



Exhibit S

**2023 EWM Treatment and
Monitoring Results Memo**



Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: 2023 Eurasian Watermilfoil (EWM) Treatment Results
Date: December 18, 2023
Project: 49030011.24
c: James Bartlett (Lake Restoration, Inc.), Andrew McFerrin (Aquatic Plant Management), Tyler Mesalk (WDNR), and Alex Smith (WDNR)

The purpose of this memorandum is to present the results of the Beaver Dam Lake 2023 EWM management program. Memorandum contents include:

- Discussion of herbicide treatment of EWM during 2023.
- Overview of EWM in Beaver Dam Lake.
- Discussion of EWM in individual management areas.

In this memorandum:

- "EWM frequency of occurrence in the littoral zone" is the percent of sample points up to the 25-foot depth that contained EWM.
- "EWM extent" is the acres of EWM.
- "Percent of littoral zone with EWM" is the acres of EWM divided by the total acres of the littoral zone, which is the area up to the 25-foot depth, and then multiplied by 100 to convert to percent.

Two whole lake point-intercept plant surveys were completed in 2023 to assess the results of EWM management efforts. A survey of all plants was completed July 14, 15, 17, and 18. A survey of invasive species (EWM and curly-leaf pondweed) was completed October 2, 7, and 8. Sample locations are shown on maps found in Appendix E of the *Beaver Dam Lake Aquatic Plant Management Plan*.¹ The 2023 EWM data, together with historical data, are summarized in Table 1, Table 2, and Table 3.

The 2023 EWM management of Beaver Dam Lake included spot treatment of EWM with ProcettaCOR on June 9 in West Lake, Williams Bay, Library Lake, East Lake, and Norwegian Bay, and whole bay treatments with 2,4 D in Rabbit Island Bay on May 24, in City Bay on May 18, and in Cemetery Bay on May 19.

¹ Barr Engineering Co. 2021. *Beaver Dam Lake Aquatic Plant Management Plan*, Prepared for Beaver Dam Lake Management District. <http://www.beaverdamlake.org/apmp>

Table 1 2006-2023 EWM Frequency of Occurrence in the Littoral Zone of Beaver Dam Lake

Location	Percent of sample points up to 25-foot depth with Eurasian watermilfoil, including visuals																							
	Fall 2006	Fall 2007	Fall 2008	July 2009	Fall 2009	July 2010	Fall 2010	July 2011	Fall 2011	June 2012	July 2012	Fall 2012	May 2013	June 2013	July 2013	Fall 2013	July 2014	Fall 2014	July 2015	Fall 2015	July 2016	Fall 2016	July 2017	Fall 2017
Norwegian Bay	28.57	16.39	52.46	39.71	80.00	33.82	28.36	11.76	51.52	13.24	54.41	72.13	39.71	0.00	7.35	58.82	4.41	44.12	1.47	1.47	8.82	22.06	10.29	17.65
East Lake	5.13	0.00	13.38	14.00	27.86	22.70	27.54	28.78	33.79	N/A ¹	17.57	27.86	N/A ¹	N/A ¹	2.88	19.73	0.73	2.10	0.00	0.00	0.00	1.36	1.41	1.36
City Bay	59.12	7.74	72.84	32.78	62.13	21.67	55.93	54.40	70.39	8.89	48.07	58.90	46.93	0.00	21.67	46.11	1.67	9.44	0.00	7.78	0.00	1.67	2.22	5.56
Cemetery Bay	41.10	0.00	40.00	0.00	6.82	0.00	10.23	3.37	47.73	N/A ¹	0.00	18.39	N/A ¹	3.37	0.00	2.25	0.00	1.14	4.49	44.94	5.62	26.97	0.00	0.00
West Lake	18.77	11.07	21.19	14.84	13.33	10.59	13.61	7.35	10.18	N/A ¹	8.64	14.15	N/A ¹	N/A ²	6.69	17.31	5.50	11.52	0.00	1.21	4.28	8.36	5.83	11.64
Williams Bay	13.33	28.05	23.81	16.98	11.01	3.85	12.15	9.80	10.19	N/A ¹	3.85	15.96	N/A ¹	N/A ²	0.96	6.36	0.00	9.43	0.00	0.00	1.87	8.33	1.89	0.93
Rabbit Island Bay	39.39	28.72	30.10	18.49	20.54	12.82	26.79	10.17	17.86	0.00	1.67	11.43	N/A ²	N/A ²	0.85	3.33	1.68	5.00	0.00	1.67	4.20	10.00	0.00	3.33
Library Lake	73.33	61.97	47.30	5.04	2.60	0.72	7.41	0.00	0.00	N/A ¹	2.88	1.79	N/A ¹	N/A ¹	0.00	0.72	0.00	1.44	5.76	12.23	0.00	0.00	1.44	3.60
East Lake Basins	12.74	24.17	26.45	13.84	12.90	7.93	14.26	7.02	10.71	N/A³	5.53	12.54	N/A³	N/A³	3.48	10.95	2.88	8.06	1.17	3.31	2.30	9.09	2.71	4.96
West Lake Basins	16.79	5.52	44.89	21.97	43.72	19.67	34.89	31.38	54.31	N/A³	30.86	43.24	N/A³	N/A³	10.08	33.12	1.46	10.65	1.05	11.46	3.03	6.98	3.33	6.98
Beaver Dam Lake— All Basins	14.42	15.77	34.46	17.17	25.96	12.77	22.64	17.43	29.51	N/A³	16.03	26.16	N/A³	N/A³	6.17	20.29	2.30	9.11	1.12	6.64	2.73	7.84	3.08	6.16

¹N/A Frequency of occurrence not available because the area was not surveyed

² N/A Frequency of occurrence not available because limited areas were surveyed - not the whole lake/bay area. Rabbit Island Bay channels surveyed and a small area near the Eagle Point boat launch.

³N/A Frequency of occurrence not available because some areas were not surveyed and/or only limited areas were surveyed in West Lake (area near Eagle Point boat landing) and Rabbit Island Bay (only the channels)

⁴All EWM was rake removed during the 2019 fall plant survey.

⁵The majority of the EWM was in the west canal and all EWM in Rabbit Island Bay was rake removed during the 2019 fall plant survey.

⁶All EWM was rake removed during the 2020 fall plant survey.

Table 1 (Continued) 2006-2023 EWM Frequency of Occurrence in the Littoral Zone of Beaver Dam Lake

Location	Percent of sample points up to 25-foot depth with Eurasian watermilfoil, including visuals											
	July 2018	Fall 2018	July 2019	Fall 2019	July 2020	Fall 2020	July 2021	Fall 2021	July 2022	Fall 2022	July 2023	Fall 2023
Norwegian Bay	1.47	2.94	0.00	4.41	0.00	0.00	0.00	0.00	1.47	4.41	0.00	0.00
East Lake	0.00	0.00	0.00	0.00	0.00	0.71 ⁶	0.00	0.00	0.00	5.52	0.00	0.00
City Bay	0.00	1.67	0.00	2.22	0.00	3.89	0.56	0.56	2.22	14.44	0.00	0.00
Cemetery Bay	0.00	0.00	5.62	14.61	3.37	2.25	1.12	7.87	14.61	33.71	1.12	6.74
West Lake	2.76	6.83	0.31	0.31 ⁴	1.85	13.54	0.00	1.21	2.42	3.33	0.30	0.00
Williams Bay	0.94	1.90	0.94	0.94 ⁴	12.15	27.10	0.00	1.83	0.00	1.83	0.92	0.00
Rabbit Island Bay	0.84	4.17	0.00	3.36 ⁵	5.88	16.81	0.00	0.00	10.08	23.53	0.00	5.04
Library Lake	5.76	10.07	0.00	0.72 ⁴	2.16	5.04	0.00	0.00	0.72	5.04	0.00	0.00
East Lake Basins	0.21	1.05	1.04	4.18	0.63	2.09	0.41	1.66	3.73	13.90	0.21	1.24
West Lake Basins	2.75	6.27	0.29	1.01	4.20	14.49	0.00	0.86	3.01	6.89	0.29	0.86
Beaver Dam Lake— All Basins	1.71	4.12	0.60	2.31	2.74	9.42	0.17	1.19	3.31	9.75	0.25	1.02

⁴All EWM was rake removed during the 2019 fall plant survey.

⁵The majority of the EWM was in the west canal and all EWM in Rabbit Island Bay were rake removed during the 2019 fall plant survey.

⁶All EWM was rake removed during the 2020 fall plant survey.

Table 2 2006-2023 EWM Extent in Beaver Dam Lake

Location	Acreage of EWM (based on plant surveys)																							
	Fall 2006	Fall 2007	Fall 2008	July 2009	Fall 2009	July 2010	Fall 2010	July 2011	Fall 2011	June 2012	July 2012	Fall 2012	May 2013	June 2013	July 2013	Fall 2013	July 2014	Fall 2014	July 2015	Fall 2015	July 2016	Fall 2016	July 2017	Fall 2017
Norwegian Bay	3.64	4.75	18.12	8.65	28.23	12.09	9.61	1.99	19.67	3.36	21.21	26.91	15.16	0.00	2.19	23.37	1.10	17.89	0.45	0.81	2.48	6.94	4.66	6.19
East Lake	0.00	0.00	9.34	8.14	19.37	14.13	17.48	17.18	23.93	N/A ¹	11.33	19.98	N/A ¹	N/A ¹	1.18	15.72	0.33	0.90	0.00	0.00	0.00	1.97	0.63	0.48
City Bay	60.25	3.94	68.06	27.89	61.62	20.11	54.01	47.97	73.66	7.65	48.76	55.75	50.85	0.00	20.70	49.01	0.79	7.26	0.00	6.87	0.00	1.50	2.37	5.13
Cemetery Bay	10.90	0.00	17.80	0.00	1.81	0.00	3.97	0.86	21.32	N/A ¹	0.00	7.17	N/A ¹	0.75	0.00	0.51	0.00	0.26	1.54	31.56	1.70	13.76	0.00	0.00
West Lake	25.27	11.36	33.19	24.59	19.67	15.80	25.15	8.65	14.78	N/A ¹	15.31	23.11	N/A ¹	3.15 ²	10.05	29.13	7.23	29.94	0.00	1.72	6.83	20.64	9.46	21.05
Williams Bay	3.63	10.23	12.64	9.48	4.80	1.15	6.68	4.57	4.65	N/A ¹	1.68	6.92	N/A ¹	0.26 ²	0.33	2.46	0.00	7.45	0.00	0.00	0.92	5.78	1.89	0.26
Rabbit Island Bay	5.80	12.36	13.21	10.57	8.51	6.26	11.47	4.22	8.01	0.00	0.51	5.64	0.00 ²	N/A ²	0.38	1.45	0.61	3.11	0.00	1.37	1.41	9.51	0.00	0.83
Library Lake	0.66	0.59	3.62	0.40	0.09	0.04	0.72	0.00	0.00	N/A ¹	0.20	0.04	N/A ¹	N/A ¹	0.00	0.06	0.00	0.14	0.70	1.90	0.02	0.00	0.20	0.43
East Lake Basins	74.79	8.69	113.32	44.68	111.03	46.33	85.07	67.99	138.58	N/A³	81.30	109.81	N/A³	N/A³	24.07	88.60	2.22	26.31	1.99	39.24	4.18	24.16	7.66	11.80
West Lake Basins	35.36	34.54	62.66	45.04	33.07	23.25	44.02	17.44	27.44	N/A³	17.70	35.70	N/A³	N/A³	10.76	33.10	7.84	40.64	0.70	4.99	9.18	35.93	11.55	22.57
Beaver Dam Lake— All Basins	110.15	43.23	175.98	89.72	144.10	69.58	129.09	85.43	166.02	N/A³	99.00	145.51	N/A³	N/A³	35.88	121.70	10.06	66.96	2.68	44.23	13.36	60.10	19.21	34.37

¹N/A EWM extent not available because the area was not surveyed

²EWM extent is based on survey of limited areas—not the whole lake/bay area. Rabbit Island Bay channels surveyed and a small area near the Eagle Point boat launch which included portions of West Lake and Williams Bay.

³All EWM was rake removed during the 2019 fall plant survey.

⁴The majority of the EWM in the west canal and all EWM in Rabbit Island Bay were rake removed during the 2019 fall plant survey.

⁵All EWM was rake removed during the 2020 fall plant survey.

Table 2 (Continued) 2006-2023 EWM Extent in Beaver Dam Lake

Location	Acreage of EWM (based on plant surveys)											
	July 2018	Fall 2018	July 2019	Fall 2019	July 2020	Fall 2020	July 2021	Fall 2021	July 2022	Fall 2022	July 2023	Fall 2023
Norwegian Bay	0.30	0.65	0.00	0.70	0.00	0.00	0.00	0.00	0.23	0.89	0.00	0.00
East Lake	0.00	0.00	0.00	0.00	0.00	0.24 ⁵	0.00	0.00	0.00	2.54	0.00	0.00
City Bay	0.00	1.56	0.00	0.97	0.00	3.75	0.14	0.27	1.03	11.95	0.00	0.00
Cemetery Bay	0.00	0.00	1.22	4.10	1.41	0.74	0.27	3.75	7.43	18.69	0.70	3.12
West Lake	5.46	12.35	1.55	0.36 ³	4.41	27.89	0.00	2.64	3.99	4.73	0.30	0.00
Williams Bay	0.72	0.54	0.27	0.25 ³	8.76	17.29	0.00	0.71	0.11	0.43	0.38	0.00
Rabbit Island Bay	0.27	1.32	0.00	0.62 ⁴	3.96	11.26	0.00	0.00	4.59	15.06	0.00	0.73
Library Lake	0.76	1.85	0.00	0.04 ³	0.24	0.51	0.00	0.00	0.04	0.61	0.00	0.00
East Lake Basins	0.30	2.21	1.22	5.77	1.41	4.73	0.41	4.02	8.69	34.07	0.70	3.12
West Lake Basins	7.21	16.06	1.82	1.27	17.37	56.95	0.00	3.35	8.73	20.83	0.68	0.73
Beaver Dam Lake— All Basins	7.52	18.27	3.04	7.05	18.78	61.68	0.41	7.37	17.42	54.90	1.38	3.85

³All EWM was rake removed during the 2019 fall plant survey.

⁴The majority of the EWM in the west canal and all EWM in Rabbit Island Bay were rake removed during the 2019 fall plant survey.

⁵All EWM was rake removed during the 2020 fall plant survey.

Table 3 2006-2023 Percent of Littoral Zone with EWM in Beaver Dam Lake

Location	Percent of Littoral Zone with EWM (based on plant surveys)																				
	Fall 2006	Fall 2007	Fall 2008	July 2009	Fall 2009	July 2010	Fall 2010	July 2011	Fall 2011	July 2012	Fall 2012	July 2013	Fall 2013	July 2014	Fall 2014	July 2015	Fall 2015	July 2016	Fall 2016	July 2017	Fall 2017
Norwegian Bay	9.52	12.42	47.38	22.62	73.82	31.62	25.13	0.05	51.44	55.47	70.38	5.72	61.11	2.88	46.79	1.18	2.12	6.49	18.15	12.18	16.19
East Lake	0.00	0.00	14.83	12.92	30.75	22.43	27.75	27.27	37.98	17.98	31.71	1.87	24.95	0.53	1.43	0.00	0.00	0.00	3.13	0.93	0.71
City Bay	59.45	3.89	67.15	27.52	60.80	31.92	53.29	47.33	72.68	48.11	55.01	20.42	48.36	0.78	7.17	0.00	6.78	0.00	1.48	2.34	5.06
Cemetery Bay	20.21	0.00	33.00	0.00	3.36	0.00	7.36	1.59	39.53	0.00	13.29	0.00	0.94	0.00	0.48	2.86	58.51	3.15	25.51	0.00	0.00
West Lake	17.60	7.91	23.12	17.13	13.70	11.01	17.52	6.03	10.30	10.67	16.10	7.00	20.29	5.04	20.86	0.00	1.20	4.76	14.86	6.43	14.30
Williams Bay	7.95	22.41	27.70	20.77	10.52	2.52	0.15	10.01	10.19	3.68	15.15	0.72	5.39	0.00	12.29	0.00	0.00	2.02	11.74	3.93	0.54
Rabbit Island Bay	9.56	20.38	21.78	17.43	14.03	10.32	18.91	6.96	13.21	0.84	9.30	0.63	2.39	1.01	5.13	0.00	2.26	2.33	15.72	0.00	1.36
Library Lake	4.81	4.30	26.40	2.92	0.66	0.29	5.25	0.00	0.00	1.46	0.27	0.00	0.45	0.00	0.99	5.11	13.86	0.15	0.00	1.44	3.14
East Lake Basins	29.15	3.39	44.17	17.42	43.28	18.06	33.16	26.51	54.02	31.69	42.81	9.38	34.54	0.87	10.26	1.99	15.30	1.63	9.42	2.93	4.52
West Lake Basins	13.42	13.11	23.78	17.09	12.55	8.82	16.70	6.62	10.41	6.72	13.55	4.08	12.56	2.98	15.42	0.70	1.89	3.48	13.69	4.27	8.35
Beaver Dam Lake— All Basins	21.18	8.31	33.84	17.25	27.71	13.38	24.82	16.43	31.92	19.04	27.98	6.90	23.40	1.93	12.87	2.68	8.50	2.57	11.58	3.62	6.47

Table 3 (Continued) 2006-2023 Percent of Littoral Zone with EWM in Beaver Dam Lake

Location	Percent of Littoral Zone with EWM (based on plant surveys)											
	July 2018	Fall 2018	July 2019	Fall 2019	July 2020	Fall 2020	July 2021	Fall 2021	July 2022	Fall 2022	July 2023	Fall 2023
Norwegian Bay	0.78	1.70	0.00	1.83	0.00	0.00	0.00	0.00	0.61	2.32	0.00	0.00
East Lake	0.00	0.00	0.00	0.00	0.00	0.36 ³	0.00	0.00	0.00	3.80	0.00	0.00
City Bay	0.00	1.54	0.00	0.96	0.00	3.70	0.14	0.26	1.01	11.79	0.00	0.00
Cemetery Bay	0.00	0.00	2.26	7.60	2.62	1.37	0.49	6.96	13.78	34.65	1.30	5.78
West Lake	3.70	8.37	1.05	0.24 ¹	2.99	18.90	0.00	1.79	2.70	3.20	0.20	0.00
Williams Bay	1.51	1.13	0.57	0.52 ¹	18.40	36.30	0.00	1.49	0.22	0.90	0.80	0.00
Rabbit Island Bay	0.44	2.16	0.00	1.01 ²	6.47	18.40	0.00	0.00	7.50	24.62	0.00	1.19
Library Lake	5.54	13.49	0.00	0.29 ¹	1.76	3.69	0.00	0.00	0.32	4.46	0.00	0.00
East Lake Basins	0.12	0.85	0.47	2.22	0.54	1.82	0.16	1.54	3.34	13.09	0.27	1.20
West Lake Basins	2.67	5.95	0.67	0.47	6.43	21.08	0.00	1.24	3.23	7.71	0.25	0.27
Beaver Dam Lake—All Basins	1.42	3.45	0.57	1.33	3.54	11.63	0.08	1.39	3.28	10.35	0.26	0.73

¹All EWM was rake removed during the 2019 fall plant survey.

²The majority of the EWM in the west canal and all EWM in Rabbit Island Bay were rake removed during the 2019 fall plant survey.

³All EWM was rake removed during the 2020 fall plant survey.

1.0 Herbicide Treatment of EWM

Goal 1 of the Beaver Dam Lake Management District’s (District) Beaver Dam Lake Aquatic Plant Management Plan is to “reduce Eurasian watermilfoil (EWM) and curly-leaf pondweed (CLP) levels to less than or equal to 7 percent of the littoral zone while minimizing harm to native aquatic plants.”¹ The goal was attained in 2017 (Table 3) when the EWM level was reduced to 6 percent of the littoral area. Treatments in 2018 through 2019 continued goal attainment. The 2020 treatment intended to continue goal attainment, but an unexpected increase in EWM during the 2020 growing season resulted in an October EWM level of 12 percent of the littoral area, which failed to meet the District’s EWM goal. The 2021 herbicide treatment reduced the EWM level to 0.08 percent of the littoral area in July and 1.39 percent in October, which met the District’s EWM goal. The 2022 treatment intended to continue goal attainment, but an unexpected increase during the 2022 growing season resulted in an October EWM level of 10 percent of the littoral area, which failed to meet the District’s EWM goal.

In 2023, the District treated 40.55 acres with the herbicide ProcellaCoR on June 9 — 17.86 acres in West Lake, 3.12 acres in Williams Bay, 1.89 acres in Library Lake, 4.33 acres in Norwegian Bay, 11.70 acres in East Lake, and 1.65 acres in City Bay (Table 4, Figure 1, and Figure 2) — and 125.37 acres with 2,4-D — 61.8 acres in Rabbit Island Bay on May 24, 33.28 acres in City Bay on May 18, and 30.29 acres in Cemetery Bay on May 19 (Table 4, Figure 1, and Figure 2).

Table 4 2023 Beaver Dam Lake EWM Herbicide Treatment Program

Location	EWM Extent (ac)	EWM Management Method	EWM Management Area	Name of Herbicide	Herbicide Dose Applied to Treatment Area	Estimated Whole Bay/Basin Concentration	Date Herbicide Applied
West Lake	4.73	Herbicide	17.86	ProcellaCOR	4 PDU	--	6/9/2023
Williams Bay	0.43	Herbicide	3.12	ProcellaCOR	4 PDU	--	6/9/2023
Rabbit Island Bay	15.06	Herbicide	61.80	2,4-D	1.37 ppm	0.4 ppm	5/24/2023
Library Lake	0.61	Herbicide	1.89	ProcellaCOR	6 PDU	--	6/9/2023
Norwegian Bay	0.89	Herbicide	4.33	ProcellaCOR	4 PDU	--	6/9/2023
East Lake	2.54	Herbicide	11.70	ProcellaCOR	4 PDU	--	6/9/2023
City Bay	11.95	Herbicide	1.65	ProcellaCOR	4 PDU	--	6/9/2023
		Herbicide	33.28	2,4-D	2.50 ppm	0.8 ppm	5/18/2023
Cemetery Bay	18.69	Herbicide	30.29	2,4-D	0.75 ppm	0.4 ppm	5/19/2023

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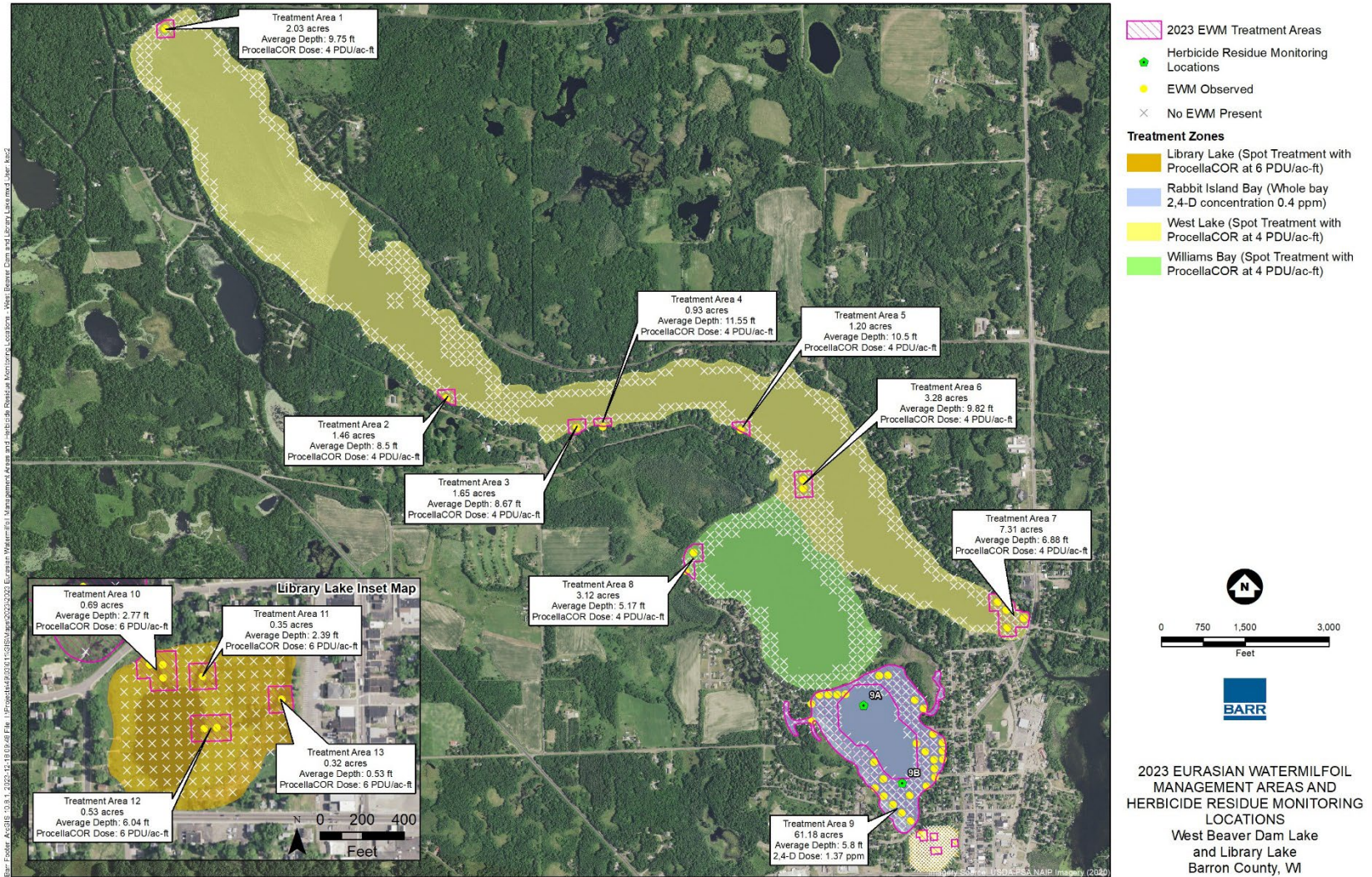


Figure 1 2023 Beaver Dam Lake Eurasian Watermilfoil Herbicide Treatment Areas and Herbicide Residue Monitoring Locations: West Basins

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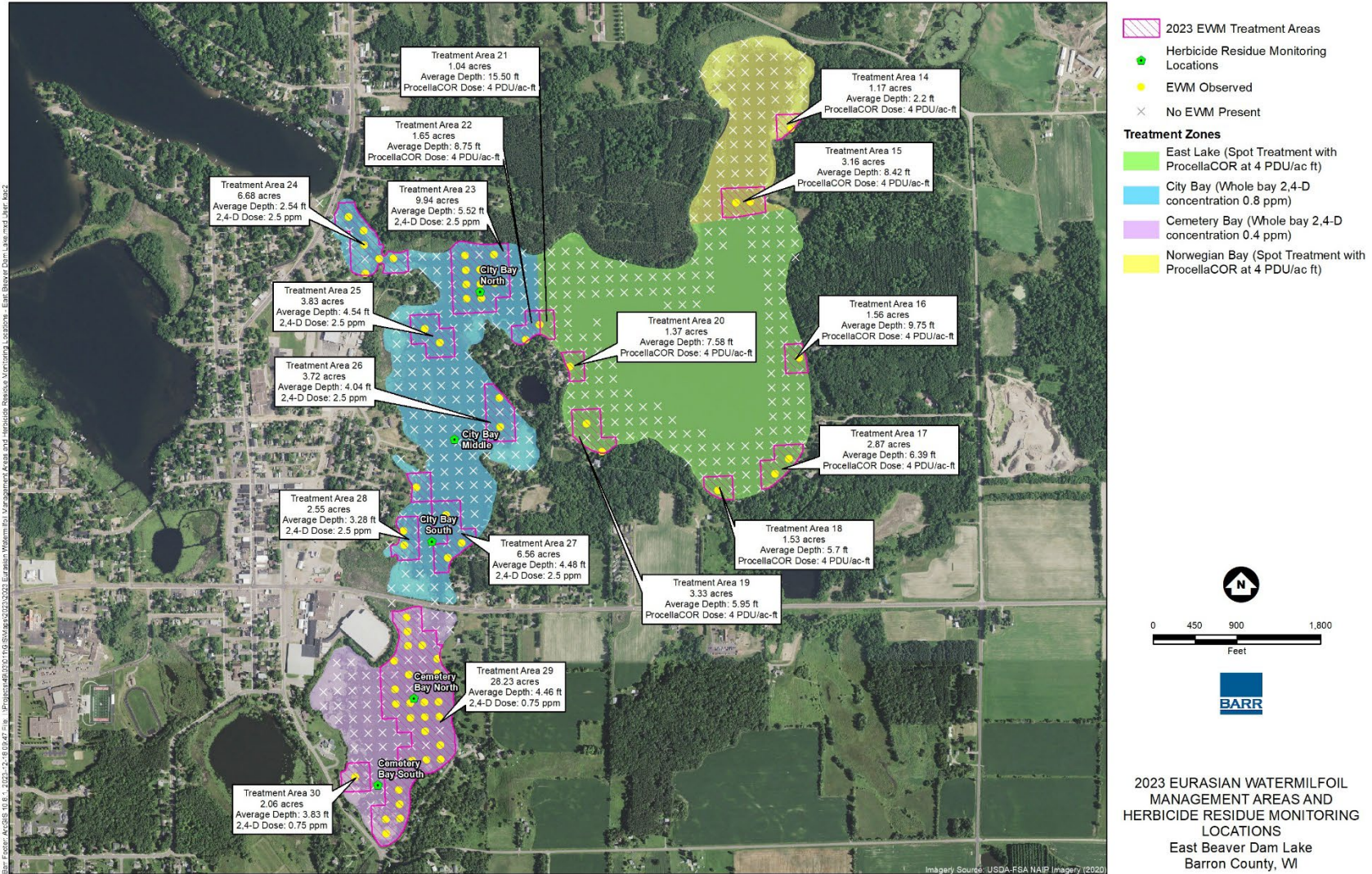


Figure 2 2023 Beaver Dam Lake Eurasian Watermilfoil Herbicide Treatment Areas and Herbicide Residue Monitoring Locations: East Basins

2.0 Lake-Wide EWM

Post-treatment EWM extent is shown in Figure 3, Figure 4, Figure 5, and Figure 6. The data indicate EWM was only observed within one of the 2023 treatment areas in July — a single sample point in Cemetery Bay — documenting treatment success. EWM was observed at two untreated areas in July — a single sample point in West Lake and a single sample point in Williams Bay — but was not observed at these locations in October. Despite this success, EWM frequency and extent in Beaver Dam Lake increased between July and October because of expansion of EWM in Cemetery Bay and the appearance of EWM in Rabbit Island Bay. EWM expanded in Cemetery Bay from one sample point in July to six sample points in October and was observed at a single sample point in Rabbit Island Bay during October.

Between October 2022 and July 2023,

- EWM frequency decreased from 10 percent in October 2022 to 0.3 percent in July 2023 (Table 1 and Figure 7);
- EWM extent decreased from 55 acres in October 2022 to 1 acre in July 2023 (Table 2 and Figure 8); and
- percent of littoral zone with EWM decreased from 10 percent in October 2022 to 0.3 percent in July 2023 (Table 3 and Figure 9).

Expansion of EWM between July (Figure 3 and Figure 4) and October of 2023 (Figure 5 and Figure 6):

- Increased EWM frequency from 0.3 percent in July to 1 percent in October (Table 1 and Figure 7),
- Increased EWM extent from 1 acre in July to 4 acres in October (Table 2 and Figure 8); and
- Increased the percent of littoral zone with EWM from 0.3 percent in July to 1 percent in October (Table 3 and Figure 9).

The 1 percent of the littoral zone with EWM in October met the District's goal of reducing Eurasian watermilfoil (EWM) to less than or equal to 7 percent of the littoral zone.

The fall 2023 EWM frequency, extent, and percent of littoral area values were the lowest fall values observed during the 2006 through 2023 measurement period.

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: 2023 EWM Treatment Results
Date: December 18, 2023
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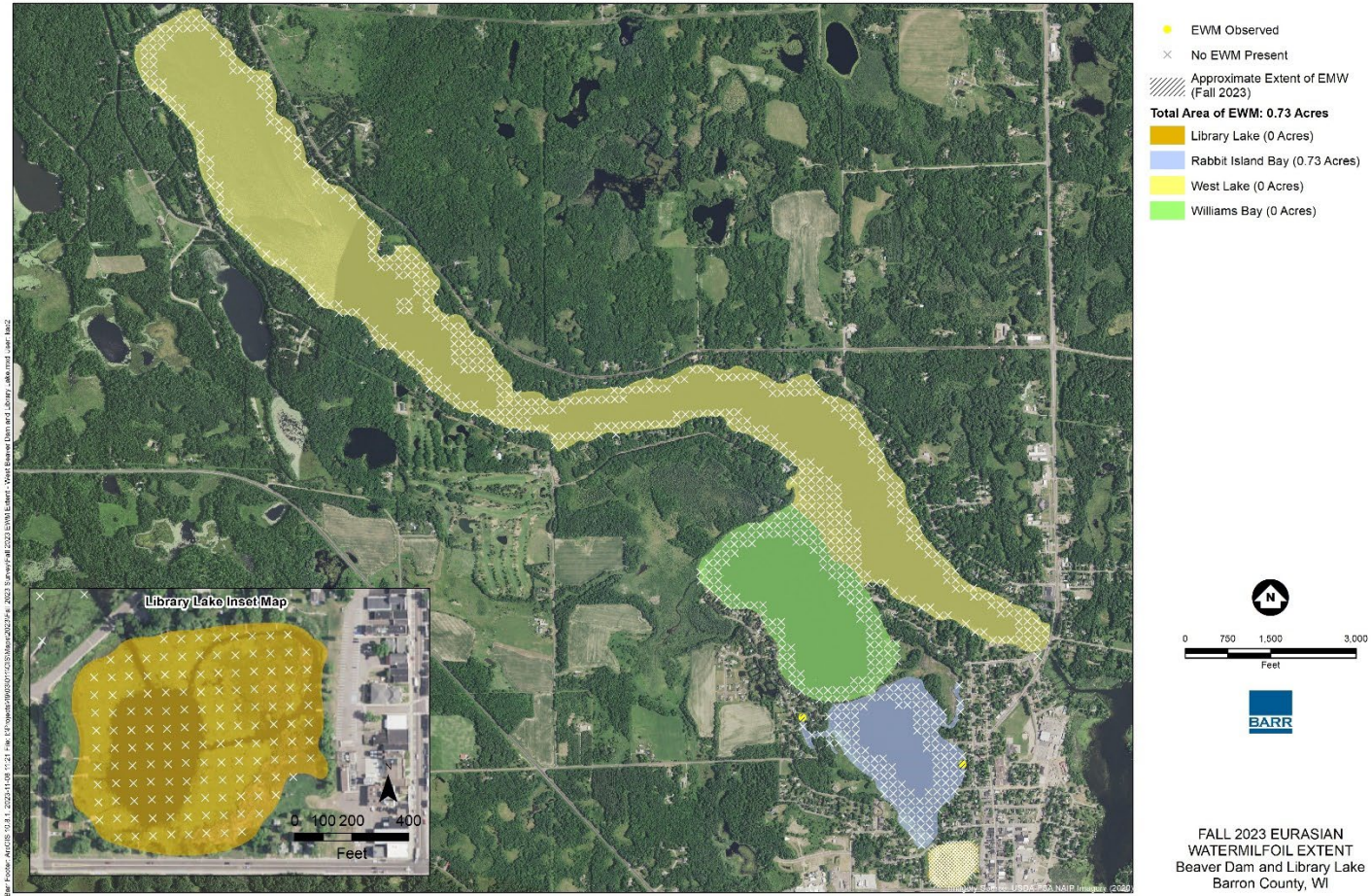


Figure 5 October 2023 Eurasian Watermilfoil Extent in Beaver Dam Lake (West Basins)

2006-2023 Beaver Dam Lake Frequency of Occurrence

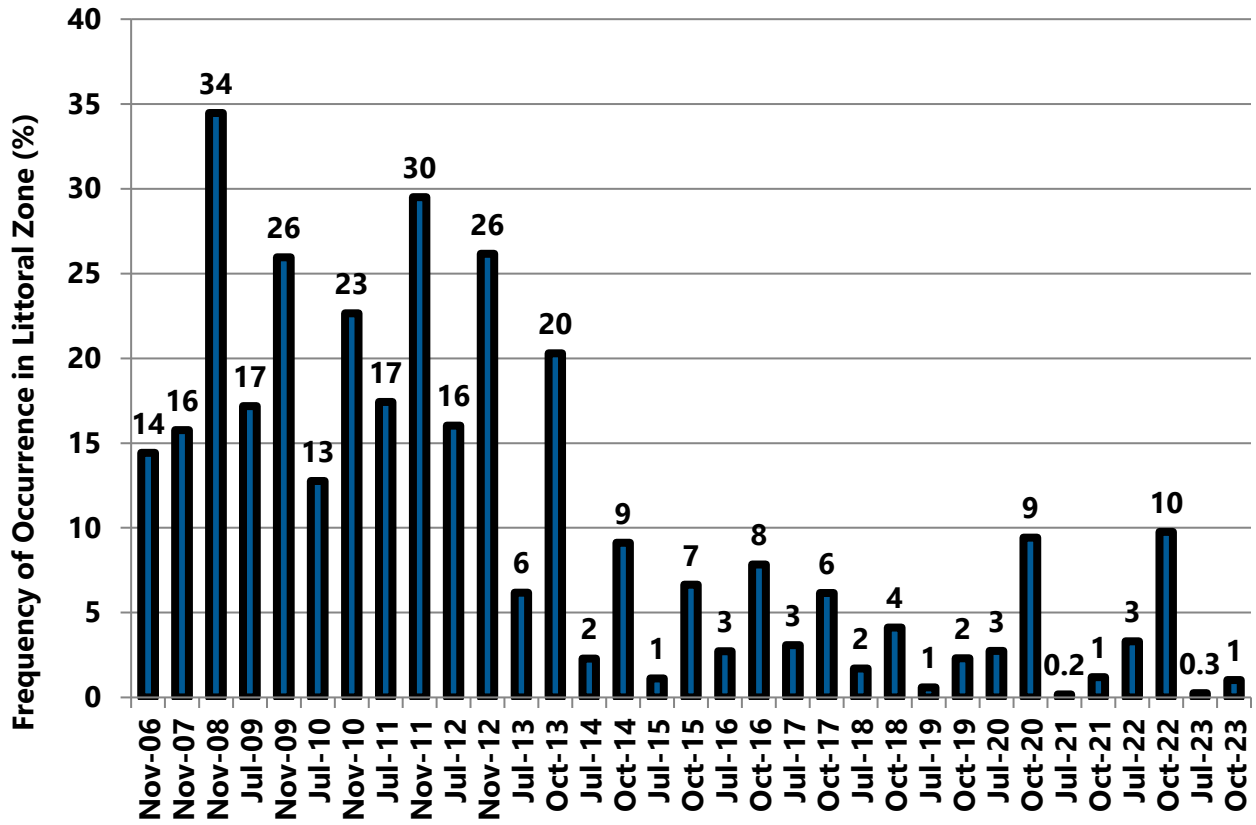


Figure 7 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in the Littoral Zone

2006-2023 Beaver Dam Lake EWM Extent

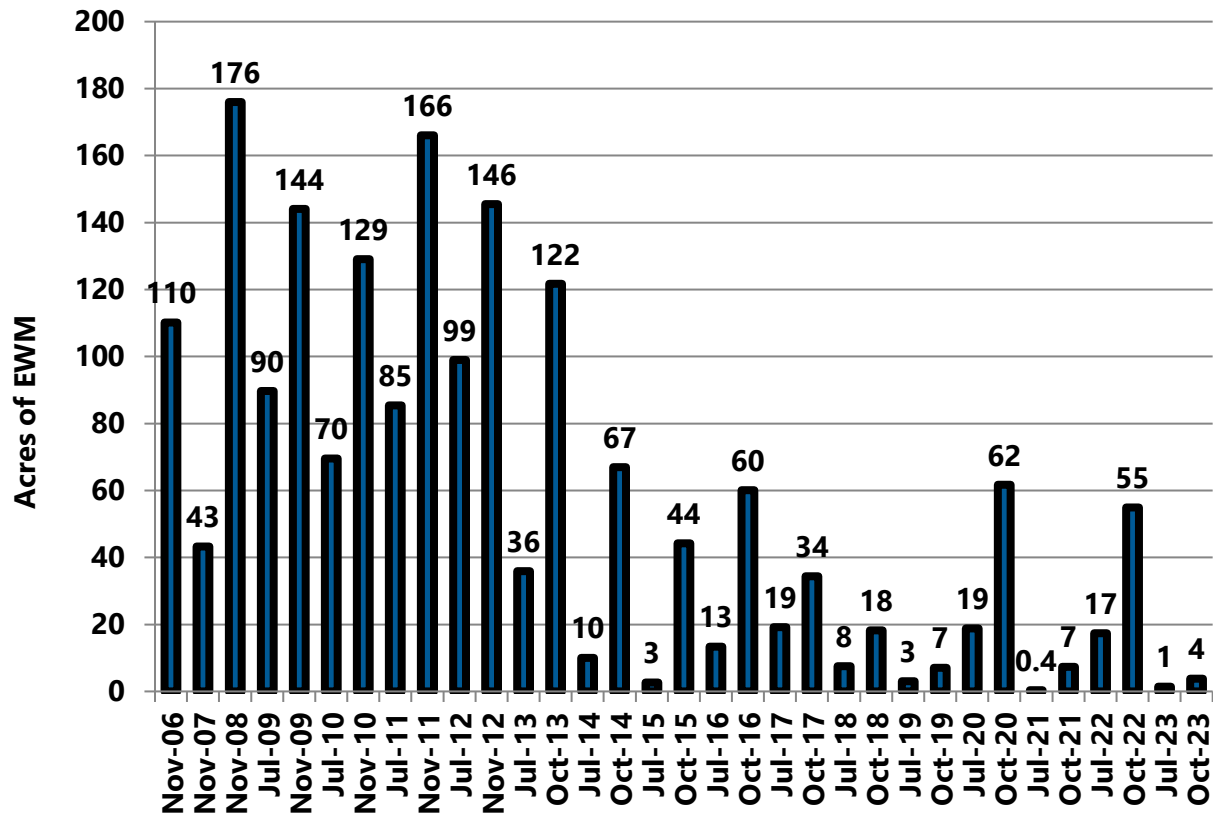


Figure 8 2006-2023 Beaver Dam Lake EWM Acreage

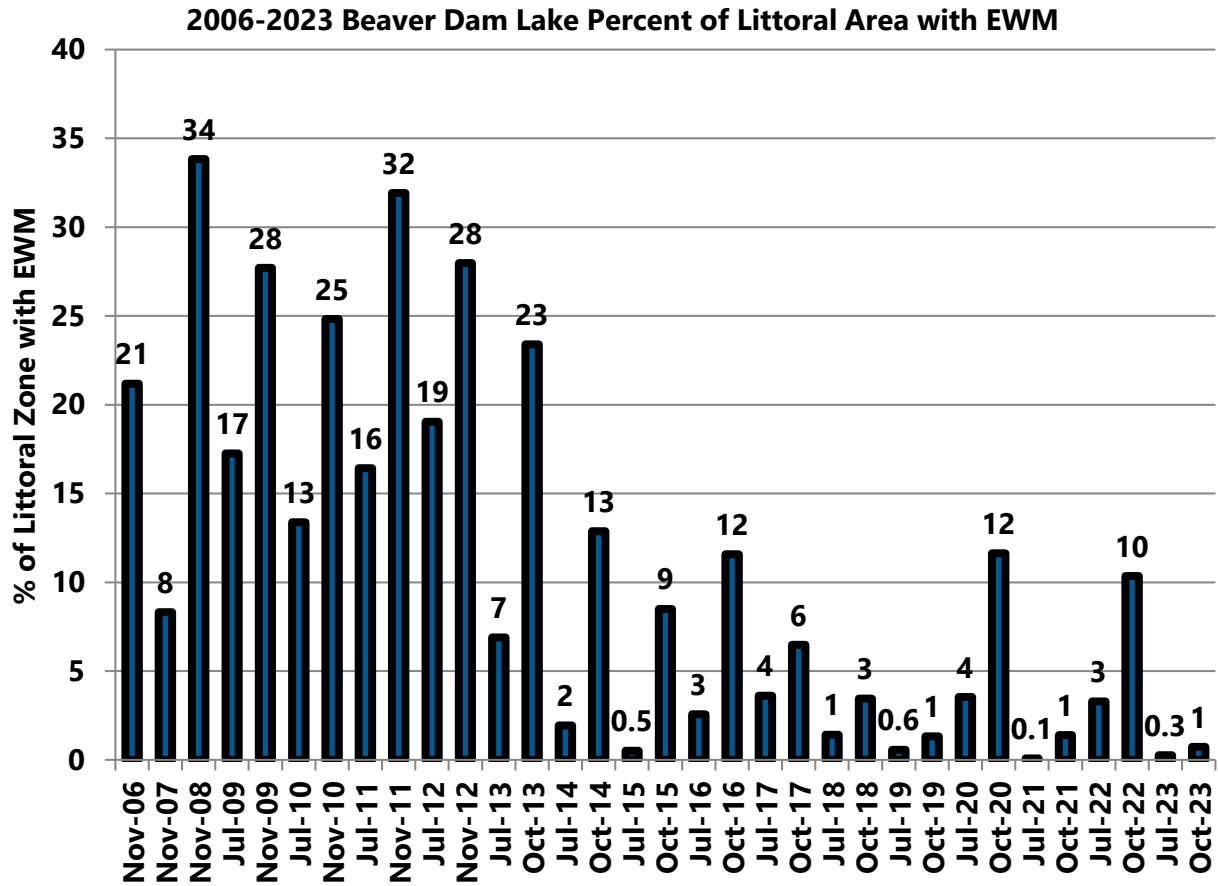


Figure 9 2006-2023 Beaver Dam Lake Percent of Littoral Zone with EWM

To: Beaver Dam Lake Management District (Board of Commissioners)
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3.0 Individual EWM Management Areas

3.1 West Lake

In 2023, EWM management in West Lake consisted of herbicide treatment of 17.86 acres. On June 9, a ProcellaCOR dose of 4 PDU was applied to Treatment Area 1 through Treatment Area 7 shown on Figure 1.

The treatment was successful and EWM was not observed within any of the treated areas during July and October 2023. EWM was observed at a single untreated location in July, but was not observed in West Lake during October (Figure 1, Figure 3, and Figure 5).

- EWM frequency decreased from 3 percent in October 2022 to 0.3 percent in July 2023 to 0 percent in October 2023 (Table 1 and Figure 10);
- EWM extent decreased from 5 acres in October 2022 to 0.3 acres in July 2023 to 0 acres in October 2023 (Table 2, Figure 3, Figure 5, and Figure 11); and
- percent of littoral zone with EWM decreased from 3 percent in October 2022 to 0.2 percent in July 2023 to 0 percent in October 2023 (Table 3 and Figure 12).

2006-2023 Beaver Dam Lake EWM Frequency of Occurrence: West Lake

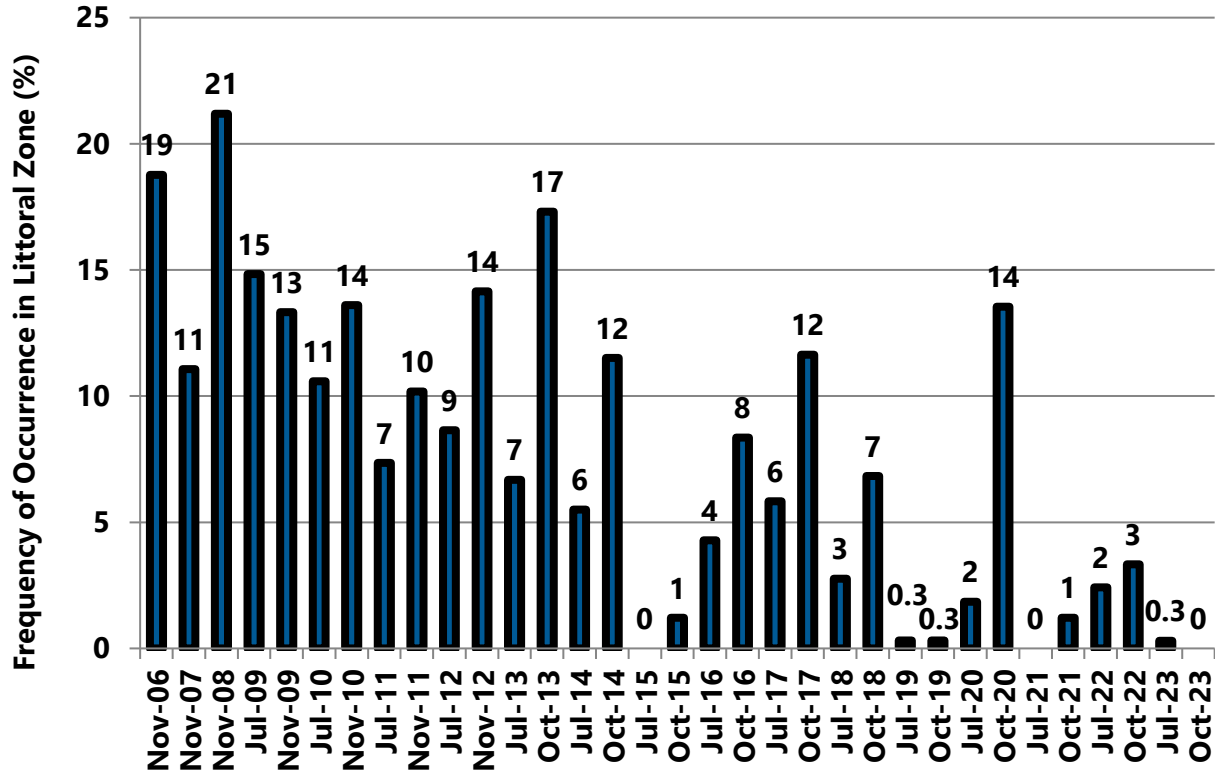


Figure 10 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: West Lake

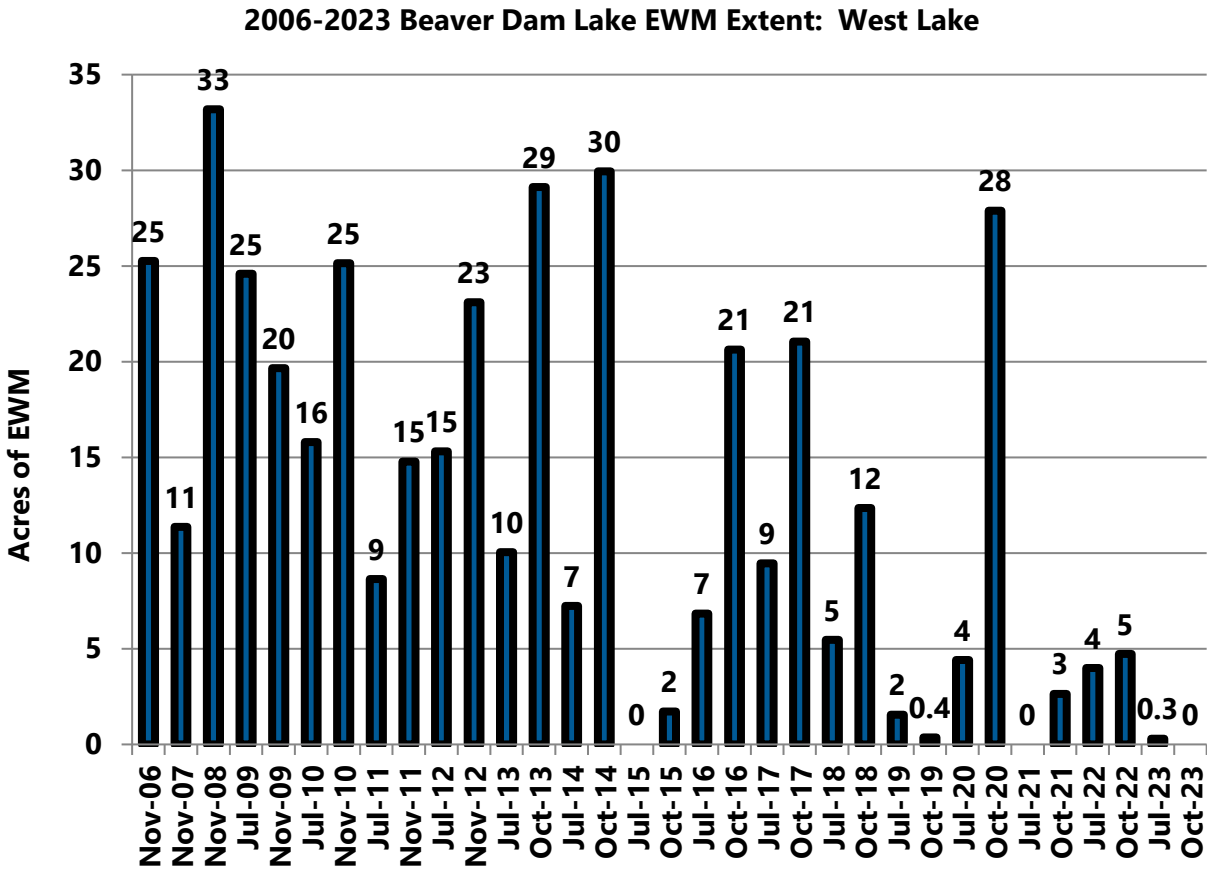


Figure 11 2006-2023 Beaver Dam Lake EWM Acreage: West Lake

2006-2023 Beaver Dam Lake Percent of Littoral Zone with EWM: West Lake

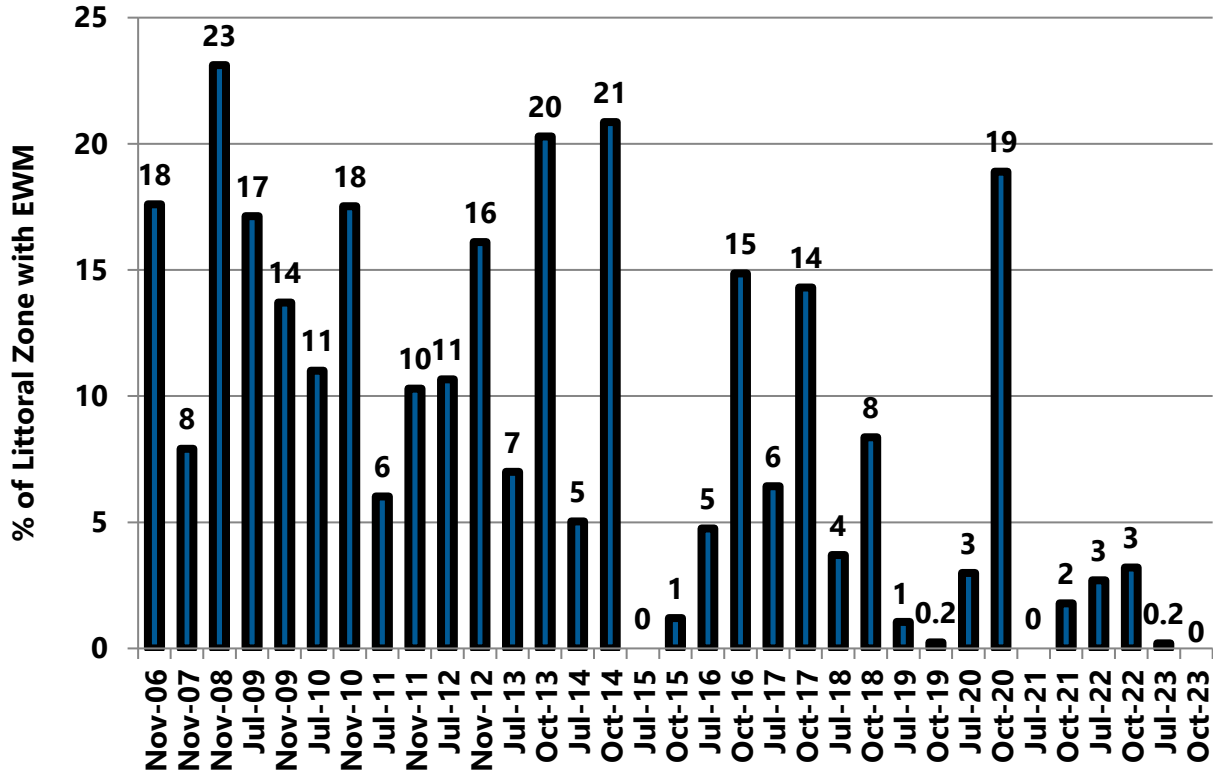


Figure 12 2006-2023 Percent of Littoral Zone with EWM: West Lake

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: 2023 EWM Treatment Results
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3.2 Williams Bay

In 2023, EWM management in Williams Bay consisted of herbicide treatment of 3.12 acres. On June 9, a ProcellaCOR dose of 4 PDU was applied to Treatment Area 8 shown on Figure 1.

The treatment was successful and EWM was not observed in the treatment area in July or October 2023 (Figure 3 and Figure 5). EWM was observed at a single untreated sample point during July but was not observed in Williams Bay in October (Figure 3 and Figure 5).

- EWM frequency declined from 2 percent in October 2022 to 1 percent in July 2023 to 0 percent in October 2023 (Table 1 and Figure 15);
- EWM extent was 0.4 acres in October 2022 and July 2023 and then declined to 0 acres in October 2023 (Table 2, Figure 3, Figure 5, and Figure 18); and
- percent of littoral zone with EWM was 1 percent in October 2022 and July 2023 and then decreased to 0 percent in October 2023 (Table 3 and Figure 19).

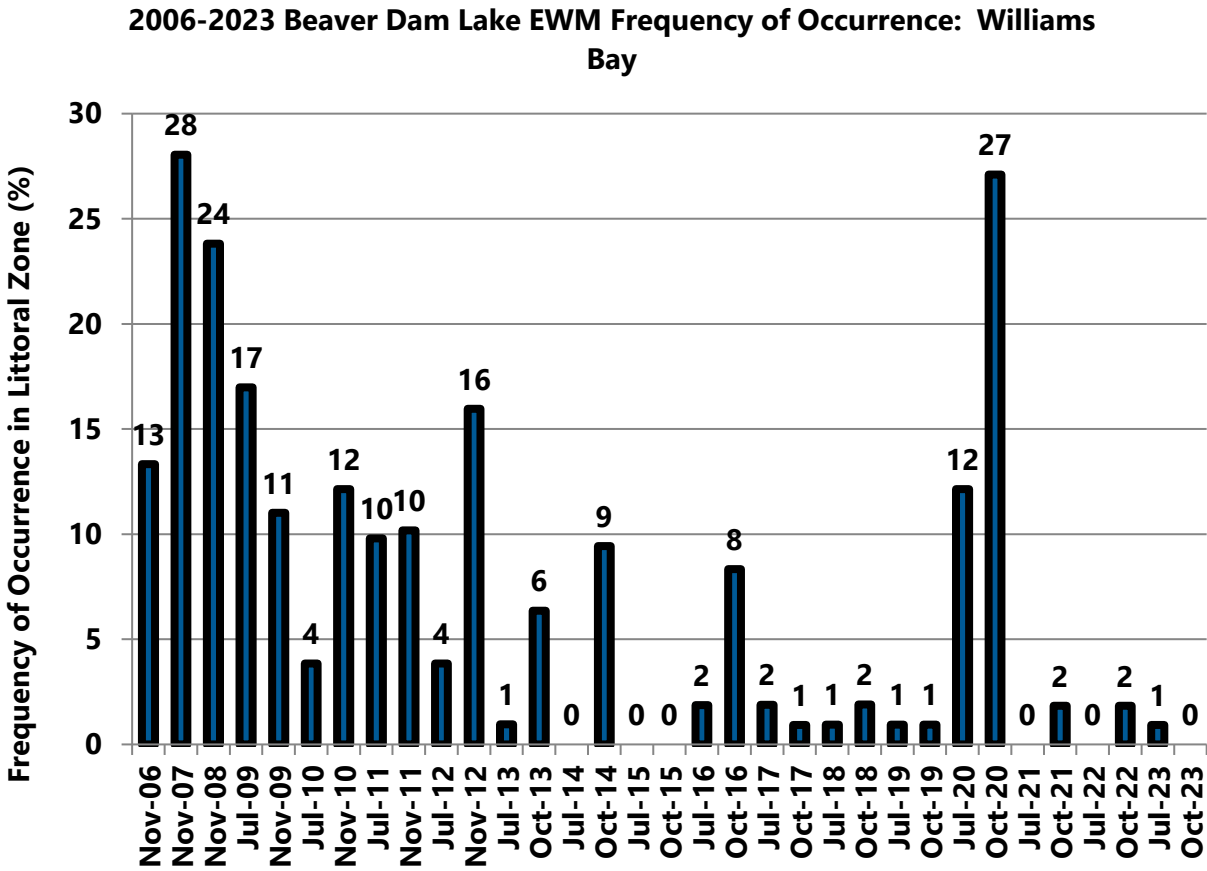


Figure 13 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Williams Bay

2006-2023 Beaver Dam Lake EWM Extent: Williams Bay

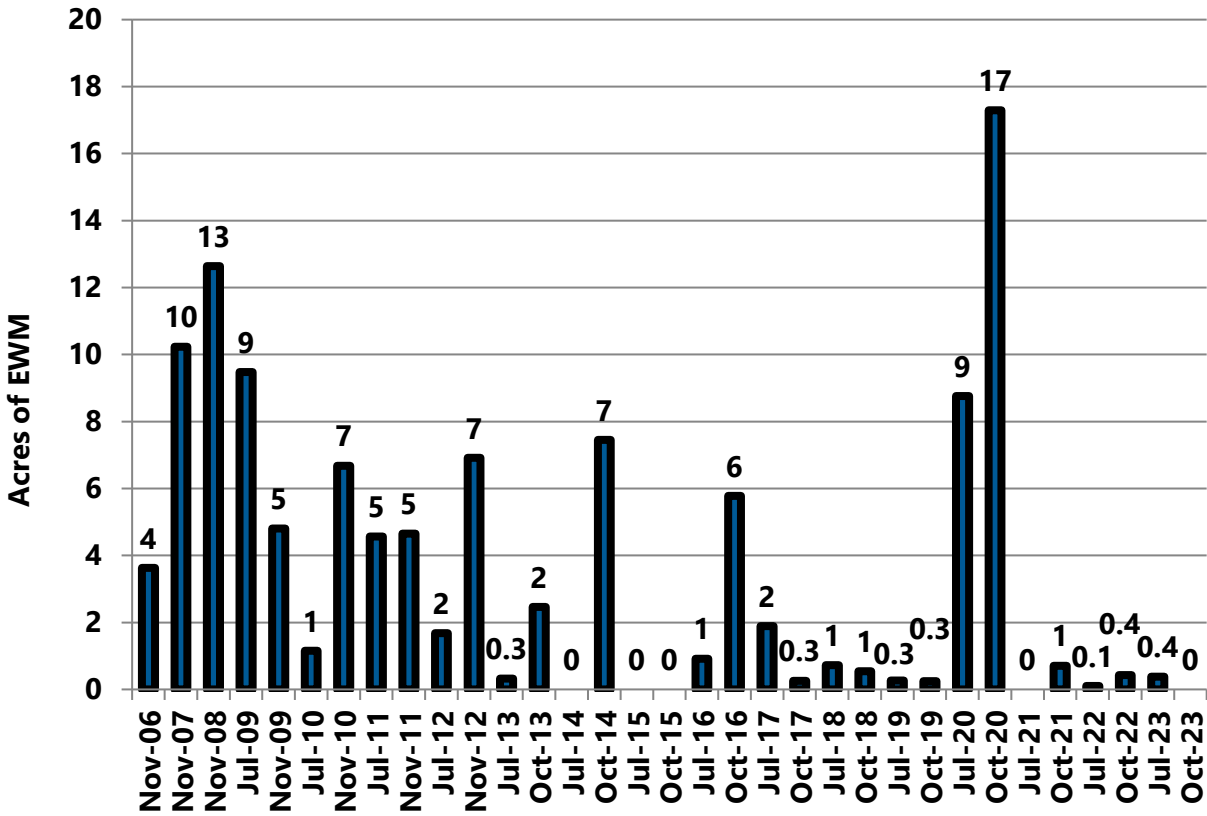


Figure 14 2006-2023 Beaver Dam Lake EWM Acreage: Williams Bay

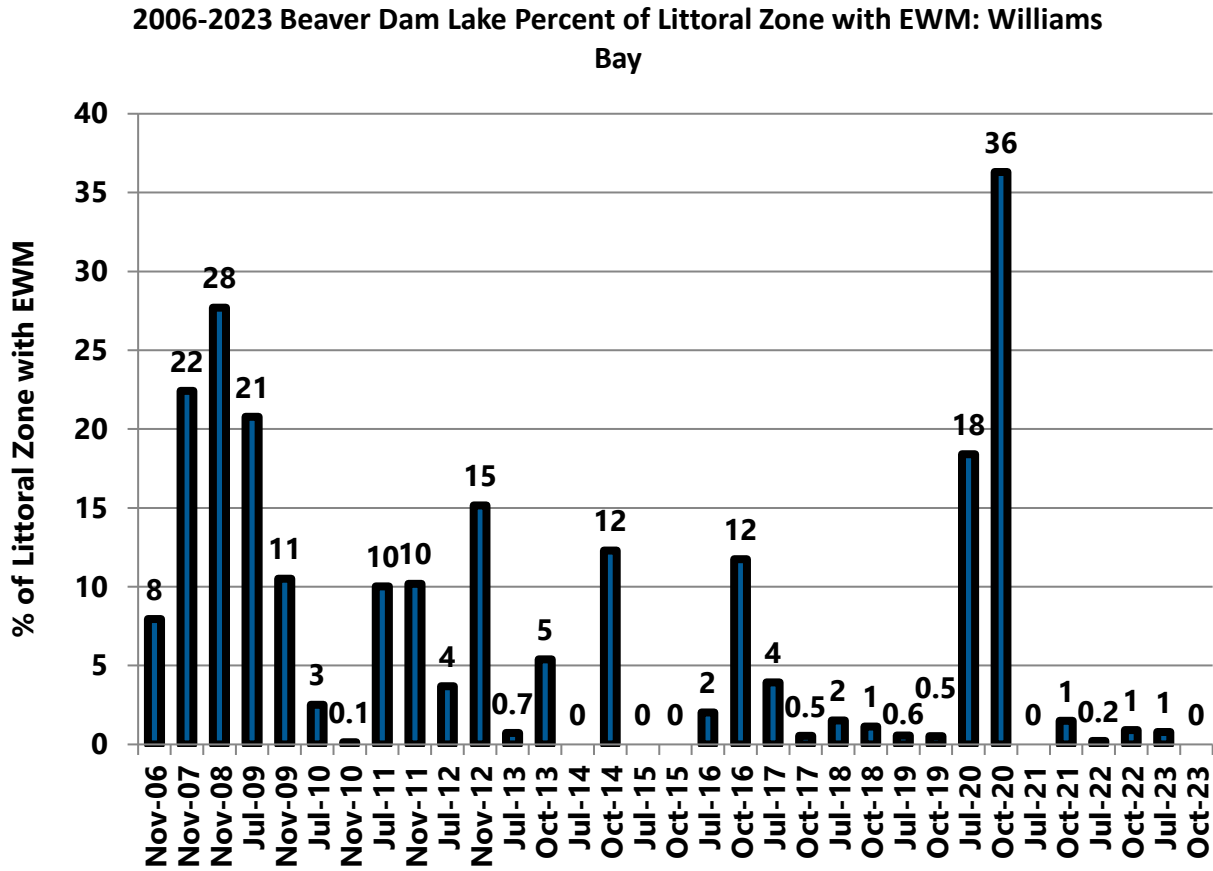


Figure 15 2006-2023 Percent of Littoral Zone with EWM: Williams Bay

3.3 Rabbit Island Bay

In 2023, EWM management consisted of herbicide treatment of 61.8 acres. On May 24, a 2,4-D dose of 1.37 ppm was applied to Treatment Area 9 shown on Figure 1. The expected whole bay 2,4-D concentration after treatment was 0.4 ae² ppm. 2,4-D samples were collected from location 9B within the treated area and from location 9A outside of the treated area (Figure 1) at 1 and 4 hours and 1, 2, 3, 5, 7, 12, 19, and 26 days after treatment. As shown in Figure 16, a 2,4-D concentration of 0.3 ae² ppm sustained for at least 4 days has been found to be lethal to EWM. The 2,4-D concentrations in Rabbit Island Bay were at least 0.3 ppm ae² (300 µg/L ae²) for at least 5 days after treatment at Site 9B, located within the treated area and for one day after treatment at Site 9A, located outside of the treated area (Figure 17).

EWM was not observed in Rabbit Island Bay during the July plant survey (Figure 3), but a handful of single stemmed EWM plants were found and rake removed from the northwest canal and along the southeast shoreline in October.

- EWM frequency decreased from 24 percent in October 2022 to 0 percent in July 2023 and then increased to 5 percent in October 2023 (Table 1 and Figure 18);
- EWM extent decreased from 15 acres in October 2022 to 0 acres in July 2023 and then increased to 1 acre in October 2023 (Table 2, Figure 3, Figure 5, and Figure 19);
- Percent of littoral zone with EWM decreased from 25 percent in October 2022 to 0 percent in July 2023 and then increased to 1 percent in October 2023 (Table 3 and Figure 20).

² ae is acid equivalent which is the concentration of the active ingredient in 2,4-D (i.e., the ingredient that kills EWM)

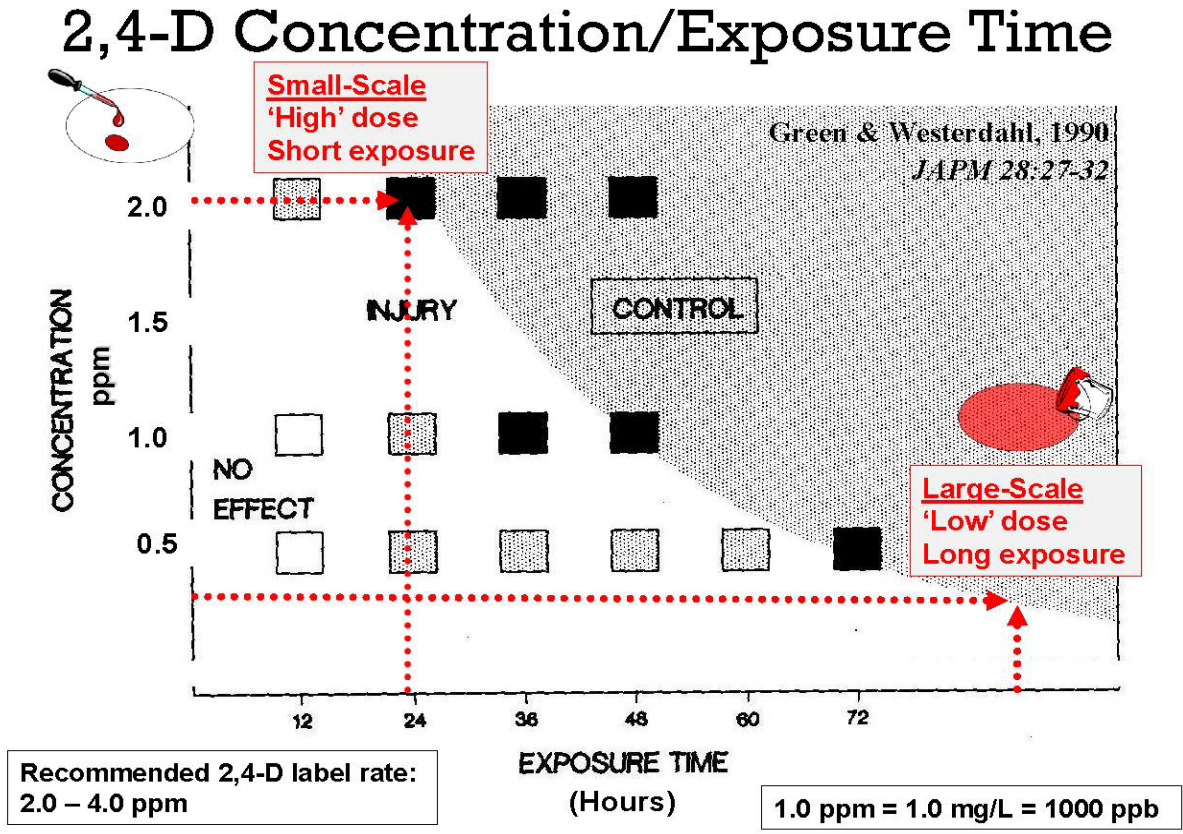


Figure 16 2,4-D Concentration/Exposure Time Relationship and EWM Control

(Figure Credit: Nault, Michelle and John Skogerboe. 2014. *Scientific Evaluation of Efficacy and Selectivity of Herbicide Treatments in Wisconsin Lakes*. Presentation at UMISC—October 22, 2014 in Duluth, Minnesota)

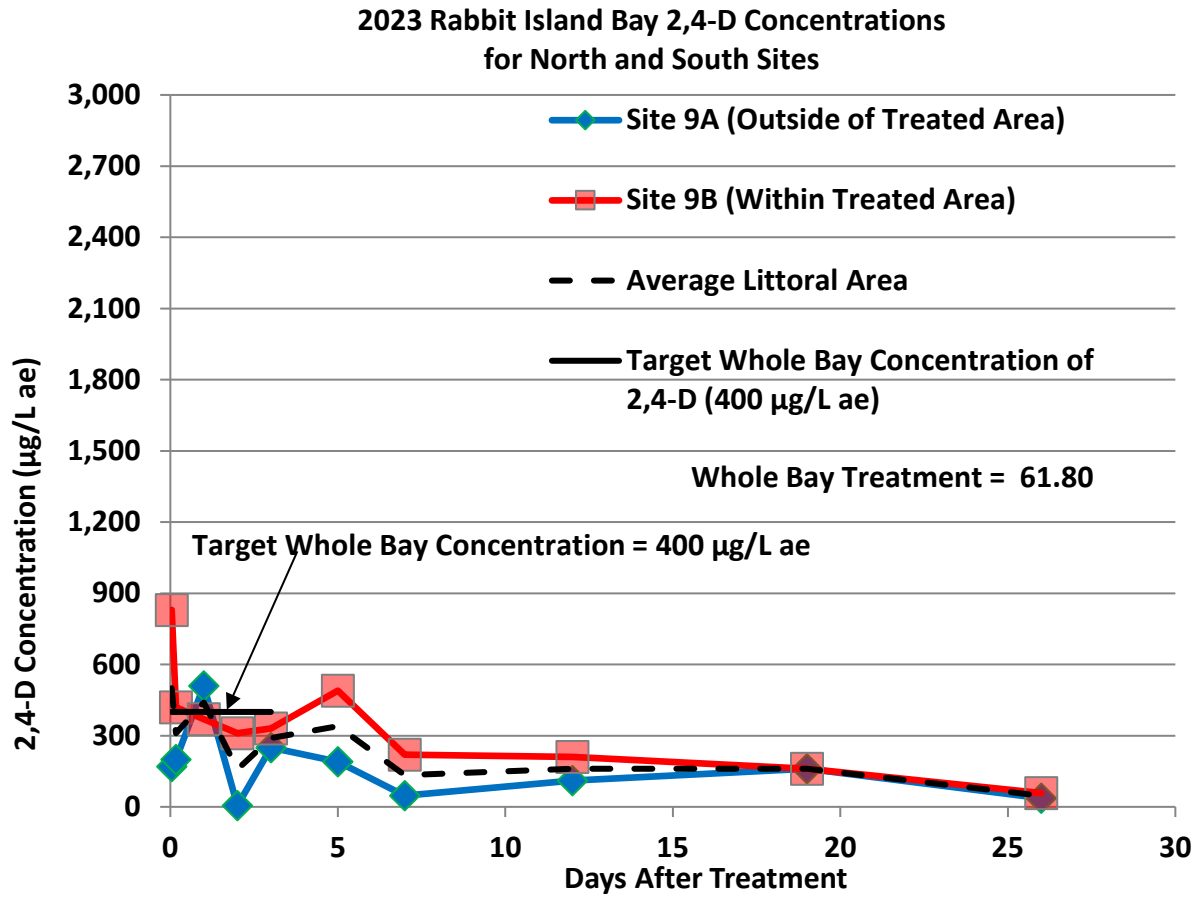


Figure 17 2023 Rabbit Island Bay 2,4-D Concentrations for Sites 9A and 9B

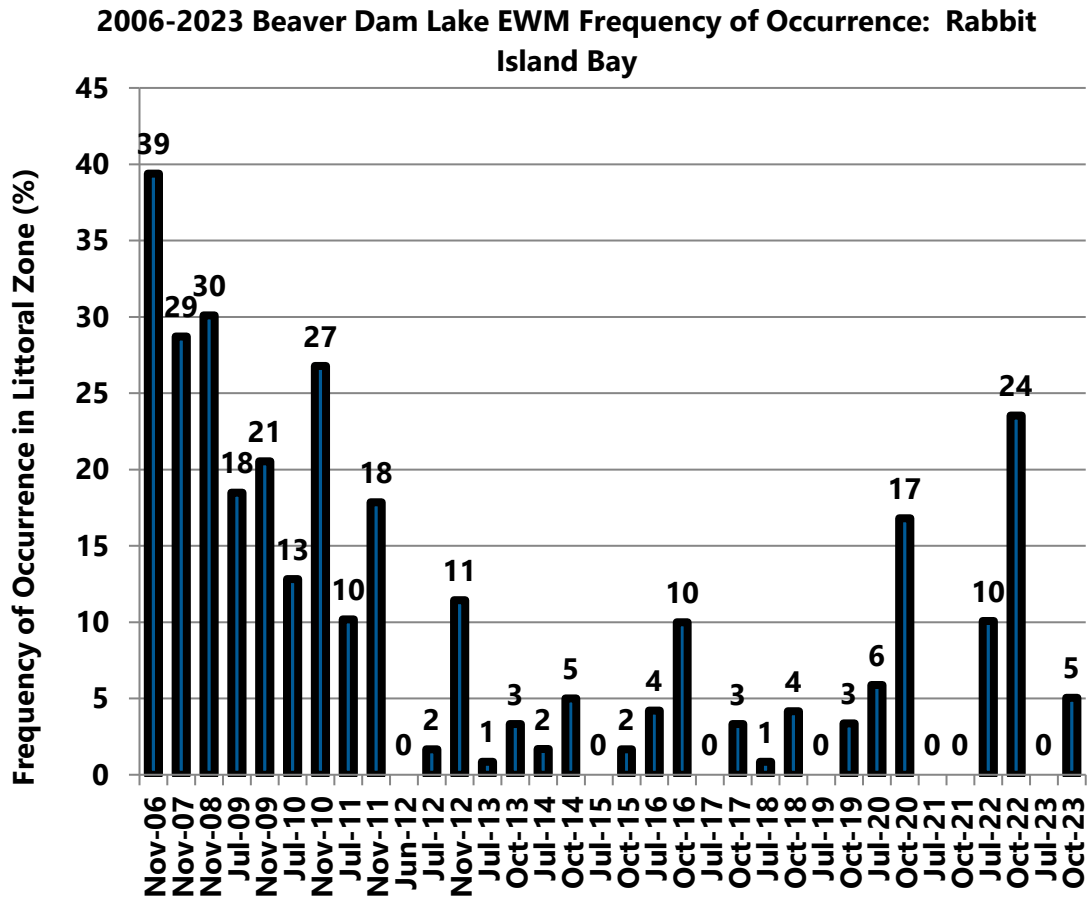


Figure 18 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Rabbit Island Bay

2006-2023 Beaver Dam Lake EWM Extent: Rabbit Island Bay

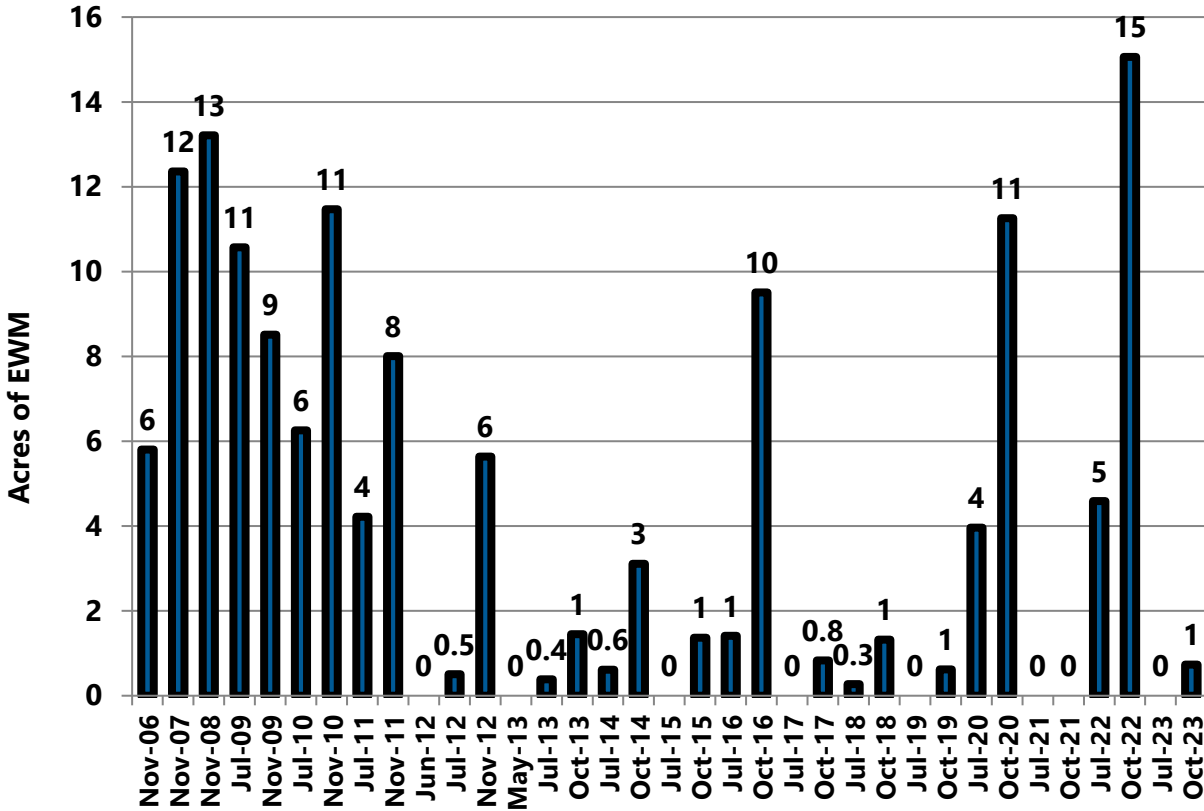


Figure 19 2006-2023 Beaver Dam Lake EWM Acreage: Rabbit Island Bay

2006-2023 Beaver Dam Lake Percent of Littoral Zone with EWM: Rabbit Island Bay

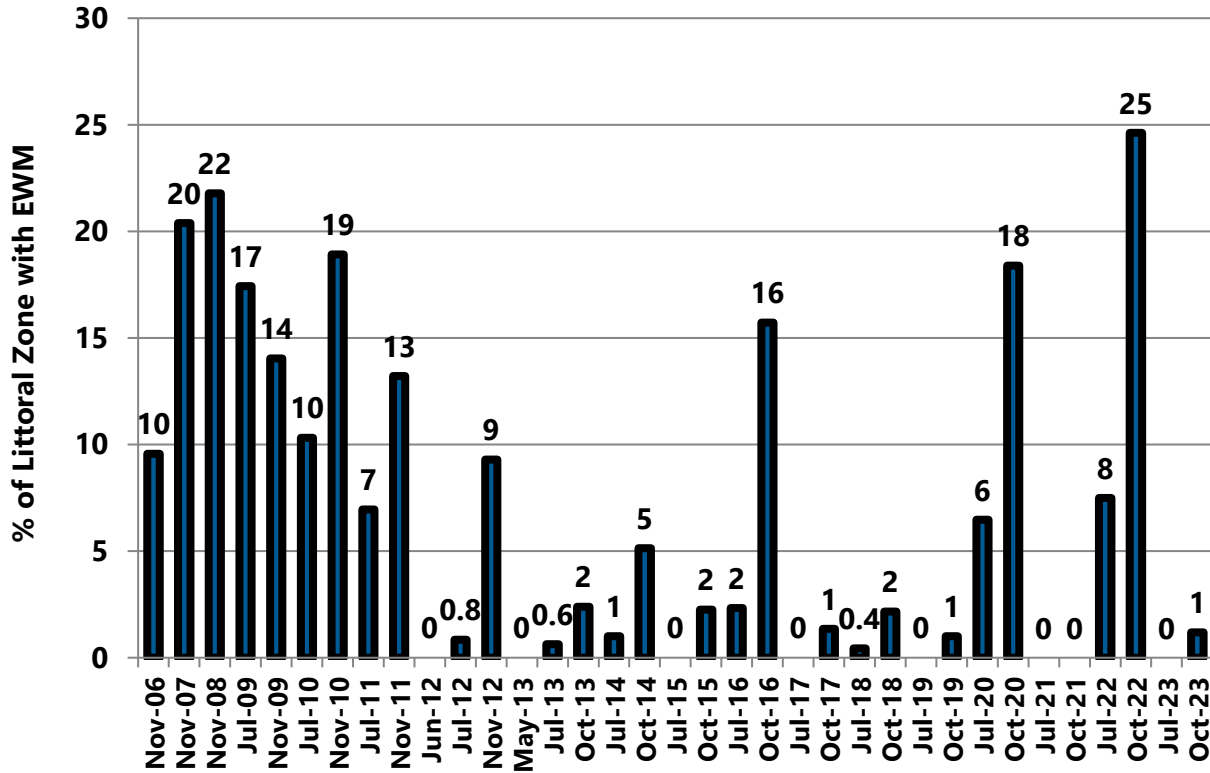


Figure 20 2006-2023 Percent of Littoral Zone with EWM: Rabbit Island Bay

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3.4 Library Lake

In 2023, EWM management in Library Lake consisted of herbicide treatment of 1.89 acres. On June 9, a ProcellaCOR dose of 6 PDU was applied to Treatment Areas 10 through 13 shown on Figure 1.

The treatment was successful and EWM was not observed in Library Lake in July or October 2023 (Figure 3 and Figure 5).

- EWM frequency decreased from 5 percent in October 2022 to 0 percent in July and October 2023 (Table 1 and Figure 21);
- EWM extent decreased from 0.6 acres in October 2022 to 0 acres in July and October 2023 (Table 2, Figure 3, Figure 5, and Figure 22); and
- Percent of littoral zone with EWM decreased from 4 percent in October 2022 to 0 percent in July and October 2023 (Table 3 and Figure 23).

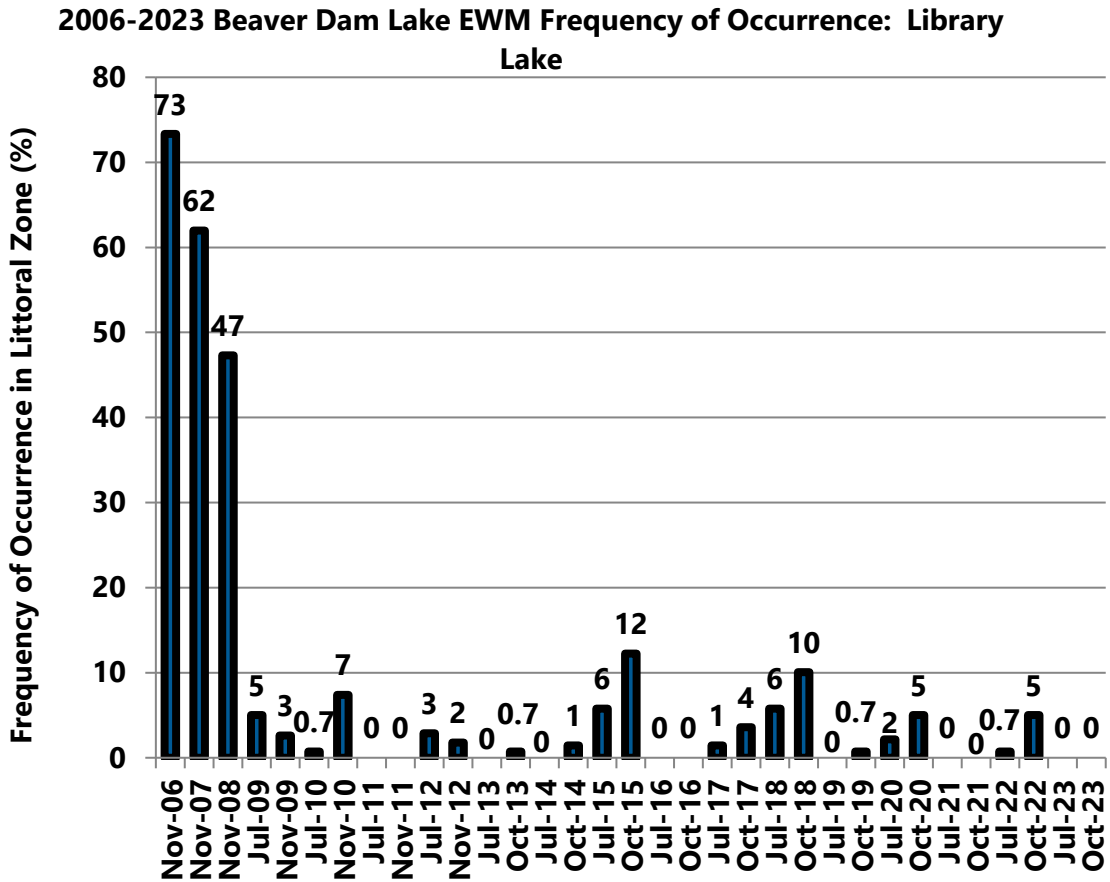


Figure 21 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Library Lake

2006-2023 Beaver Dam Lake EWM Extent: Library Lake

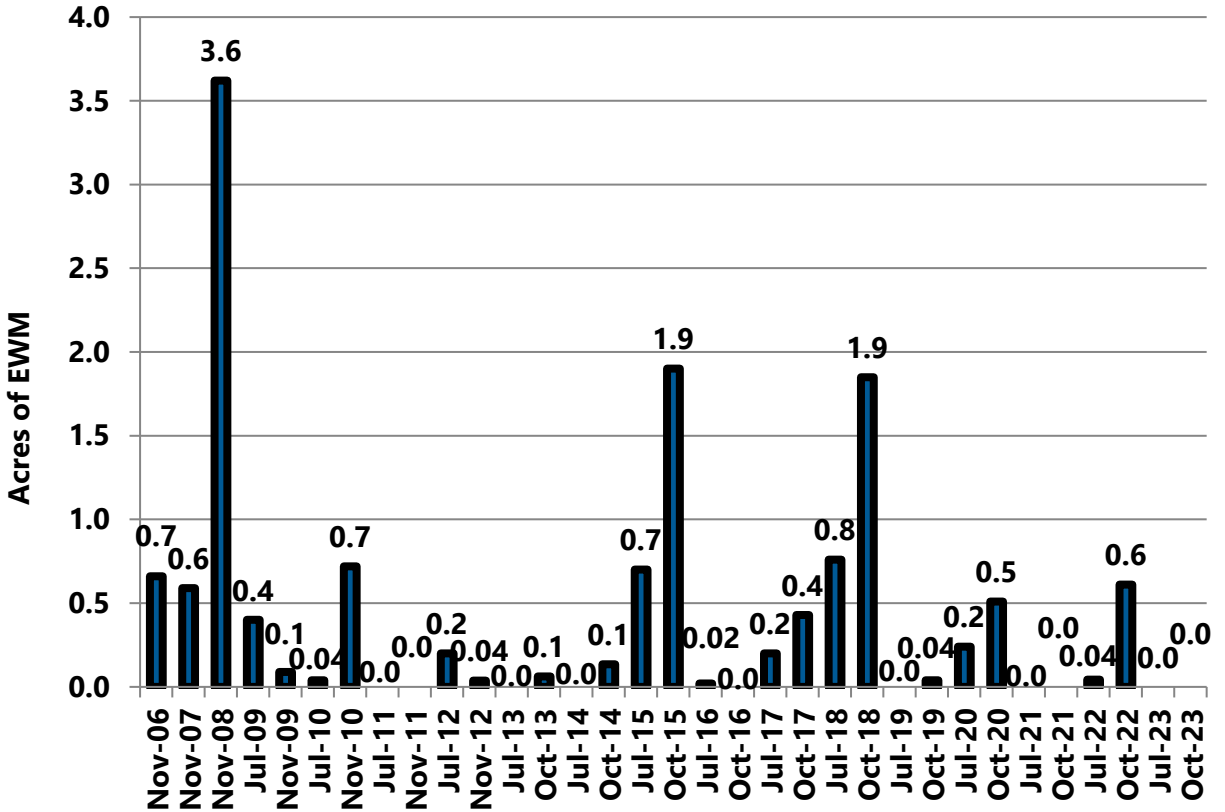


Figure 22 2006-2023 Beaver Dam Lake EWM Acreage: Library Lake

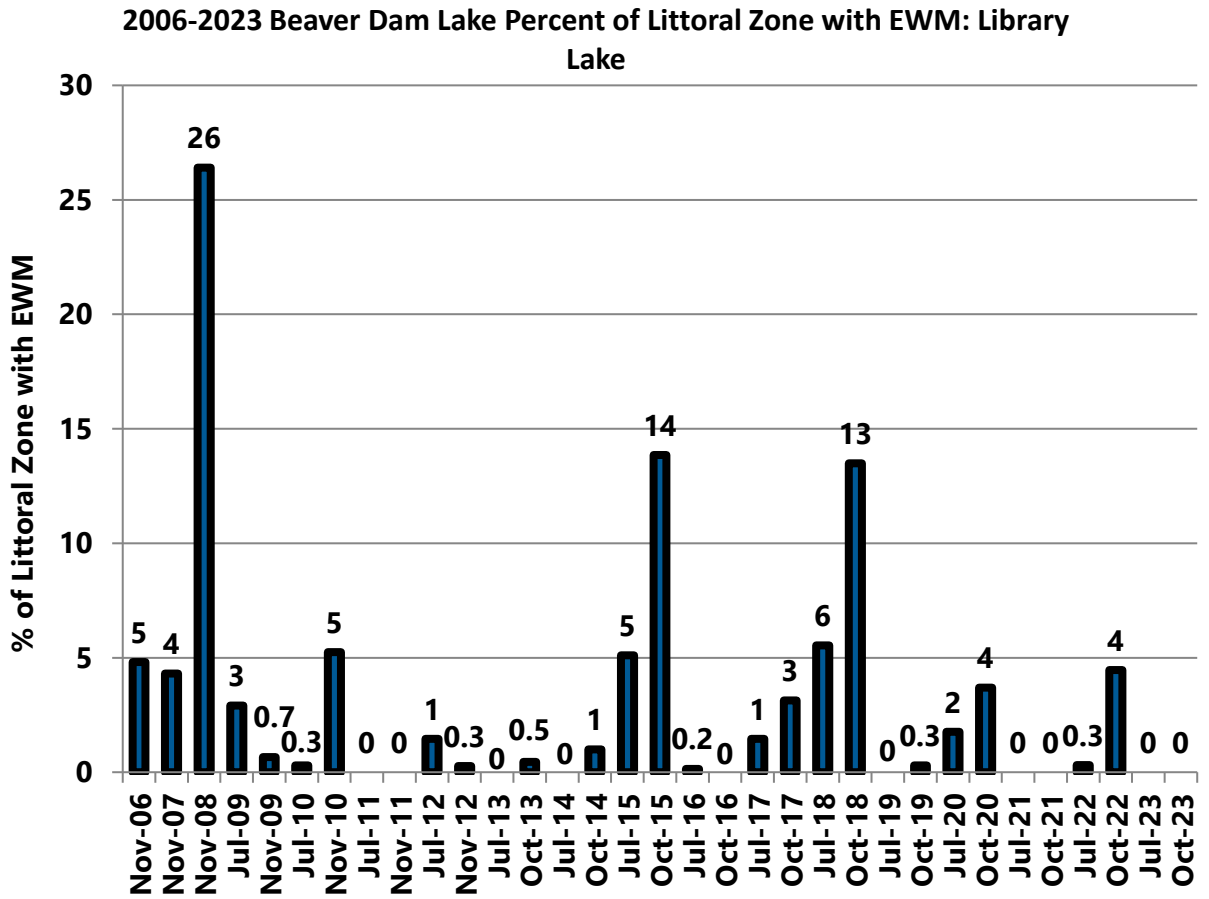


Figure 23 2006-2023 Percent of Littoral Zone with EWM: Library Lake

3.5 Cemetery Bay

In 2023, EWM management of Cemetery Bay consisted of herbicide treatment of 30.29 acres. On May 19, a 2,4-D dose of 0.75 ppm was applied to Treatment Areas 29 and 30 shown in Figure 2. The expected whole bay 2,4-D concentration after treatment was 0.4 ae² ppm. 2,4-D samples were collected from one location within the treated area (Cemetery Bay North, Figure 2) and one location outside of the treated area (Cemetery Bay South, Figure 2). As shown in Figure 16, a 2,4-D concentration of 0.3 ae² ppm sustained for at least 4 days has been found to be lethal to EWM. Both the North and South sites sustained a lethal concentration of 2,4-D for at least 4 days. The 2,4-D concentrations at the Cemetery Bay North site, located within the treated area, were at least 0.3 ppm ae² (300 µg/L ae²) for at least 7 days after treatment and concentrations at the South site, located outside of the treated area, were at least 0.3 ppm ae² (300 µg/L ae²) during days 3 through 7 after treatment (Figure 24).

A handful of EWM plants were observed at a single location near the outlet during the July plant survey (Figure 4). EWM was spreading along the southeast shoreline and in the outlet channel during the October plant survey and was observed at 6 locations (Figure 6).

- EWM frequency decreased from 34 percent in October 2022 to 1 percent in July 2023 and then increased to 7 percent in October 2023 (Table 1 and Figure 25);
- EWM extent decreased from 19 acres in October 2022 to 1 acre in July 2023 and then increased to 3 acres in October 2023 (Table 2, Figure 4, Figure 6, and Figure 26); and
- Percent of littoral zone with EWM decreased from 35 percent in October 2022 to 1 percent in July 2023 and then increased to 6 percent in October 2023 (Table 3 and Figure 27).

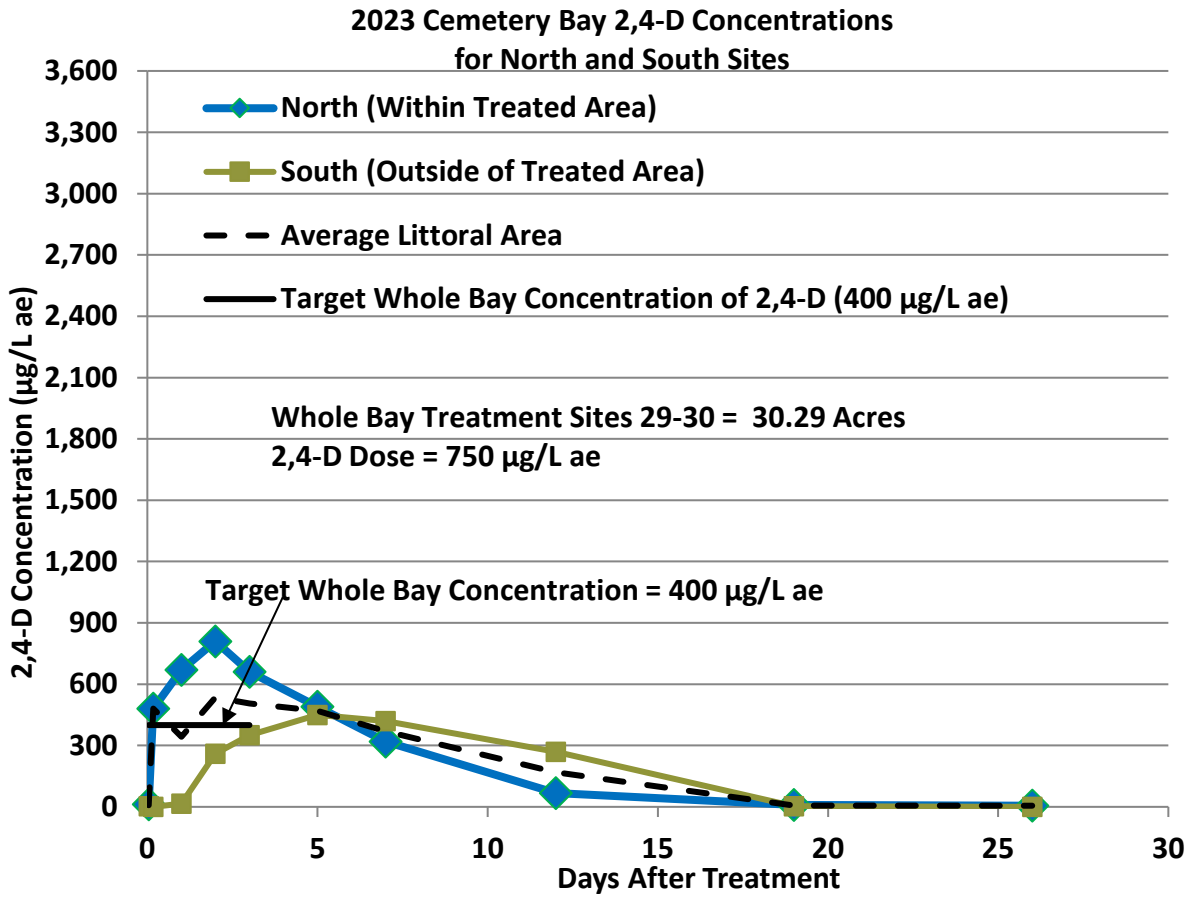


Figure 24 2023 Cemetery Bay 2,4-D Concentrations for North and South Sites

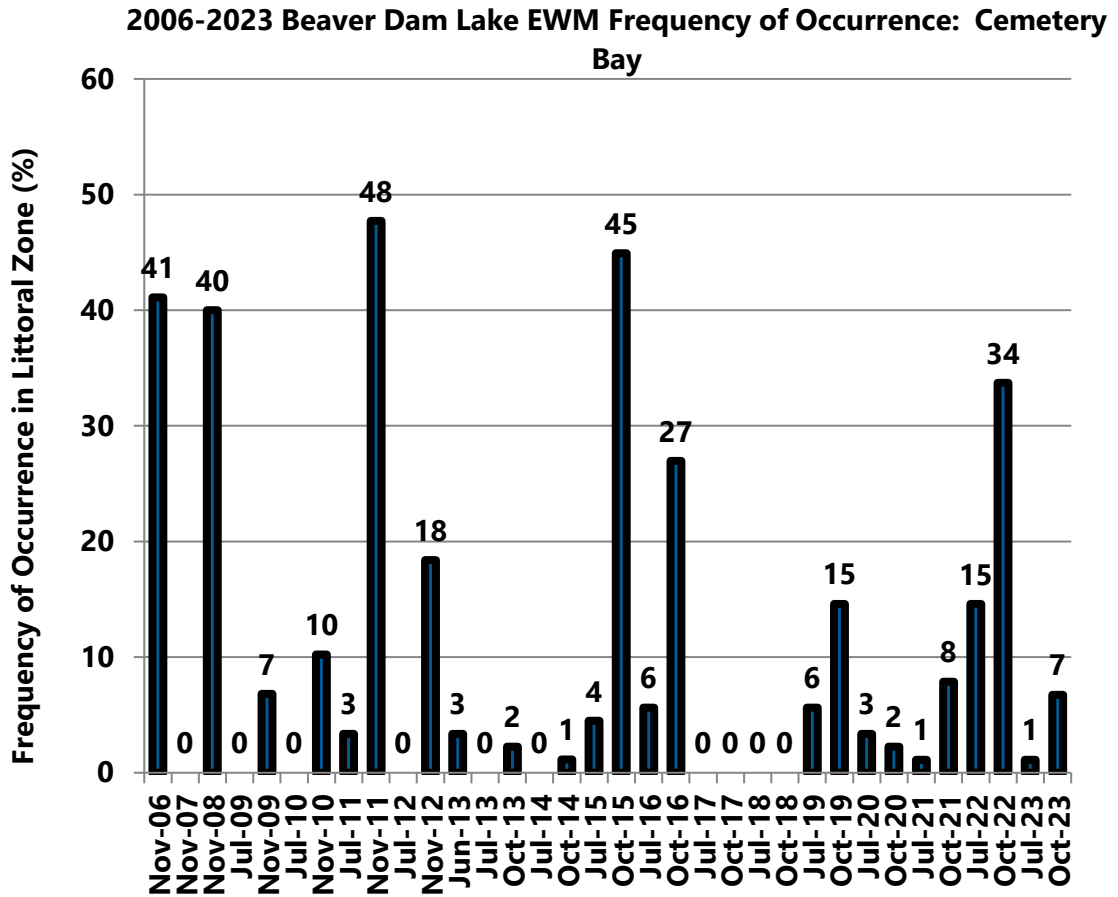


Figure 25 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Cemetery Bay

2006-2023 Beaver Dam Lake EWM Extent: Cemetery Bay

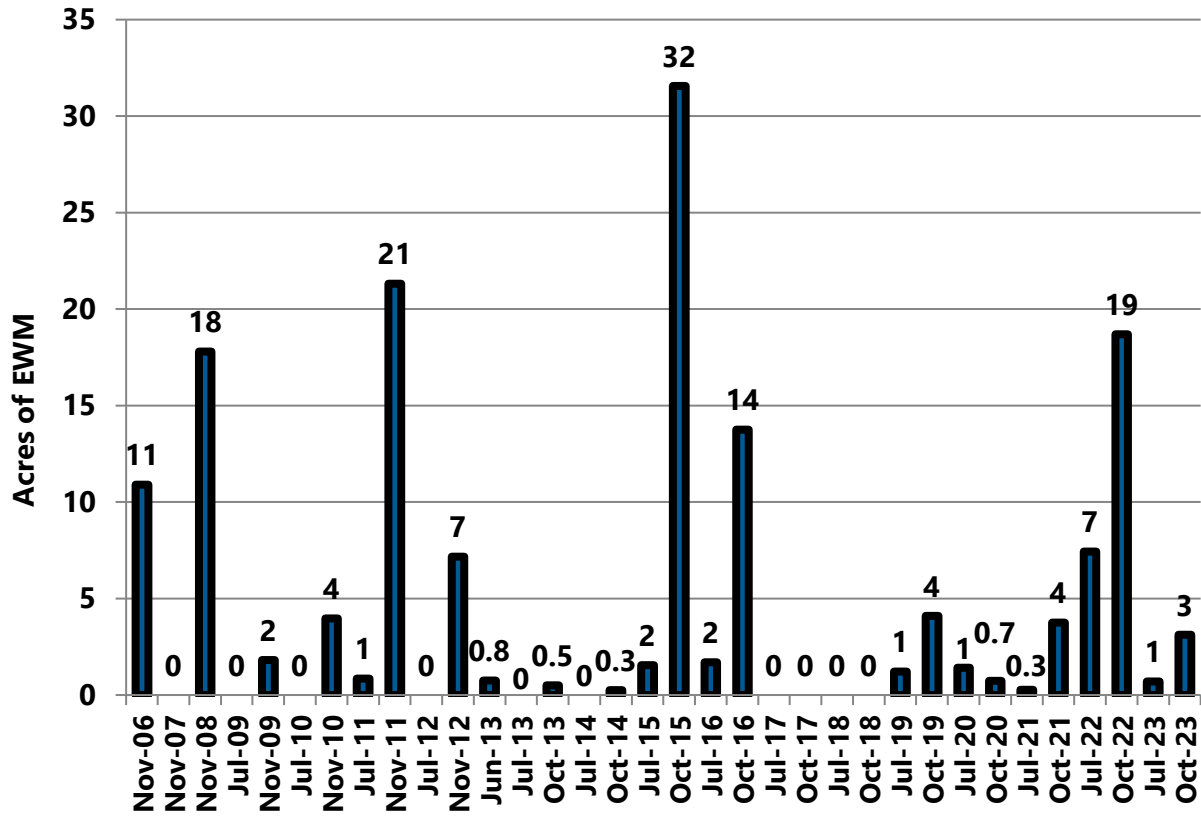


Figure 26 2006-2023 Beaver Dam Lake EWM Acreage: Cemetery Bay

**2006-2023 Beaver Dam Lake Percent of Littoral Zone with EWM:
 Cemetery Bay**

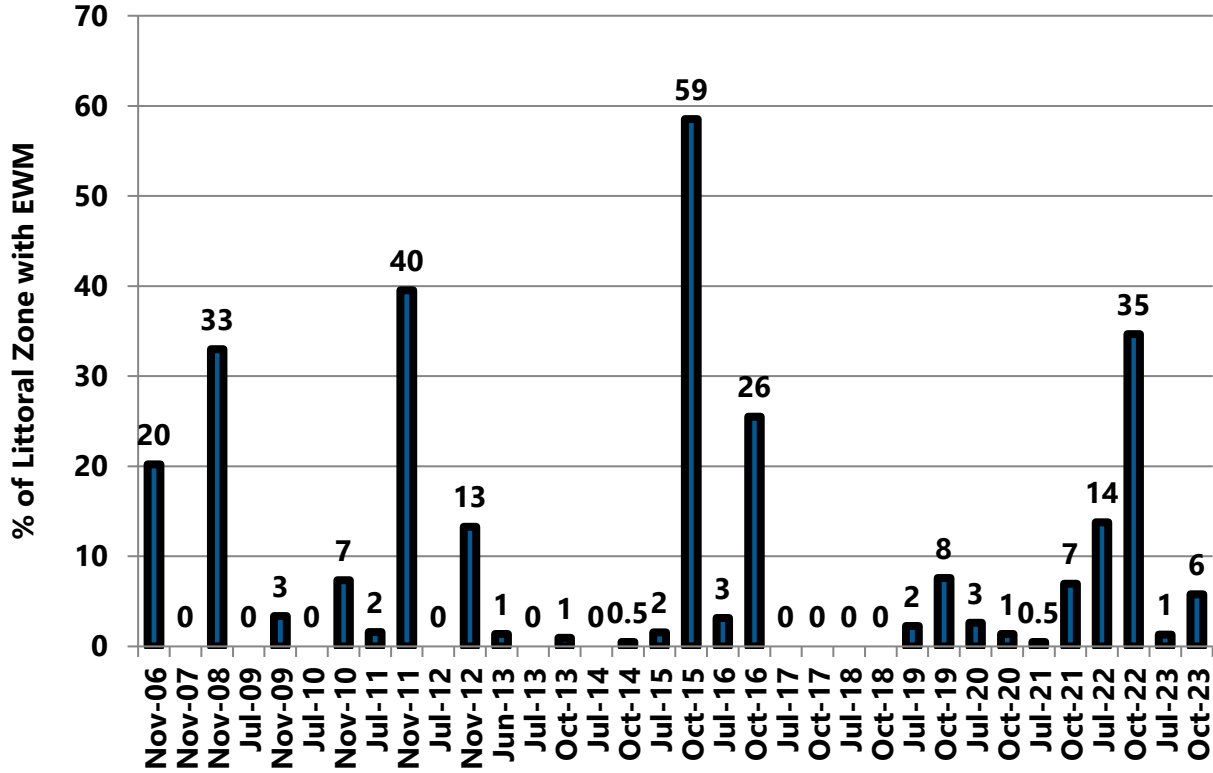


Figure 27 2006-2023 Percent of Littoral Zone with EWM: Cemetery Bay

3.6 City Bay

In 2023, EWM management in City Bay consisted of herbicide treatment of 34.93 acres. On June 9, a ProcellaCOR dose of 4 PDU was applied to Treatment Area 22 shown on Figure 2. This 1.65 acre treatment area was immediately adjacent to Treatment Area 21 (Figure 2), located in East Lake and also treated with ProcellaCOR. All other EWM areas in City Bay were treated with 2,4-D in 2023.

On May 18, a 2,4-D dose of 2.5 ppm was applied to Treatment Areas 23 through 28 shown in Figure 2. The expected whole bay 2,4-D concentration after treatment was 0.8 ae² ppm. 2,4-D samples were collected from one location within the treated area (City Bay North, Figure 2) and two locations outside of the treated area (City Bay Middle and City Bay South, Figure 2). As shown in Figure 16, a 2,4-D concentration of 0.3 ae² ppm sustained for at least 4 days has been found to be lethal to EWM. Only the South site sustained a lethal concentration of 2,4-D for at least 4 days. Untreated waters flowing into City Bay from upstream areas in the lake (i.e., from West Lake basins and from East Lake) diluted the herbicide applied to City Bay resulting in lower 2,4-D concentrations in the North and Middle sites than the South site. The 2,4-D concentrations at the City Bay North site were at least 0.3 ppm ae² (300 µg/L ae²) on 1 and 4 hours after treatment and on 2 days after treatment (Figure 28). The 2,4-D concentrations at the City Bay Middle site were at least 0.3 ppm ae² (300 µg/L ae²) on 3 days after treatment (Figure 28). The 2,4-D concentrations at the City Bay South site were at least 0.3 ppm ae² (300 µg/L ae²) on 1 and 4 hours after treatment and on 3 to 7 days after treatment (Figure 28).

The herbicide treatments were successful and EWM was not observed in City Bay during the July and October plant surveys (Figure 4 and Figure 6).

- EWM frequency decreased from 14 percent in fall of 2022 to 0 percent in July and October 2023 (Table 1 and Figure 29);
- EWM extent decreased from 12 acres in fall of 2022 to 0 acres in July and October 2023 (Table 2, Figure 4, Figure 6, and Figure 30); and
- Percent of littoral zone with EWM decreased from 12 percent in fall of 2022 to 0 percent in July and October 2023 (Table 3 and Figure 31).

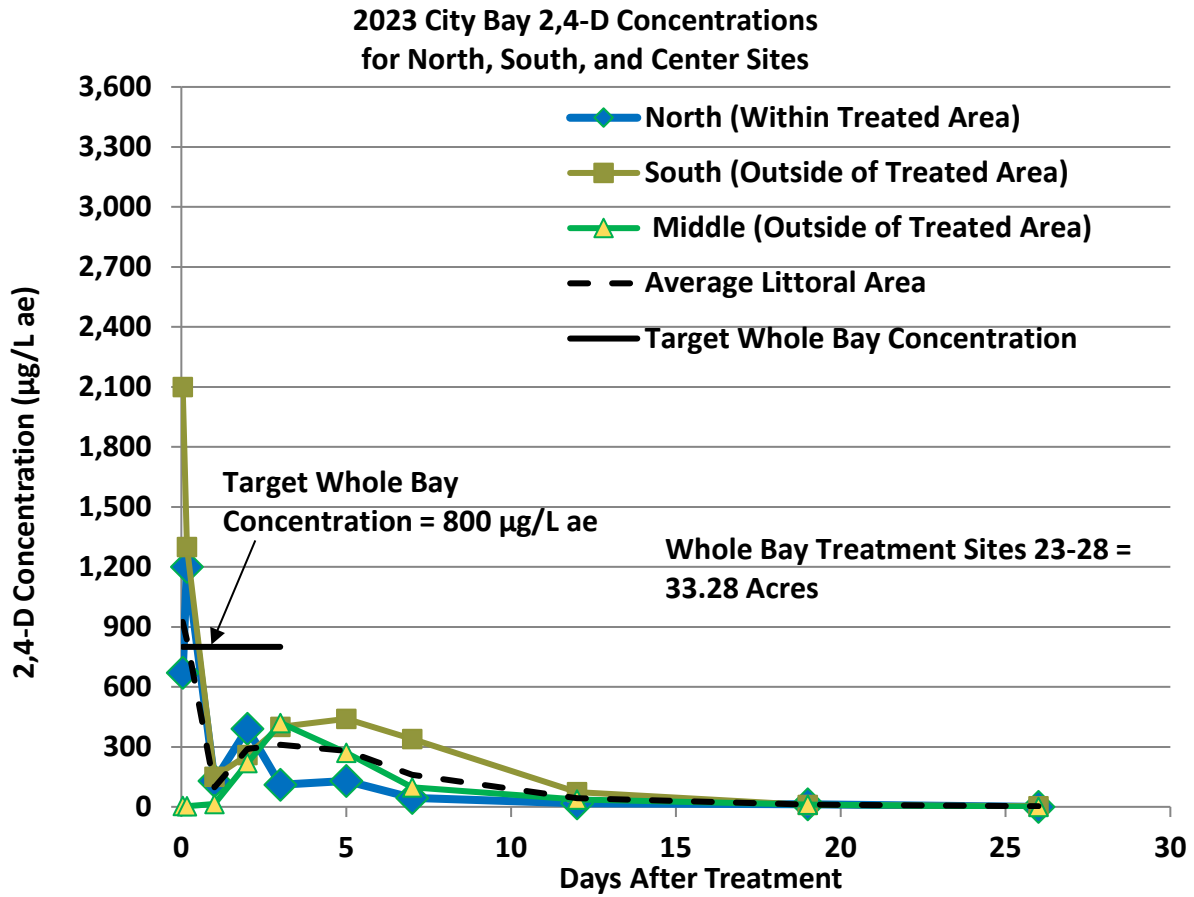


Figure 28 2023 City Bay 2,4-D Concentrations for North, Middle, and South Sites

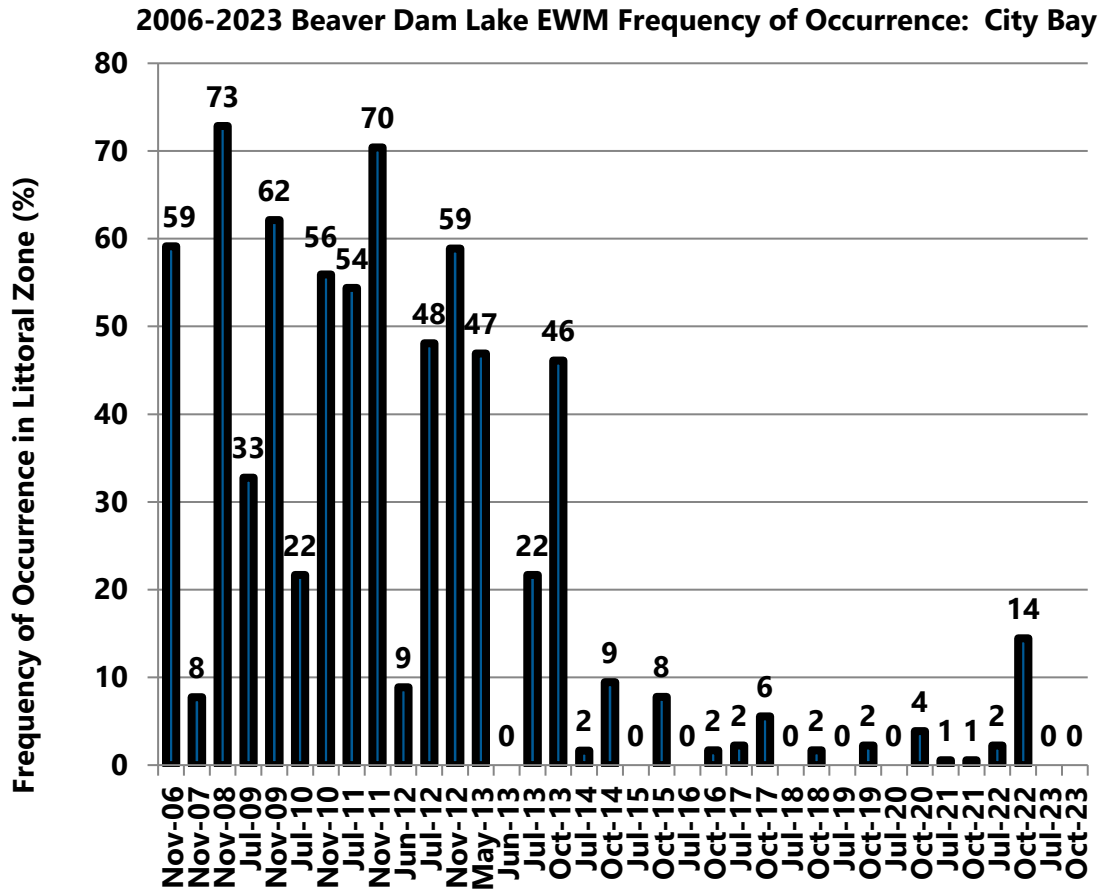


Figure 29 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone:
 City Bay

2006-2023 Beaver Dam Lake EWM Extent: City Bay

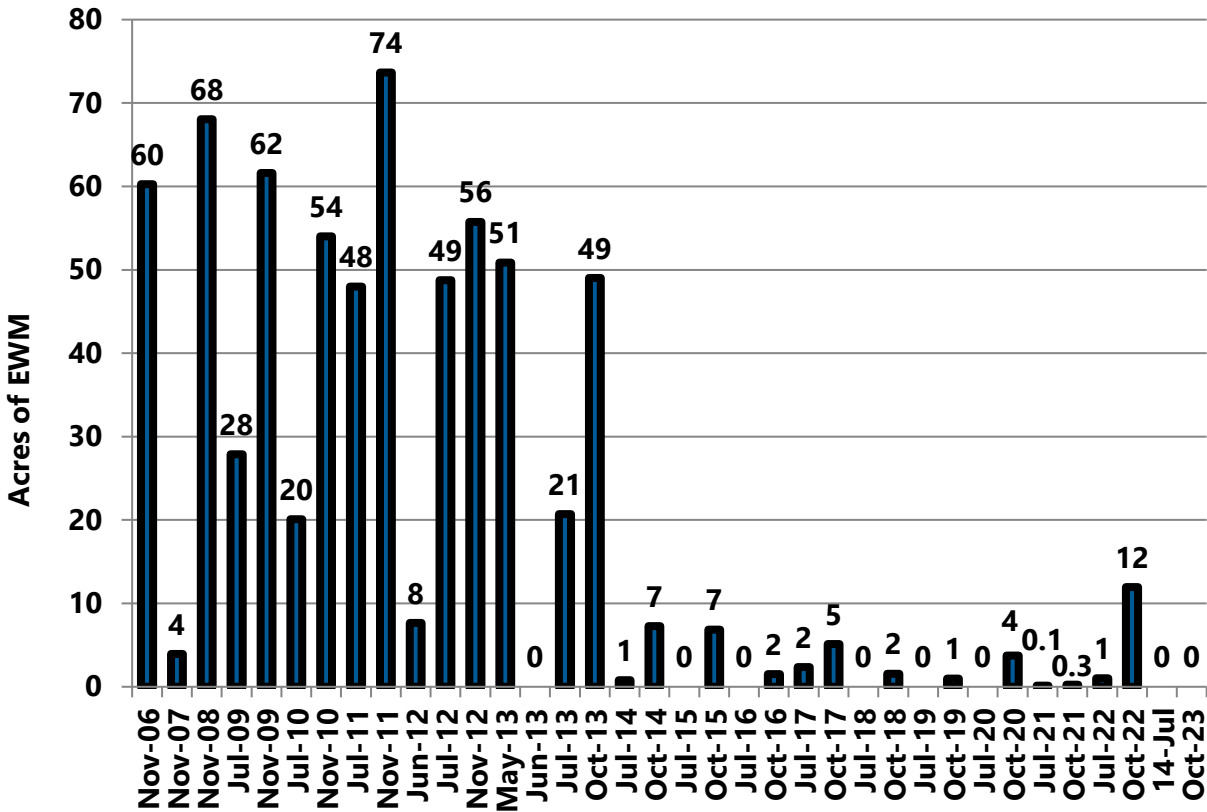


Figure 30 2006-2023 Beaver Dam Lake EWM Acreage: City Bay

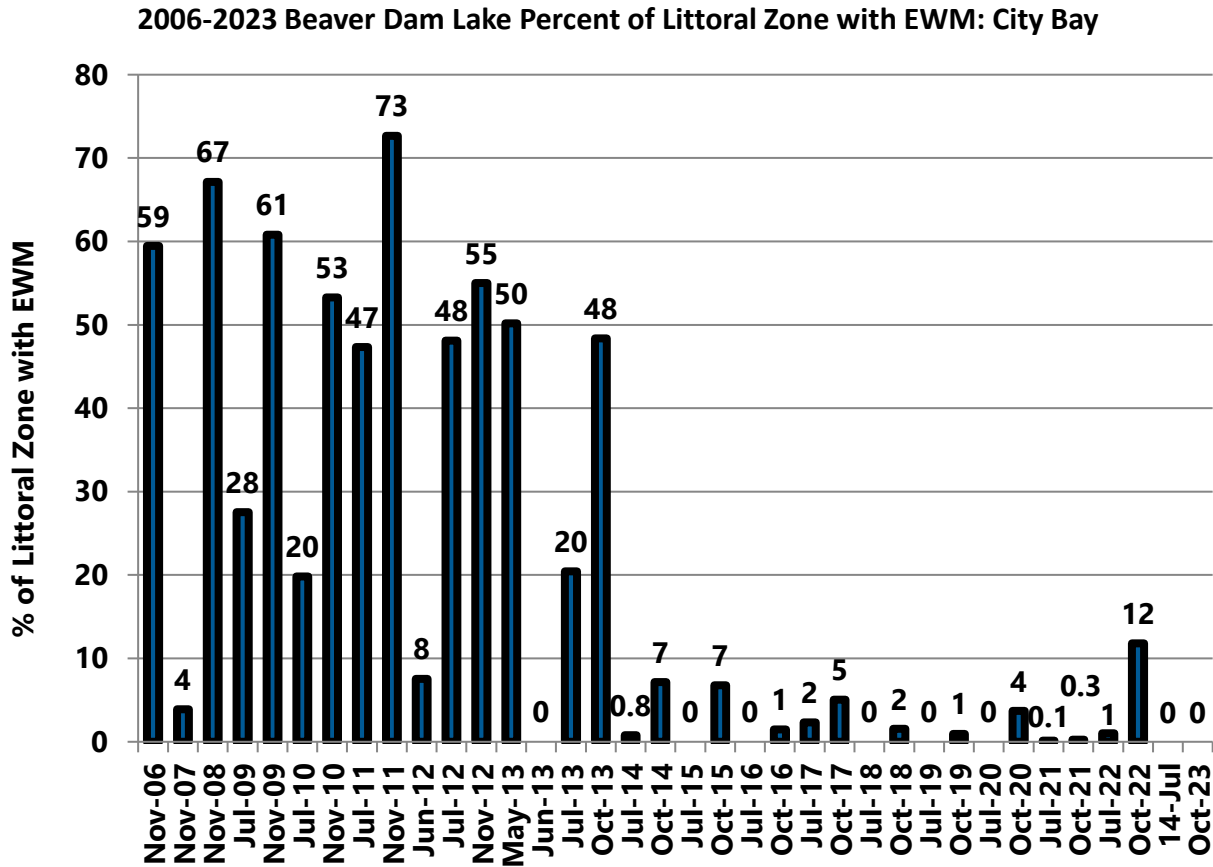


Figure 31 2006-2023 Percent of Littoral Zone with EWM: City Bay

3.7 East Lake

EWM was not observed in East Lake during 2018, 2019, and July of 2020. EWM was observed at one location near the northeast corner of East Lake during October 2020, but all EWM was rake removed. In 2021, EWM was not observed in East Lake during the July and October plant surveys. EWM was not observed during the July 2022 plant survey, but reappeared in October 2022. In 2023, EWM management in East Lake consisted of herbicide treatment of 11.70 acres. On June 9, a ProcellaCOR dose of 4 PDU was applied to Treatment Areas 16 through 21 shown on Figure 2. The treatment was successful and EWM was not observed in East Lake during the July and October plant surveys.

- EWM frequency decreased from 6 percent in fall of 2022 to 0 percent in July and October 2023 (Table 1 and Figure 32);
- EWM extent decreased from 3 acres in fall of 2022 to 0 acres in July and October 2023 (Table 2, Figure 4, Figure 6, and Figure 33); and
- Percent of littoral zone with EWM decreased from 4 percent in fall of 2022 to 0 percent in July and October 2023 (Table 3 and Figure 34).

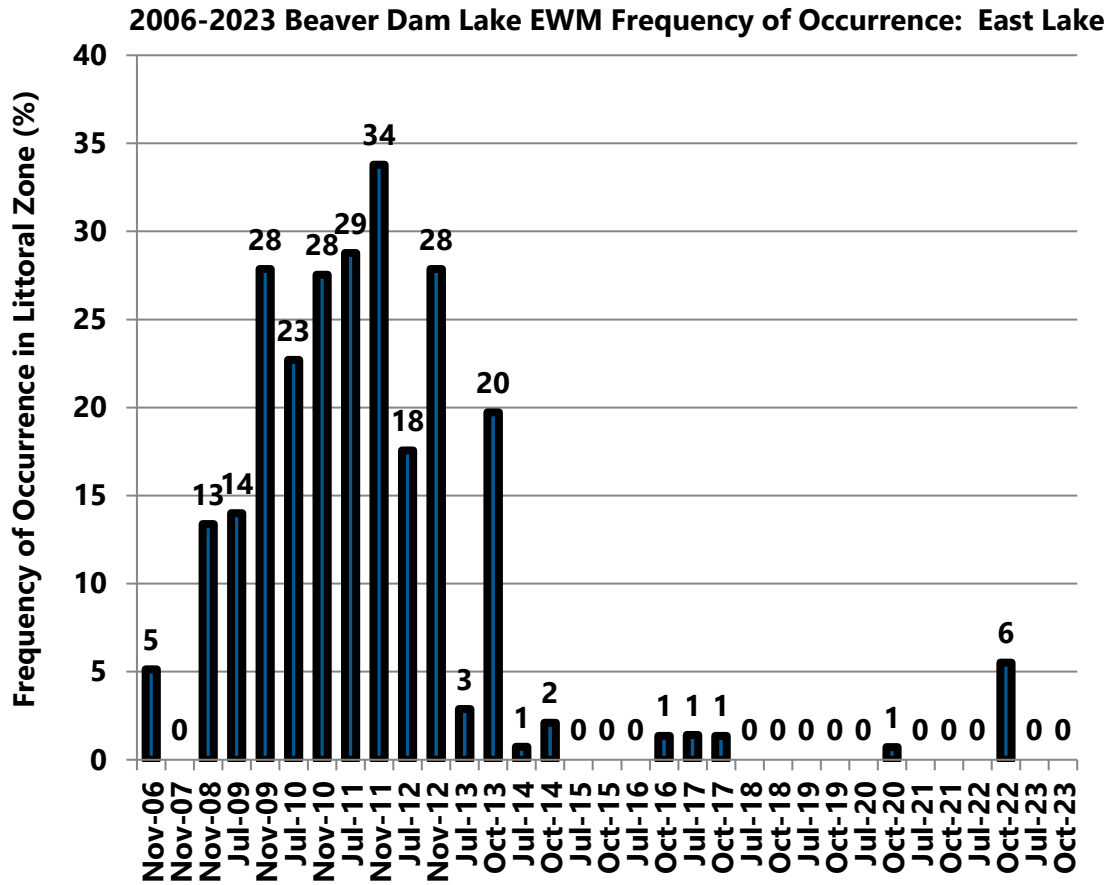


Figure 32 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: East Lake

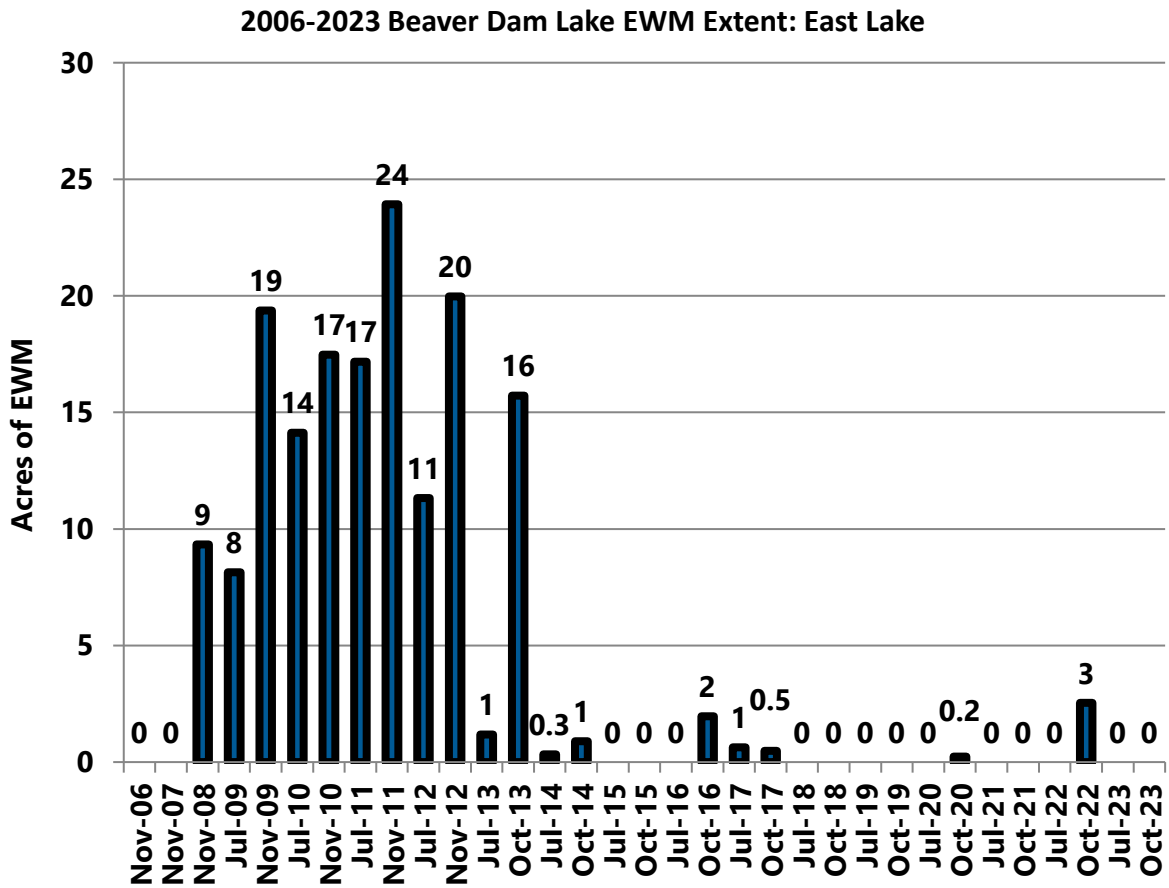


Figure 33 2006-2023 Beaver Dam Lake EWM Acreage: East Lake

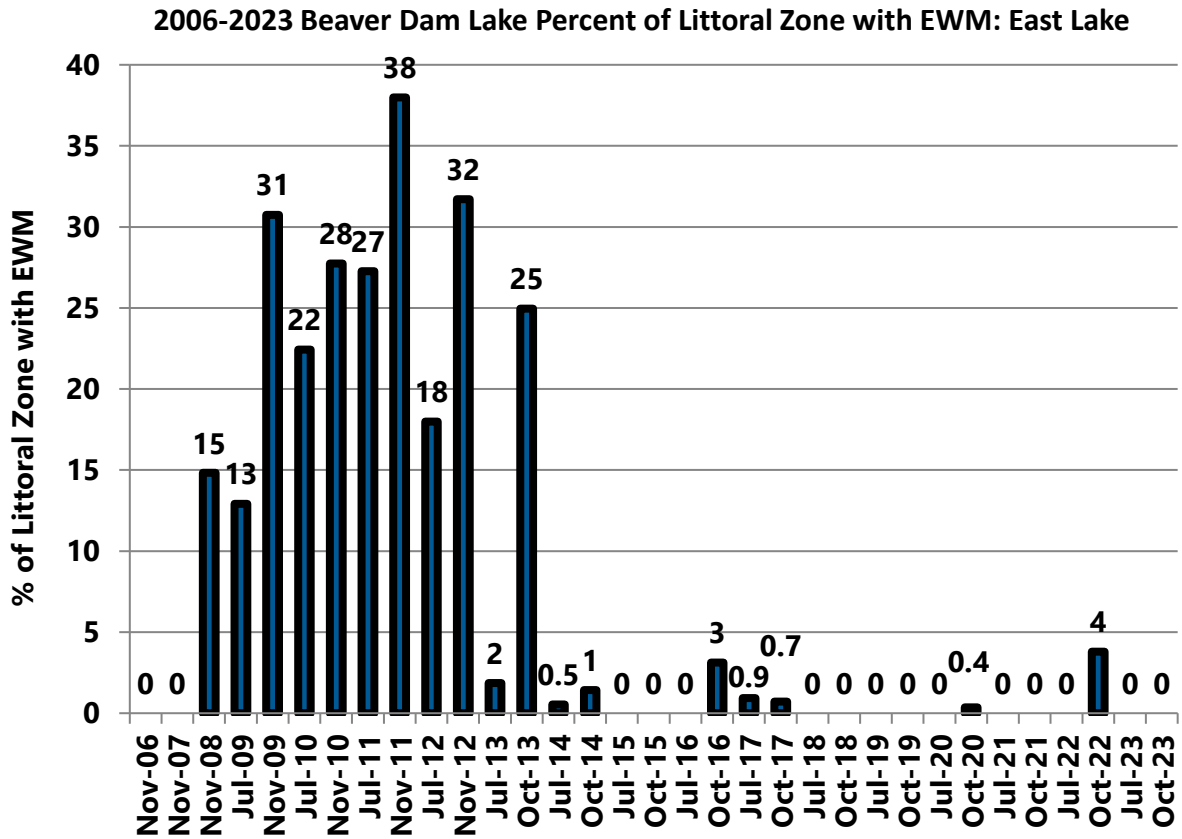
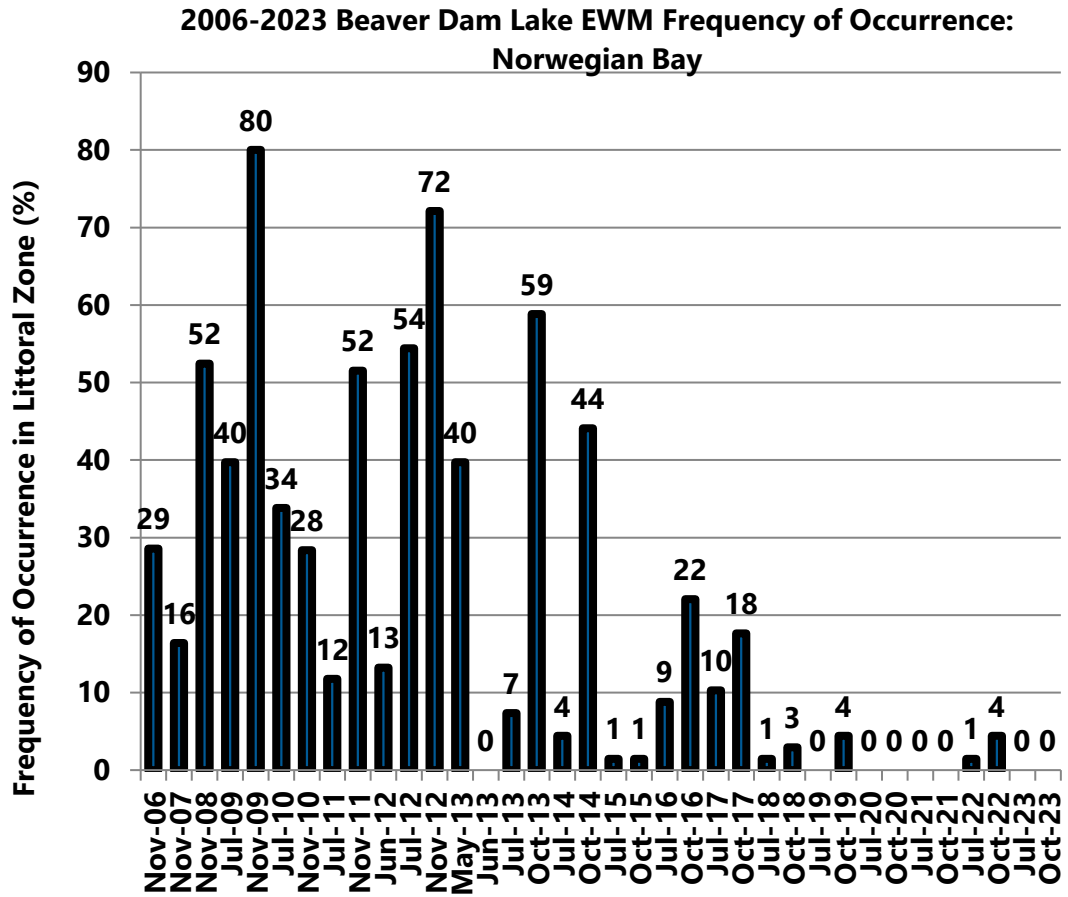


Figure 34 2006-2023 Percent of Littoral Zone with EWM: East Lake

3.8 Norwegian Bay

In 2020 and 2021, EWM was not observed in Norwegian Bay during either the July or October plant surveys. EWM reappeared in July 2022 and increased in extent between July and October 2022. In 2023, EWM management in Norwegian Bay consisted of herbicide treatment of 4.33 acres. On June 9, a ProcettaCOR dose of 4 PDU was applied to Treatment Areas 14 through 15 shown on Figure 2. The treatment was successful and EWM was not observed in Norwegian Bay during the July and October plant surveys.

- EWM frequency decreased from 4 percent in fall of 2022 to 0 percent in July and October 2023 (Table 1 and Figure 35);
- EWM extent decreased from 1 acre in fall of 2022 to 0 acres in July and October 2023 (Table 2, Figure 4, Figure 6, and Figure 36); and
- Percent of littoral zone with EWM decreased from 2 percent in fall of 2022 to 0 percent in July and October 2023 (Table 3 and Figure 37).



**Figure 35 2006-2023 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone:
Norwegian Bay**

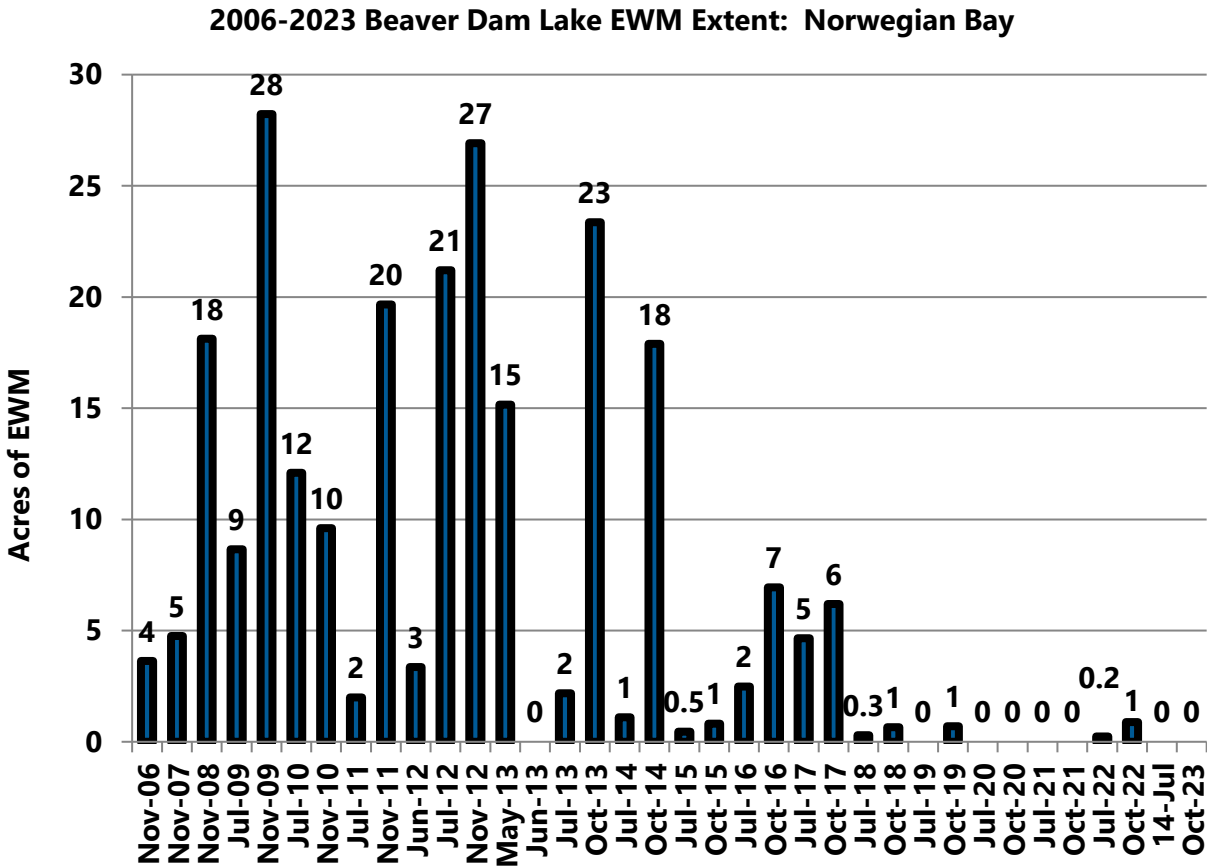


Figure 36 2006-2023 Beaver Dam Lake EWM Acreage: Norwegian Bay

**2006-2023 Beaver Dam Lake Percent of Littoral Zone with EWM:
 Norwegian Bay**

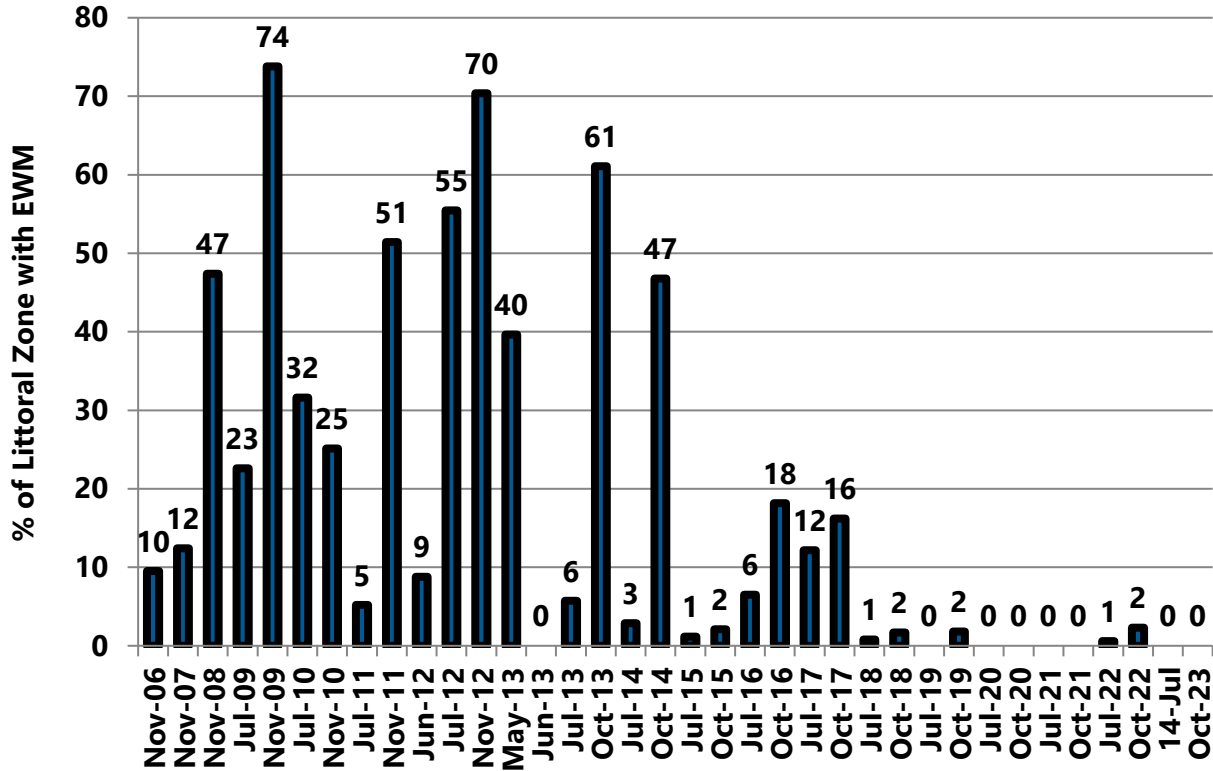


Figure 37 2006-2023 Percent of Littoral Zone with EWM: Norwegian Bay

4.0 Summary

Goal 1 of the District's Beaver Dam Lake Aquatic Plant Management Plan is to "reduce Eurasian watermilfoil (EWM) and curly-leaf pondweed (CLP) levels to less than or equal to 7 percent of the littoral zone while minimizing harm to native aquatic plants."¹ The goal was attained in 2017 and treatments in 2018 through 2019 continued goal attainment. A 2020 treatment intended to continue goal attainment, but EWM extent increased during the 2020 growing season to 12 percent of the littoral zone by October and failed to meet the District's EWM goal. A 2021 treatment attained the District's EWM goal and the 2022 treatment intended to continue goal attainment. However, EWM extent increased during the 2022 growing season to 10 percent of the littoral area and again failed to meet the District's EWM goal.

In 2023, the District treated 40.55 acres with the herbicide ProcellaCoR on June 9 — 17.86 acres in West Lake, 3.12 acres in Williams Bay, 1.89 acres in Library Lake, 4.33 acres in Norwegian Bay, 11.70 acres in East Lake, and 1.65 acres in City Bay (Table 4, Figure 1, and Figure 2) — and 125.37 acres with 2,4-D — 61.8 acres in Rabbit Island Bay on May 24, 33.28 acres in City Bay on May 18, and 30.29 acres in Cemetery Bay on May 19.

The successful 2023 treatment reduced EWM extent from 10 percent of the littoral area in October 2022 to 0.26 percent in July 2023. EWM was only observed within one of the 2023 treatment areas in July — a single sample point in Cemetery Bay. However, EWM was observed at two untreated areas in July — a single sample point in West Lake and a single sample point in Williams Bay — but was not observed at these locations in October. The appearance of EWM in Rabbit Island Bay during October and the increase in EWM extent during the growing season in Cemetery Bay increased the EWM extent in Beaver Dam Lake from 0.26 percent of the littoral area in July to 0.73 percent in October. In Rabbit Island Bay, EWM was not observed in July, but was observed and rake removed from a single sample point in October. In Cemetery Bay, EWM expanded from one sample point in July to six sample points in October (Table 3). Nonetheless, the District's EWM goal was attained in 2023. Herbicide treatment of Cemetery Bay in 2024 will continue goal attainment. Because the EWM observed in Rabbit Island Bay during October was rake removed and EWM was not observed in West Lake, Williams Bay, Library Lake, Norwegian Bay, East Lake, and City Bay during October, herbicide treatment is not needed in these areas during 2024.

The fall 2023 EWM frequency, extent, and percent of littoral area values were the lowest fall values observed during the 2006 through 2023 measurement period.

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