1.0 weevils/stem (Golden Sands 2016). 2022 is the first year where lake-wide weevil densities are within this window, but the density of where weevils are effect at EWM management appears to vary lake by lake (Newman 2004).

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.

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 weak 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)

While success is not to be determined until Aug 2023, addressing current data might be pertinent. The 2022 lake-wide rake fullness for EWM was 1.15, which is above the target of 1.0. In general, the average rake fullness for all species in Upper Buckatabon had also increased from 2020-2022: from 1.16 to 1.15 to 1.67. To be considered successful, the EWM rake fullness should be maintained at 1.0 in 2023.

The percentage of dense acres of EWM in 2022 was at 2.7%. This figure would be considered successful if maintained in 2023.

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. Several volunteers offered their time and expertise in 2022. Thanks go to Carolyn Barthel, Dan Benson, Tom Christensen, Gary Croisatiere, Peggy DeFrancheschi, Sue Kleiner, Jim Kleiner, Quita Sheehan, Jodi Lepsch, and Amy Thorstenson.

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.

Artwich, Bill and Barb Gajewski. "Buckatabon Lakes Eurasian Watermilfoil Management Project." Upper and Lower Buckatabon Lakes – Vilas County, WI. 2022 Final Reporting.

Balciunas, Joseph K. "Insects and other macroinvertebrates associated with Eurasian Watermilfoil in the United States". Technical report A-82-5. Aquatic Plan Management Laboratory, Agricultural Research Service, US Army Corps of Engineers. Oct 1982.

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.

Jester, L.L., M.A. Bozek, D.R. Halsel, and S.P. Sheldon. 2000. *Euhrychiopsis lencontei* distribution, abundance and experimental augmentation for Eurasian watermilfoil control in Wisconsin lakes. Journal of Aquatic Plant Management. 38:88-97.

Liesch, Patrick. March 22, 2023. "Re: ID help please".

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, R.M 2004. Biological control of Eurasian watermilfoil by aquatic insects: basic insights from an applied problem. Archiv fur Hydrobiologie 159 (2):145-184.

Newman, R.M., M.E. Borman, and S.W. Castro. 1997. "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]. 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.

Thorstenson, Amy. July 25, 2022. "Re: Buckatabon Weevil Project".

APPENDIX C

2022 EWM Management Summary – Hand Pulling

EST. 2013

AQUATIC PLANT MANAGEMENT

Buckatabon Lakes EWM Removal Report 2022

PO Box 1134 Minocqua, WI 54548

Buckatabon Lakes EWM Manual Removal Summary 2022

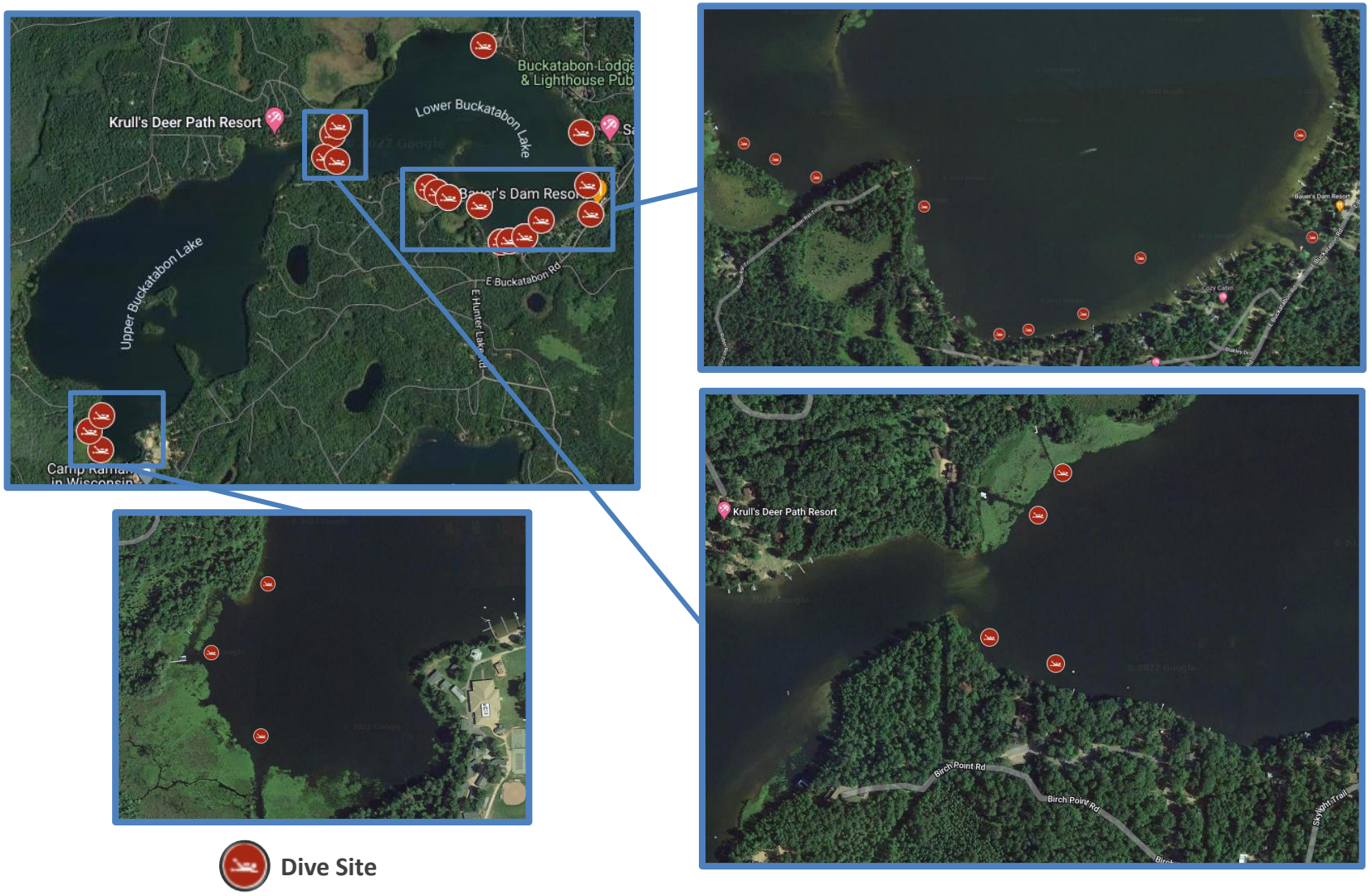
Dive Background In September 2022, APM completed four (4) days of traditional hand harvesting for Eurasian Watermilfoil (EWM) on Buckatabon Lake in Vilas County, WI. The hand harvesting team focused their effort at many sites around mostly Lower Buckatabon as prioritized by the Many Waters LLC. In total APM was able to remove **31.0 cubic feet of EWM** from Upper and Lower Buckatabon Lakes.

Date	Weather Conditions	Water Temp (F)	Underwater Dive Time (hrs)	AIS Removed (cubic ft)
9/7/2022	Sunny	69	6.0	8.5
9/8/2022	Cloudy	68	6.2	10.5
9/9/2022	Cloudy	68	6.2	10.5
9/15/2022	Cloudy	65	3.2	1.5
Grand Total			**21.5**	**31.0**

Dive Location	Avg. Water Depth	# of Dives	Underwater Dive Time	AIS Removed (cubic feet)
LB - Buckaton Creek Dam	2.0	1	0.9	1.0
LB - Channel	4.6	4	2.6	2.5
LB - E Shoreline	5.0	1	0.8	0.0
LB - N Shoreline	4.0	1	0.9	0.5
LB - S Shoreline	6.0	6	7.2	13.0
LB - Sandy Shores	5.0	1	0.2	0.5
LB - SE Bay	7.2	9	6.2	8.5
UB - SW Bay	6.8	3	2.8	5.0
Grand Total	**6.0**	**26**	**21.5**	**31.0**

Dive Highlights and Recommendations: The hand harvesting team made their way clockwise around Lower Buckatabon, diving at prioritized locations along certain sections of shoreline. Overall, Buckatabon Lakes should continue to 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 and Lower Buckatabon Lake.

Map of Buckatabon 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
9/7/2022	UB - SW Bay	46.00752	-89.35233	0.58	0.0	Single or Few	6.0	Pondweeds	0.0	Organic
9/7/2022	UB - SW Bay	46.00859	-89.35324	0.92	1.0	Single or Few	6.0	Pondweeds	0.0	Organic
9/7/2022	UB - SW Bay	46.00947	-89.35220	1.25	4.0	Small Plant Colony	8.5	Pondweeds	1.0	Organic/Sand
9/7/2022	LB - Channel	46.02570	-89.33297	1.08	1.5	Scattered	4.0	Pondweeds	0.5	Organic
9/7/2022	LB - Buckaton Creek Dam	46.02109	-89.31156	0.92	1.0	Highly Scattered	2.0	Pondweeds	0.5	Organic/Sand
9/7/2022	LB - Channel	46.02441	-89.33371	0.58	0.5	Scattered	5.0	Pondweeds	0.0	Organic/Sand
9/7/2022	LB - Channel	46.02414	-89.33270	0.67	0.5	Scattered	5.5	Pondweeds	0.0	Organic/Sand
9/8/2022	LB - S Shoreline	46.02264	-89.32512	1.25	3.0	Scattered	6.0	Grasses	0.5	Organic
9/8/2022	LB - S Shoreline	46.02238	-89.32437	1.25	2.0	Scattered	6.0	Grasses	0.0	Organic
9/8/2022	LB - S Shoreline	46.02208	-89.32340	1.08	1.5	Scattered	6.0	Grasses	0.0	Organic/Sand
9/8/2022	LB - SE Bay	46.02160	-89.32082	0.58	0.5	Highly Scattered	7.0	Grasses	0.0	Organic/Sand
9/8/2022	LB - SE Bay	46.01949	-89.31903	0.42	0.0	Single or Few	7.0	Grasses	0.5	Organic/Sand
9/8/2022	LB - SE Bay	46.01956	-89.31833	0.58	0.5	Highly Scattered	7.5	Grasses	0.0	Organic/Sand
9/8/2022	LB - SE Bay	46.01982	-89.31702	1.00	3.0	Small Plant Colony	7.5	Grasses	0.0	Organic/Sand
9/9/2022	LB - S Shoreline	46.02264	-89.32512	1.25	3.0	Scattered	6.0	Grasses	0.5	Organic
9/9/2022	LB - S Shoreline	46.02238	-89.32437	1.25	2.0	Scattered	6.0	Grasses	0.0	Organic
9/9/2022	LB - S Shoreline	46.02208	-89.32340	1.08	1.5	Scattered	6.0	Grasses	0.0	Organic/Sand
9/9/2022	LB - SE Bay	46.02160	-89.32082	0.58	0.5	Highly Scattered	7.0	Grasses	0.0	Organic/Sand
9/9/2022	LB - SE Bay	46.01949	-89.31903	0.42	0.0	Single or Few	7.0	Grasses	0.5	Organic/Sand
9/9/2022	LB - SE Bay	46.01956	-89.31833	0.58	0.5	Highly Scattered	7.5	Grasses	0.0	Organic/Sand
9/9/2022	LB - SE Bay	46.01982	-89.31702	1.00	3.0	Small Plant Colony	7.5	Grasses	0.0	Organic/Sand
9/15/2022	LB - SE Bay	46.02075	-89.31566	1.00	0.5	Highly Scattered	7.0	Northern Milfoil	0.0	Sand
9/15/2022	LB - E Shoreline	46.02278	-89.31185	0.83	0.0	Highly Scattered	5.0	Grasses	0.0	Organic/Sand
9/15/2022	LB - Sandy Shores	46.02582	-89.31231	0.17	0.5	Single or Few	5.0	Pondweeds	0.0	Organic/Sand
9/15/2022	LB - N Shoreline	46.03083	-89.32048	0.92	0.5	Scattered	4.0	Pondweeds	0.0	Organic/Sand
9/15/2022	LB - Channel	46.02615	-89.33259	0.25	0.0	Single or Few	4.0	Pondweeds	0.0	Organic
Total	**26**			**21.49**	**31.0**					