



Exhibit J

2019 EWM Treatment and Monitoring Results



Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: 2019 EWM Treatment Results
Date: November 26, 2019
Project: 49030011.20
c: James Bartlett (Lake Restoration, Inc.) and Alex Smith (WDNR)

The purpose of this memorandum is to present the results of the Beaver Dam Lake 2019 EWM management program. Memorandum contents include:

- Discussion of herbicide treatment of EWM during 2019.
- 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 2019 to assess the results of EWM management efforts. A survey of all plants was completed July 17 through 20 and 24. A survey of invasive species (EWM and curly-leaf pondweed) was completed October 13, 19, and 20. Sample locations are

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shown on maps found in Appendix E of the *Beaver Dam Lake Aquatic Plant Management Plan*.¹ The 2019 EWM data, together with historical data, are summarized in Tables 1 through 3.

The 2019 EWM management of Beaver Dam Lake included (1) spot treatment of EWM in West Lake, Williams Bay, Rabbit Island Bay, Norwegian Bay, and City Bay and (2) large scale treatment of EWM in Library Lake.

Because EWM was not observed in East Lake or Cemetery Bay during the fall 2018 plant survey, EWM management was not needed in 2019.

¹ Barr Engineering Company. 2018. *Beaver Dam Lake Aquatic Plant Management Plan*, Prepared for Beaver Dam Lake Management District. <http://www.beaverdamlake.org/apmp>

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Table 1 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Beaver Dam Lake

Location	% 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	July 2018	Fall 2018	July 2019	Fall 2019	
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		10.29	17.65	1.47	2.94	0.00	4.41	
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	0.00	0.00	0.00	0.00	
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	0.00	1.67	0.00	2.22	
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	0.00	0.00	0.00	5.62	14.61
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 ²	N/A ²	6.69	17.31	5.50	11.52	0.00	1.21	4.28	8.36	5.83	11.64	2.76	6.83	0.31	0.31 ¹	
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 ²	N/A ²	0.96	6.36	0.00	9.43	0.00	0.00	1.87	8.33	1.89	0.93	0.94	1.90	0.94	0.94 ¹	
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	0.84	4.17	0.00	3.36 ²	
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	0.00	1.44	3.60	5.76	10.07	0.00	0.72 ¹	
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	0.21	1.05	1.04	4.18	
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	2.75	6.27	0.29	1.01	
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	1.71	4.12	0.60	2.31	

N/A¹ Frequency of occurrence not available because the area was not surveyed

N/A² 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.

N/A³ 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)

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

²The 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.

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Table 2 2006-2019 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	July 2018	Fall 2018	July 2019	Fall 2019	
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	0.30	0.65	0.00	0.70	
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	0.00	0.00	0.00	0.00	
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	0.00	1.56	0.00	0.97	
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	0.00	0.00	0.00	1.22	4.10
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	5.46	12.35	1.55	0.36 ³	
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	0.72	0.54	0.27	0.25 ³	
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	0.27	1.32	0.00	0.62 ⁴	
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	0.76	1.85	0.00	0.04 ³	
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	0.30	2.21	1.22	5.77	
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	7.21	16.06	1.82	1.27	
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	7.52	18.27	3.04	7.05	

N/A¹ EWM extent not available because the area was not surveyed

² EWM 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.

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Table 3 2006-2019 % of Littoral Zone with EWM in Beaver Dam Lake

Location	% 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	July 2018	Fall 2018	July 2019	Fall 2019
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	0.78	1.70	0.00	1.83
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	0.00	0.00	0.00	0.00
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	0.00	1.54	0.00	0.96
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	0.00	0.00	2.26	7.60
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	3.70	8.37	1.05	0.24 ¹
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	1.51	1.13	0.57	0.52 ¹
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	0.44	2.16	0.00	1.01 ²
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	5.54	13.49	0.00	0.29 ¹
East Lake Total:	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	0.12	0.85	0.47	2.22
West Lake Total:	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	2.67	5.95	0.67	0.47
Beaver Dam Lake Total	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	1.42	3.45	0.57	1.33

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.

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1.0 Herbicide Treatment of EWM

In 2019, the Beaver Dam Lake Management District treated 47.61 acres of EWM with herbicide: 10.00 acres with 2,4-D, 16.03 acres with diquat, 18.20 acres with Aquasstrike, and 3.38 acres with ProcellaCOR (Table 4). The District goal of reducing Eurasian watermilfoil (EWM) to no more than 7 percent of the littoral zone area while minimizing harm to native aquatic plants was attained in 2017 (Table 3). The 2019 herbicide treatment was intended continue goal attainment for the lake and further reduce EWM extent. Six areas of the lake received herbicide treatment in 2019—West Lake, Williams Bay, Rabbit Island Bay, Library Lake, Norwegian Bay, and City Bay. Herbicide treatment areas are shown in Figures 1 through 3.

Table 4 2018 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	Expected Whole Bay/Lake Concentration (ppm)
West Lake	12.35	Herbicide Treatment	18.20	Aquasstrike	6.5 quarts/acre foot	--
		Herbicide Treatment	4.84	Diquat	2 gallons per acre	--
		Herbicide Treatment	3.38	ProcellaCOR	4 PDU/acre foot ¹	
Williams Bay	0.54	Herbicide Treatment	2.10	Diquat	2 gallons per acre	
Rabbit Island Bay	1.32	Herbicide Treatment	2.76	Diquat	2 gallons per acre	--
Library Lake	1.85	Herbicide Treatment	10.00	2,4-D	0.44 ppm ae ² 2,4_D	0.40 ppm ae ² 2,4-D
Norwegian Bay	0.65	Herbicide Treatment	2.86	Diquat	2 gallons per acre	
City Bay	1.56	Herbicide Treatment	3.47	Diquat	2 gallons per acre	

¹One Prescription Dose Unit (PDU) contains 3.17 fluid ounces of product.

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

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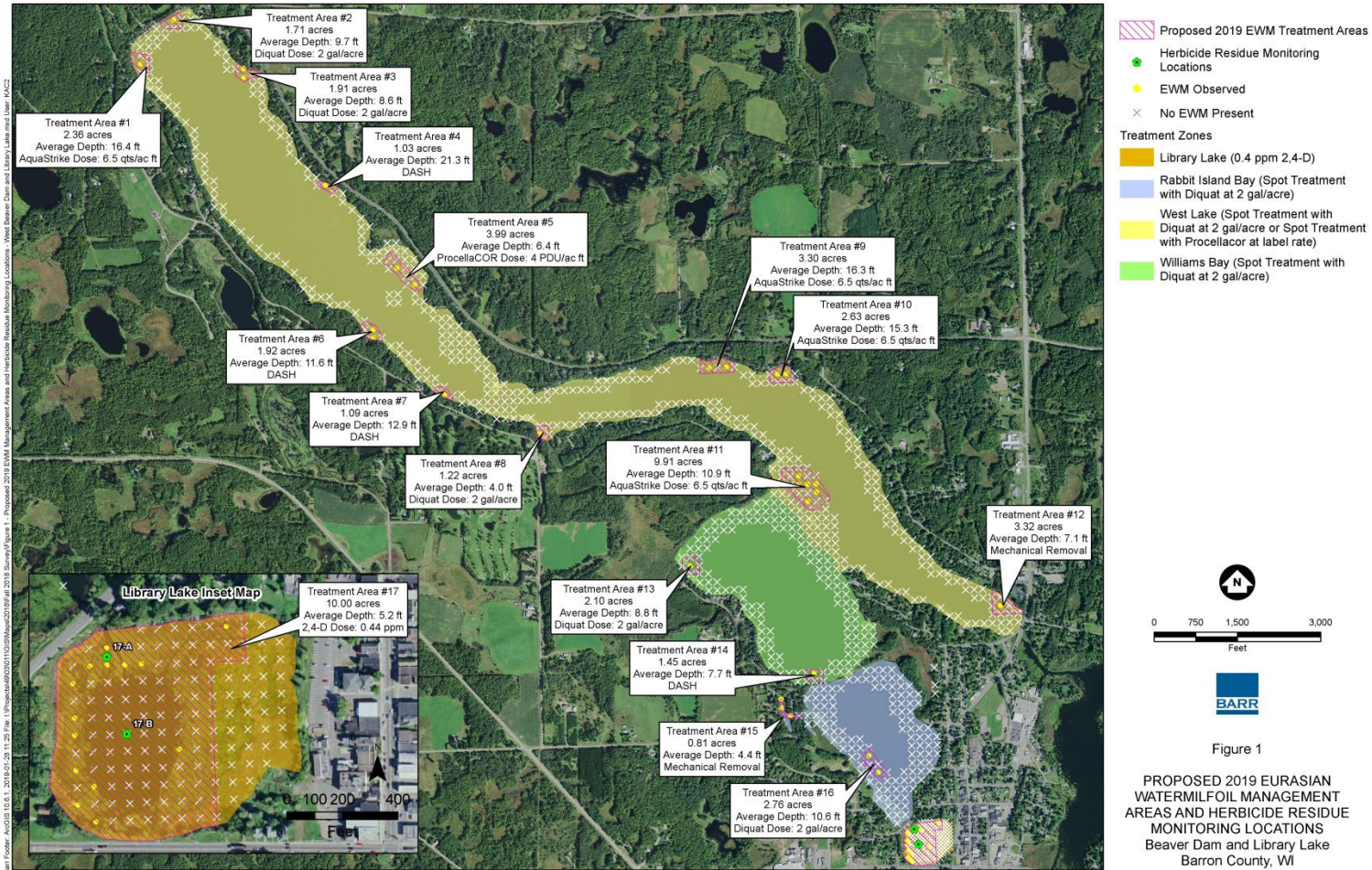


Figure 1 2019 Beaver Dam Lake Eurasian Watermilfoil Treatment Areas and Herbicide Residue Monitoring Locations: West Lake

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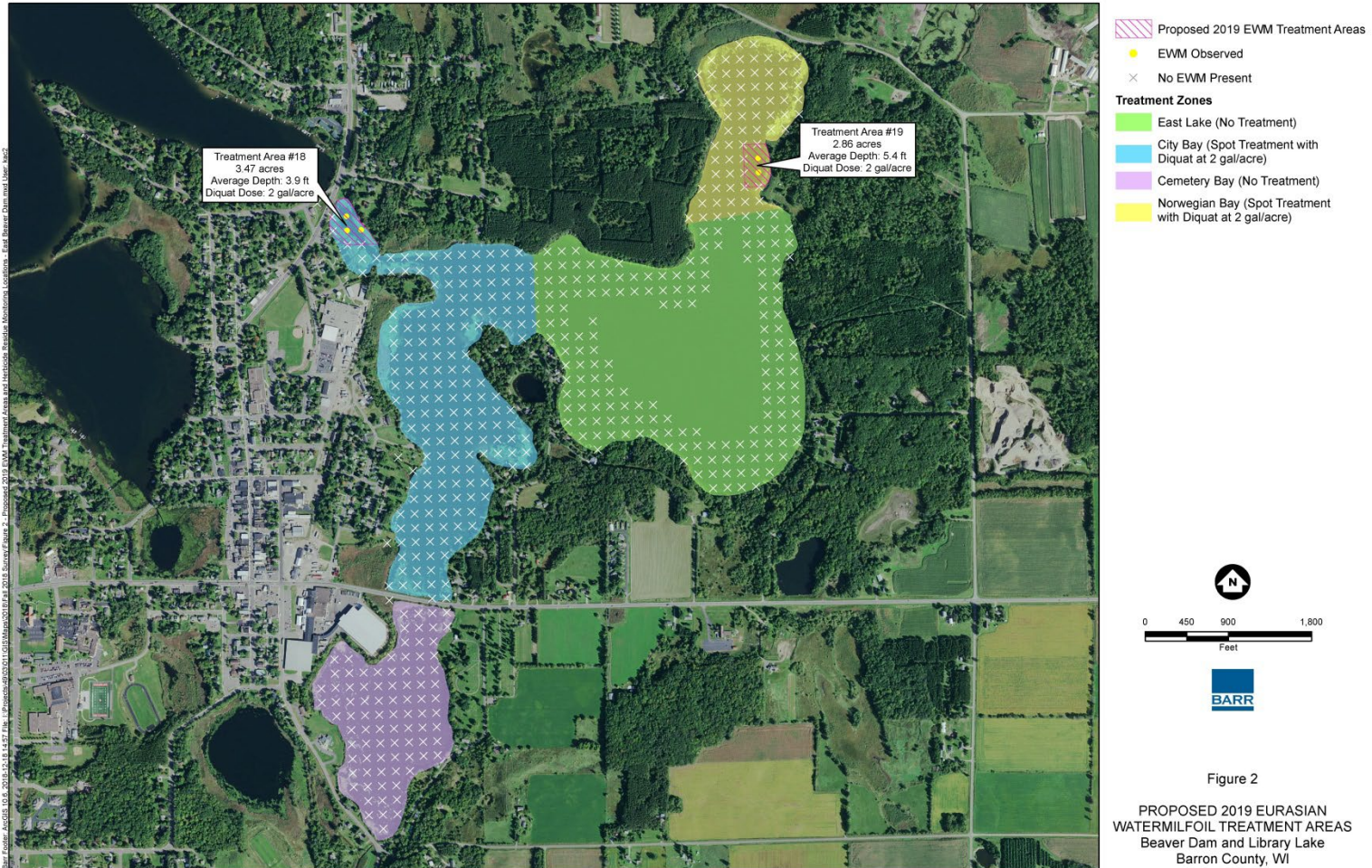


Figure 2 2019 Beaver Dam Lake Eurasian Watermilfoil Treatment Areas: East Lake

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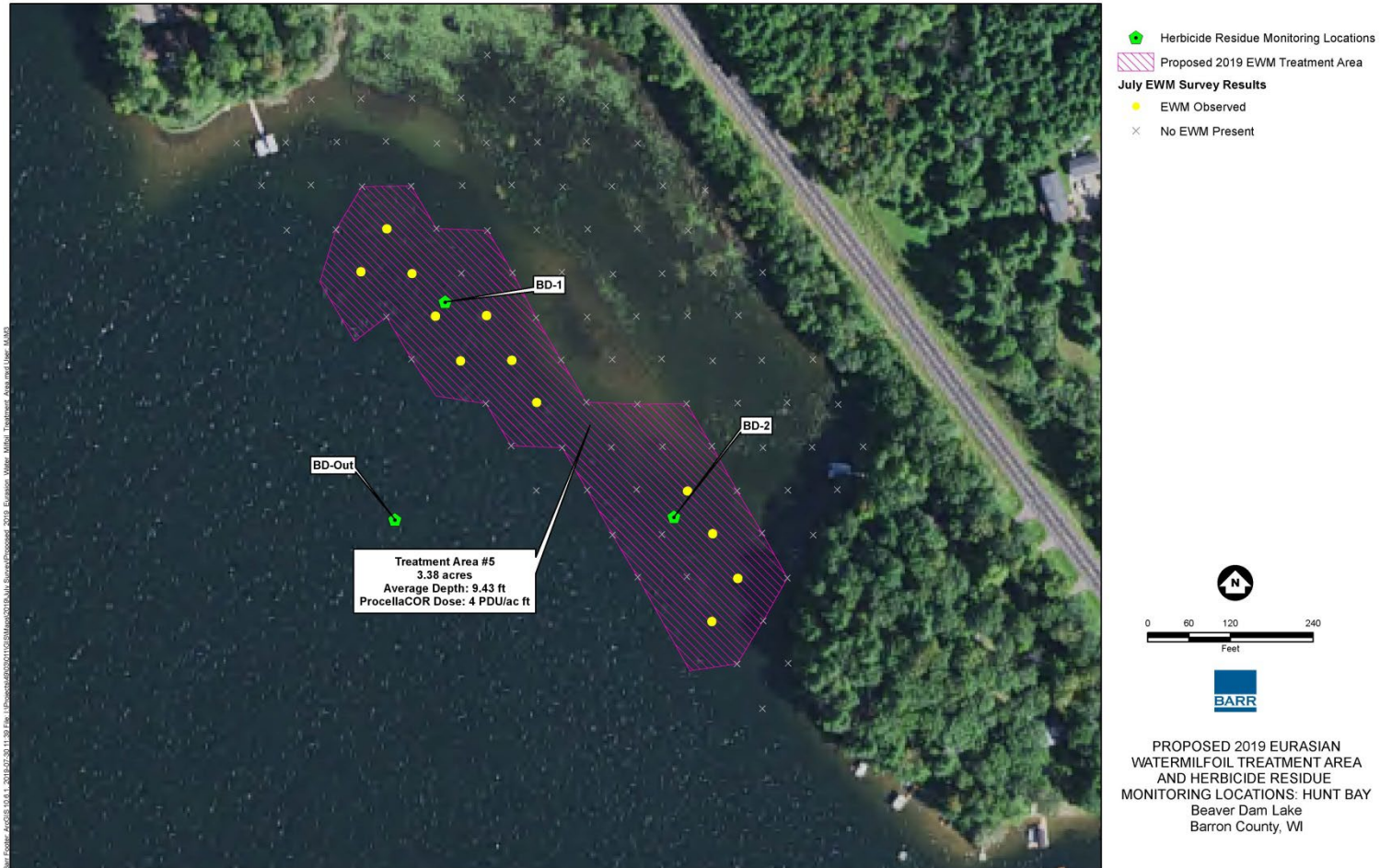


Figure 3 2019 Beaver Dam Lake Eurasian Watermilfoil Treatment Area and Herbicide Monitoring Locations: Hunt Bay

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In 2019, 2,4-D residue samples were collected from two Library Lake locations: 17A and 17B. Herbicide residue sample locations are shown in Figure 1. Samples were collected at intervals of approximately 0.04, 0.16, 1, 2, 3, 5, 7, 12, 19, and 26 days after treatment (DAT). Samples at each site were collected at mid-depth (above the thermocline) and preserved with 3 drops of muriatic acid to fix the 2,4-D and prevent degradation. Samples were stored in a refrigerator until shipped to the Wisconsin Department of Hygiene Laboratory in Madison, Wisconsin for analysis of 2,4-D.

In 2019, ProcellaCOR samples were collected at elbow depth from 3 Hunt Bay locations: BD-1, BD-2, and BD-Out. Samples were collected at intervals of 3, 6, 9, 12, 24, and 48 hours after treatment (HAT) and shipped to SePro for analysis. The monitoring program was coordinated by the WDNR as a part of a statewide effort to evaluate ProcellaCOR residue after treatments. Lab analyses were funded by WDNR.

2.0 Lake-Wide EWM

The 2019 EWM management efforts:

- Reduced EWM frequency by 85 percent—from 4 percent in fall of 2018 to 0.6 percent in July of 2019 (Table 1 and Figure 4),
- Reduced EWM extent by 83 percent—from 18 acres in fall of 2018 to 3 acres in July of 2019 (Table 2 and Figure 5),
- Reduced percent of littoral zone with EWM by 83 percent—from 3.5 percent in fall of 2018 to 0.6 percent in July of 2019 (Table 3 and Figure 6).

However, expansion of EWM between July and October:

- Increased EWM frequency from 0.6 percent in July of 2019 to 2.3 percent in October of 2019 (Table 1 and Figure 4),
- Increased EWM extent from 3 acres in July of 2019 to 7 acres in October of 2019 (Table 2 and Figure 5),
- Increased percent of littoral zone with EWM from 0.6 percent in July of 2019 to 1.3 percent in October of 2019 (Table 3 and Figure 6).

The fall 2019 EWM extent was the lowest fall EWM extent observed since monitoring began in 2006. Fall EWM extent during 2006 through 2018 ranged from 18 acres to 176 acres compared with 7 acres in fall of 2019 (Table 2 and Figure 5). The percent of littoral area with EWM during fall of 2006 through 2018 ranged from 3 percent to 34 percent compared with 1.3 percent in fall of 2019 (Table 3 and Figure 6).

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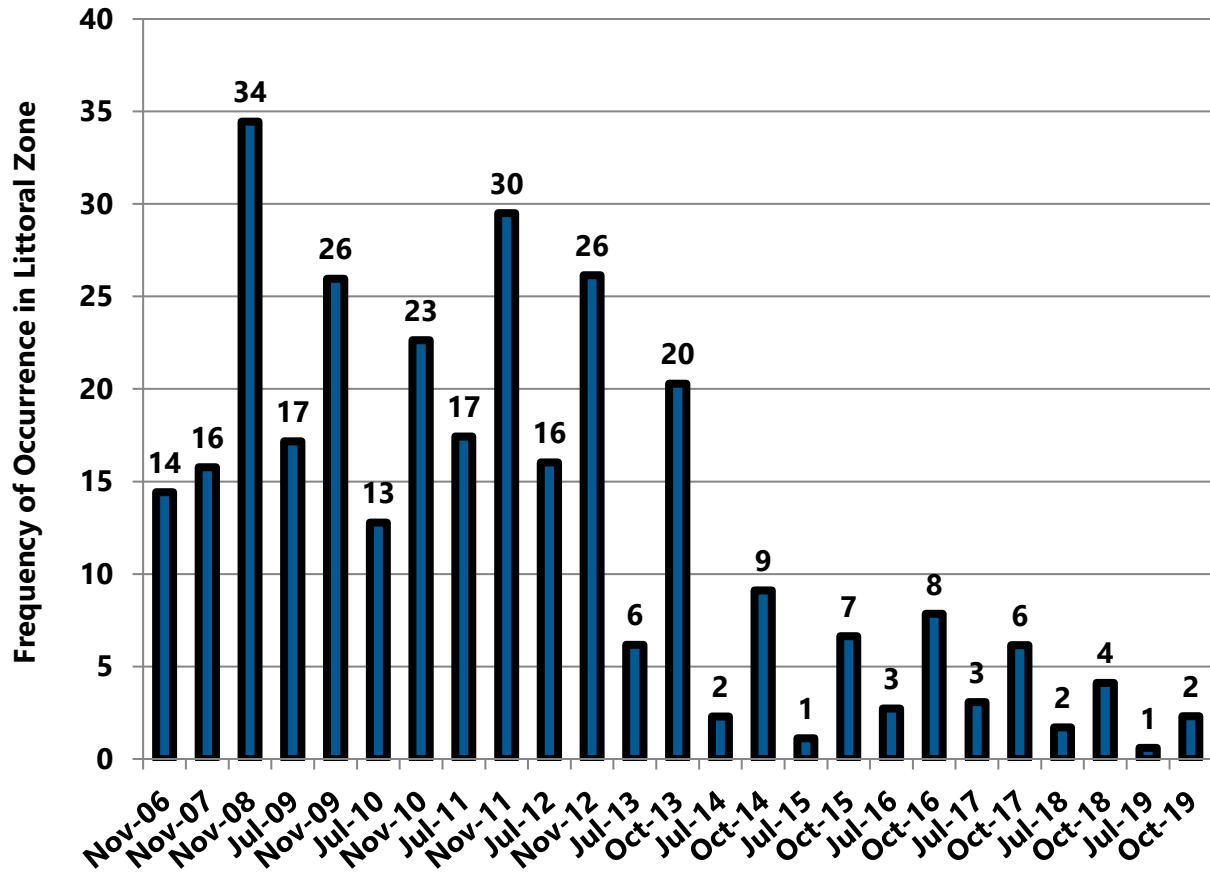


Figure 4 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in the Littoral Zone

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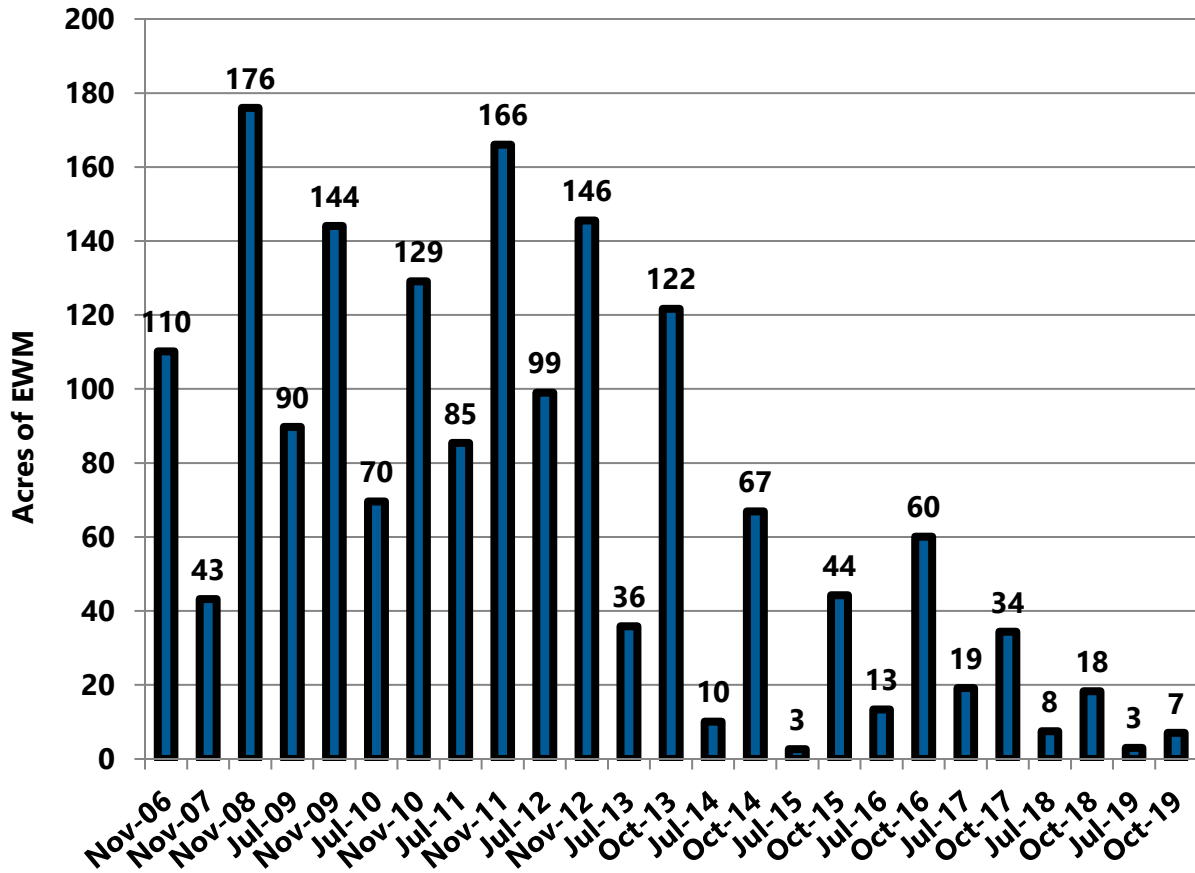


Figure 5 2006-2019 Beaver Dam Lake EWM Acreage

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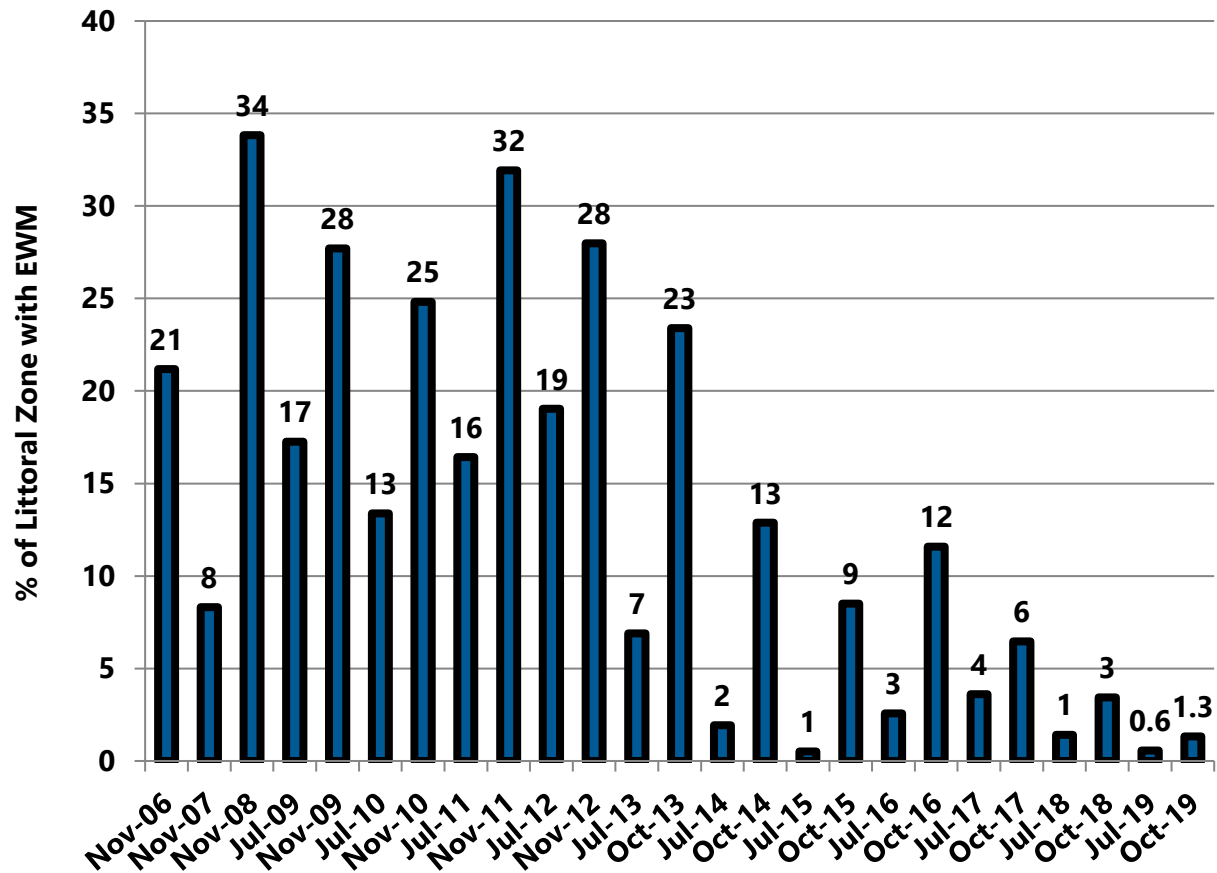


Figure 6 2006-2019 Beaver Dam Lake Percent of Littoral Zone with EWM

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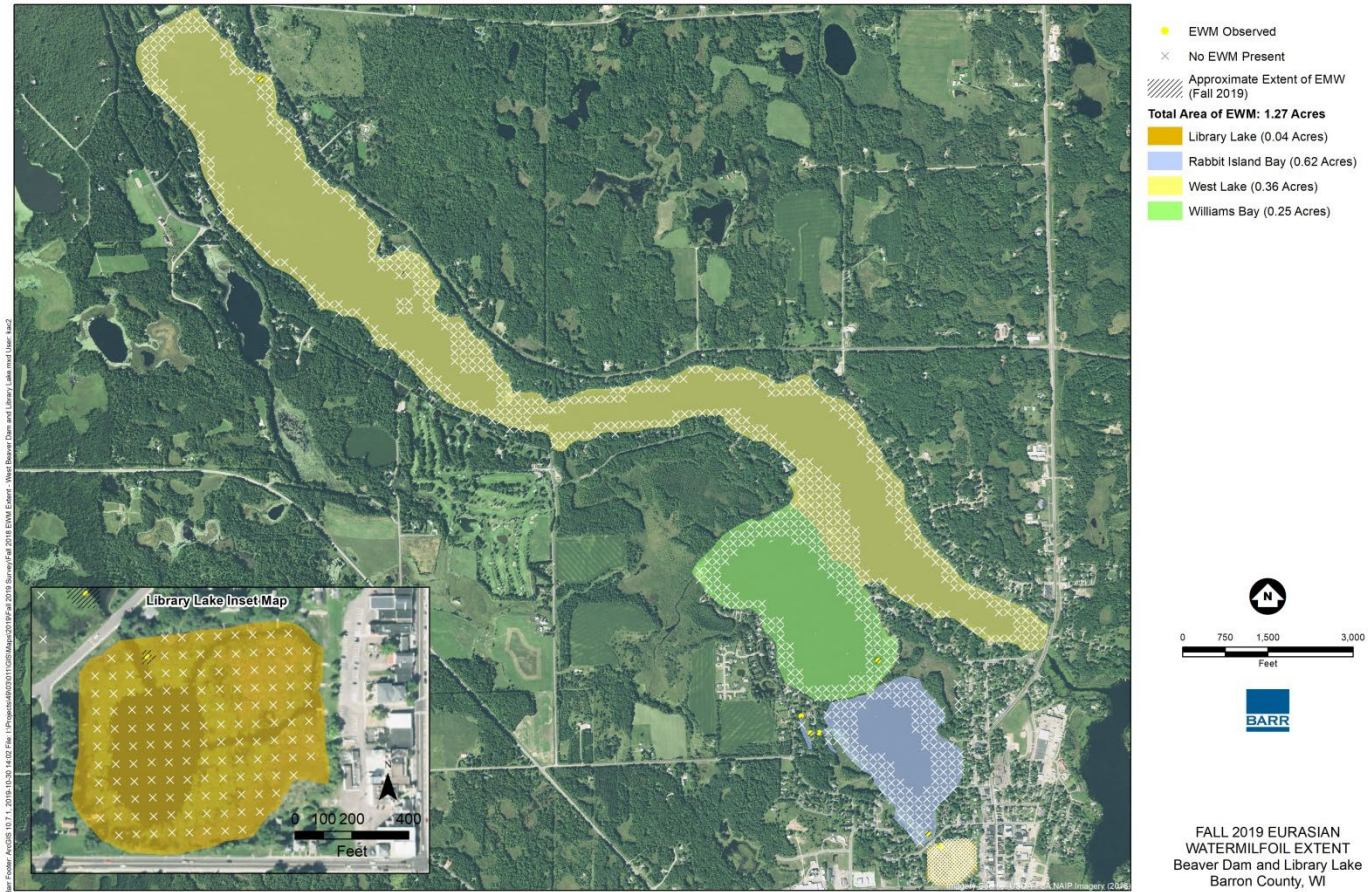


Figure 7 Fall 2019 Eurasian Watermilfoil Extent in Beaver Dam Lake (West Basins)

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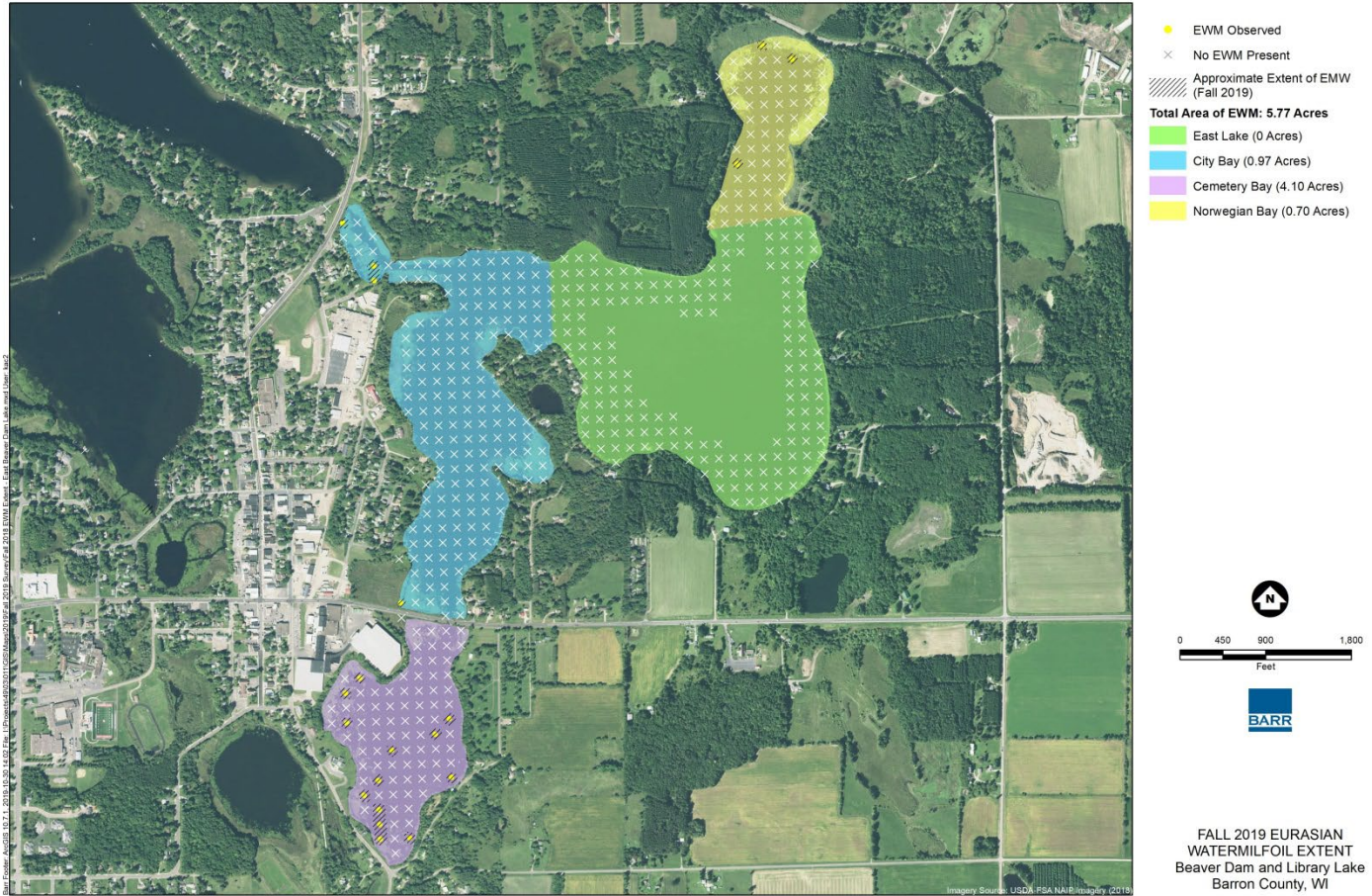


Figure 8 Fall 2019 Eurasian Watermilfoil Extent in Beaver Dam Lake (East Basins)

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3.0 Individual EWM Management Areas

3.1 West Lake

In 2019, EWM management in West Lake consisted of herbicide treatment in 8 locations totaling 26.42 acres (18 percent of the littoral area of West Lake). Treatment locations are shown in Figures 1 and 3.

The herbicide diquat was applied to three locations – Treatment Areas 2 and 3 on May 20 and Treatment Area 8 on May 14. The three individual areas ranged in size from 1.22 acres to 1.91 acres and totaled 4.84 acres. The herbicide diquat was applied at a dose of 2 gallons per acre.

The herbicide Aquastrike was applied to four locations – Treatment Area 1 on May 15, Treatment Areas 9 and 10 on May 29, and Treatment Area 11 on May 30. The four individual areas ranged in size from 2.36 acres to 9.91 acres (Figure 1) and totaled 18.20 acres. The four areas were treated with Aquastrike at a dose of 6.5 quarts per acre.

Because EWM was not observed in Treatment Area 5 within Hunt Bay (Figure 1) during May, the area was not treated with ProcellaCOR. However, the July plant survey documented the presence of EWM in Hunt Bay. Results of the July plant survey were used to create a EWM treatment map for Hunt Bay (Figure 3). The Hunt Bay Treatment Area was designated as Treatment Area 5 and was similar in size to the area intended for treatment in spring (3.99 acre area intended for spring treatment compared with 3.38 acre area from July plant survey). Treatment Area 5 within Hunt Bay was treated with ProcellaCOR on August 19 at a dose of 4 Prescription Dose Units (PDU) per acre foot. 1 PDU contains 3.17 fluid ounces of product.

The 2019 herbicide treatment:

- Reduced EWM frequency from 7 percent in fall of 2018 to 0.3 percent in July of 2019 (Table 1 and Figure 9),
- Reduced EWM extent from 12 acres in fall of 2018 to 2 acres in July of 2019 (Table 2 and Figure 10),
- Reduced percent of littoral zone with EWM from 8 percent in fall of 2018 to 1 percent in July of 2019 (Table 3 and Figure 11).

EWM frequency remained stable between summer and fall plant surveys—0.3 percent in July and October. However, the treatment of EWM in Hunt Bay during August reduced EWM extent and percent of littoral area with EWM between the summer and fall plant surveys:

- From 2 acres in July of 2019 to 0.4 acres in October of 2019 (Table 2 and Figure 10),

- From 1 percent in July of 2019 to 0.2 percent in October of 2019 (Table 3 and Figure 11).

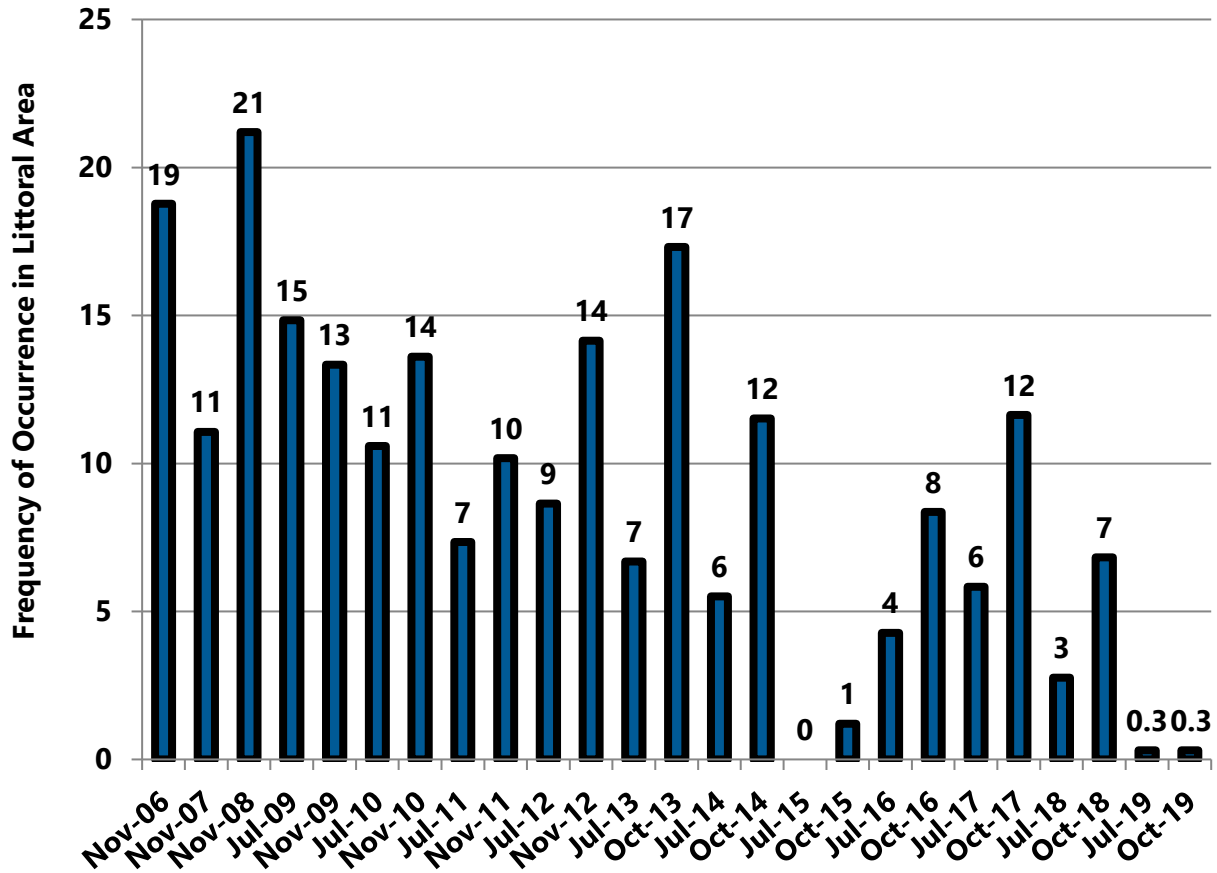


Figure 9 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: West Lake

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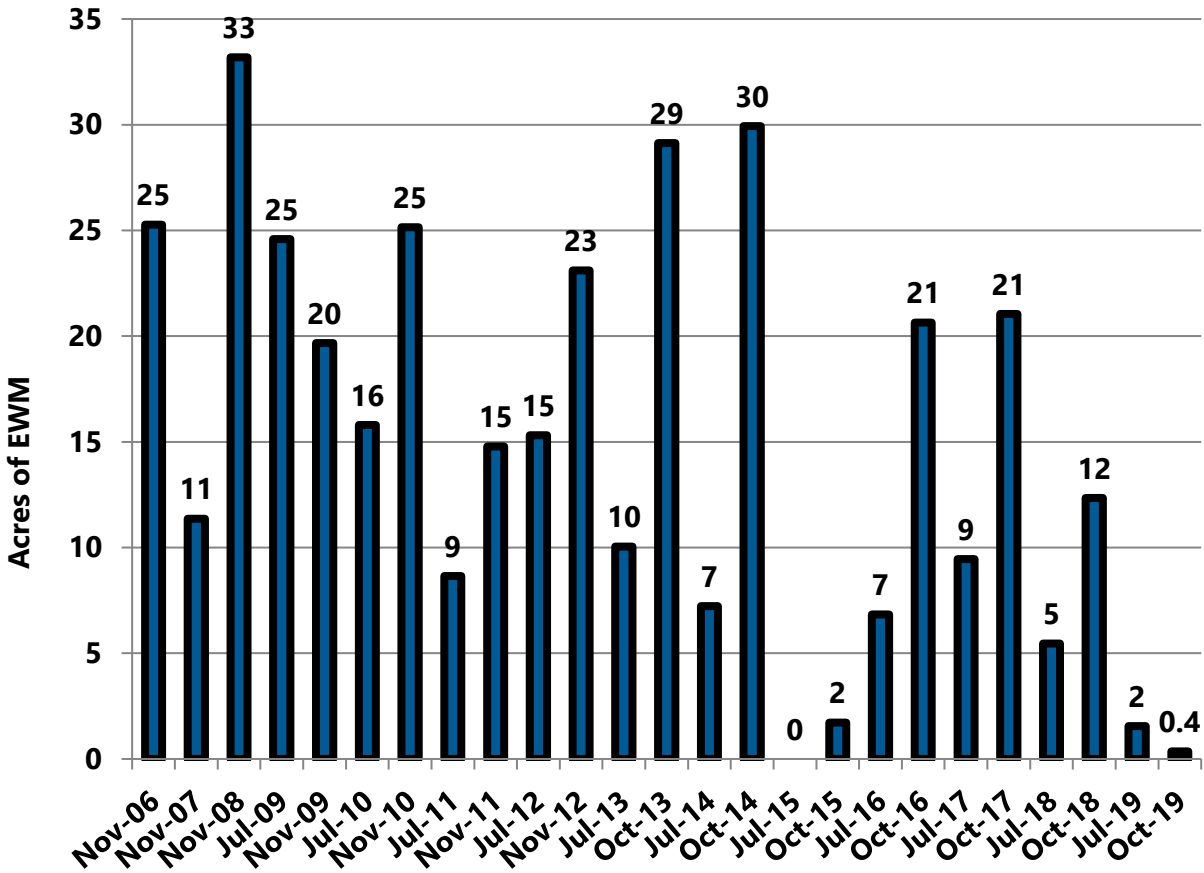


Figure 10 2006-2019 Beaver Dam Lake EWM Acreage: West Lake

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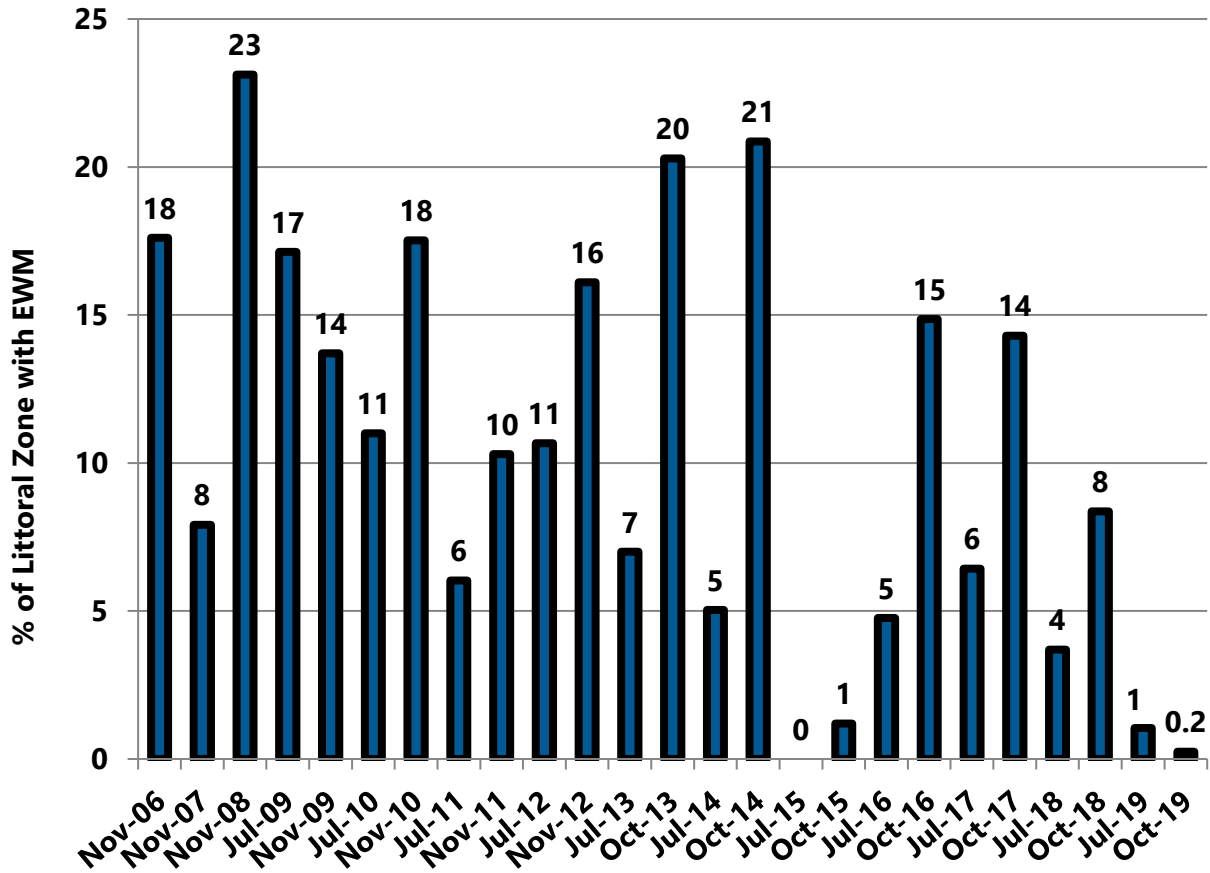


Figure 11 2006-2019 Percent of Littoral Zone with EWM: West Lake

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3.2 Williams Bay

In 2019, EWM management in Williams Bay consisted of herbicide treatment in one location, Treatment Area 13 (Figure 1), totaling 2.10 acres (4 percent of the littoral area of Williams Bay). The area was treated with the herbicide diquat at a dose of 2 gallons per acre on May 14.

The 2019 herbicide treatment:

- Reduced EWM frequency from 2 percent in fall of 2018 to 1 percent in July of 2019 (Table 1 and Figure 12),
- Reduced EWM extent from 0.54 acres in fall of 2018 to 0.27 acres in July of 2019 (Table 2 and Figure 13),
- Reduced percent of littoral zone with EWM from 1 percent in fall of 2018 to 0.6 percent in July of 2019 (Table 1 and Figure 14).

EWM frequency, extent, and percent of littoral area with EWM remained relatively stable between the summer and fall plant surveys (Tables 1 through 3 and Figures 12 through 14).



In 2019, small scale herbicide treatments in Williams Bay, pictured above, reduced EWM extent from 0.54 acres in fall of 2018 to 0.25 acres in fall of 2019.

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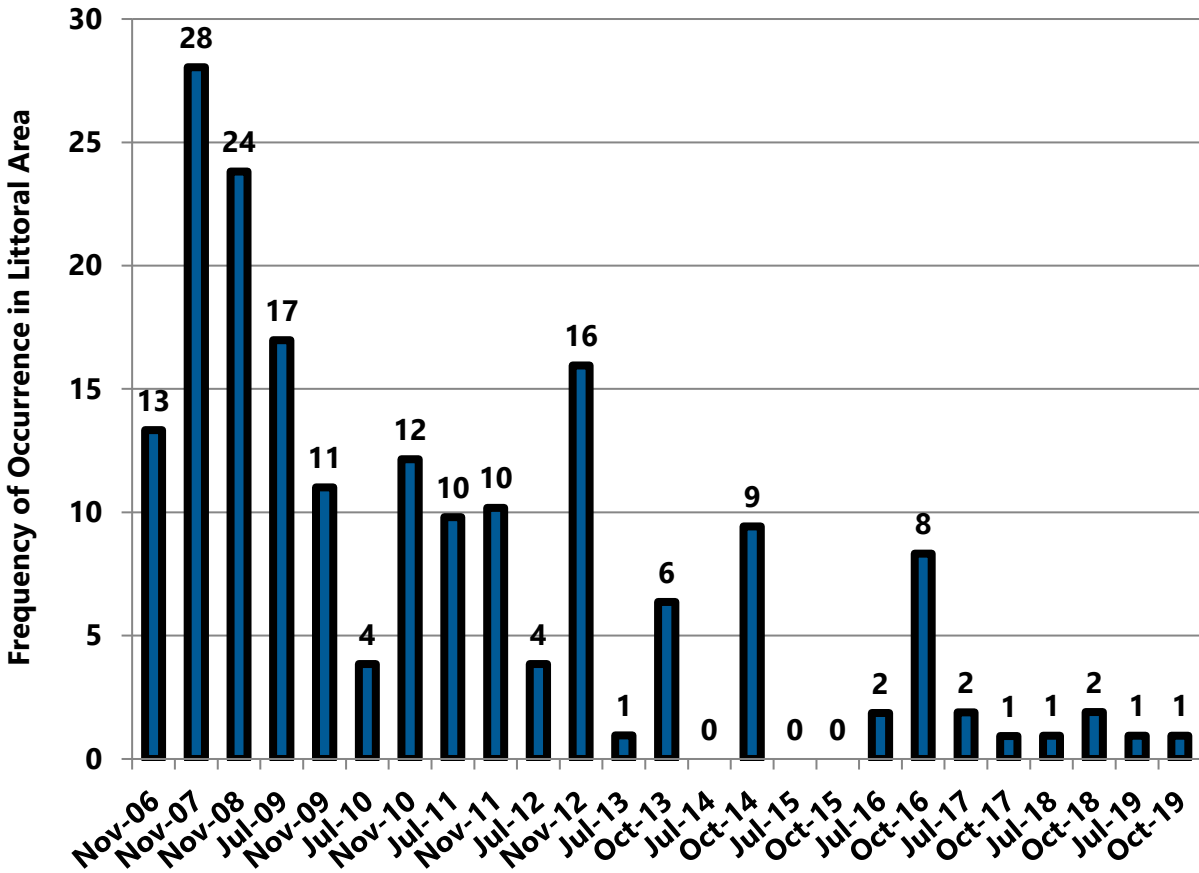


Figure 12 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Williams Bay

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Subject: 2019 EWM Treatment Results
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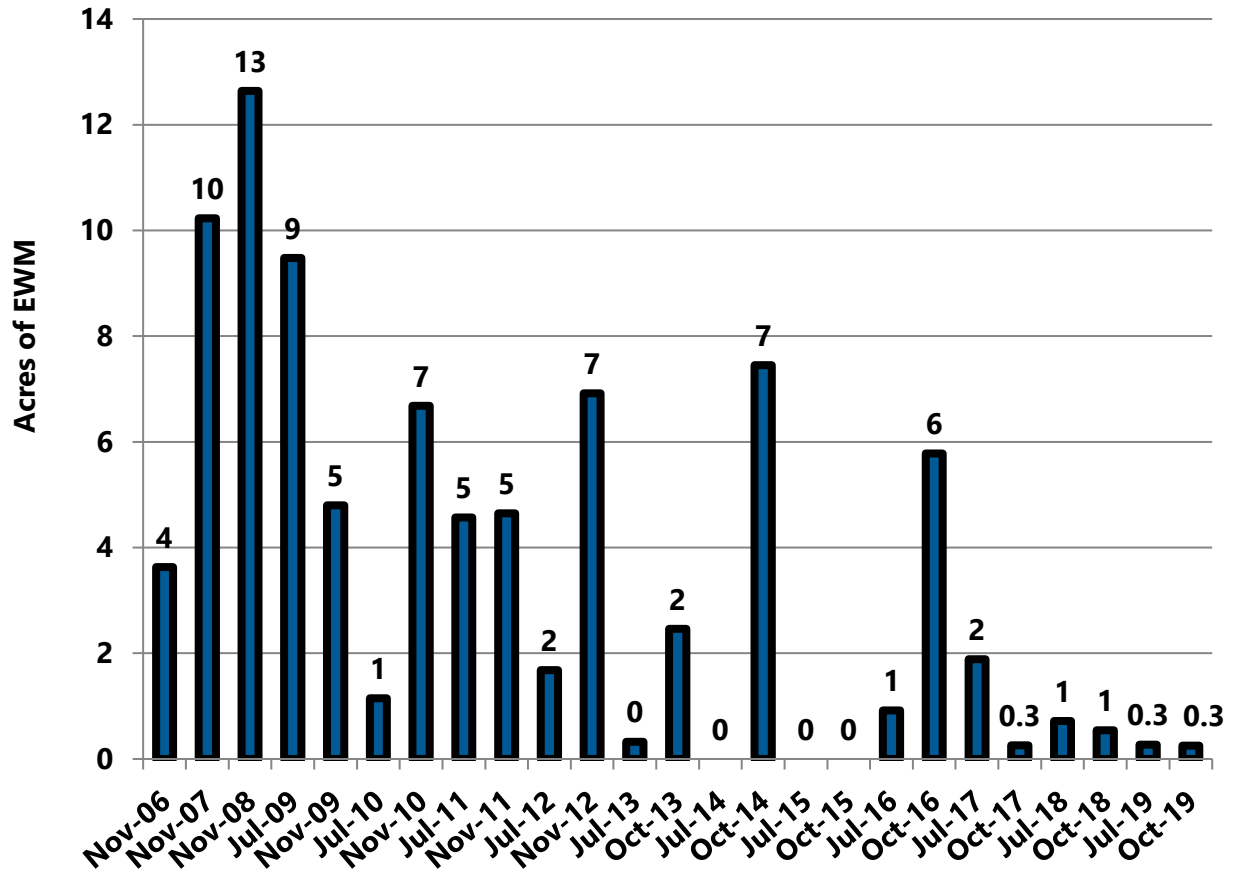


Figure 13 2006-2019 Beaver Dam Lake EWM Acreage: Williams Bay

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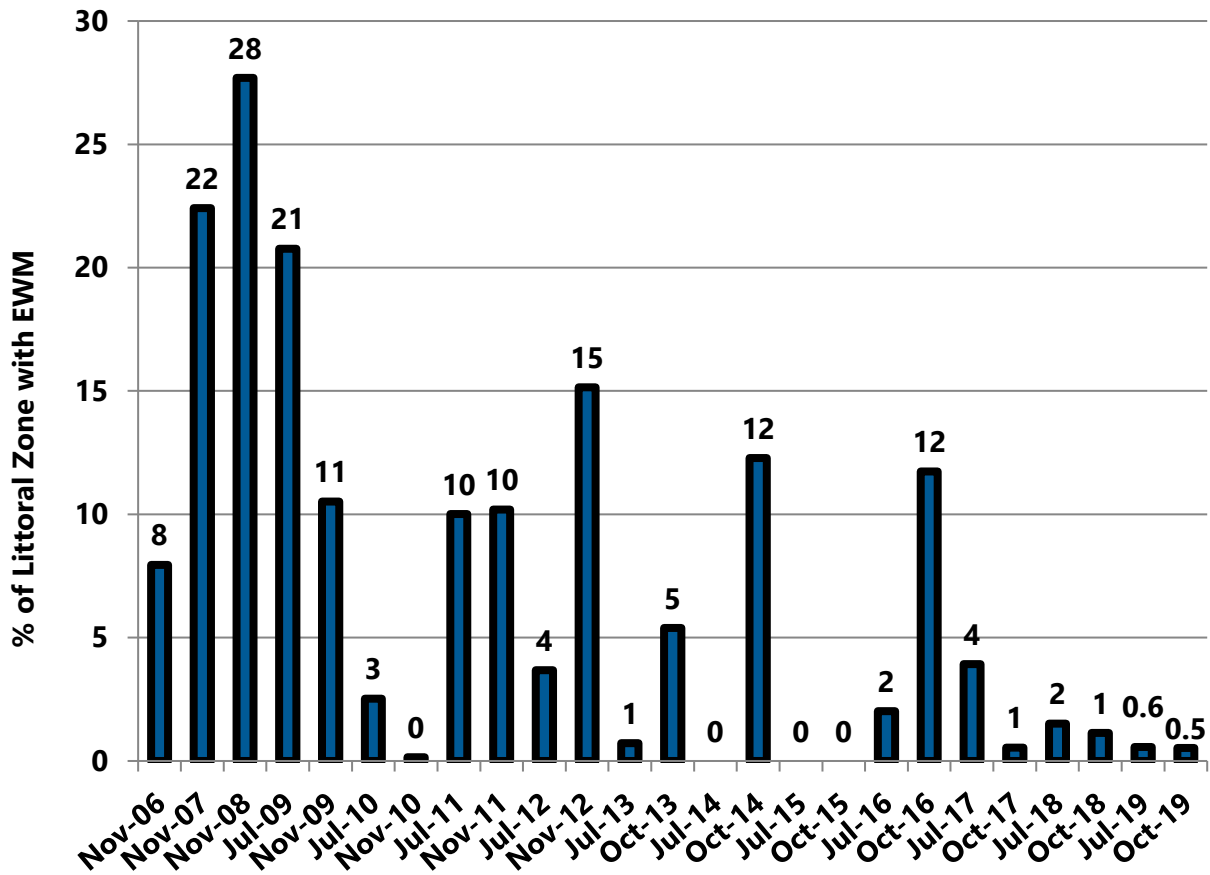


Figure 14 2006-2019 Percent of Littoral Zone with EWM: Williams Bay

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3.3 Rabbit Island Bay

In 2019, EWM management in Rabbit Island Bay consisted of herbicide treatment in one location, Treatment Area 16 (Figure 1), totaling 2.76 acres (5 percent of the littoral area of Rabbit Island Bay). The area was treated with the herbicide diquat at a dose of 2 gallons per acre on May 31. The treatment attained EWM control and EWM was not observed in Rabbit Island Bay during the fall survey (Figure 7).

The fall 2018 survey documented EWM in the west canal of Rabbit Island Bay. Although no EWM management occurred in 2019, EWM was not observed in the west canal of Rabbit Island Bay during the July survey. However, EWM was again documented in the west canal of Rabbit Island Bay during the fall plant survey (Figure 7).

The 2019 herbicide treatment:

- Reduced EWM frequency from 4 percent in fall of 2018 to 0 percent in July of 2019 (Table 1 and Figure 15);
- Reduced EWM extent from 1.3 acres in fall of 2018 to 0 acres in July of 2019 (Table 2 and Figure 16);
- Reduced percent of littoral zone with EWM from 2 percent in fall of 2018 to 0 percent in July of 2019 (Table 3 and Figure 17).

The reappearance of EWM in the west canal of Rabbit Island Bay during the 2019 fall plant survey increased Rabbit Island Bay EWM frequency, extent, and percent of littoral area with EWM between the summer and fall plant surveys:

- EWM frequency increased from 0 percent in July of 2019 to 3 percent in October of 2019 (Table 1 and Figure 15);
- EWM extent increased from 0 percent in July of 2019 to 0.6 acres in October of 2019 (Table 2 and Figure 16);
- Percent of littoral area with EWM increased from 0 percent in July of 2019 to 1 percent in October of 2019 (Table 3 and Figure 17).

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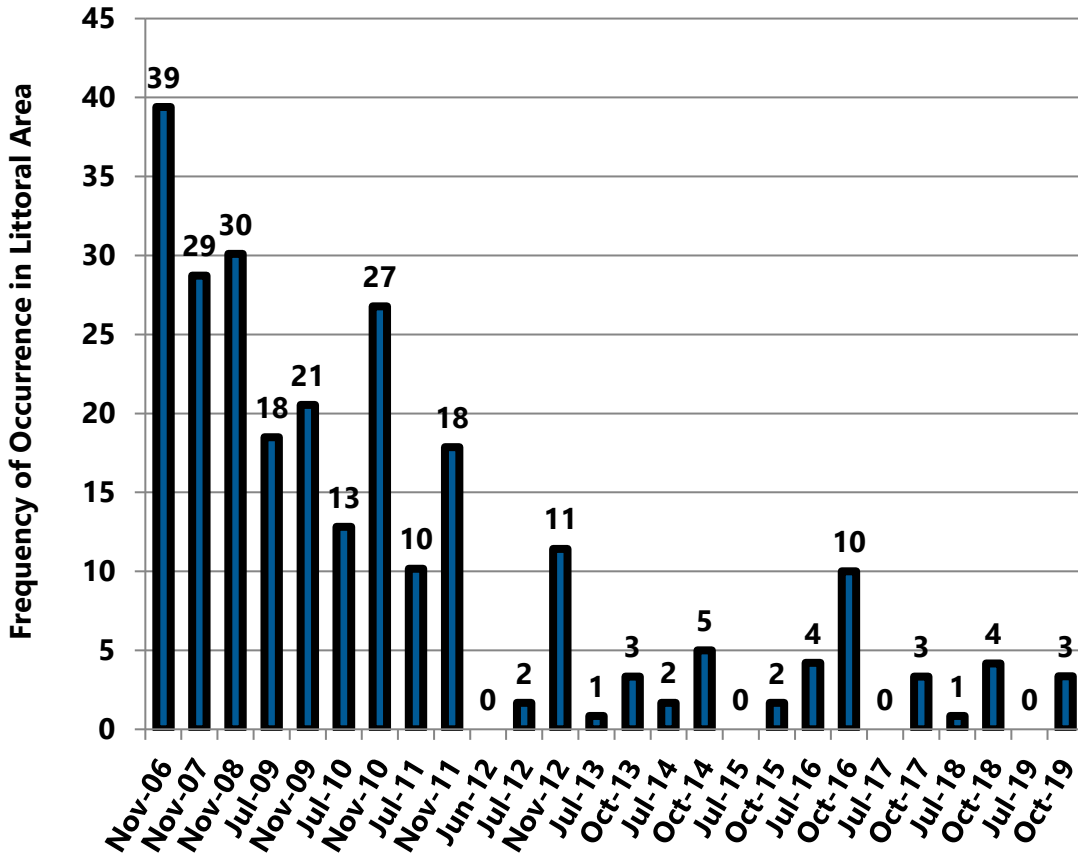


Figure 15 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone:
 Rabbit Island Bay

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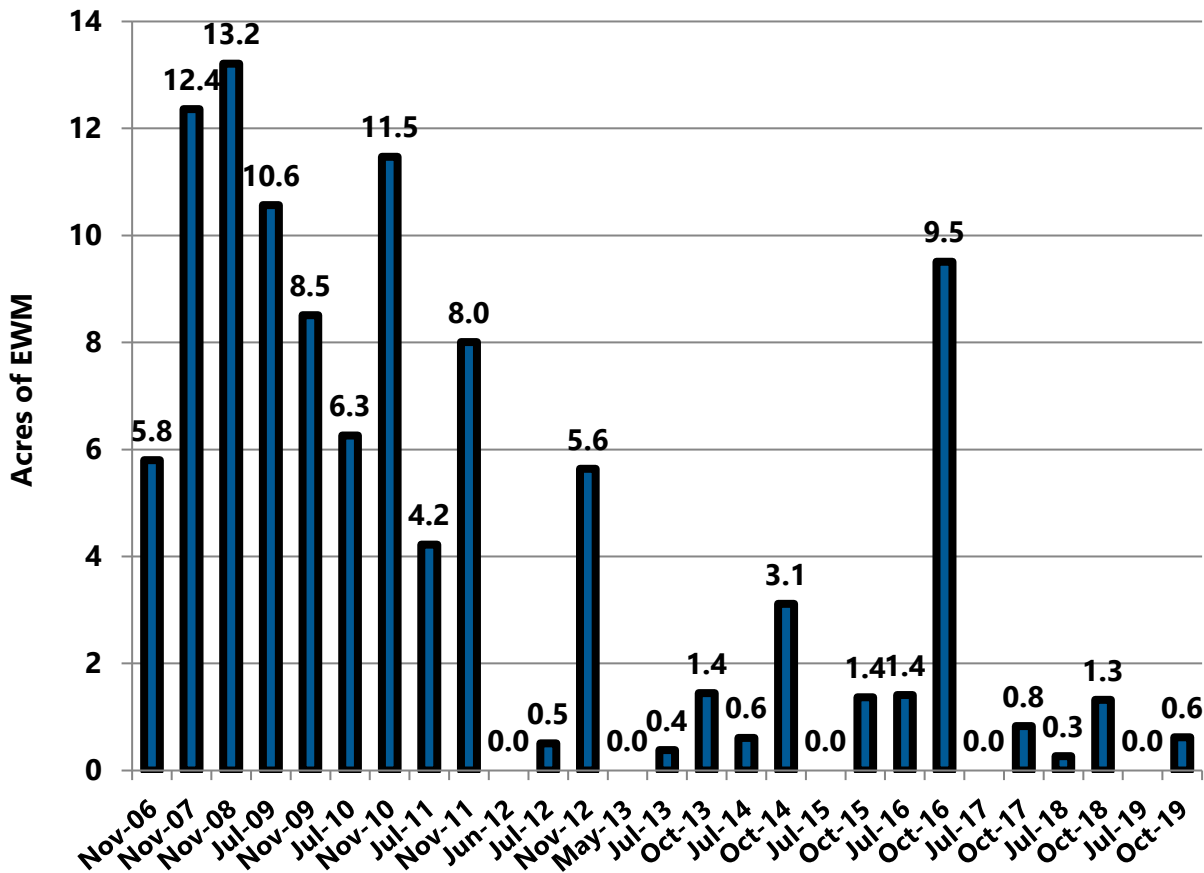


Figure 16 2006-2019 Beaver Dam Lake EWM Acreage: Rabbit Island Bay

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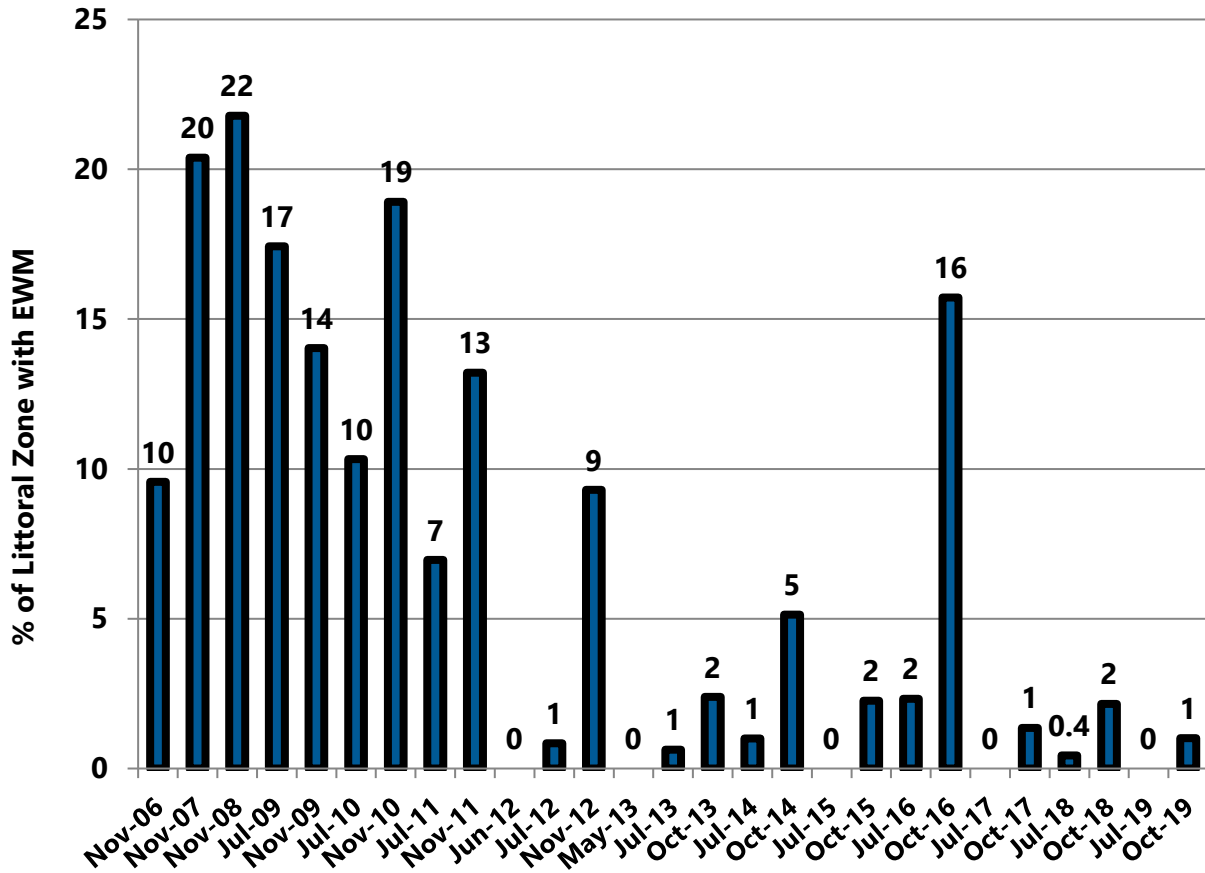


Figure 17 2006-2019 Percent of Littoral Zone with EWM: Rabbit Island Bay

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3.4 Library Lake

A large scale 2,4-D treatment of Library Lake occurred on May 8, 2019. A 2,4-D dose of 0.44 ppm was applied to Treatment Area 17, totaling 10 acres (73 percent of the littoral area of Library Lake). The expected whole lake 2,4-D concentration after treatment was 0.4 ae² ppm. 2,4-D samples were collected from two locations within the treatment area (Figure 1). As shown in Figure 18, the target whole lake 2,4-D concentration of 0.4 ae² ppm was attained and documented on one day after treatment. As shown in Figure 19, 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 Library Lake were at least 0.3 ppm ae³ (300 µg/L ae²) for at least 3 days after treatment at one sample location and for at least 7 days after treatment at the second sample location (Figure 18). An average of the herbicide concentrations at the two sample locations indicates that, on average, a 2,4-D concentration of at least 0.3 ppm ae⁴ (300 µg/L ae²) was sustained for at least 7 days after treatment. EWM was not observed in Library Lake in July, verifying that the herbicide treatment was lethal to the EWM.

The 2019 herbicide treatment:

- Reduced EWM frequency from 10 percent in fall of 2018 to 0 percent in July of 2019 (Table 1 and Figure 20);
- Reduced EWM extent from 1.85 acres in fall of 2018 to 0 acres in July of 2019 (Table 2 and Figure 21);
- Reduced percent of littoral zone with EWM from 13 percent in fall of 2018 to 0 percent in July of 2019 (Table 3 and Figure 22).

During the fall plant survey, five EWM plants were observed in Library Lake near the outlet to Rabbit Island Bay. The reappearance of EWM in Library Lake in fall increased EWM frequency, extent, and percent littoral area with EWM between July and October:

- Increased EWM frequency from 0 percent in July of 2019 to 1 percent in October of 2019 (Table 1 and Figure 20);
- Increased EWM extent from 0 acres in July of 2019 to 0.04 acres in October of 2019 (Table 2 and Figure 21);

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

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- Increased percent of EWM in littoral area from 0 percent in July of 2019 to 0.3 percent in October of 2019 (Table 3 and Figure 22).

All five EWM plants observed in Library Lake during the fall plant survey were rake removed.

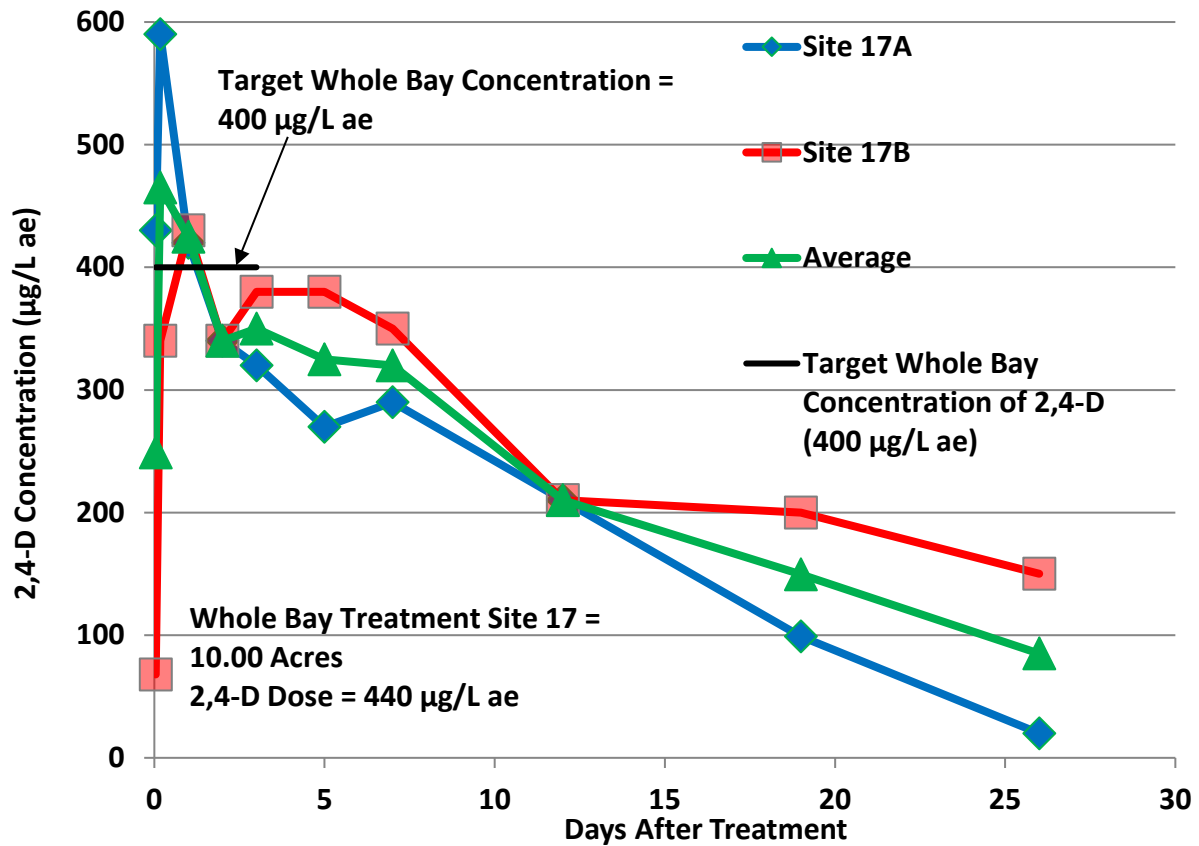


Figure 18 2,4-D Residue – Library Lake

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2,4-D Concentration/Exposure Time

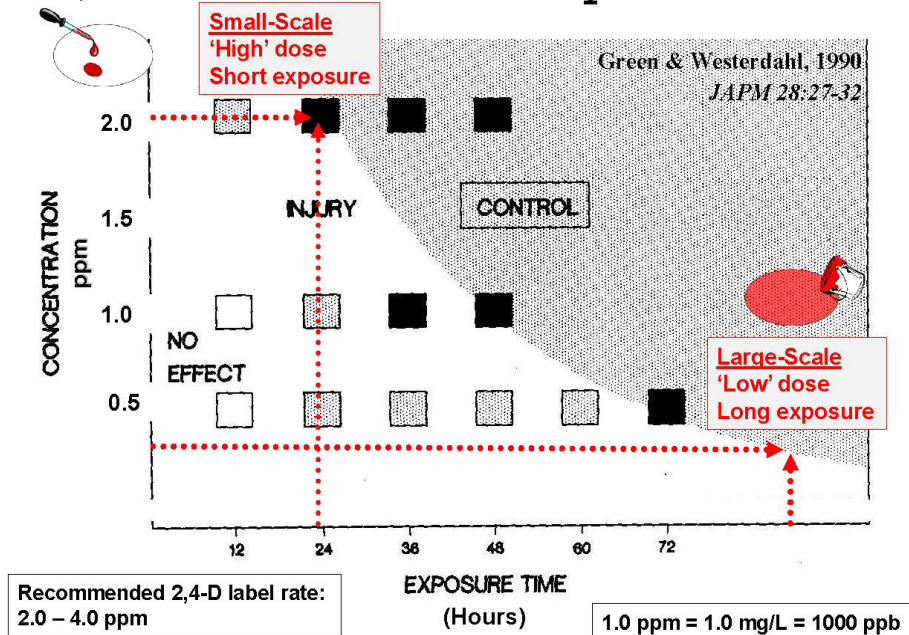


Figure 19 2,4-D Concentration/Exposure Time Relationship and EWM Control (Figure Credit: Nault, Michelle and John Skogerboe. 2014. *Scientific Evaluation of Efficacy and Selectivity of Herbicide Treatments in Wisconsin Lakes*. Presentation at UMISC— October 22, 2014 in Duluth, Minnesota)

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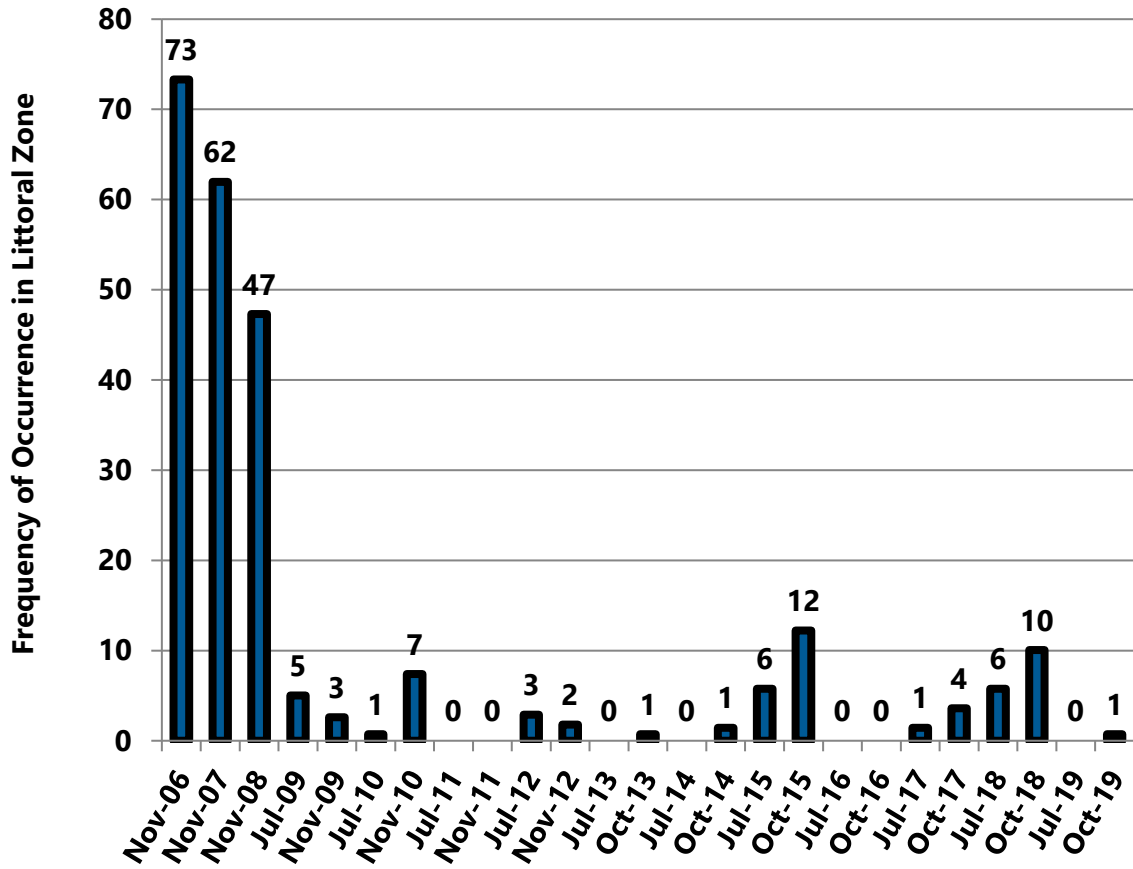


Figure 20 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Library Lake

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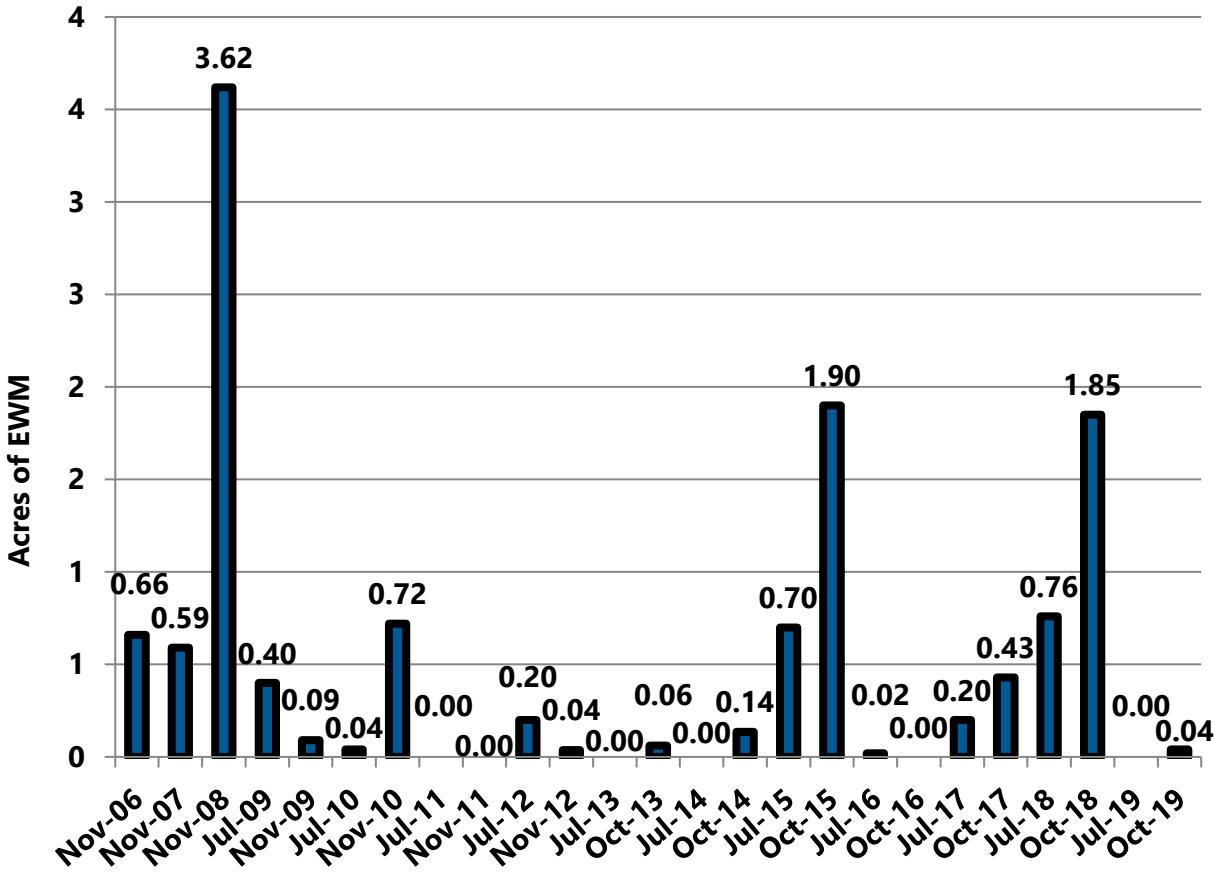


Figure 21 2006-2019 Beaver Dam Lake EWM Acreage: Library Lake

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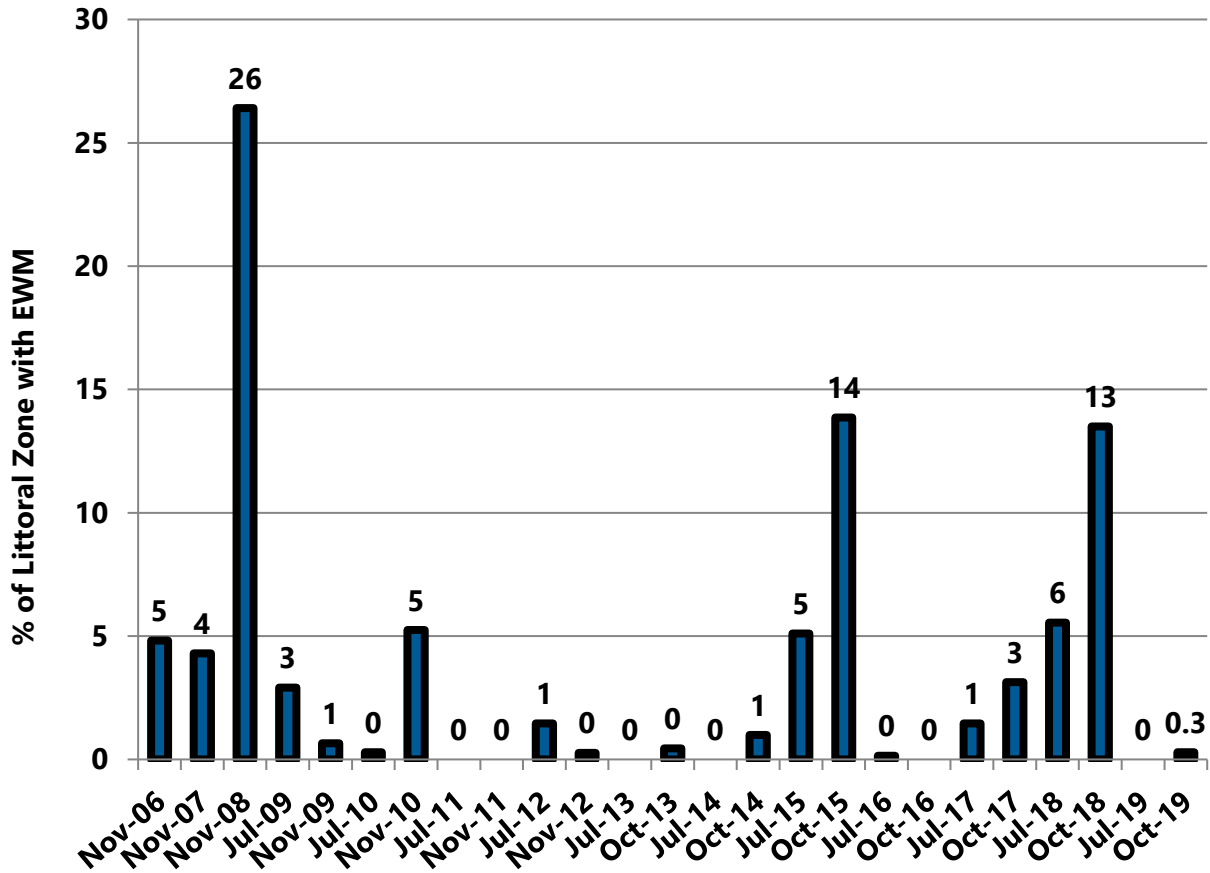


Figure 22 2006-2019 Percent of Littoral Zone with EWM: Library Lake

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3.5 Cemetery Bay

EWM was observed annually in Cemetery Bay during the 2008 through 2016 fall plant surveys, but was not observed during the 2017 and 2018 July and October plant surveys. EWM was documented in Cemetery Bay during the July 2019 plant survey and expanded in extent between July and October. Consequently, EWM frequency, extent, and percent of littoral area with EWM increased:

- From 0 percent in fall of 2018 to 6 percent in July of 2019 and 15 percent in October of 2019 (Table 1 and Figure 23);
- From 0 acres in fall of 2018 to 1.2 acres in July of 2019 and 4.1 acres in October of 2019 (Table 2 and Figure 24);
- From 0 percent in fall of 2018 to 2 percent in July of 2019 and 8 percent in October of 2019 (Table 3 and Figure 25).



EWM was not observed in Cemetery Bay, pictured above, during 2017 through 2018, but was again documented in Cemetery Bay during the July and October 2019 plant surveys. (Photo Credit: Endangered Resource Services, LLC)

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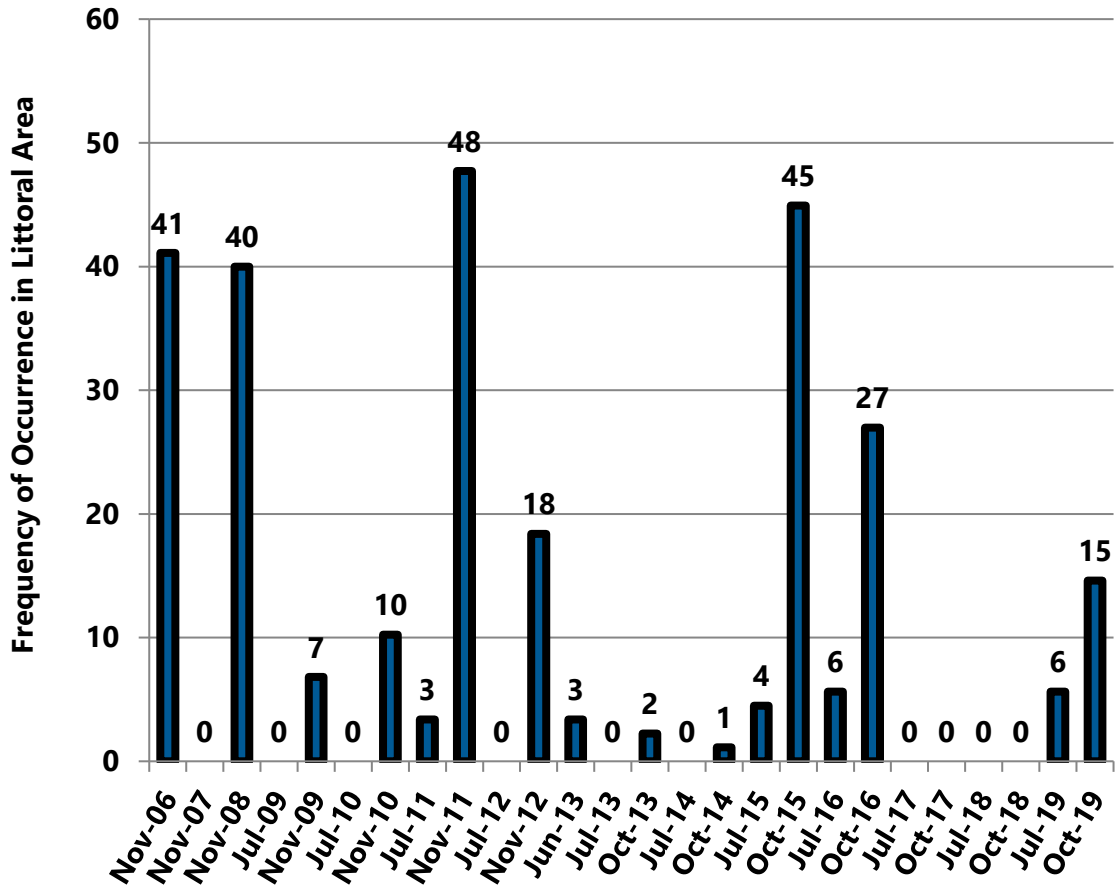


Figure 23 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: Cemetery Bay

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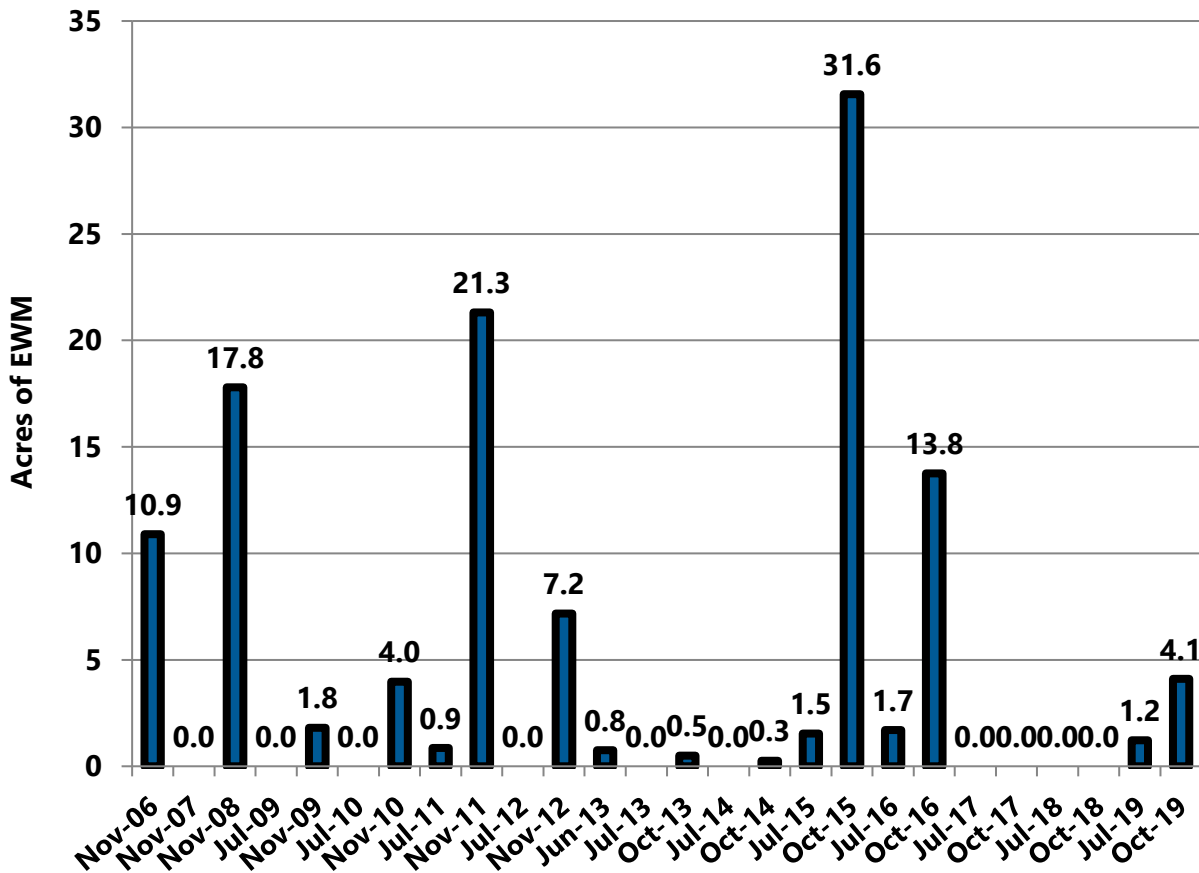


Figure 24 2006-2019 Beaver Dam Lake EWM Acreage: Cemetery Bay

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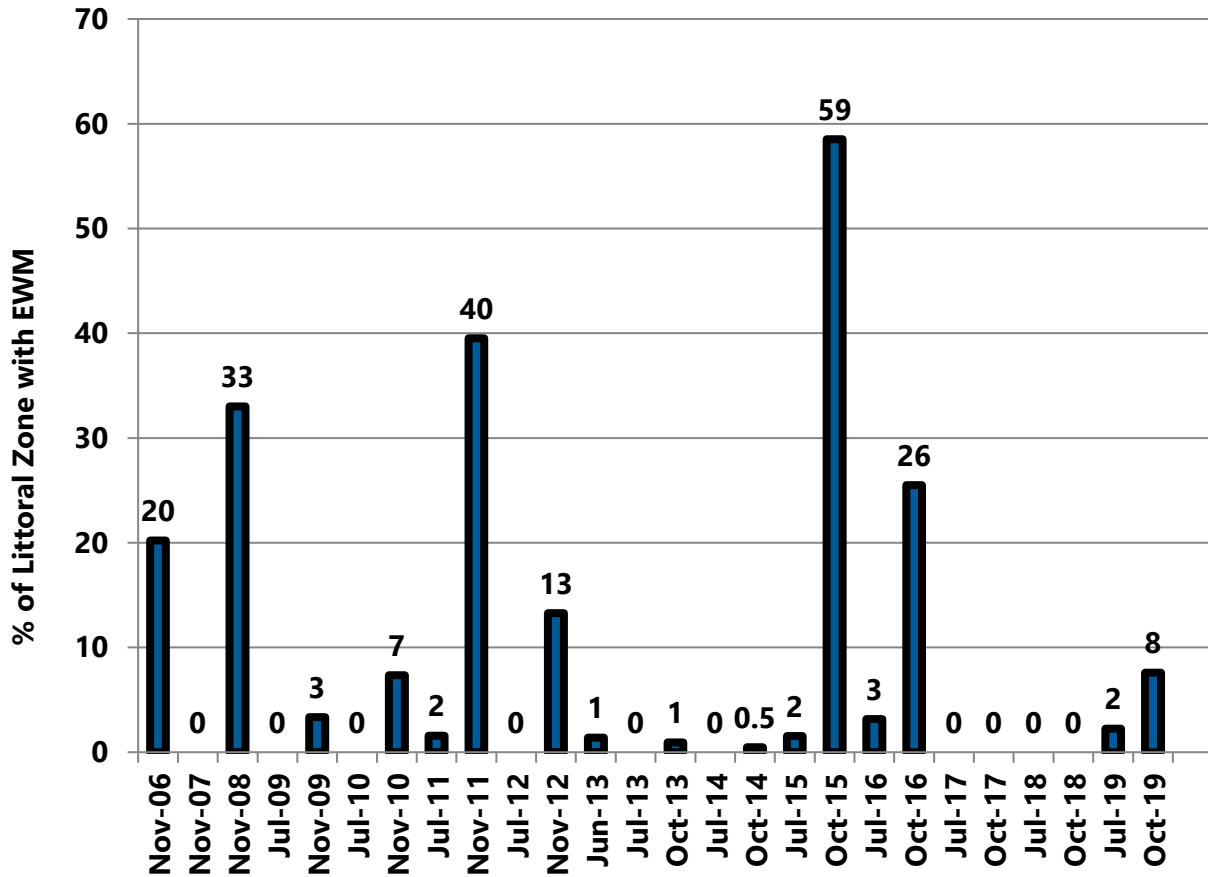


Figure 25 2006-2019 Percent of Littoral Zone with EWM: Cemetery Bay

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3.6 City Bay

In 2019, EWM management in City Bay consisted of herbicide treatment in one location, Treatment Area 18 (Figure 2), totaling 3.47 acres (3 percent of the littoral area of City Bay). The area was treated with the herbicide diquat at a dose of 2 gallons per acre on May 16. The treatment attained EWM control and EWM was not observed in City Bay during the July plant survey.

The 2019 treatment:

- Reduced EWM frequency from 2 percent in fall of 2018 to 0 percent in July of 2019 (Table 1 and Figure 26),
- Reduced EWM extent from 2 acres in fall of 2018 to 0 acres in July of 2019 (Table 2 and Figure 27),
- Reduced percent of littoral zone with EWM from 2 percent in fall of 2018 to 0 percent in July of 2019 (Table 3 and Figure 28).

However, EWM reappeared in October:

- EWM frequency increased from 0 percent in July of 2019 to 2 percent in October of 2019 (Table 1 and Figure 26),
- EWM extent increased from 0 acres in July of 2019 to 1 acre in October of 2019 (Table 2 and Figure 27),
- Percent of littoral zone with EWM increased from 0 percent in July of 2019 to 1 percent in October of 2019 (Table 3 and Figure 28).

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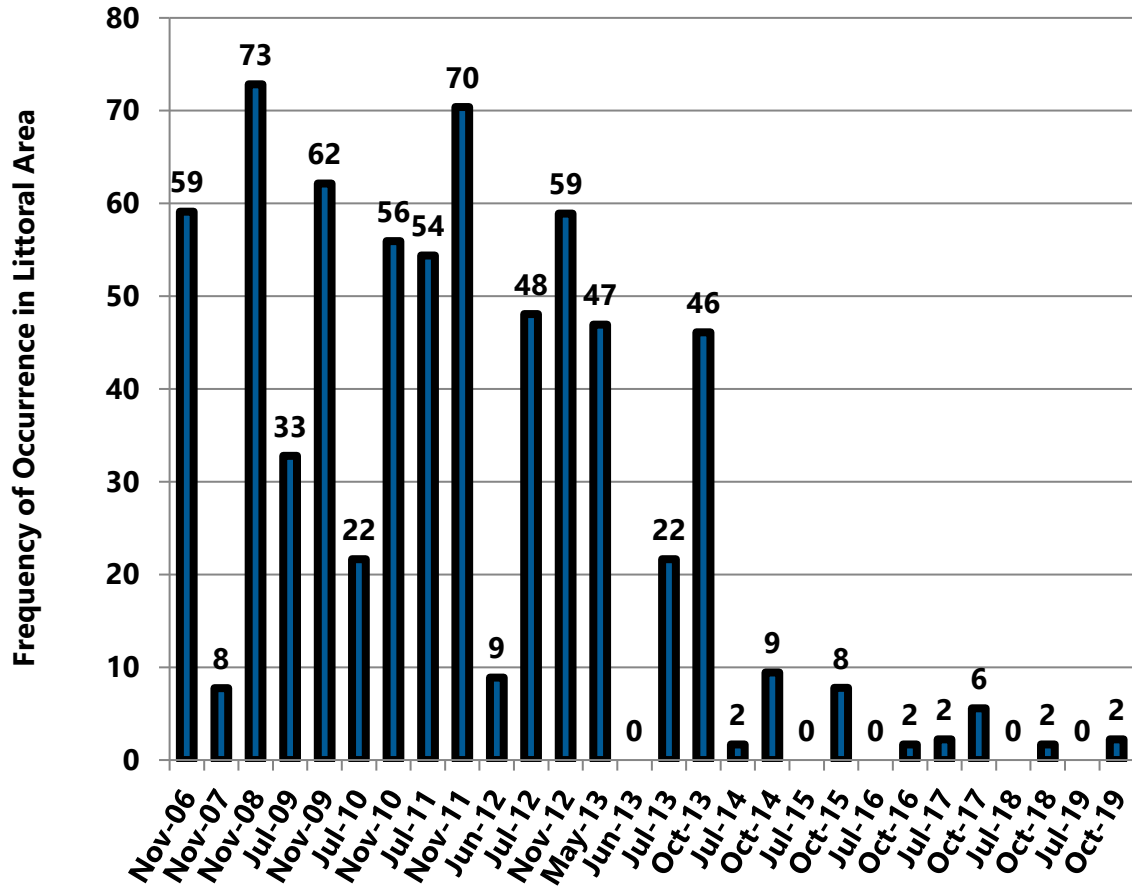


Figure 26 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: City Bay

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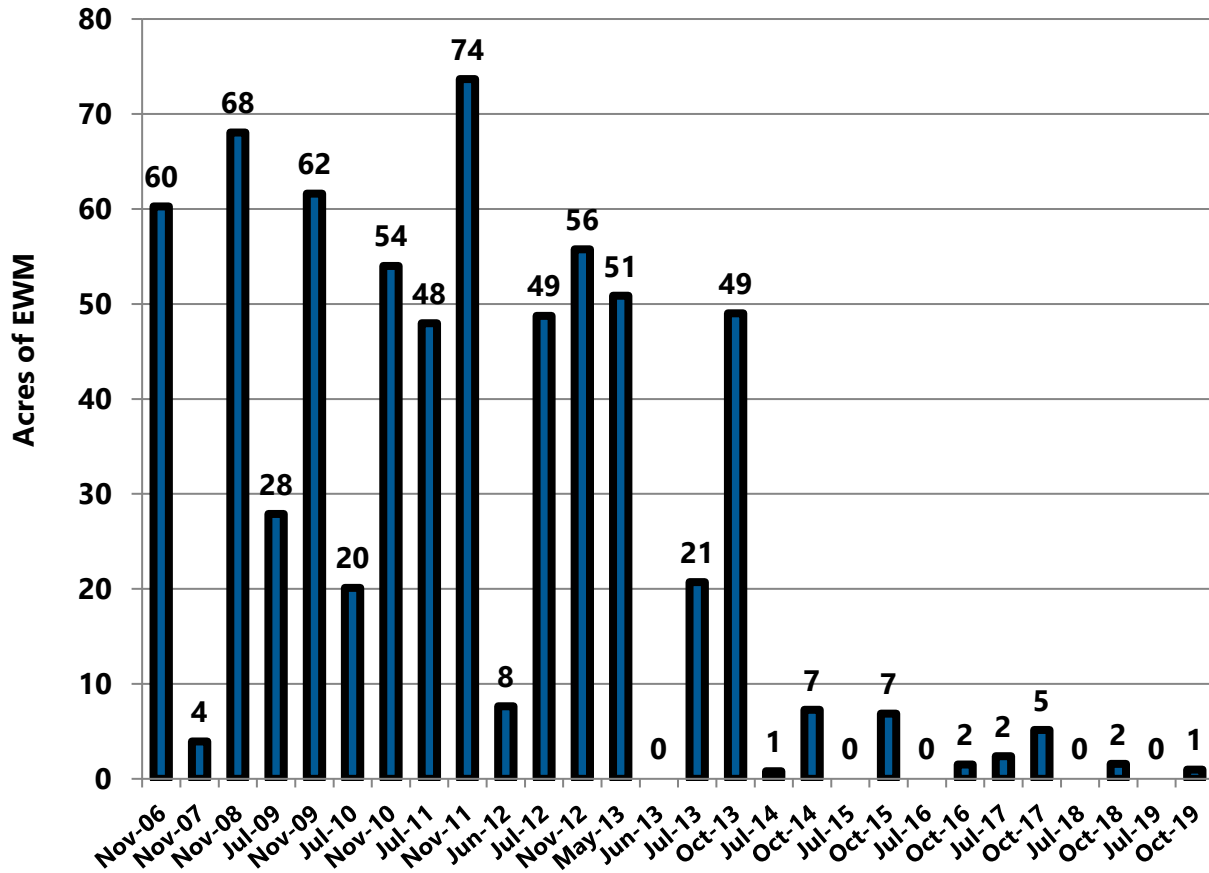


Figure 27 2006-2019 Beaver Dam Lake EWM Acreage: City Bay

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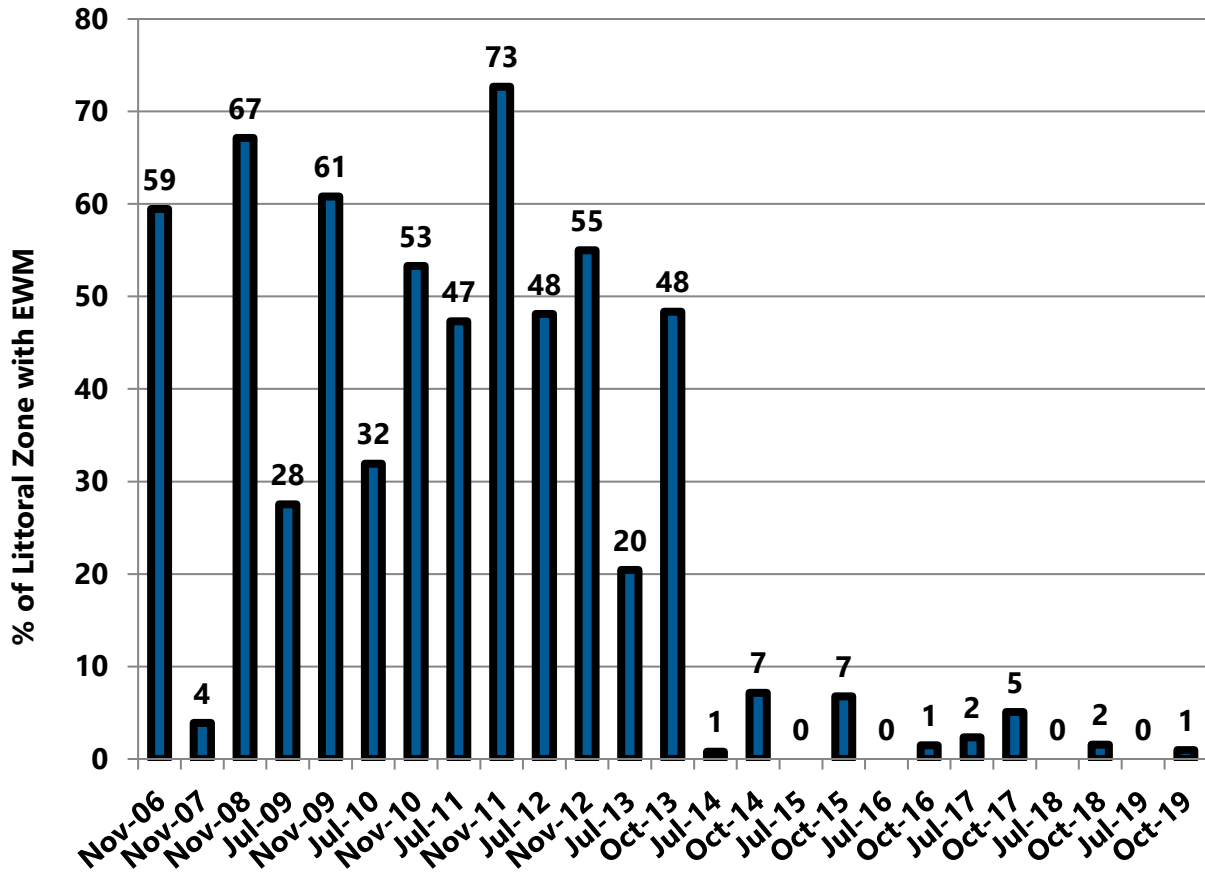


Figure 28 2006-2019 Percent of Littoral Zone with EWM: City Bay

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3.7 East Lake

EWM has not been observed in East Lake since fall of 2017. Despite no EWM management in East Lake in 2018, EWM declined and was not observed during the July or October plant surveys. In 2019, EWM was again not observed in East Lake during the July and October plant surveys (Tables 1 through 3, Figures 8, 29, 30, and 31).



EWM was not observed in East Lake (pictured above), in 2019.

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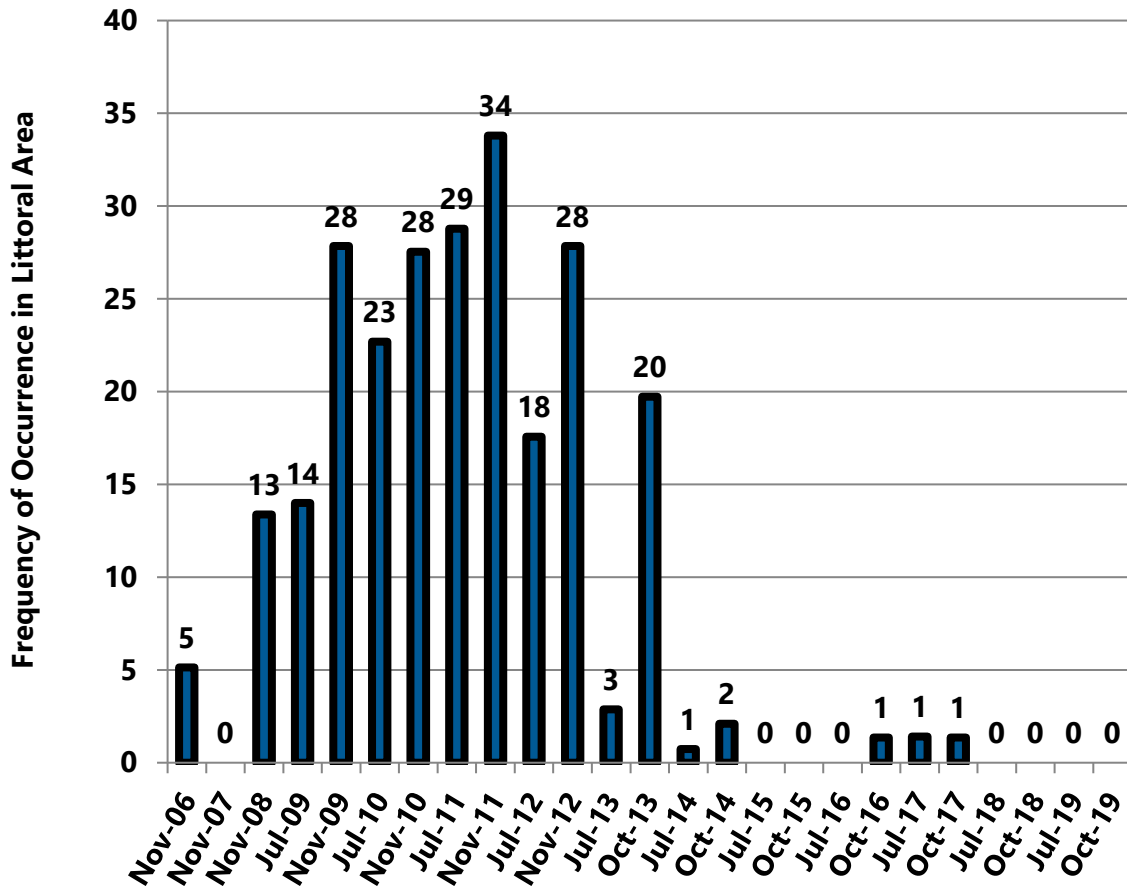


Figure 29 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone: East Lake

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Subject: 2019 EWM Treatment Results
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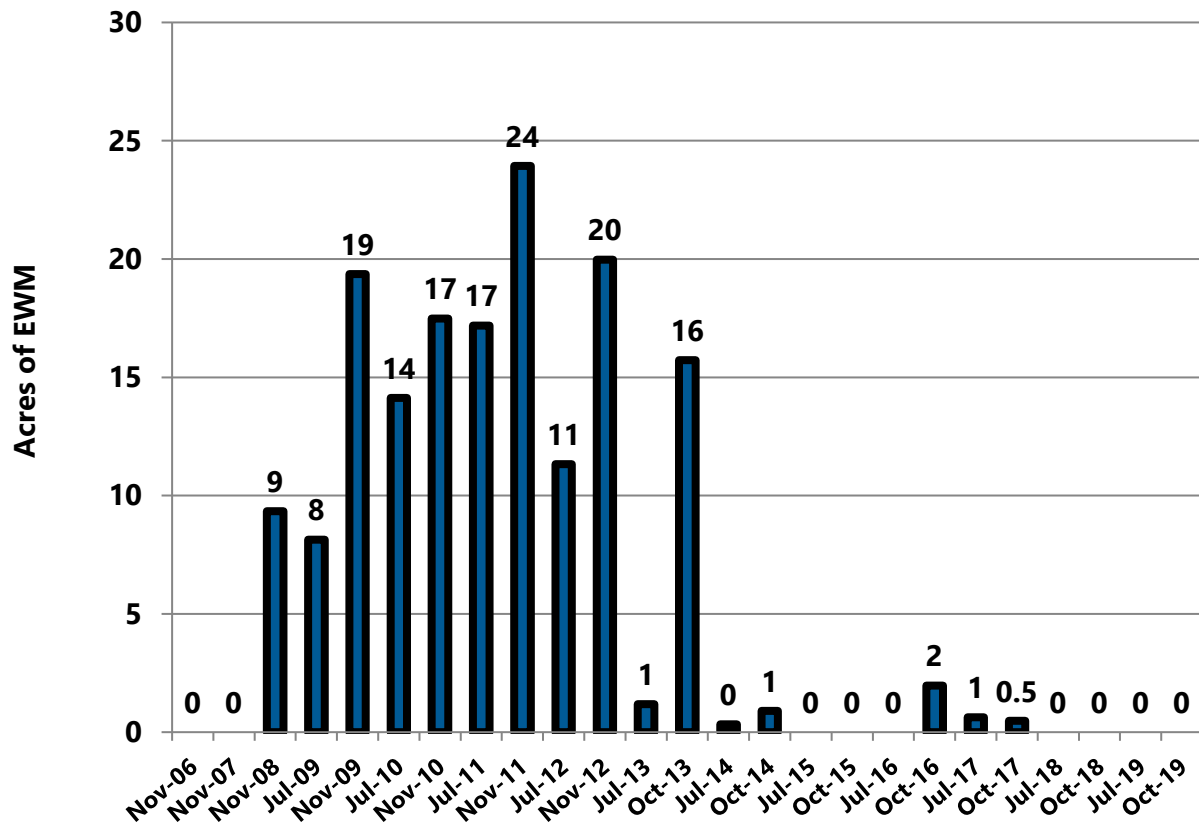


Figure 30 2006-2019 Beaver Dam Lake EWM Acreage: East Lake

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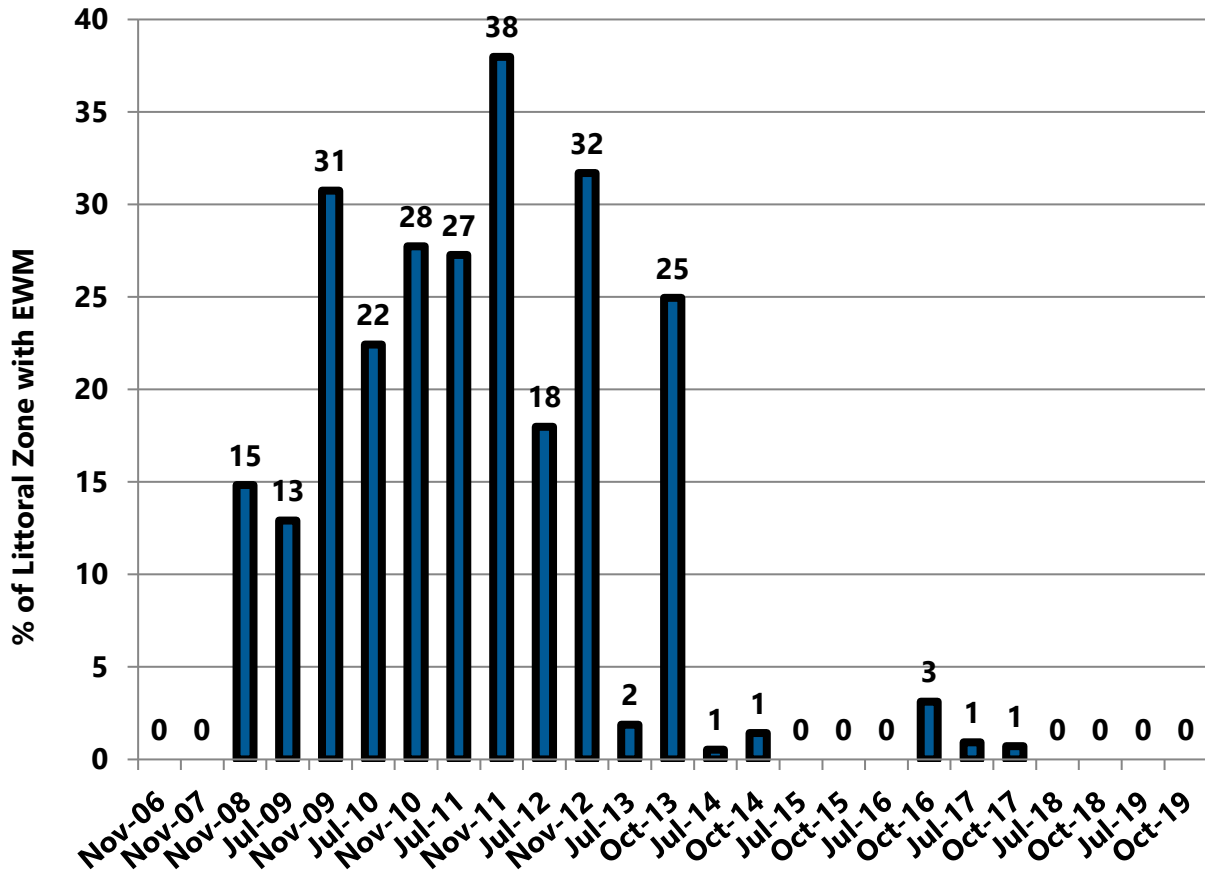


Figure 31 2006-2019 Percent of Littoral Zone with EWM: East Lake

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3.8 Norwegian Bay

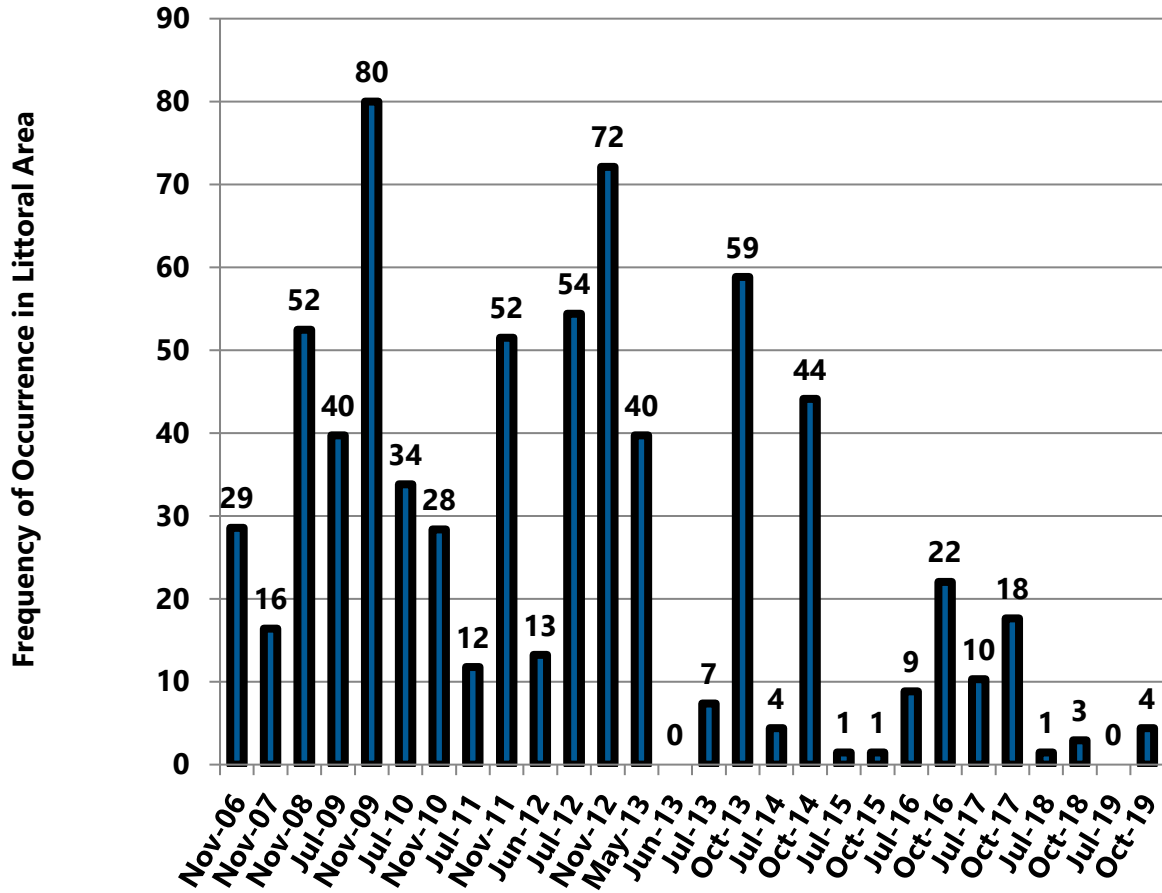
In 2019, EWM management in Norwegian Bay consisted of herbicide treatment in one location, Treatment Area 19 (Figure 2), totaling 2.86 acres (7 percent of the littoral area of Norwegian Bay). The area was treated with the herbicide diquat at a dose of 2 gallons per acre on May 13. The treatment attained EWM control and EWM was not observed in Norwegian Bay during the July plant survey.

The 2019 treatment:

- Reduced EWM frequency from 3 percent in fall of 2018 to 0 percent in July of 2019 (Table 1 and Figure 32),
- Reduced EWM extent from 0.7 acres in fall of 2018 to 0 acres in July of 2019 (Table 2 and Figure 33),
- Reduced percent of littoral zone with EWM from 2 percent in fall of 2018 to 0 percent in July of 2019 (Table 3 and Figure 34).

However, EWM reappeared in October:

- EWM frequency increased from 0 percent in July of 2019 to 4 percent in October of 2019 (Table 1 and Figure 32),
- EWM extent increased from 0 acres in July of 2018 to 0.7 acres in October of 2019 (Table 2 and Figure 33),
- Percent of littoral zone with EWM increased from 0 percent in July of 2018 to 2 percent in October of 2019 (Table 3 and Figure 34).



**Figure 32 2006-2019 Beaver Dam Lake EWM Frequency of Occurrence in Littoral Zone:
 Norwegian Bay**

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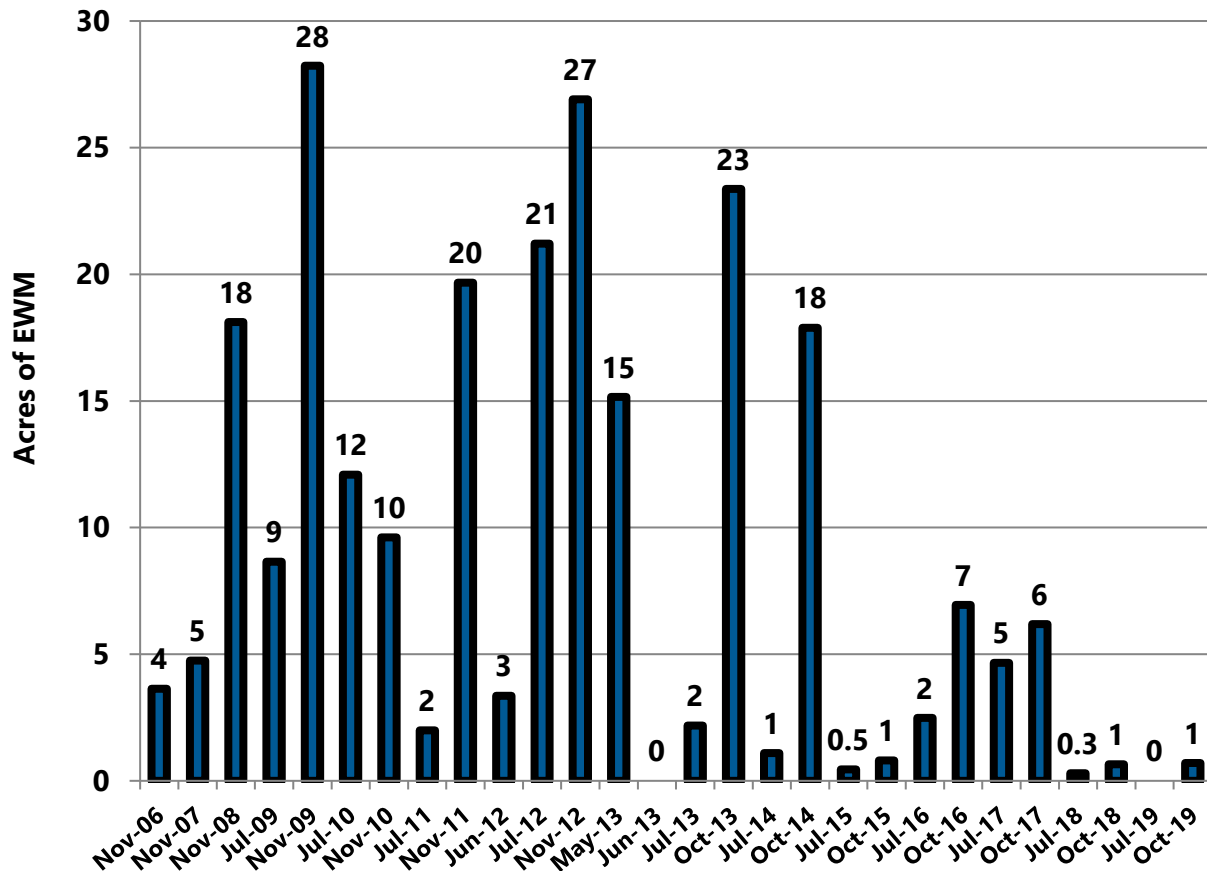


Figure 33 2006-2019 Beaver Dam Lake EWM Acreage: Norwegian Bay

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: 2019 EWM Treatment Results
Date: November 26, 2019
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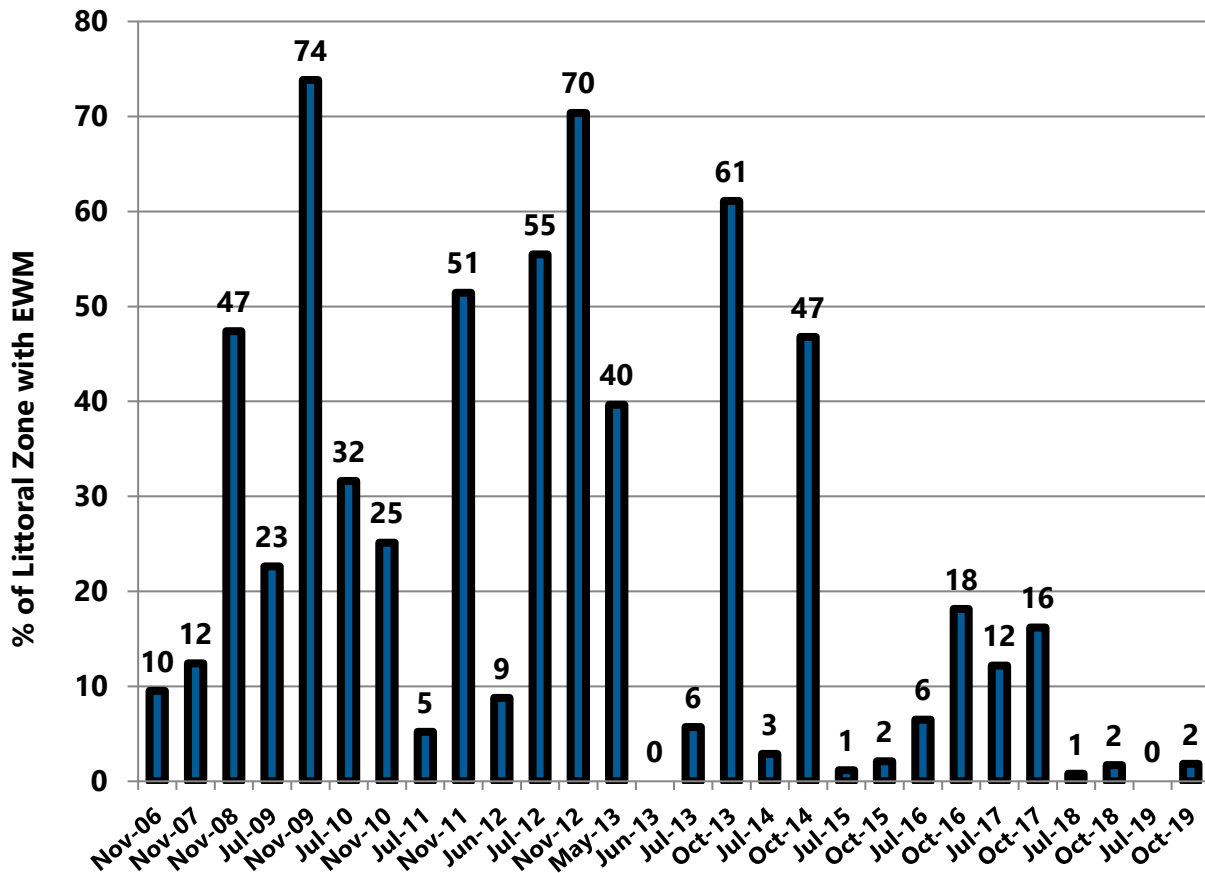


Figure 34 2006-2019 Percent of Littoral Zone with EWM: Norwegian Bay

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4.0 Summary

In 2019, six areas of Beaver Dam Lake received herbicide treatment—West Lake, Williams Bay, Rabbit Island Bay, Library Lake, City Bay, and Norwegian Bay. Five areas received small scale herbicide treatments—West Lake, Williams Bay, Rabbit Island Bay, City Bay and Norwegian Bay. One area received a large scale herbicide treatment—Library Lake. EWM management did not occur in East Lake and Cemetery Bay.

The fall 2019 EWM extent was the lowest fall EWM extent and percent littoral area observed since monitoring began in 2006. Fall EWM extent during 2006 through 2018 ranged from 18 acres to 176 acres compared with 7 acres in fall of 2019 (Table 2 and Figure 5). The percent of littoral area with EWM during fall of 2006 through 2018 ranged from 3 percent to 34 percent compared with 1 percent in fall of 2019 (Table 3 and Figure 6).

The Beaver Dam Lake percent of littoral area with EWM declined by 61 percent between fall of 2018 and fall of 2019—from 3 percent in October of 2018 to 1 percent in October of 2018 (Table 3 and Figure 6). The decline in 2019 was attributed to the herbicide treatment. While the 2017 EWM management efforts attained the District goal of reducing EWM to no more than seven percent of the littoral zone, the 2018 and 2019 management efforts further reduced EWM to one percent of the littoral zone.

Comparing fall 2018 and fall 2019 data indicates:

West Lake—Small scale herbicide treatments reduced EWM frequency and extent by 96 percent and 97 percent, respectively, and percent of littoral area with EWM by 97 percent (Tables 1 through 3 and Figures 9 through 11). In fall of 2019, EWM extent in West Lake was 0.4 acres, which was 0.2 percent of the littoral area. All EWM observed during the fall plant survey was rake removed. However, a citizen observed a 20 foot by 60 foot rectangular ellipse of EWM on sunken island prior to Labor Day (Figure 35). Because the EWM patch did not occur at a sample point, it was not documented during the fall plant survey.

Williams Bay—Small scale herbicide treatment reduced EWM frequency and extent by 53 percent and 54 percent, respectively, and percent of littoral area with EWM by 54 percent (Tables 1 through 3 and Figures 12 through 14). In fall of 2019, EWM extent in Williams Bay was 0.5 acres (Table 2 and Figure 13). All EWM observed during the fall plant survey was rake removed.

Rabbit Island Bay—Small scale herbicide treatment reduced EWM frequency and extent by 25 percent and 54 percent, respectively and percent of littoral area with EWM by 50 percent (Tables 1 through 3 and Figures 15 through 17). The only EWM present in fall of 2019 was 0.6 acres within the west canal of Rabbit Island Bay. EWM present at this location in fall of 2018 disappeared in July and reappeared in October.

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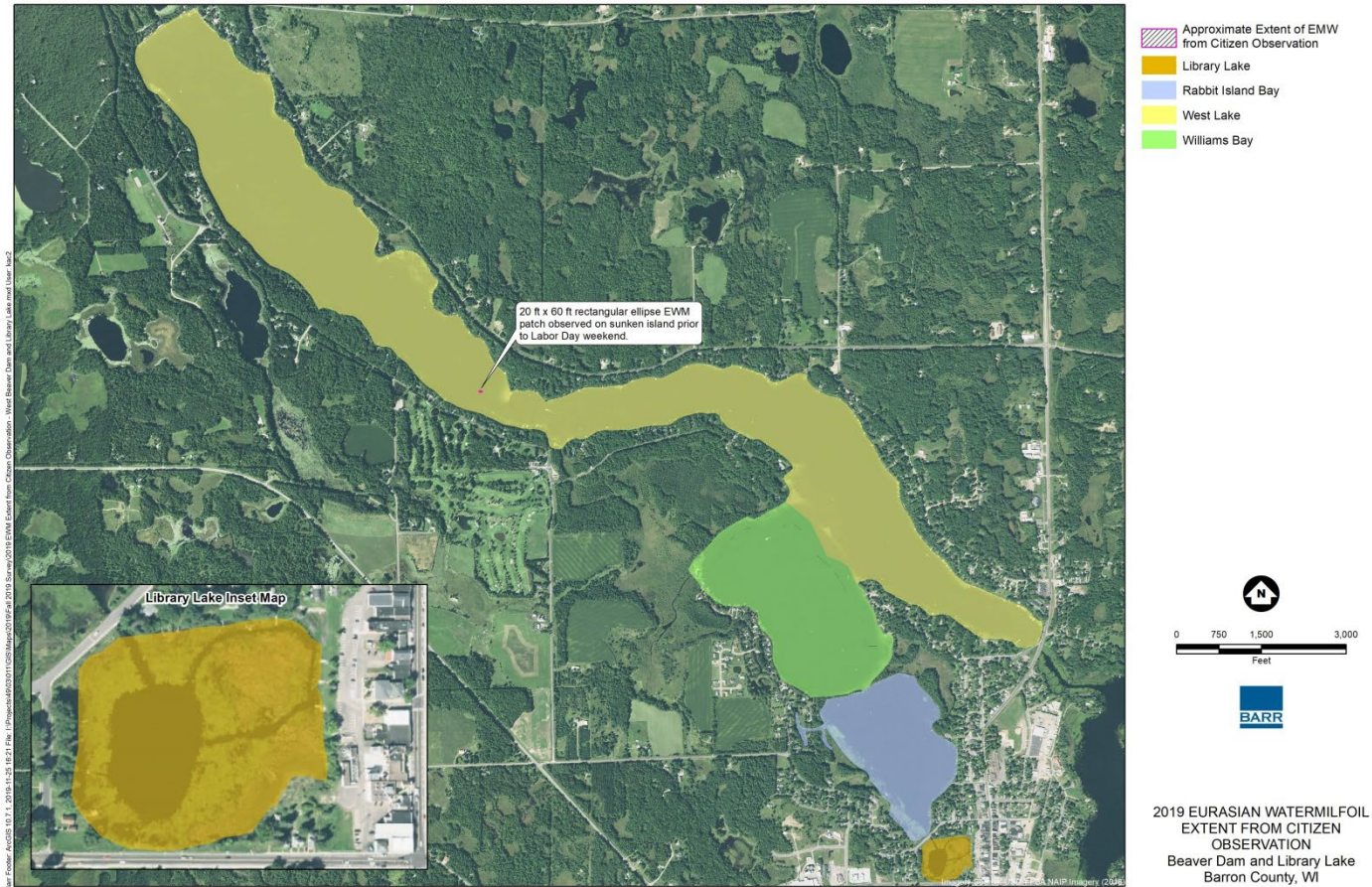


Figure 35 Citizen Observed EWM in Beaver Dam Lake (West Lake)

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Library Lake—Large scale herbicide treatment reduced EWM frequency and extent by 93 percent and 98 percent, respectively, and percent of littoral area with EWM by 98 percent (Tables 1 through 3 and Figures 20 through 22). In fall of 2019, EWM extent in Library Lake was 0.04 acres (Table 2 and Figure 21). All EWM observed during the fall plant survey was rake removed.

Cemetery Bay—Because EWM was not observed in Cemetery Bay during the fall 2018 plant survey, EWM management was not needed in 2019. EWM was documented in the July 2019 plant survey and expanded in extent between July and October. In October 2019, EWM frequency had increased to 4.1 percent, EWM extent had increased to 14.6 acres, and percent of littoral area with EWM had increased to 7.6 percent (Tables 1 through 3 and Figures 23 through 25).

City Bay—Following a small scale herbicide treatment, EWM was not observed during the July plant survey. However, EWM reappeared during the fall plant survey. In October of 2019, EWM frequency had increased to 2.2 percent, EWM extent had increased to 1.0 acres, and percent of littoral area with EWM had increased to 1.0 percent (Tables 1 through 3 and Figures 26 through 28).

East Lake—EWM has not been observed in East Lake since fall of 2017 (Tables 1 through 3 and Figures 29 through 31).

Norwegian Bay— Following a small scale herbicide treatment, EWM was not observed during the July plant survey. However, EWM reappeared during the fall plant survey. In October of 2019, EWM frequency had increased to 4.4 percent, extent had increased to 0.7 acres, and percent of littoral area with EWM had increased to 1.8 percent (Tables 1 through 3 and Figures 32 through 34).