



Lake Eden 2023 Late Summer Eurasian Water Milfoil Inventory

October 17, 2023



ARROWWOOD ENVIRONMENTAL
950 BERT WHITE ROAD
HUNTINGTON, VT 05462
(802) 434-7276 FAX: (802) 329-2259

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1. Introduction

In June of 2023, Arrowwood Environmental was retained by the Lake Eden Association to conduct surveys of Eurasian water milfoil (EWM) in Lake Eden, Vermont as part of an ongoing effort to manage this invasive species in the lake. An early season, pre-treatment, survey of EWM in the lake was conducted in June, 2023 and reported on under separate cover (Lake Eden Pre-Treatment EWM Inventory, June 19, 2023). This report summarizes the methodology and results of the late summer survey conducted in August 2023.

2. Methods

The study area for the inventory consisted of the entire waterbody of Lake Eden as defined by the shoreline derived from the Vermont Hydrography Dataset (VHD). The entire littoral zone was inventoried using two different methods: 1) Visual Littoral Surveys; 2) Underwater Surveys. The methodology used for each of these survey types is outlined below.

a. Visual Littoral Survey

The entire perimeter of the lake was circumnavigated in a boat and the littoral zone was visually surveyed for the presence of EWM. A motorboat was used for the majority of the littoral zone, while a kayak was used for shallow areas less than 4' deep. Water visibility allowed for the survey of areas 8 feet deep and less with this method. In some cases, vigorous plants of EWM could be detected in water 10' deep. When EWM was detected, a GPS point was taken and data on the number of plants, area that the plant(s) occupy, and water depth was collected. For surveys conducted from a motorboat, water depth was determined by sonar from a Humminbird Helix 7 G2 sonar unit. For surveys conducted from a kayak, water depth was determined by submersing the kayak paddle to the lake bottom. Lake depth readings were rounded to the nearest ½ foot. The area occupied by EWM plants was based on a visual estimate.

All data was collected using custom digital data forms on iPhone 10 unit running ArcGIS Field Maps and Survey 123 software. These data forms include drop-down menus for plant species, water depth, and invasive species abundance and extent. The drop down-menus and digital nature

of the data forms minimize possible errors in data entry. The field data was synced online with the AE servers at the end of each field day. Raw data will be stored on the AE servers for a period of 5 years.

The map in Appendix 2 shows the areas that were surveyed using this method.

b. Underwater Surveys

Underwater Surveys were conducted in high priority areas where Visual Littoral Surveys were deemed insufficient for detecting EWM due to depth. These three areas were: Boat Launch, Boy Scout Camp, and Public Swimming Beach. In the deeper (>10' deep) areas of each of these sites, underwater surveys were conducted in transects. At the Boat Launch and Public Swimming Beach sites, the underwater transects were conducted with SCUBA gear. At the Boat Launch site, it was determined that a snorkel transect was sufficient to detect EWM. At both the Boat Launch and Boy Scout Camp sites, underwater transects were conducted across the bays. Additional underwater meander searches for EWM were also conducted at the Boy Scout Camp to ensure that all of the appropriate habitat was surveyed and all EWM was detected. Underwater transects at the Public Swimming Beach consisted of four parallel transects that were approximately 200ft long and 25ft apart. The direction of the transects followed an azimuth using an underwater compass and the length was determined by counting kicks. Underwater visibility was approximately 10' resulting in a 20' wide transect.

During the transect, the diver was equipped with multiple numbered marker buoys. When EWM was detected, a marker buoy was placed and notes on the number of plants, area that the plant(s) occupy, and water depth was noted on an underwater writing slate. Once the transect was completed, the marker buoys were navigated to from a boat and data entered into the digital data form on the GPS unit.

c. Mapping EWM Occurrences

When EWM was detected, a GPS point was taken along with a count of the number of plants present, area occupied by the plants and the water depth. In some cases, the population of EWM was abundant and counting individuals was not realistic. In these circumstances, the infestation boundaries were GPSed using the same techniques outlined above for GPSing point locations of EWM. Once the boundaries are mapped, a percent cover of EWM within the entire mapped infestation was recorded.

3. Results

Point and polygon locations of EWM mapped in the Lake using the above methods are shown in Appendix 2. These maps were previously submitted to the Lake Eden Association on August 31, 2023 for use in guiding late summer EWM control activities. Tables 2 and 3 in Appendix 1 list each location along with number of plants, area occupied by the occurrence and water depth.

Table 1 shows a comparison of EWM data from June to August 2023.

Table 1. June to August 2023 EWM Abundance Comparison

	Site Name	Plant Count June 2023	Plant Count August 2023	Change
Point Data	Throughout Lake	155	544	+389
Polygon Data	A: Boat Launch	59	320	+261
	D: Boat Launch	8*	28	+20
	E: Boy Scout Camp	78*	97	+19
	C: Boy Scout Camp	26	77	+51
	B: Public Beach	50% cover	70% cover	+ 20% cover
	F: Public Beach	0	50% cover	+ 50% cover

* In June, the data at these sites were collected as point data

As can be seen from the data in Table 1, there was an increase in EWM plants at every site in the Lake. From the plant count data (i.e. excluding the percent cover data) there was an overall increase in number of EWM plants in the lake of 740 plants from June to August. Part of this increase may be attributable to the fact that EWM can be difficult to detect in June when the plants are just starting to grow. This error is likely more pronounced in the deeper areas where EWM is most easily detected when it is reaching the surface later in the season. However, even in shallow areas like the Public Boat Launch, there was a marked increase in EWM infestation in these areas. Of particular note is Area B, which, despite being controlled by a DASH treatment, rebounded and increased in cover by August. In general, the largest increase in number of plants occurred in the Public Swimming Beach Area. This large area of suitable habitat receives a fair amount of boat traffic which can aid in the spread of EWM.



EWM surfacing near the
boat launch
8/28/2023



Preparing for underwater
survey
8/24/2023



Public beach site
8/24/2023



Stem of EWM underwater
8/24/23/2023

Appendix 1

Tables of EWM Occurrences

Table 2. EWM recorded from point data

Depth (ft)	Plant Count	Diameter	Latitude	Longitude
4	1	1	44.712548	-72.515682
10	1	1	44.711234	-72.514136
8	3	20	44.718037	-72.511846
10	3	5	44.71843	-72.510922
2	9	10	44.718276	-72.510921
12	6	30	44.718554	-72.510617
11	16	15	44.718694	-72.510555
8	1	1	44.715247	-72.51053
10	10	20	44.718698	-72.510385
13	5	10	44.718298	-72.510339
11	8	20	44.718675	-72.510179
9	4	20	44.71876	-72.510036
6	1	1	44.718287	-72.50991
10	23	30	44.718372	-72.509835
11	11	10	44.718505	-72.509817
8	8	15	44.718383	-72.509817
8	1	1	44.719132	-72.509808
4	1	1	44.719813	-72.509706
10	15	20	44.718711	-72.509692
10	10	20	44.718975	-72.509655
10	4	10	44.719134	-72.509599
11	13	25	44.71879	-72.509491
10	30	40	44.719159	-72.509388
12	21	30	44.71929	-72.509299
11	15	35	44.718747	-72.509246
11	3	10	44.719046	-72.509222
10	2	5	44.718642	-72.509219
10	1	1	44.712605	-72.509162
11	23	25	44.718929	-72.50903
7	24	7	44.719241	-72.508945
11	6	20	44.71918	-72.508893
11	1	1	44.719073	-72.508863
12	21	30	44.71901	-72.508784
12	2	1	44.718276	-72.508782
11	11	20	44.718912	-72.508738
11	7	11	44.719075	-72.508704
10	4	10	44.718771	-72.508659
12	1	1	44.718425	-72.508624
11	7	30	44.719019	-72.508502
11	7	25	44.718637	-72.508449
10	1	1	44.712949	-72.508448
11	17	30	44.718838	-72.508381
11	5	11	44.718936	-72.508372
11	2	5	44.71865	-72.508328
12	1	1	44.718571	-72.508233
11	3	20	44.718886	-72.508214
10	3	15	44.718914	-72.507668
6	1	1	44.719879	-72.506972
8	1	1	44.718167	-72.505348

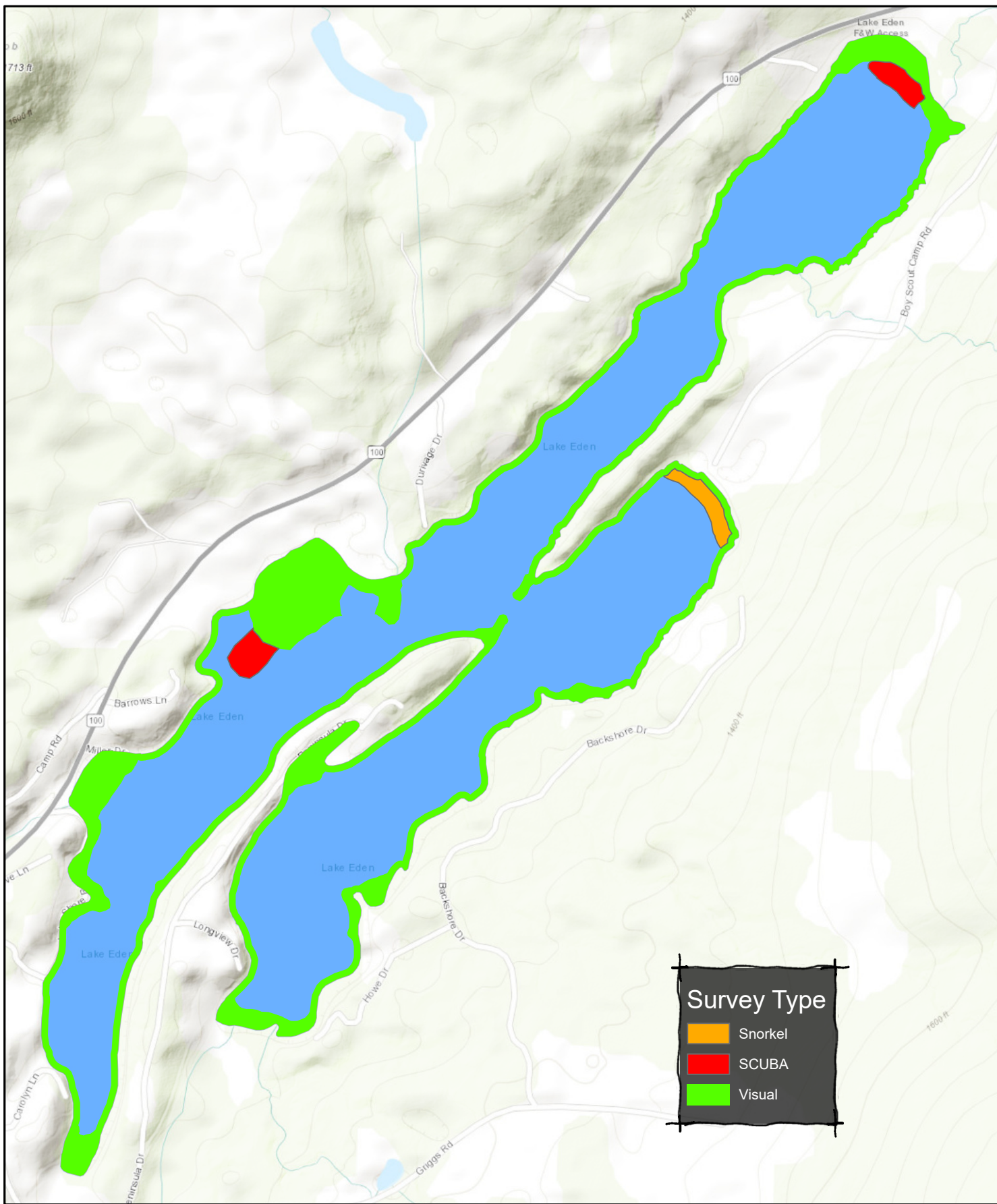
Depth (ft)	Plant Count	Diameter	Latitude	Longitude
8	1	1	44.718356	-72.505119
6	1	1	44.722072	-72.504021
7	8	10	44.71754	-72.503547
6	1	1	44.717564	-72.502847
7	1	1	44.720296	-72.502627
4	2	4	44.717562	-72.5025
8	1	1	44.717639	-72.502209
4	1	1	44.717708	-72.502039
7	2	5	44.72177	-72.501543
1	2	10	44.721285	-72.500857
4	1	1	44.721218	-72.500514
5	9	15	44.7211	-72.500322
6	6	2	44.724849	-72.500298
3	8	12	44.721056	-72.500287
12	2	10	44.720909	-72.500231
13	1	1	44.720783	-72.50008
12	1	1	44.720622	-72.49994
13	15	10	44.720587	-72.499908
12	3	10	44.720544	-72.49986
10	12	20	44.720691	-72.499769
6	2	5	44.720596	-72.499765
7	6	20	44.720662	-72.499735
8	2	8	44.720271	-72.499669
5	1	1	44.720157	-72.499626
3	3	3	44.726098	-72.49954
6	1	1	44.726244	-72.499425
5	2	20	44.724531	-72.499338
6	1	1	44.726678	-72.498464
3	2	5	44.724741	-72.498392
10	18	10	44.724833	-72.498274
8	1	1	44.727019	-72.498189
7	2	5	44.724792	-72.498092
7	1	1	44.727409	-72.497724
10	2	20	44.727264	-72.497627
9	2	1	44.727754	-72.497143
8	2	1	44.7279	-72.497028
5	1	1	44.728524	-72.496236
1	1	1	44.728243	-72.496018
5	1	1	44.728299	-72.495966
3	1	1	44.728487	-72.495852
4	4	8	44.72849	-72.495796
3	10	10	44.728599	-72.495765
10	13	30	44.728203	-72.495764
8	1	1	44.728247	-72.495654
4	2	10	44.72828	-72.49565
8	2	2	44.725905	-72.495314
4	1	1	44.726233	-72.494982
3	1	1	44.727459	-72.494874
6	6	10	44.727269	-72.494801

Table 3. EWM recorded from polygon data

Site Name	Plant Count	Depth
A: Boat Launch	320 plants	1-2'
D: Boat Launch	28 plants	1-2'
E: Boy Scout Camp	97 plants	8-12'
C: Boy Scout Camp	77 plants	5-12'
B: Public Beach	70% cover	10'
F: Public Beach	50% cover	10'

Appendix 2

Maps of Survey Areas and EWM Occurrences



Lake Eden: EWM August 2023 Survey Types

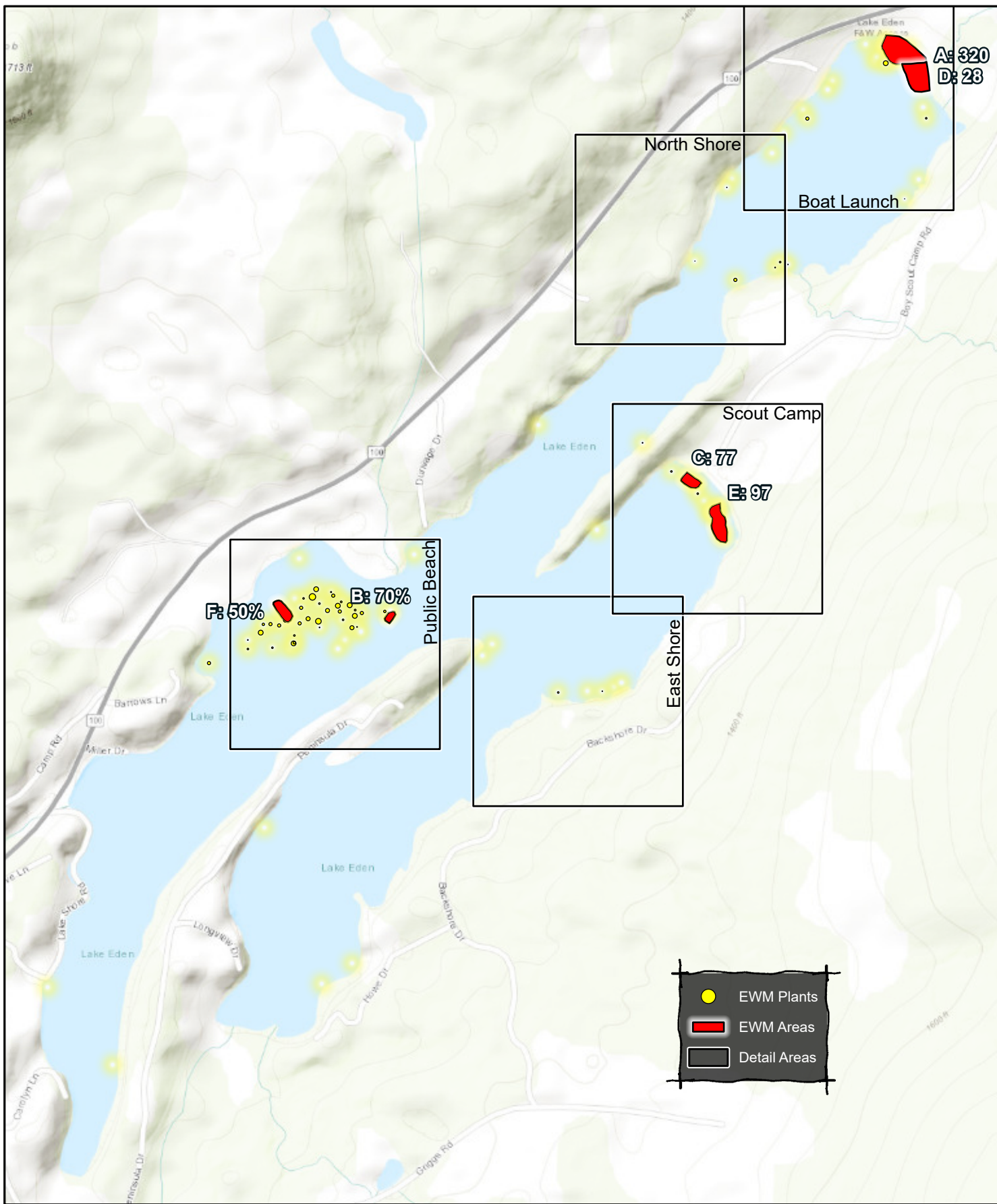
Friday, October 13, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-1
NAD 1983 StatePlane Vermont FIPS 4400

0 105210 420 630 840 Feet



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Lake Eden: Eurasian Watermilfoil August 2023

Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-1
NAD 1983 StatePlane Vermont FIPS 4400

0 105210 420 630 840 Feet



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Lake Eden: EWM August 2023 DETAIL: Boat Launch

Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet



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 EWM Plants

 EWM Areas



Lake Eden: EWM August 2023 DETAIL: East Shore

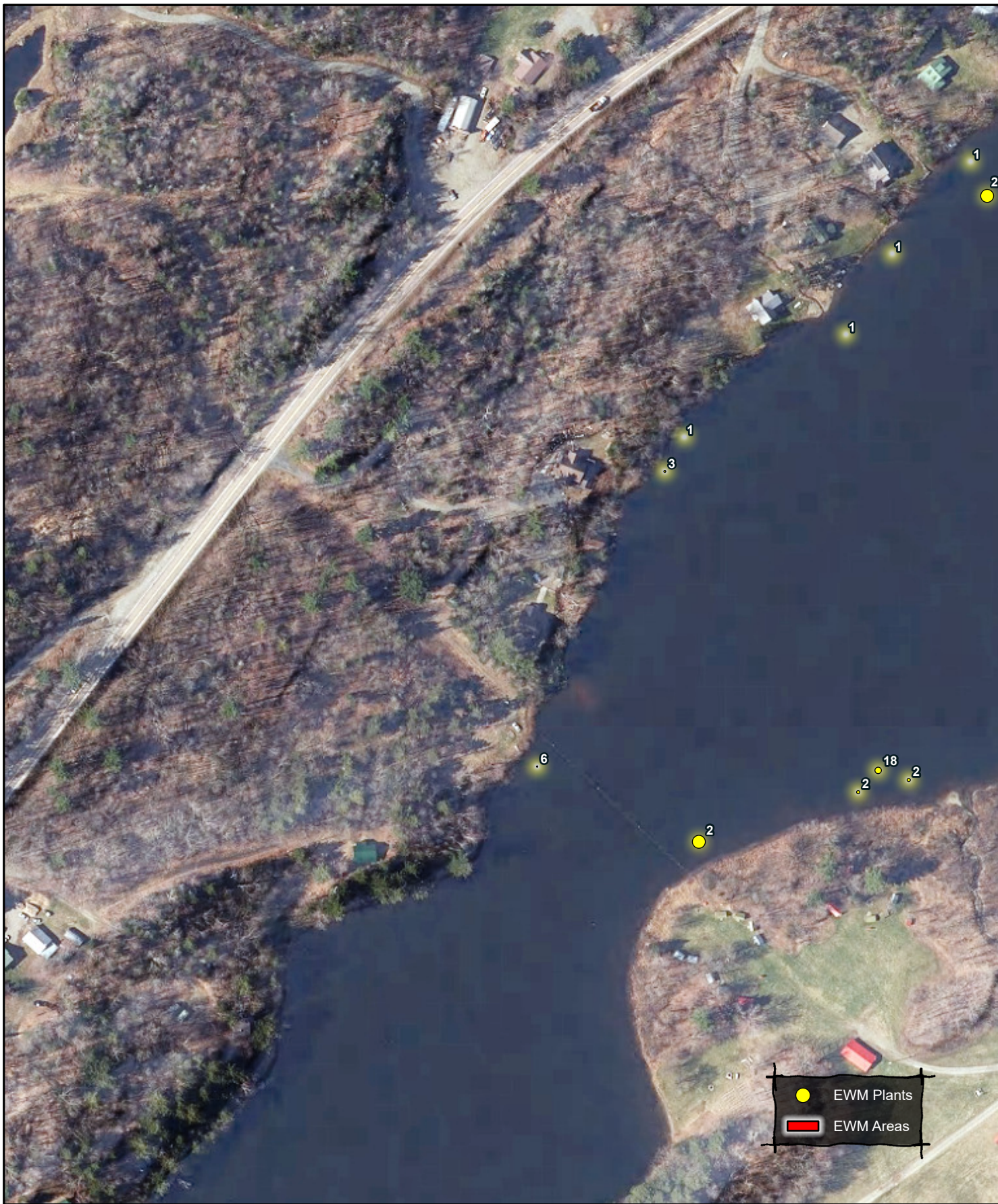
Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet



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Lake Eden: EWM August 2023 DETAIL: North Shore

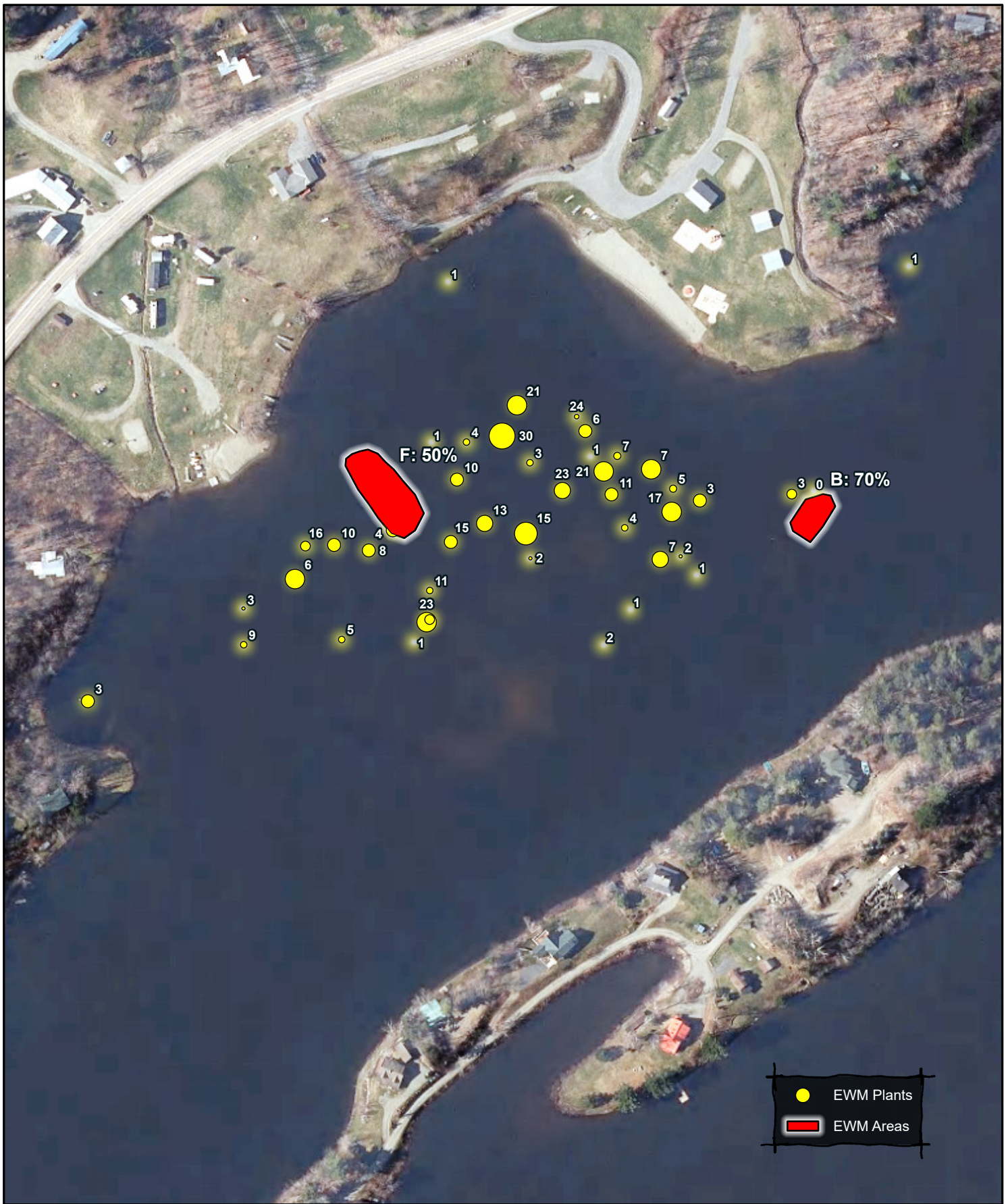
Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet



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Lake Eden: EWM August 2023 DETAIL: Public Beach

Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet





Lake Eden: EWM August 2023 DETAIL: Scout Camp

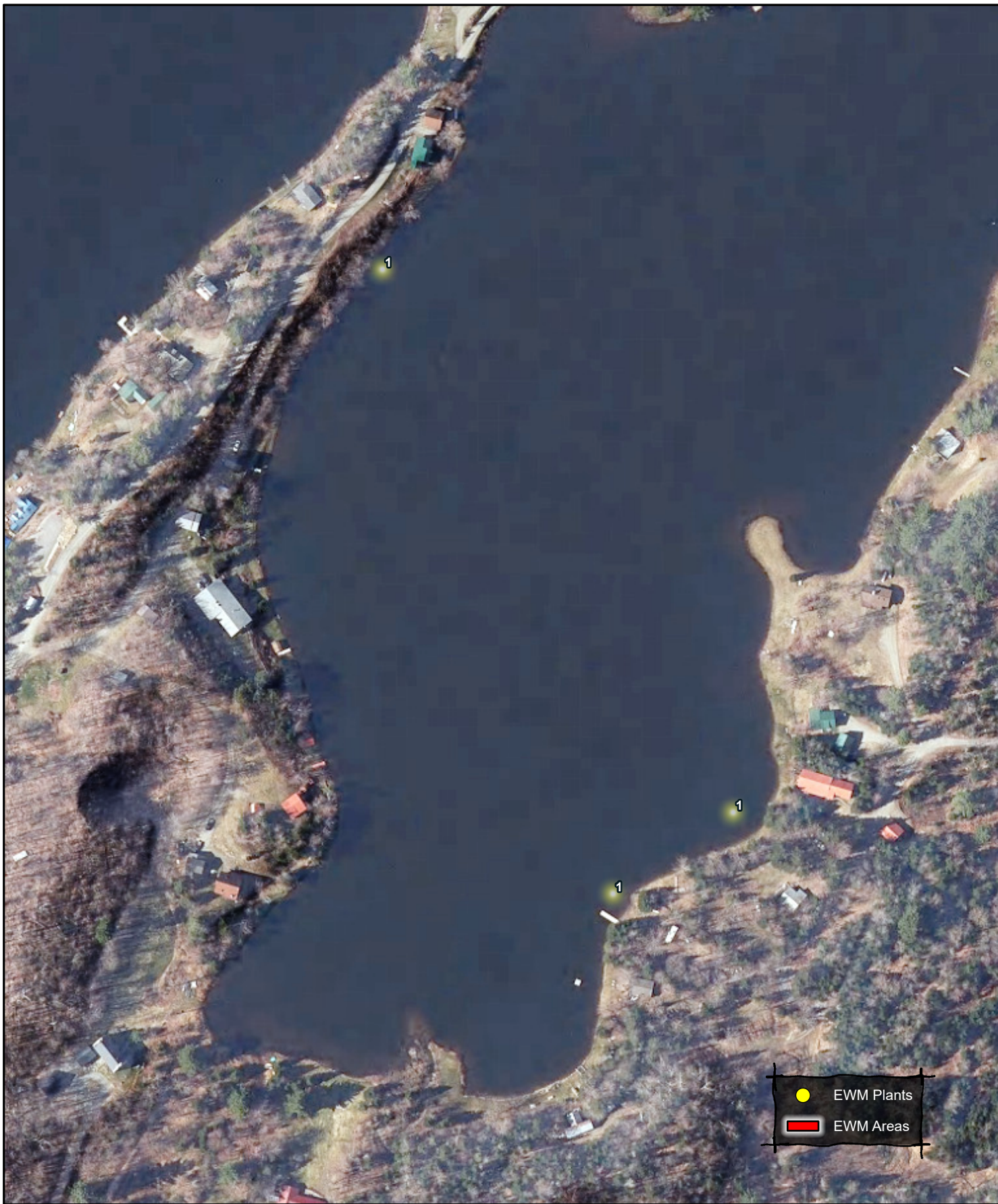
Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet



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Lake Eden: EWM August 2023 DETAIL: Southeast Bay

Thursday, August 31, 2023
Prepared By: A Worthley

File: LakeEden:8.5x11 Report 2023-2
NAD 1983 StatePlane Vermont FIPS 4400

0 25 50 100 150 200 Feet






EWM Plants


EWM Areas

