BIG MARINE LAKE, WASHINGTON COUNTY: 2023 AQUATIC VEGETATION REPORT

Report by the Invasive Species Program – Division of Ecological and Water Resources
Minnesota Department of Natural Resources

Lake: Big Marine (DOW# 82005200)

Lake Surface Area: 1799 acres

Littoral Area: 1278 acres

County: Washington

Survey Type: Point-intercept

Date of Survey (most recent): August 28, 2023

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2023 Summary:

The most recent aquatic vegetation point-intercept survey of Big Marine Lake (DOW# 82005200) was completed on August 28, 2023. Submersed plants were identified out to a maximum depth of 3.8 meters (12.5 feet). Within the littoral zone (zone in lake from the 0–15-foot depth range [0-4.5 meters]), 93% of sampled points contained native submersed taxa. The average number of native submersed taxa per sample point was 3.6. Twenty-five submersed plant species were documented during the 2023 survey including one invasive submersed plant species, Eurasian watermilfoil. Historically, curly-leaf pondweed has also been observed in earlier timed surveys. Offshore herbicide treatments targeting Eurasian watermilfoil have been organized since 2009 by the Big Marine Lake Association. Native abundance and species richness have remained high during this timeframe.

Summary Table. Summary of aquatic submersed plants in Big Marine Lake, Washington County, Minnesota (DOW# 82005200) as indicated by results of point-intercept surveys. Values were calculated from the littoral depth range (0 – 15 feet).

PI Survey Date	% Frequency of EWM*	Max Depth of Growth in feet [95%] †	% Points w/ Native Submersed Taxa	Mean Native Submersed Taxa/ Point	# Submersed Taxa	AVG Secchi Depth (m)
AUG 2010	12	12	100	3.8	19	-
AUG 2015	15	16	99	3.9	26	3.8
AUG 2016	17	16	99	4.0	35	4.1
AUG 2017	28	14	97	3.8	29	3.7
AUG 2020	19	12	95	4.0	29	4.1
AUG 2023	7	13	93	3.6	25	4.4

*EWM is short of Eurasian watermilfoil
†95th percentile calculated based on all vegetated sampling points
Taxa refers to groups of submersed aquatic plant species or genera
AVG – average Secchi depth (water clarity measurement) from May - September

Lake Description:

Big Marine Lake is a 1799-acre lake located near Forest Lake, Minnesota. It has two invasive aquatic plant species: Eurasian watermilfoil (*Myriophyllum spicatum*, abbreviated as EWM) and curly-leaf pondweed (*Potamogeton crispus,* abbreviated as CLP). The maximum depth of water is 15.24 meters (50 feet). Approximately 71% of the lake is littoral. Big Marine Lake is mesotrophic and contains a moderate level of nutrients. For more information on Big Marine Lake water quality: http://cf.pca.state.mn.us/water/watershedweb/wdip/waterunit.cfm?wid=82-0052-00 and https://arcgis.dnr.state.mn.us/ewr/whaflakes/.

Table 1 – Secchi Averages. Average Secchi disk observations in meters for Big Marine Lake, Washington County, Minnesota (DOW# 82005200). Data gathered from the Washington Conservation District.

YEAR	MAY	JUNE	JULY	AUG	SEPT	Secchi Depth Average [May-Sept]
2014	4.4	4.5	3.4	4.1	2.6	3.8
2015	4.5	4.6	3.7	3.4	2.8	3.8
2016	5.6	4.6	3.8	3.1	3.5	4.1
2017	4.1	4.2	3.5	3.7	2.9	3.7
2018	4.0	5.8	4.0	4.0	3.7	4.3
2019	6.1	6.0	4.5	4.5	4.8	5.2
2020	5.2	3.5	4.2	3.8	3.7	4.1
2021	4.7	4.8	4.1	4.3	3.5	4.3
2022	3.7	3.5	3.2	4.0	3.5	3.6
2023	4.5	4.4	4.5	4.0	4.6	4.4

Management History:

In recent years, 2019 through 2023, a combined treatment using ProcellaCOR and Diquat was used to target EWM and was organized by the Big Marine Lake Association (BMLA). Eight to 16 acres were treated with triclopyr from 2016 to 2018, while previous management utilized 2,4-D. In 2016, BMLA evaluated the effectiveness of various herbicides and exposures on spot treatments of EWM through herbicide concentration monitoring and pre/post treatment invasive plant delineations using a third-party consultant. The BMLA have observed a reduction in areas treated for EWM (19 acres in 2015, 11.65 acres in 2020). See **Table 2 – Invasive Plant Management Summary** below for more information on historical invasive plant management activities.

Table 2 – Invasive Plant Management Summary. Characteristics and history of herbicide treatment for Big Marine Lake, Washington County, Minnesota (DOW# 82005200). Total acres: 1799, littoral acres: 1278, 15% littoral acres: 191.7.

Date	Treatment [W, P, N]	Target Species	Total Acres Treated	Herbicide	Licensed Commercial Applicator
JUL 2009	P	EWM	9.5	2,4-D	Lake Management
JUN 2010	P	EWM	19	2,4-D	Lake Management
JUN 2011	P	EWM	16	2,4-D	Lake Management
JUN 2012	P	EWM	27	2,4-D	Lake Management
JUN 2013	P	EWM	30	2,4-D	Lake Management
JUL 2014	P	EWM	40	2,4-D	PLM Lake & Land Management Corp
JUN 2015	P	EWM	35	2,4-D (liquid & granular)	PLM Lake & Land Management Corp
JUN 2016	P	EWM	16	Triclopyr	PLM Lake & Land Management Corp
JUN 2017	P	EWM	11.6	Triclopyr	PLM Lake & Land Management Corp
JUN 2018	P	EWM	8	Triclopyr	PLM Lake & Land Management Corp
JUN 2019	P	EWM	8.7	ProcellaCOR/ Diquat	PLM Lake & Land Management Corp
JUL 2020	P	EWM	0.6	ProcellaCOR/ Diquat	PLM Lake & Land Management Corp
JUN 2021	P	EWM	31.12	ProcellaCOR/ Diquat	PLM Lake & Land Management Corp
JUL 2022	P	EWM	4.43	ProcellaCOR/ Diquat	PLM Lake & Land Management Corp
JUN 2023	P	EWM	20.41	ProcellaCOR/ Diquat	PLM Lake & Land Management Corp

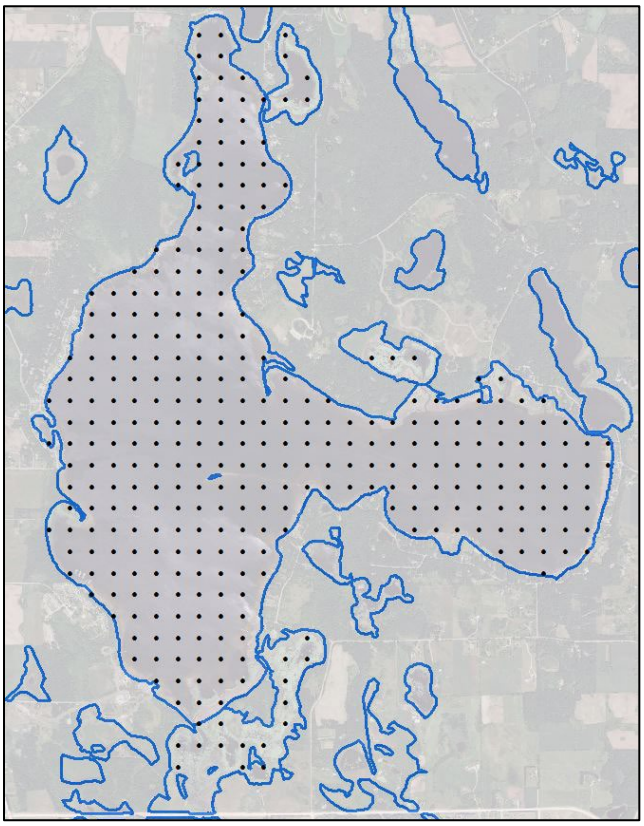
Treatment: W (whole lake), P (partial lake), N (no treatment)
EWM is an abbreviation for Eurasian watermilfoil

Survey Objectives:

Point-intercept surveys were used to assess the distribution of aquatic plants in Big Marine Lake. The primary purpose for this type of survey is to 1) develop baseline knowledge of the current plant community in a lake, and over time, 2) compare year to year plant variation (in plant presence and spatial location). Moreover, this survey will help the Minnesota Department of Natural Resources and our partners monitor native plant communities and evaluate possible responses to invasive aquatic plant management efforts. It is important to note that distributions of aquatic plants may vary from year to year due to effects such as differences in weather, as well as the effects from plant and water quality management.

Survey Methods:

We used a point intercept survey method developed by John Madsen in "Aquatic Plant Control Technical Note MI-02, 1999". Survey points were placed 150-200 meters apart using a Geographic Information System (GIS). This spacing allowed for placement of 174-341 points. Plant samples were collected by throwing and dragging a double-sided rake along the lake bottom at each point. Plant samples were assessed on the boat to determine species and rake fullness as a surrogate for abundance (scale of zero [no plants] to 4 [dense, matted on the surface] was used in 2012 – 2017 and a zero to 3 scale in 2018 and subsequent years). Frequencies of occurrence percentages (i.e. how often a plant species was found in the lake) were calculated based on the littoral zone (the portion of the lake that is less than 15 feet in depth).



Survey Observations:

The Minnesota Department of Natural Resources (MN DNR) Invasive Species Program conducted a preliminary point intercept survey of Big Marine Lake in 2010 (187 sampling point survey). Since 2015, a more extensive point intercept survey has been conducted (174-341 sampling point survey). In 2023, maximum depth of rooted vegetation was at 3.8 meters and 93% of points within the littoral zone contained native taxa (see **Table 3 – Point Intercept Metrics** for historical point-intercept survey calculations). There was an average of 3.6 native taxa per point and a total of 24 submersed native taxa observed as well as one invasive species, which is consistent with the past five historical surveys.

The most common native taxa included coontail, naiad, variable-leaf pondweed, fern-leaf pondweed, and flat-stem pondweed (see **Table 4 – Plant Frequency Occurrence** for historical plant frequency observations). Ten pondweed species were observed in the most recent survey in 2023 offering a high level of diversity for a metro lake. Throughout the past 13 years, frequencies of most native submersed plants have increased or remained largely the same. Leafy pondweed and white-stem pondweed were observed at higher frequencies during the 2023 survey than other years. Other macrophyte species observed in 2023 at lower frequencies included: water stargrass, quillwort, dwarf watermilfoil, and bladderwort. Narrowleaf water plantain (Alisma gramineum), a rare aquatic plant, was observed in the 2016 survey.

Eurasian watermilfoil was found at a 7% frequency of occurrence (FOO) – its lowest frequency observed by the MN DNR since the first survey in 2010 – while curly-leaf-pondweed has only been found in 2016. While Eurasian watermilfoil has persisted in Big Marine Lake for 15 years, its abundance has remained stable – below 30% FOO – as observed by the MN DNR.

Table 3 – Point Intercept Metrics. Summary of point intercept metrics for Big Marine Lake, Washington County, Minnesota (DOW# 82005200). Blue highlighted values were calculated from littoral depth range (0 – 15 ft).

Survey Metrics	AUG 2010	AUG 2015	AUG 2016	AUG 2017	AUG 2020	AUG 2023
Treated (Y/N)	Y	Y	Y	Y	Y	Y
Surveyor	MN DNR	MN DNR	MN DNR	MN DNR	MN DNR	MN DNR
Total # Points Sampled	122	341	313	314	174	210
Max Depth of Growth (95%)	12	16	16	14	12	13
# Point in Max Depth Range	115	228	219	217	118	196
# Points in Littoral (0-15 feet)	121	221	213	223	128	210
% Points w/ Submersed Native Taxa	100	99	99	97	95	93
Mean Submersed Native Taxa/ Point	3.8	3.9	4.0	3.8	4.0	3.6
# Submersed Native Taxa	18	25	33	28	28	24
# Submersed Non-Native Taxa	1	1	2	1	1	1

Photos 1 & 2. Left (1): Rake of native aquatic plants from point intercept survey in August 2023. Right (2): Collection of native mussels observed during the point intercept survey in August 2023. Big Marine Lake, Washington County, Minnesota (DOW# 82005200).

Table 4 – Plant Frequency Occurrence. Historic percent frequency of occurrence for submersed vegetation within the littoral zone (0 – 15 feet) in Big Marine Lake, Washington County, Minnesota (DOW# 82005200).

Taxonomic Name, Submersed Plants	Common Name	AUG 2010	AUG 2015	AUG 2016	AUG 2017	AUG 2020	AUG 2023
*Myriophyllum spicatum**	Eurasian watermilfoil*	12	15	17	28	19	7
Ceratophyllum demersum	Coontail	53	59	51	47	41	41
Macroalgae	Muskgrass & Stonewort	21	24	23	25		
Chara spp.	Muskgrass					20	17
Nitella spp.	Stonewort					2	2
Eleocharis acicularis	Needle spikerush	-	1	1	3	7	6
Elodea canadensis	Canadian waterweed	43	32	31	34	27	20
Megalodonta beckii	Water marigold	6	7	6	10	9	5
Myriophyllum sibiricum	Northern watermilfoil	34	28	28	19	10	22
Najas spp.	Naiad	45	48	26	35	43	46
Potamogeton amplifolius	Large-leaf pondweed	7	3	3	8	10	14
Potamogeton foliosus	Leafy pondweed	-	12	-	-	20	7
Potamogeton gramineus	Variable-leaf pondweed	16	22	25	17	35	31
Potamogeton illinoensis	Illinois pondweed	17	15	12	11	9	9
Potamogeton praelongus	White-stem pondweed	14	34	32	27	27	2
Potamogeton pusillus	Small pondweed	-	1	-	14	5	2
Potamogeton richardsonii	Clasping-leaf pondweed	6	-	13	8	5	13
Potamogeton robbinsii	Fern pondweed	30	26	28	29	31	39
Potamogeton strictifolius	Narrowleaf pondweed	-	-	11	2	-	-
Potamogeton zosteriformis	Flat-stem pondweed	40	51	52	42	52	41
Ranunculus aquatilis	White-water crowfoot	3	3	6	9	3	1
Stuckenia pectinata	Sago pondweed	11	2	2	-	1	13
Vallisneria americana	Water celery	17	12	15	15	23	20

Floating, free-floating & emergent plants observed: *Alisma gramineum* (Narrowleaf water-plantain)#, *Brasenia schreberi* (Watershield), *Juncus pelocarpus* (Brown-fruited rush), *Lemna trisulca* (Forked duckweed), *Lythrum salicaria* (Purple loosestrife), *Nymphaea odorata* (White waterlily), *Nuphar variegata* (Bullhead pondlily), *Persicaria amphibia* (Water smartweed), *Pontederia cordata* (Pickerelweed), *Potamogeton natans* (Floating pondweed), *Sagittaria spp*. (Arrowhead), *Schoenoplectus americanus* (Three-square bulrush), *Sparganium spp.* (Bur-reed), *Schoenoplectus acutus* (Hardstem bulrush), and *Veronica spicata* (Speedwell).
Less common (< 5% frequency) submersed vegetation observed: *Ceratophyllum echinatum* (Spiny hornwort) in 2017 & 2020, *Heteranthera dubia* (Water stargrass) in 2010, 2015 -2017, 2020, & 2023, *Isoetes spp.* (Quillwort) in 2023, *Myriophyllum tenellum* (Dwarf/leafless watermilfoil) in 2023, *Myriophyllum verticillatum* (Whorl-leaf watermilfoil) in 2015 & 2020, *Potamogeton crispus* (Curly-leaf pondweed)*, *Potamogeton epihydrus* (Ribbon-leaf pondweed) in 2016, *Potamogeton friesii* (Fries' pondweed) in 2016 & 2017, *Potamogeton nodosus* (Long-leaf pondweed), *and Utricularia spp.* (Bladderwort) in 2015-2017, 2020, & 2023.
*Denotes invasive aquatic plant
#Denotes rare species

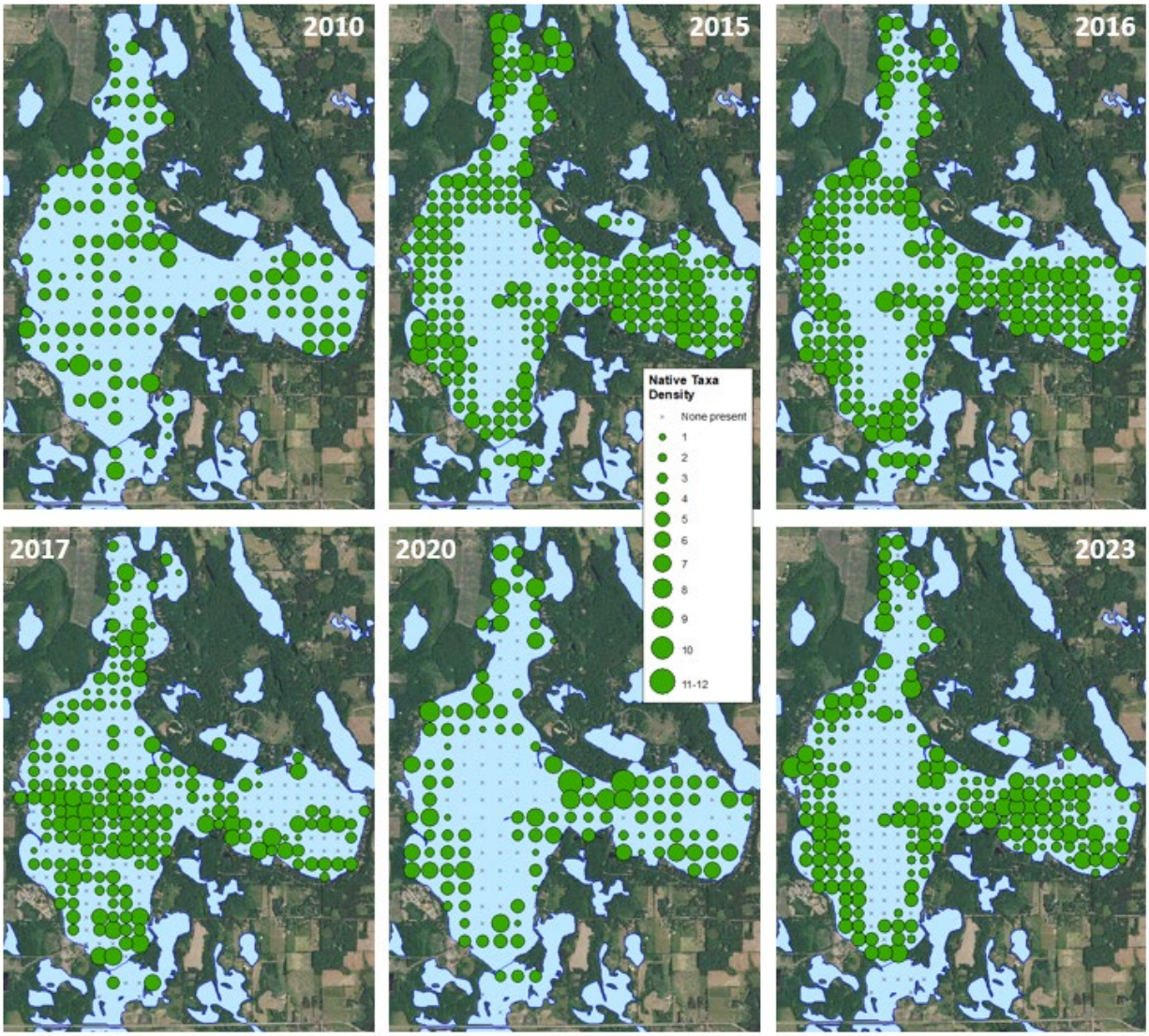


Figure 1 – Native Species Taxa Density. Spatial distribution and species richness (# of native species per sample point) of all submersed plant species from Minnesota Department of Natural Resources point intercept surveys. Big Marine Lake, Washington County, Minnesota (DOW# 82005200).

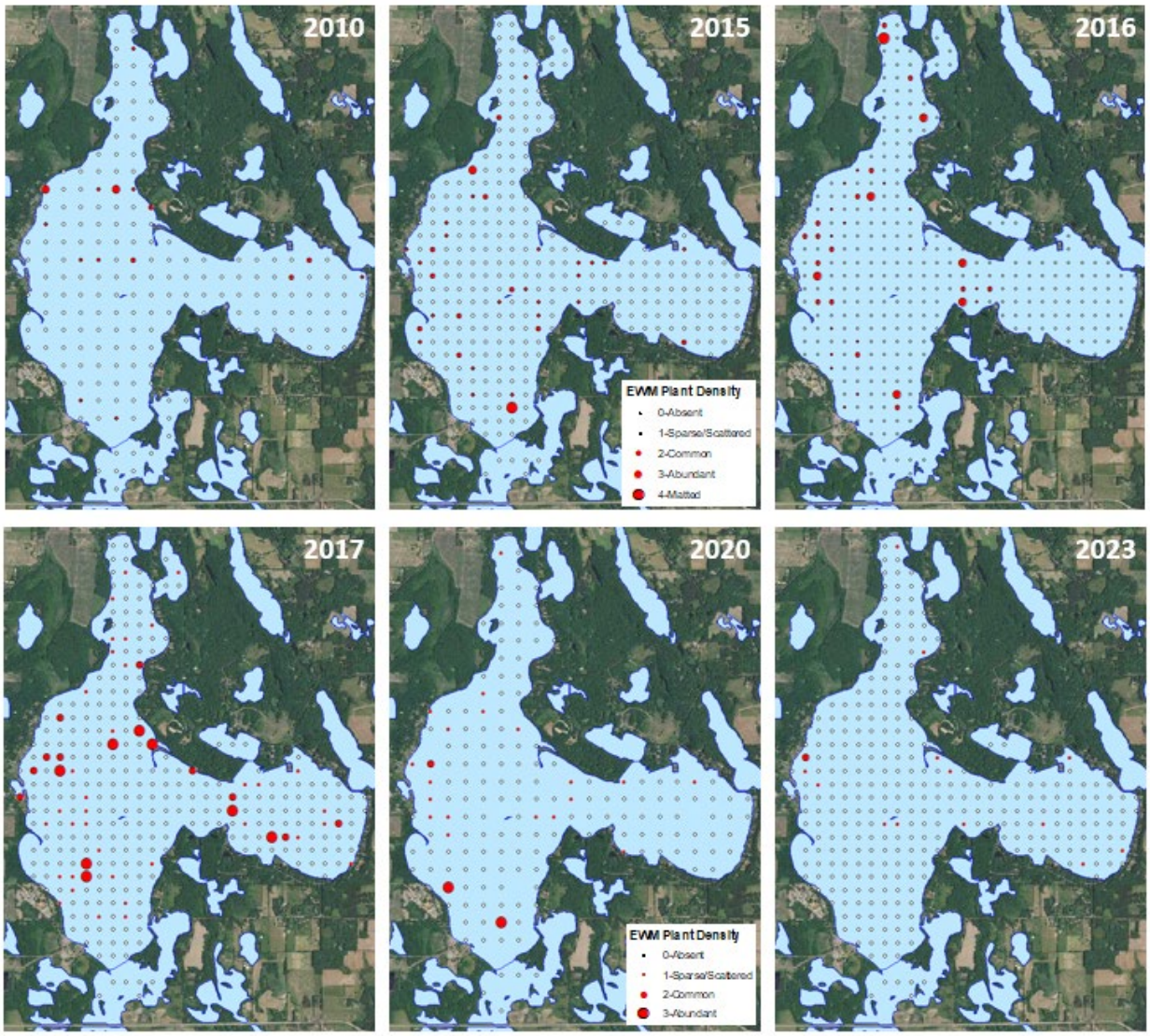


Figure 2 – Eurasian Watermilfoil Density. Spatial distribution and rake density rating per sample point of Eurasian watermilfoil from Minnesota Department of Natural Resources point intercept surveys. Densities were based on a 0 – 4 scale in 2010 to 2016 and a 0 – 3 scale in 2017 to 2023. Big Marine Lake, Washington County, Minnesota (DOW# 82005200).