

## Memorandum

**To:** Beaver Dam Lake Management District (Board of Commissioners)  
**From:** Barr Engineering Company (Meg Rattei)  
**Subject:** 2013 EWM Treatment Results  
**Date:** August 21, 2013  
**Project:** 49030011.12  
**c:** Kevin Kretsch (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist)

The Beaver Dam Lake Management District treated 247 acres of Beaver Dam Lake with 2,4-D in 2013 to attain the District goal of reducing Eurasian watermilfoil (EWM) to ten percent of the littoral zone area while minimizing harm to native aquatic plants (Table 1).

**Table 1 2013 EWM Treatment Plan**

Treatment Area	Acres Treated	2,4-D Concentration Applied to Each Treatment Area (ppm)	Expected Lake-Concentration of 2,4-D (ppm)
<b>West Lake Basins</b>			
West Lake	23.12	4	0.07
Williams Bay	25.24	4	0.3
Rabbit Island Bay	14.89	4	0.3
Library Lake	1.67	2.3	0.3
<b>East Lake Basins</b>			
Norwegian Bay	37.89	0.5	0.5
East Lake	34.46	4	0.5
City Bay	102.08	0.5	0.5
Cemetery Bay	7.78	2	0.3

The purpose of this memorandum is to present the results of the 2013 herbicide treatment program to control Eurasian watermilfoil (EWM) in Beaver Dam Lake. This memorandum discusses the changes in EWM frequency and extent between the fall of 2012 and July of 2013. The historical changes of EWM since 2006 are presented in Figures 1 and 2 and Tables 1 and 2, but not discussed in this memorandum.

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The memorandum first discusses lake-wide treatment results and then discusses results from the eight treatment zones: West Lake, Williams Bay, Rabbit Island Bay, Library Lake, Norwegian Bay, East Lake, City Bay, and Cemetery Bay. The eight treatment zones differed in herbicide dose and/or expected post-treatment zone-wide herbicide concentration.

EWM frequency in this memorandum is the percent of sample points up to the 20-foot depth containing EWM. It should be noted that the current District goal is to attain a lake-wide EWM frequency of 10 percent or less.

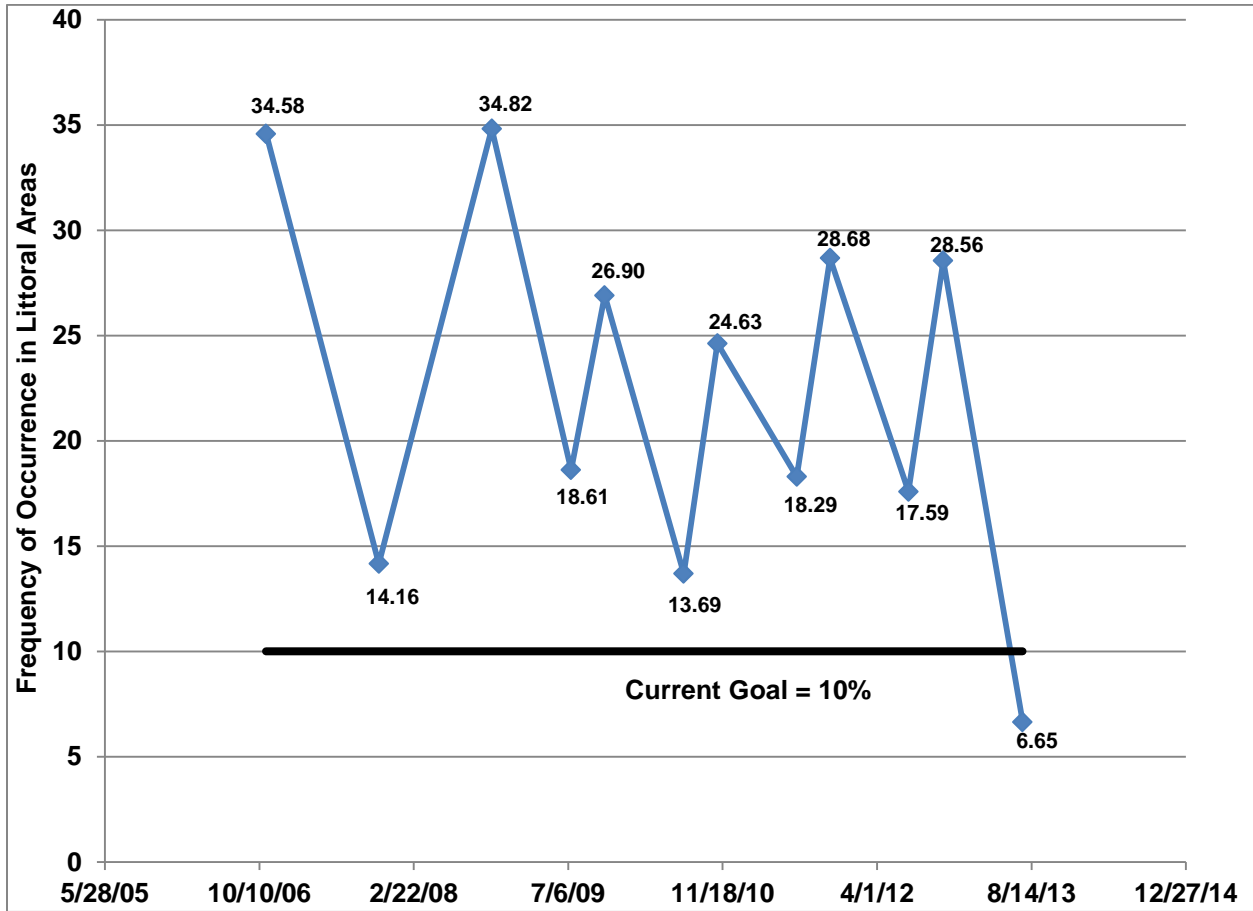
## **1.0 2013 EWM Treatment Results**

### **1.1 Lake-Wide Treatment Results**

The July 2013 aquatic plant survey results indicate the herbicide treatment reduced EWM frequency from 29 percent in the fall of 2012 to 7 percent during July of 2013 (Figure 1). The current District goal of 10 percent was met in July (Figure 1). The lake will again be surveyed in the fall to determine whether or not this goal continues to be met. In past years, the EWM frequency has increased by about 10 percent between summer and fall (Figure 1).

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**Figure 1 2006-2013 Beaver Dam Lake Frequency of Occurrence in Littoral Area**

The 2013 herbicide treatment reduced EWM extent from 146 acres in the fall of 2012 to 36 acres in July of 2013 (Figure 2).

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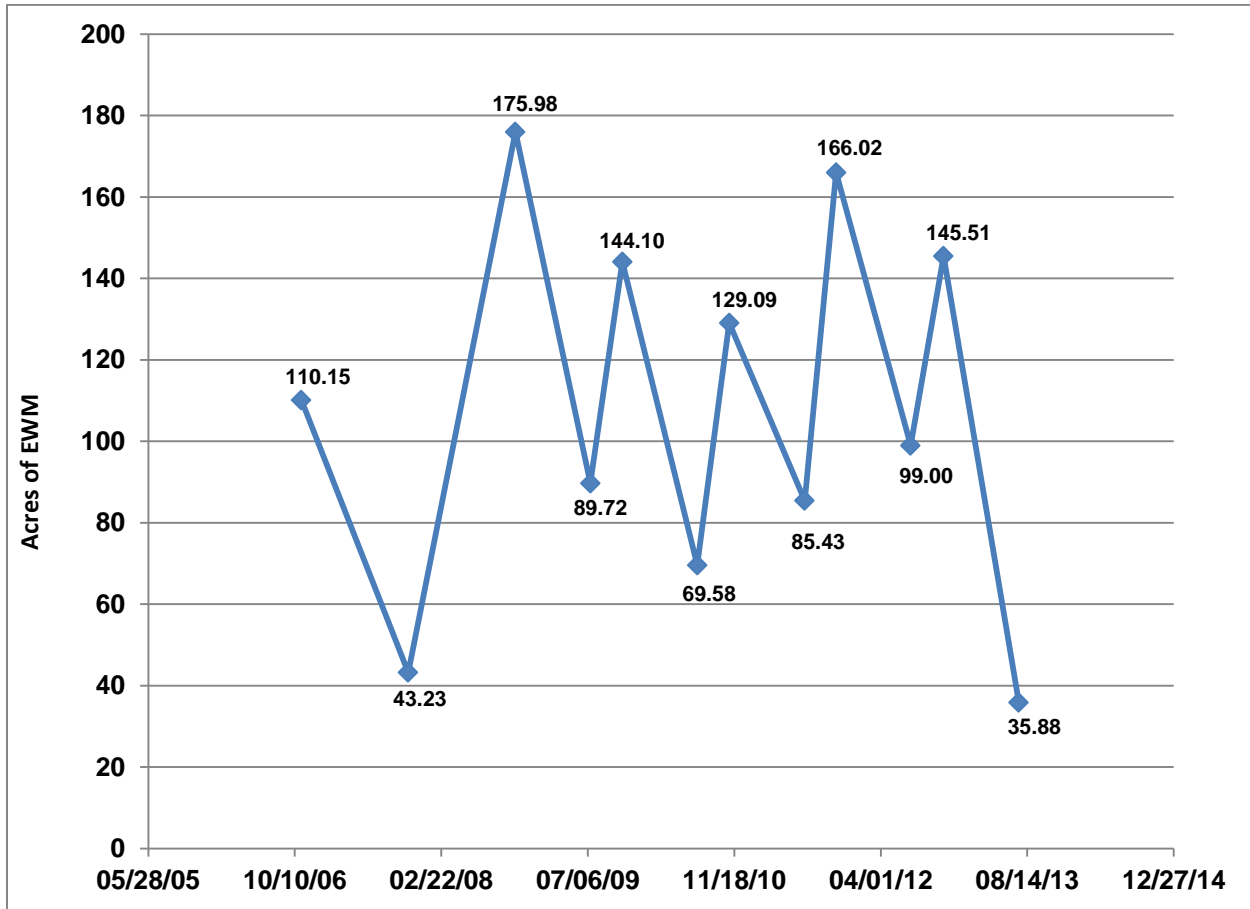


Figure 2 2006-2013 Beaver Dam Lake EWM Acreage

### 1.2 Results from the Eight Treatment Zones

Changes in EWM in the eight treatment zones were determined in two ways – changes in frequency and changes in extent. Changes in EWM frequency and extent in the eight treatment zones, shown in Tables 2 and 3, include:

- **West Lake** – EWM frequency and extent were reduced by more than 50 percent. Frequency was reduced from 16 percent in fall of 2012 to 7 percent in July of 2013. EWM extent was reduced from 23 acres in fall of 2012 to 10 acres in July of 2013.

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- **Williams Bay** – EWM frequency and extent were reduced by more than an order of magnitude. EWM frequency was reduced from 18 percent in fall of 2012 to 1 percent in July of 2013. EWM extent was reduced from 7 acres in fall of 2012 to 0.3 acres in July of 2013.
- **Rabbit Island Bay** – EWM frequency and extent were reduced by more than an order of magnitude. EWM frequency was reduced from 13 percent in fall of 2012 to 0.9 percent in July of 2013. EWM extent was reduced from 6 acres in fall of 2012 to 0.4 acres in July of 2013.
- **Library Lake** – EWM was controlled by the treatment. Hence, EWM was not observed in July of 2013. EWM frequency was reduced from 2 percent in fall of 2012 to 0 percent in July of 2013. EWM extent was reduced from 0.04 acres in fall of 2012 to 0 acres in July of 2013.
- **City Bay**– EWM frequency and extent were reduced by more than 50 percent between the fall of 2012 and July of 2013. EWM frequency decreased from 59 percent in fall of 2012 to 22 percent in July of 2013. EWM extent decreased from 56 acres in fall of 2012 to 21 acres in July of 2013.

A pre-treatment survey in May revealed a winter decline of EWM. Because EWM grows under the ice during the winter, the unusually long winter and late ice-out probably caused the decline. EWM frequency declined from 59 percent in fall of 2012 to 47 percent in May.

EWM extent declined from 56 acres in fall of 2012 to 51 acres in May of 2013.



**Figure 3. All EWM plants observed in Norwegian Bay, East Lake, and City Bay during July were growing from old root crowns, pictured above.**

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The June survey data indicated the treatment attained control of EWM plants, but did not destroy their root crowns. Hence, EWM was not observed in City Bay during June, but was observed at a frequency of 22 percent and an extent of 21 acres in July. All EWM plants observed in July were growing from old root crowns.

During the July survey, EWM fragments extended from the boat landing toward the bay and resembled a conveyer belt of fragments. The fragments resulted from boats shredding and spreading EWM fragments as they proceeded from the boat landing through an EWM bed toward the bay. The wind was pushing these fragments along East Lake's north shoreline and into Norwegian Bay.

- **East Lake** – EWM frequency and extent were reduced by about an order of magnitude between the fall of 2012 and July of 2013. EWM frequency decreased from 35 percent in fall of 2012 to 4 percent in July of 2013. EWM extent was reduced from 20 acres in fall of 2012 to 1 acre in July of 2013. The EWM in East Lake during July consisted of plants growing from root crowns that were full of dead and decaying stems of plants killed by the herbicide treatment. The only EWM plants in July were new growth from old root crowns. During the July survey, floating EWM fragments were observed everywhere along the north shore with wind funneling them towards Norwegian Bay.
- **Norwegian Bay** –EWM frequency and extent were reduced by about an order of magnitude between the fall of 2012 and July of 2013. EWM frequency decreased from 72 percent in fall of 2012 to 7 percent in July of 2013. EWM extent decreased from 27 acres in fall of 2012 to 2 acres in in July of 2013.

A pre-treatment survey in May revealed a winter decline of EWM. Because EWM grows under the ice during the winter, the unusually long winter and late ice-out probably caused the decline. EWM frequency declined from 72 percent in fall of 2012 to 40 percent in May. EWM extent declined from 27 acres in fall of 2012 to 15 acres in May of 2013.

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The June survey data indicated the treatment attained control of EWM plants, but did not destroy their root crowns. Hence, EWM was not observed in Norwegian Bay during June, but was observed at a frequency of 7 percent and an extent of 2 acres in July. The only EWM plants observed in July were new plants growing from old root crowns in the southern portion of the bay, the area nearest the bay entrance.

- **Cemetery Bay** – EWM was not observed in July. EWM frequency decreased from 18 percent in fall of 2012 to 3 percent in June to 0 percent in July. EWM extent decreased from 7 acres in fall of 2012 to 0.8 acres in June to 0 acres in July.

Figures 3 through 10 show the EWM extent during July of 2013. The EWM extent during the fall of 2012 is found in Appendix F of the Beaver Dam Lake Aquatic Plant Management Plan. Figures 3 through 10 will be added to Appendix F of the Beaver Dam Lake Aquatic Plant Management Plan during its annual update later this year.

**Table 2. 2006-2013 Beaver Dam Lake EWM Frequency of Occurrence Summary**

Location	% of sample points up to 20 foot depth with Eurasian watermilfoil, including visuals														
	Nov-06	Nov-07	Nov-08	Jul-09	Nov-09	Jul-10	Nov-10	Jul-11	Nov-11	Jun-12	Jul-12	Nov-12	May-13	Jun-13	Jul-13
West Lake	19.21	11.74	24.24	16.72	15.22	11.68	15.46	7.99	11.22	N/A	9.72	15.60	N/A	N/A	7.43
Williams Bay	15.38	29.87	26.88	19.78	12.77	4.30	14.13	11.49	11.58	N/A	4.40	17.65	N/A	N/A	1.09
Rabbit Island Bay	39.80	30.34	31.63	19.64	21.50	13.51	28.30	11.01	18.18	0.00	1.77	12.50	N/A	N/A	0.88
Library Lake	73.33	21.36	25.93	5.07	1.59	0.75	6.40	0.00	0.00	N/A	3.01	1.96	N/A	N/A	0.00
Norwegian Bay	26.67	16.13	49.23	39.71	78.79	33.82	28.36	11.76	51.52	13.24	54.41	72.13	39.71	0	7.35
East Lake	6.06	0.00	15.20	17.65	33.91	27.83	36.54	35.40	40.83	N/A	22.03	35.45	N/A	N/A	3.57
City Bay	53.71	7.34	73.75	32.78	62.87	21.55	55.93	55.00	68.11	8.89	48.07	58.90	46.93	0	21.79
Cemetery Bay	39.47	0.00	38.64	0.00	6.82	0.00	10.23	3.37	47.73	N/A	0.00	18.39	N/A	3.37	0.00
<b>West Lake Total</b>	<b>29.66</b>	<b>19.87</b>	<b>26.27</b>	<b>15.16</b>	<b>13.15</b>	<b>8.60</b>	<b>15.63</b>	<b>7.31</b>	<b>10.11</b>	<b>N/A</b>	<b>6.08</b>	<b>14.01</b>	<b>N/A</b>	<b>N/A</b>	<b>3.78</b>
<b>East Lake Total</b>	<b>35.61</b>	<b>5.32</b>	<b>46.35</b>	<b>23.46</b>	<b>46.33</b>	<b>20.75</b>	<b>37.84</b>	<b>33.33</b>	<b>54.68</b>	<b>N/A</b>	<b>32.89</b>	<b>46.32</b>	<b>N/A</b>	<b>N/A</b>	<b>10.71</b>
<b>Beaver Dam Lake Total</b>	<b>34.58</b>	<b>14.16</b>	<b>34.82</b>	<b>18.61</b>	<b>26.90</b>	<b>13.69</b>	<b>24.63</b>	<b>18.29</b>	<b>28.68</b>	<b>N/A</b>	<b>17.59</b>	<b>28.56</b>	<b>N/A</b>	<b>N/A</b>	<b>6.65</b>

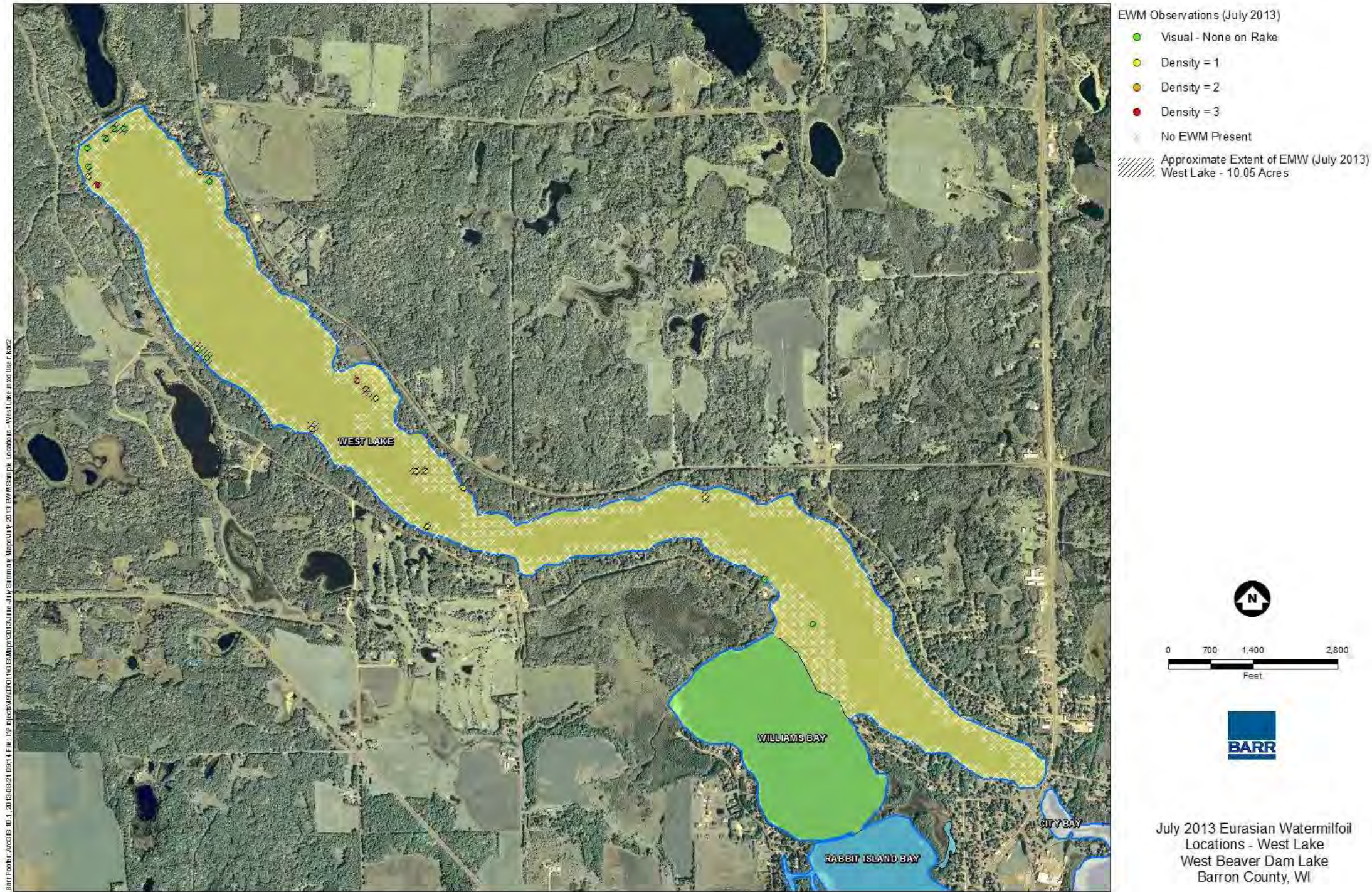


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**Table 3. 2006-2013 EWM Extent in Beaver Dam Lake**

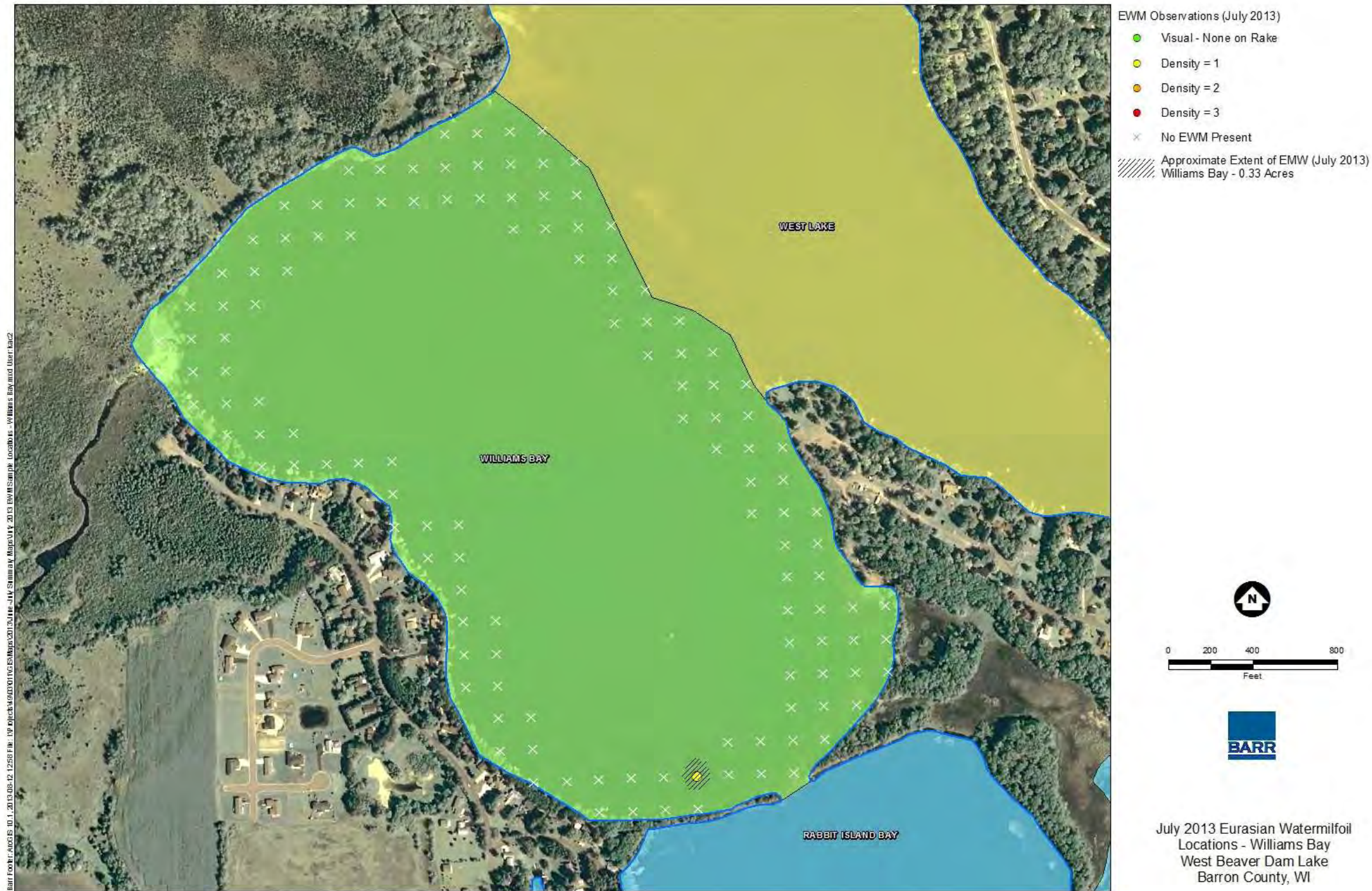
Treatment Area	Acreage of EWM (based on plant surveys)														
	Nov-06	Nov-07	Nov-08	Jul-09	Nov-09	Jul-10	Nov-10	Jul-11	Nov-11	Jun-12	Jul-12	Nov-12	May-13	Jun-13	Jul-13
West Lake	25.27	11.36	33.19	24.59	19.67	15.80	25.15	8.65	14.78	N/A	15.31	23.11	N/A	N/A	10.05
Williams Bay	3.63	10.23	12.64	9.48	4.80	1.15	6.68	4.57	4.65	N/A	1.68	6.92	N/A	N/A	0.33
Rabbit Island Bay	5.80	12.36	13.21	10.57	8.51	6.26	11.47	4.22	8.01	0	0.51	5.64	N/A	N/A	0.38
Library Lake	0.66	0.59	3.62	0.40	0.09	0.04	0.72	0.00	0.00	N/A	0.2	0.04	N/A	N/A	0.00
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
East Lake	0.00	0.00	9.34	8.14	19.37	14.13	17.48	17.18	23.93	N/A	11.33	19.98	N/A	N/A	1.18
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
Cemetery Bay	10.90	0.00	17.80	0.00	1.81	0.00	3.97	0.86	21.32	N/A	0	7.17	N/A	0.75	0.00
<b>West Lake Total:</b>	<b>35.36</b>	<b>34.54</b>	<b>62.66</b>	<b>45.04</b>	<b>33.07</b>	<b>23.25</b>	<b>44.02</b>	<b>17.44</b>	<b>27.44</b>	<b>N/A</b>	<b>17.70</b>	<b>35.70</b>	<b>N/A</b>	<b>N/A</b>	<b>10.76</b>
<b>East Lake Total:</b>	<b>74.79</b>	<b>8.69</b>	<b>113.32</b>	<b>44.68</b>	<b>111.03</b>	<b>46.33</b>	<b>85.07</b>	<b>67.99</b>	<b>138.58</b>	<b>N/A</b>	<b>81.30</b>	<b>109.81</b>	<b>N/A</b>	<b>N/A</b>	<b>24.07</b>
<b>Beaver Dam Lake Total</b>	<b>110.15</b>	<b>43.23</b>	<b>175.98</b>	<b>89.72</b>	<b>144.10</b>	<b>69.58</b>	<b>129.09</b>	<b>85.43</b>	<b>166.02</b>	<b>N/A</b>	<b>99.00</b>	<b>145.51</b>	<b>N/A</b>	<b>N/A</b>	<b>35.88</b>

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**Figure 3. July 2013 EWM Extent in West Lake**

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**Figure 4. July 2013 EWM Extent in Williams Bay**

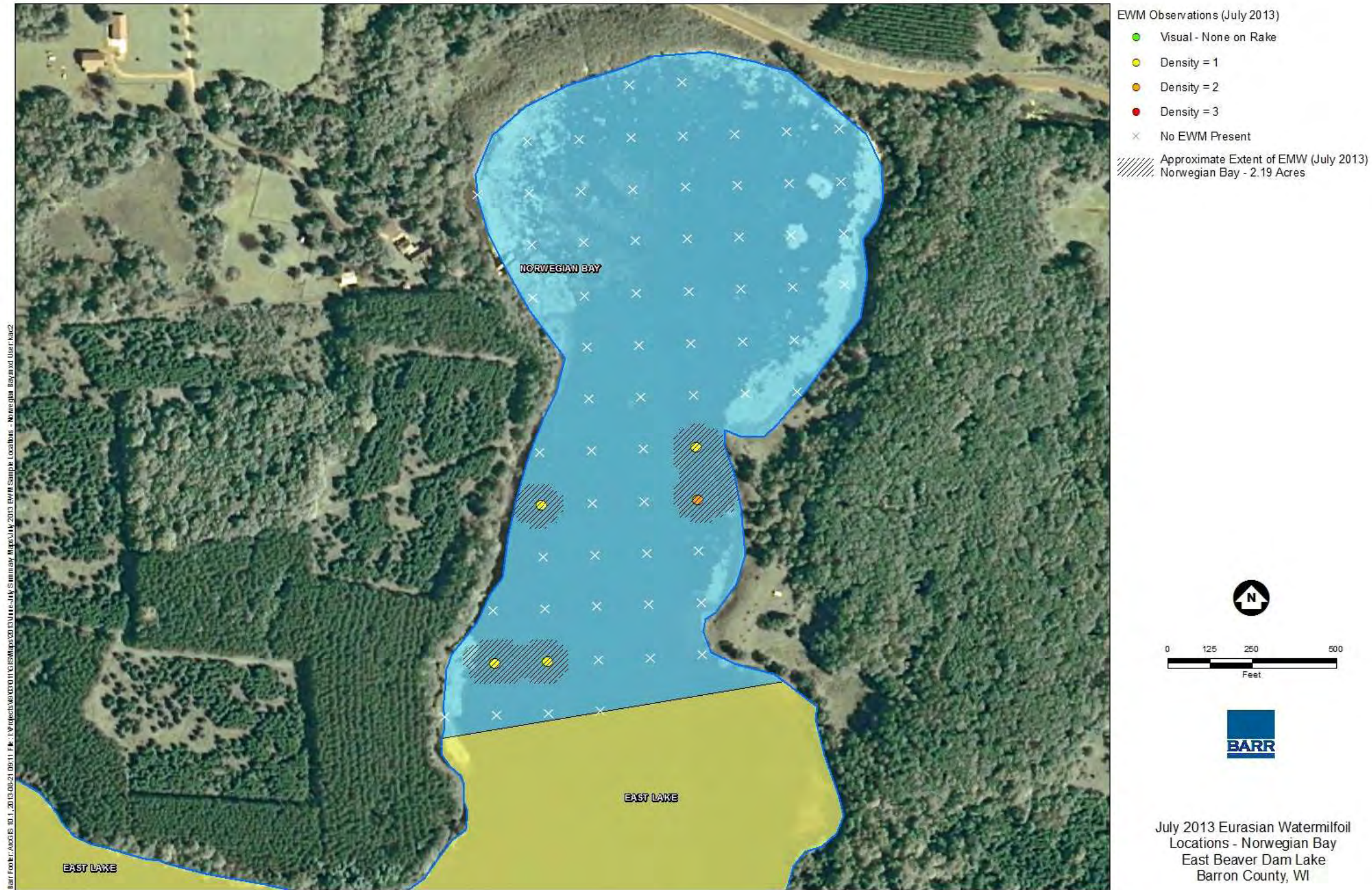


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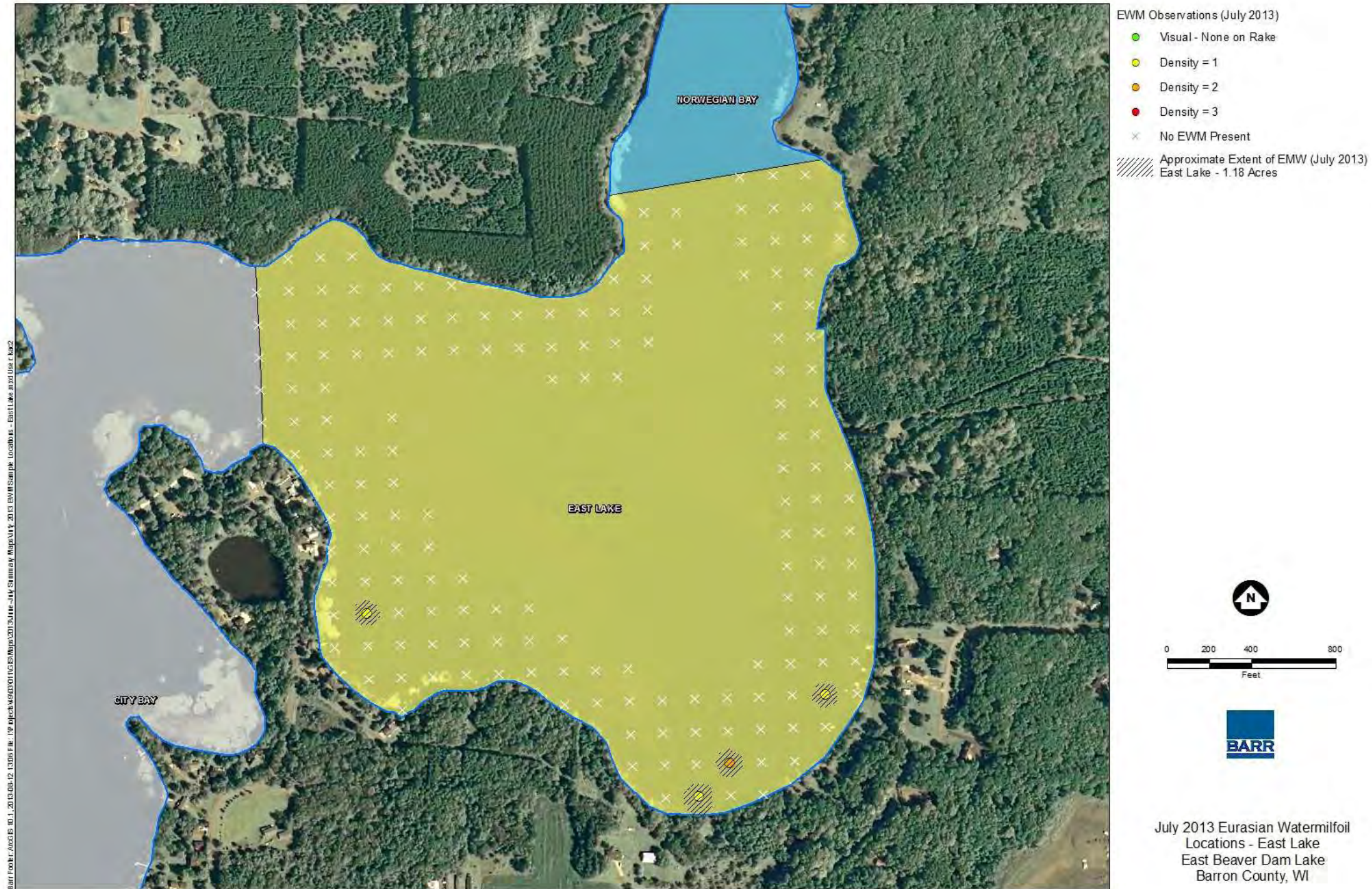
**Figure 6. July 2013 EWM Extent in Library Lake (No EWM Observed)**

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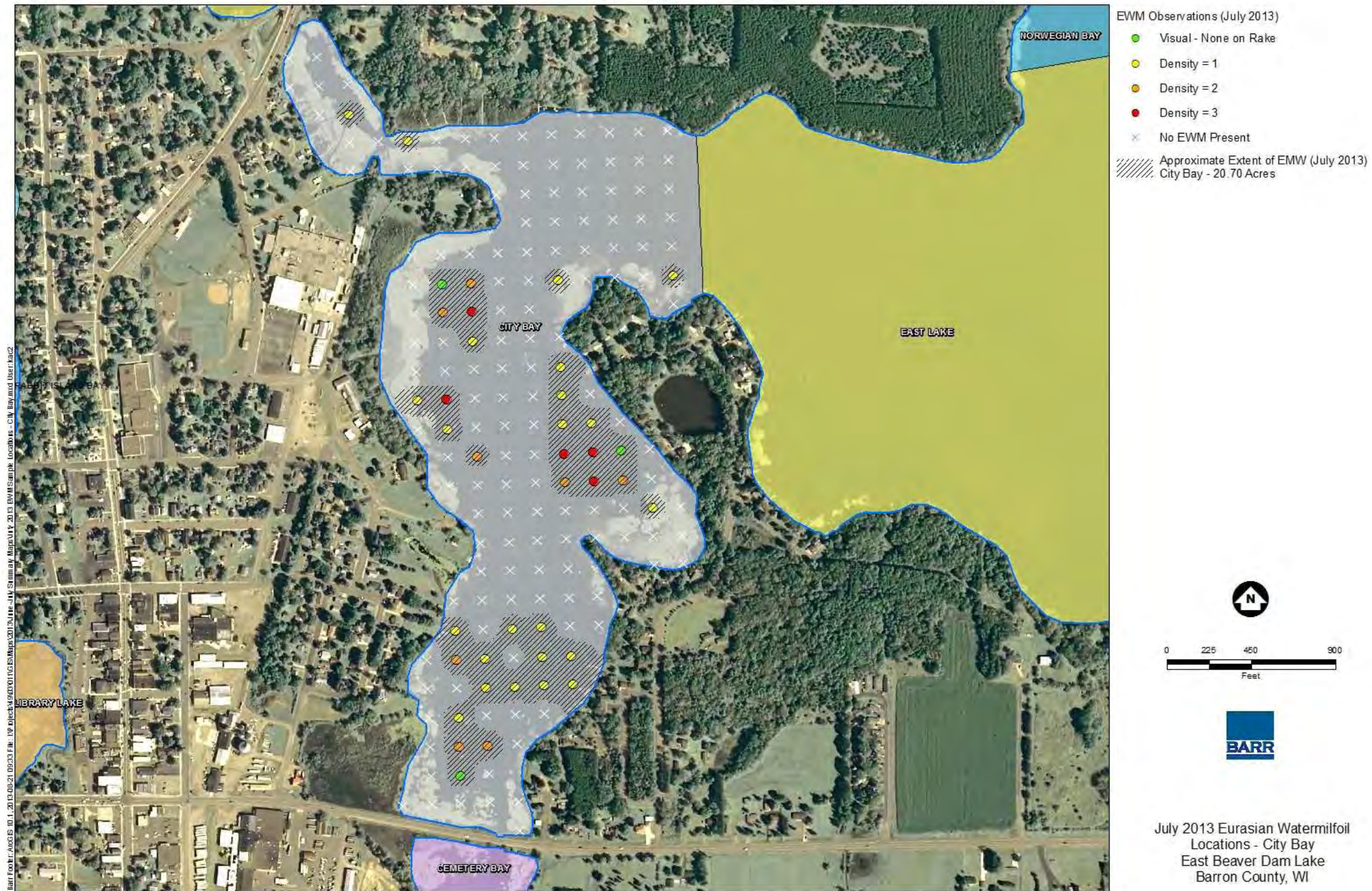
**Figure 7. 2013 EWM Extent in Norwegian Bay**

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**Figure 8. 2013 EWM Extent in East Lake**

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**Figure 9. 2013 EWM Extent in City Bay**



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Figure 10. 2013 EWM Extent in Cemetery Bay

## 2.0 Comparison of July 2013 EWM with 2013 Treatment Areas

The July 2013 EWM locations were compared with 2013 EWM treatment areas (Table 4 and Figures 11 through 18).

**Table 4. Percent of July 2013 EWM Within and Outside of 2013 Treatment Areas**

<b>Location</b>	<b>Percent of July 2013 EWM Within 2013 Treatment Areas</b>	<b>Percent of July 2013 EWM Outside of 2013 Treatment Areas</b>
Norwegian Bay	100.00	0
Cemetery Bay	No EWM	No EWM
City Bay	100.00	0
East Lake	100.00	0
West Lake	18.18	81.82
Williams Bay	100.00	0
Rabbit Island Bay	0.00	100
Library Lake	No EWM	No EWM
<b>East Lake Total:</b>	100.00	0.00
<b>West Lake Total:</b>	20.83	79.17
<b>Total Beaver Dam Lake</b>	73.61	26.39

As shown in Figures 14 and 18, EWM was not observed in Library Lake and Cemetery Bay during July.

All EWM observed in Norwegian Bay, East Lake, and City Bay during July consisted of new plants growing from old root crowns that contained dead and decaying stems from plants killed by the herbicide. Hence, 100 percent of July 2013 EWM was found within treatment areas. It appears that a higher herbicide dose may be needed to destroy both the plants and the root crowns in future treatments.

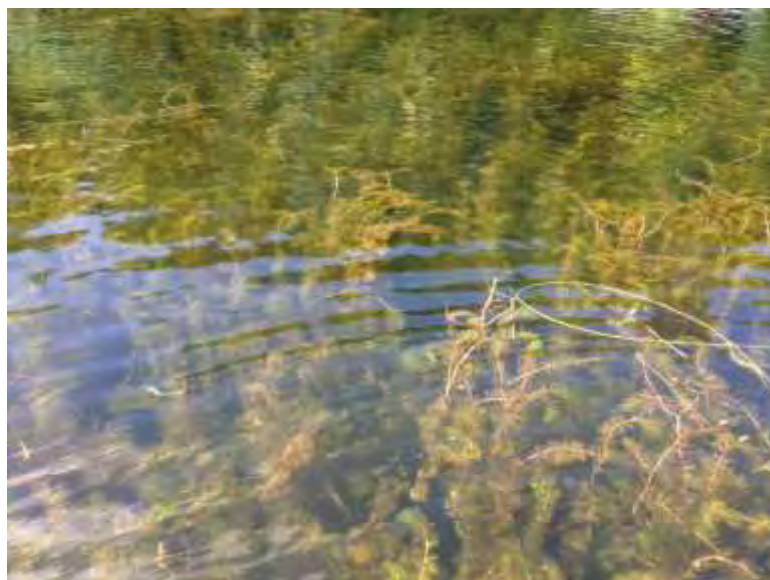
Williams Bay and Rabbit Island Bay each observed one EWM location. In Williams Bay, the EWM location was located in a treatment area. Hence, 100 percent of EWM in Williams Bay was inside of a treatment area. In Rabbit Island Bay, the single EWM location was located outside of the treatment areas. Hence, 100 percent of EWM in Rabbit Island Bay was outside of the treatment areas. The single EWM location in Rabbit Island Bay was in 19 feet of water. The EWM plants appeared to be clinging to life,

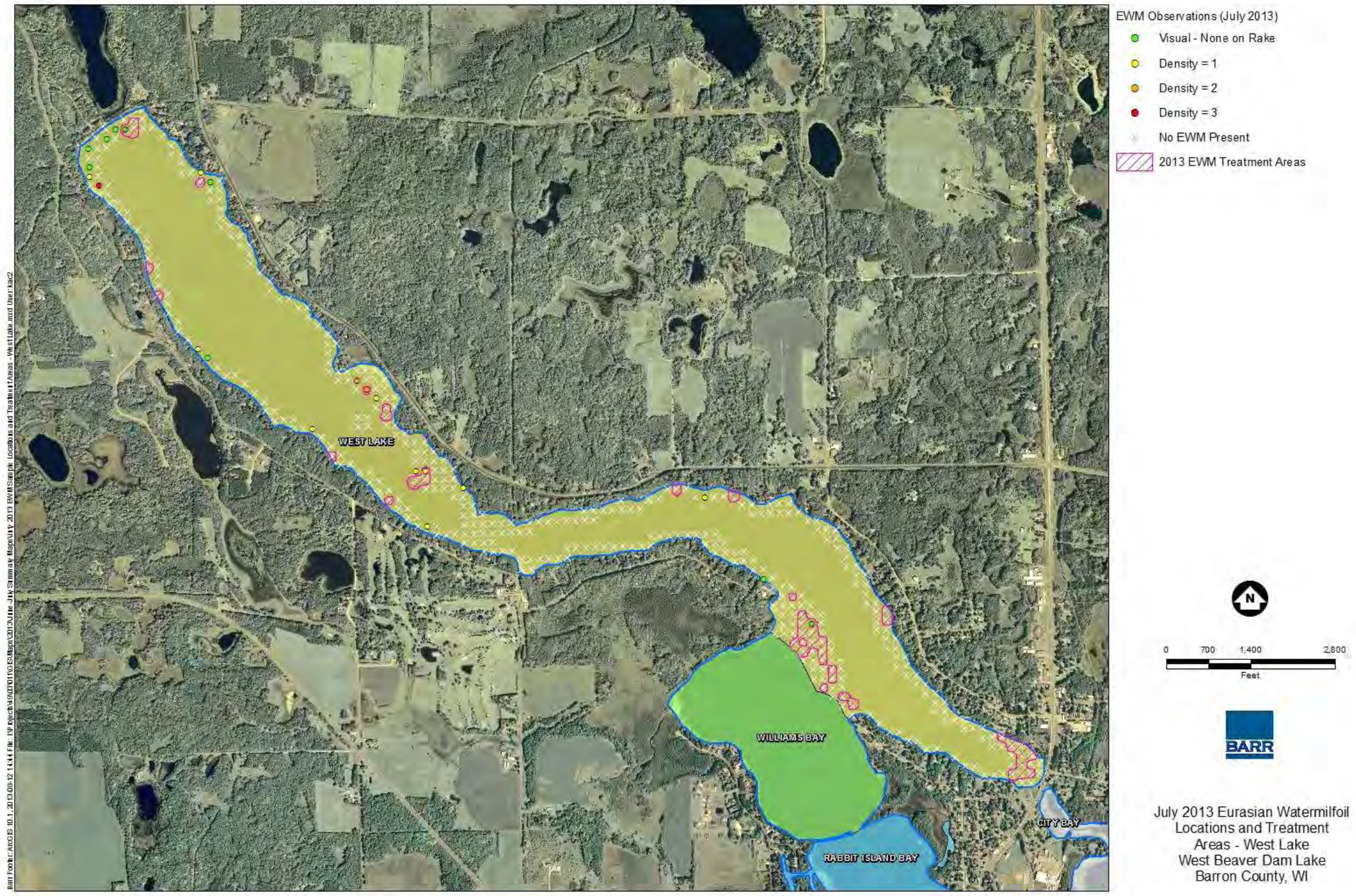
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with just a few leaflets on otherwise dead stems. Three different rake tosses were made at the EWM location and EWM was found each time, thus verifying its presence.

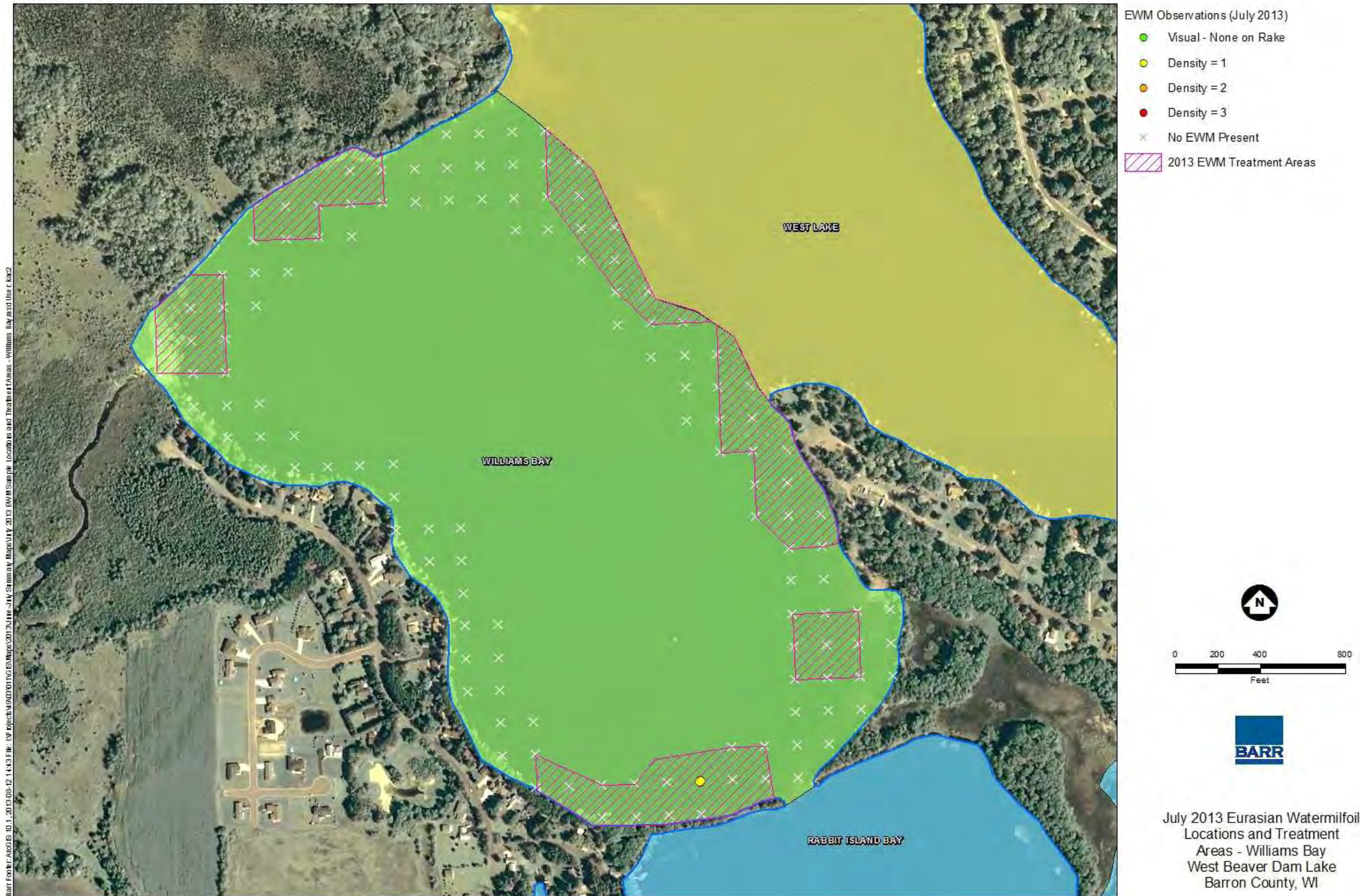
In West Lake, only 18 percent of EWM locations were found in a treatment area. Hence, most of the EWM in West Lake was a result of spread to new locations. Many residents at the far end of West Lake must motor through canopied (reaching the surface) beds of EWM to access the lake. The boats are shredding and spreading EWM to other areas of West Lake. The canopied EWM beds at the far end of West Lake are pictured below.





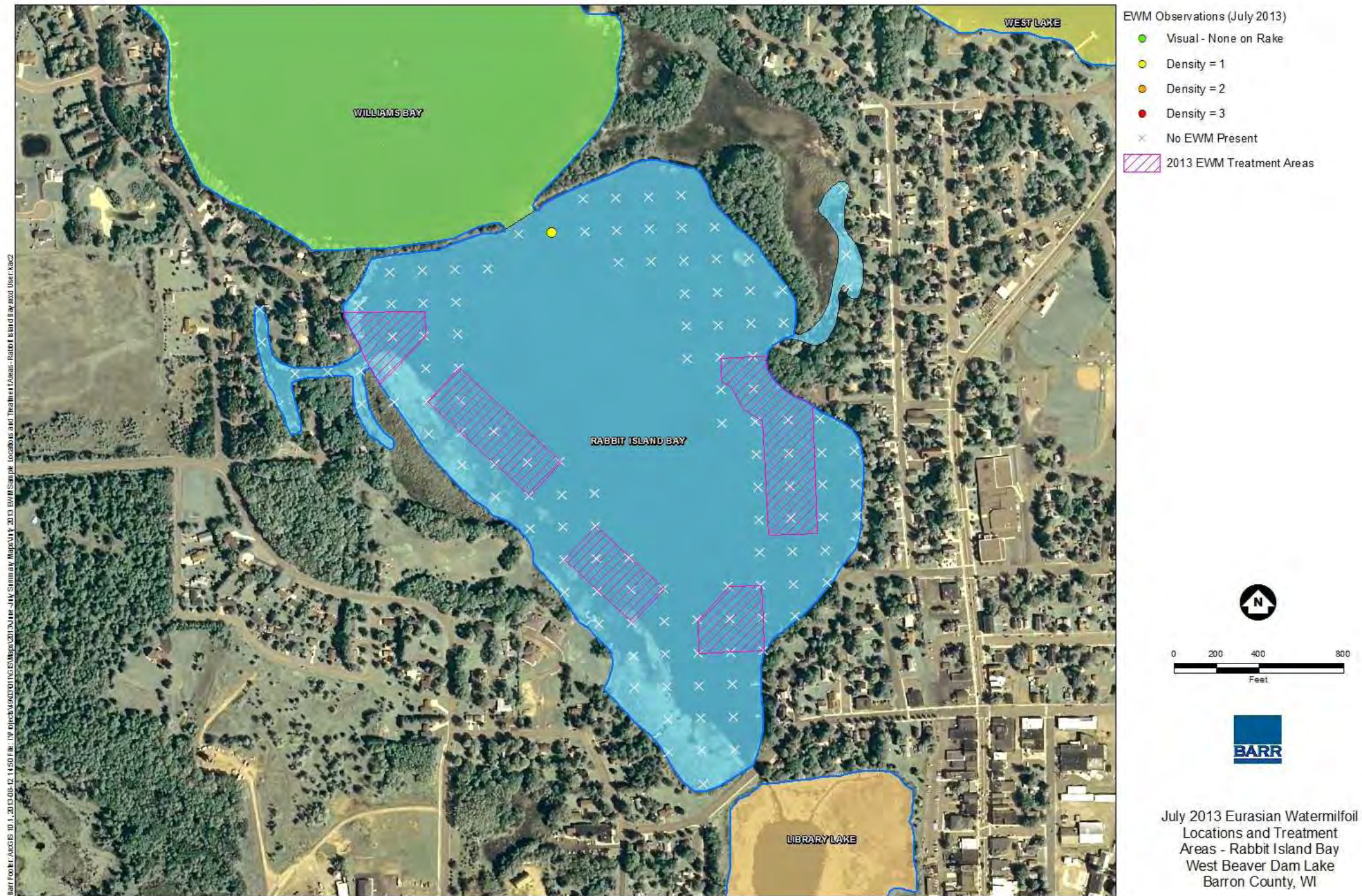
**Figure 11. Comparison of July 2013 EWM with 2013 EWM Treatment Areas in West Lake**

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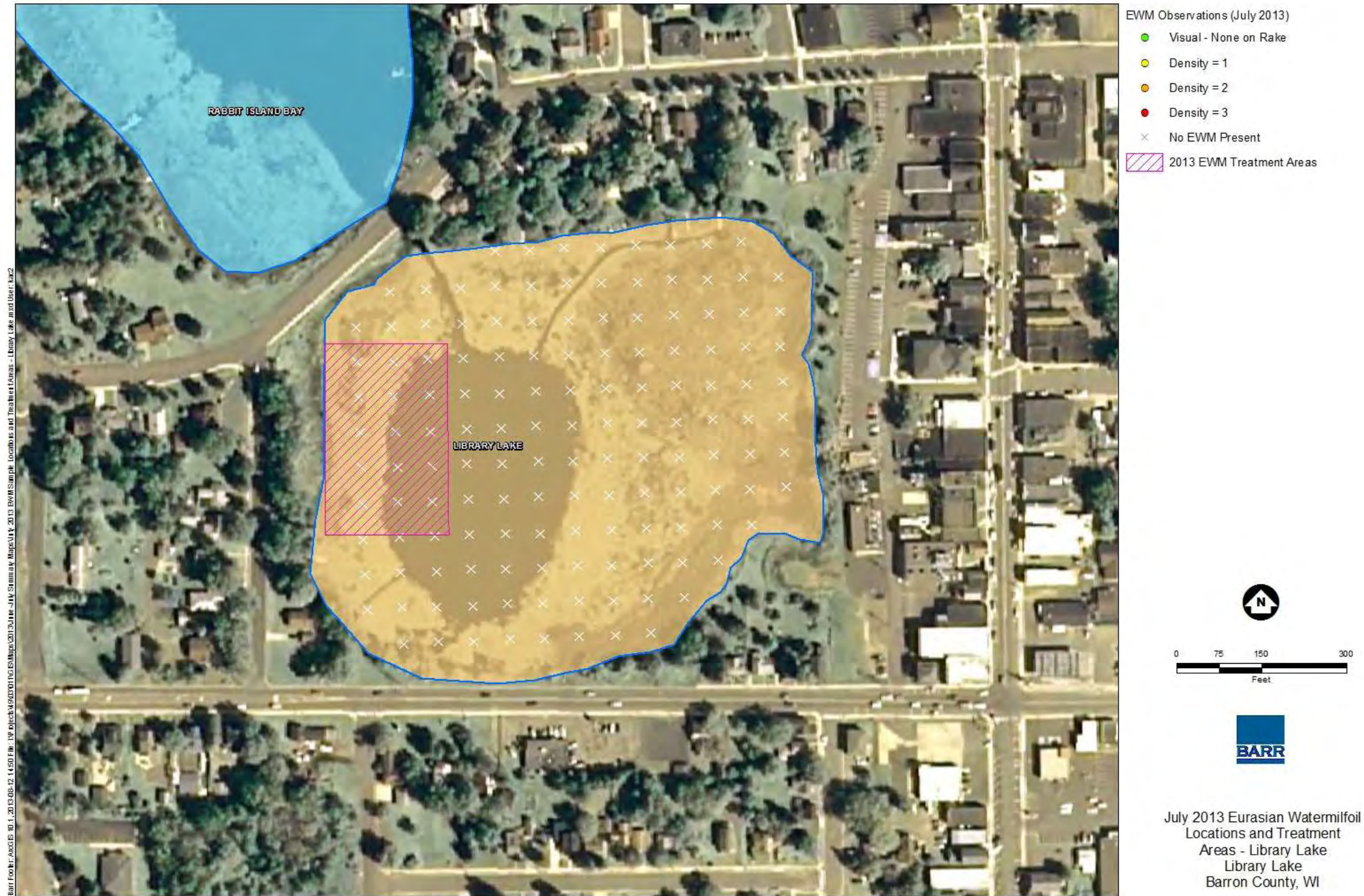
**Figure 12. Comparison of July 2013 EWM with 2013 Treatment Areas in Williams Bay**

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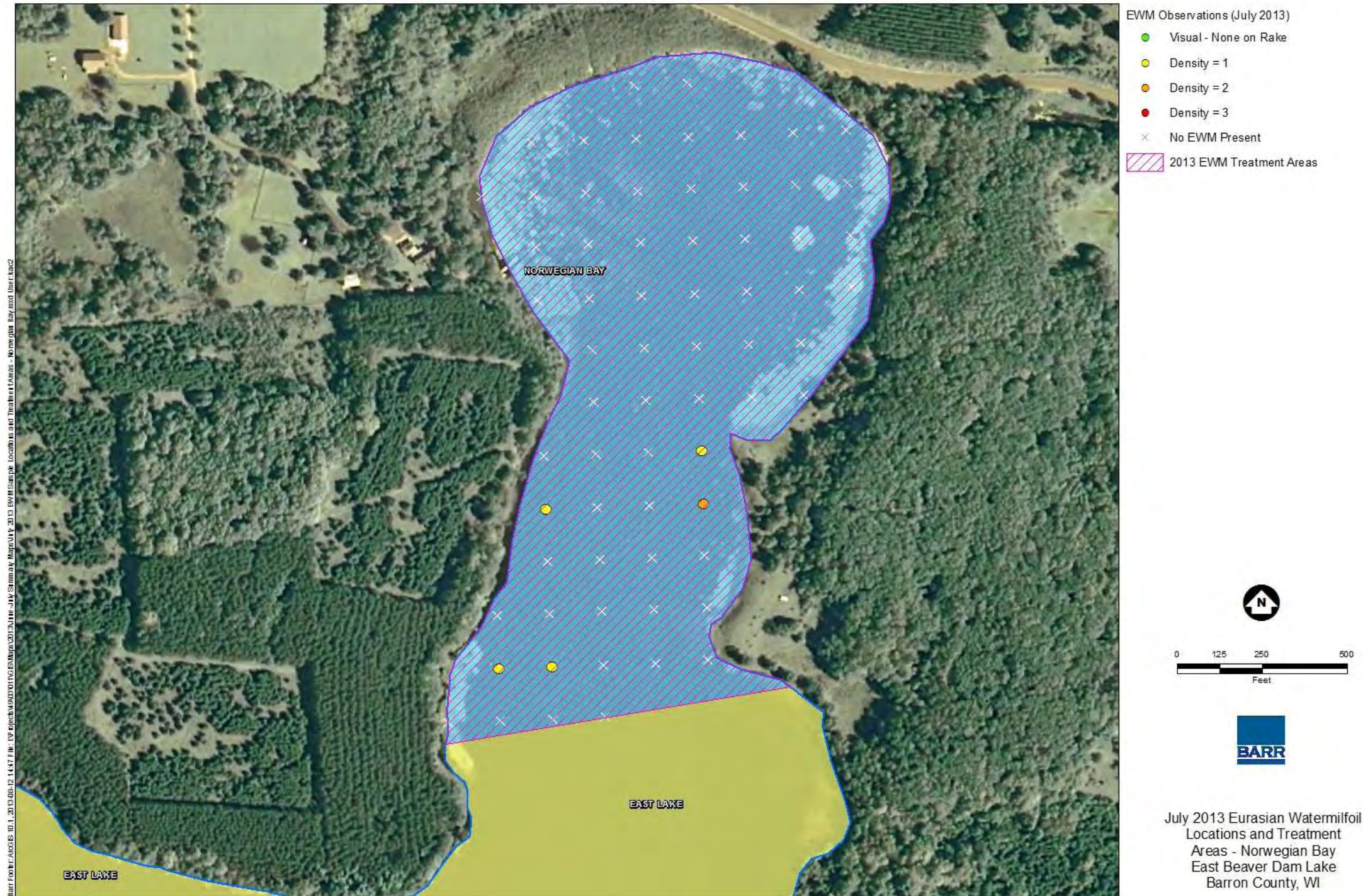
**Figure 13. Comparison of July 2013 EWM with 2013 Treatment Areas in Rabbit Island Bay**

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**Figure 14. Comparison of July 2013 EWM with 2013 Treatment Area in Library Lake (No EWM Observed in July)**

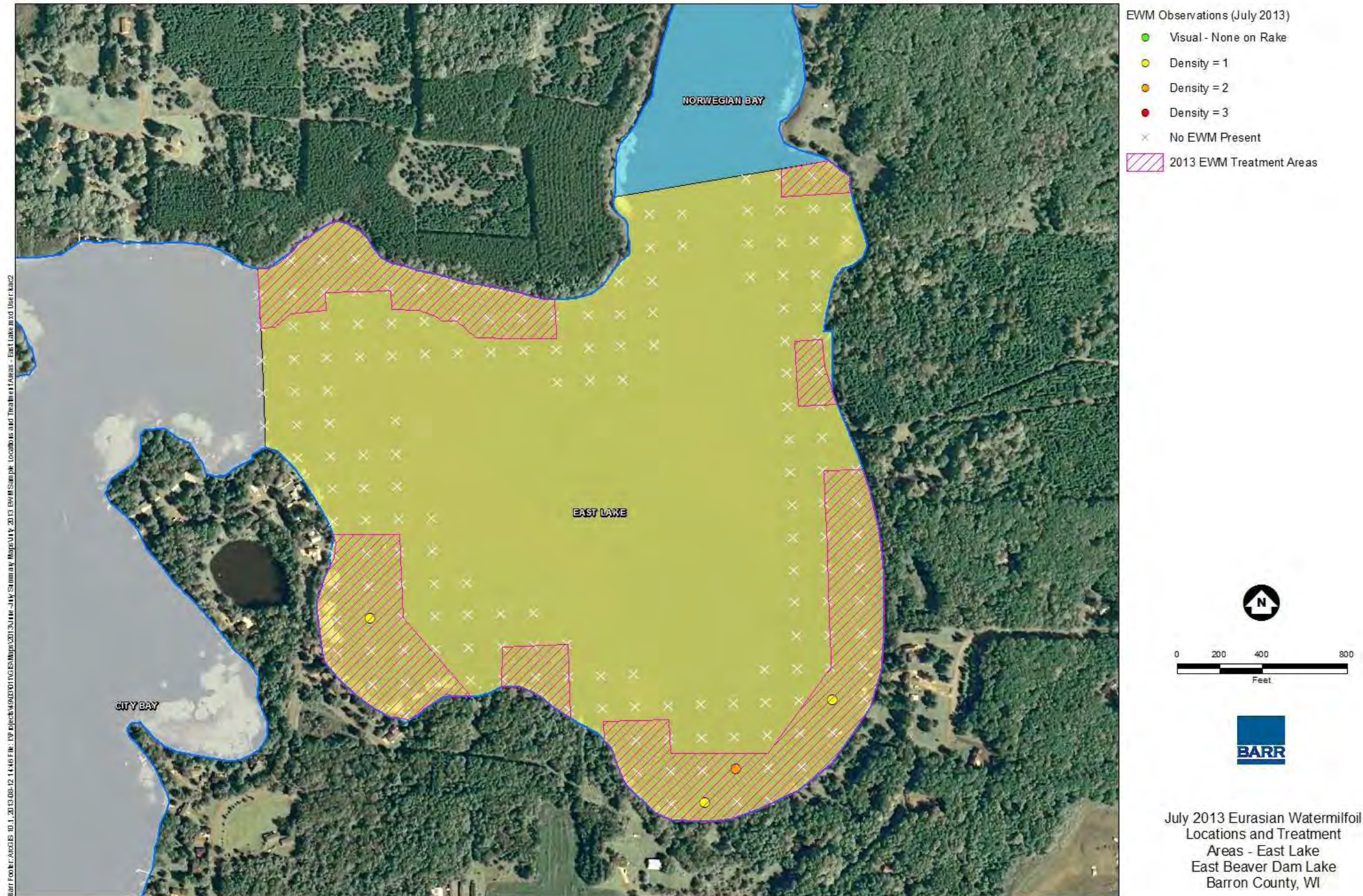
**To:** Beaver Dam Lake Management District (Board of Commissioners)  
**From:** Barr Engineering Company (Meg Raffel)  
**Subject:** 2013 EWM Treatment Results  
**Date:** August 21, 2013  
**Page:** 24  
**Project:** 49030011.12  
**c:** Kevin Kretsch (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist working with WDNR)



**Figure 15. Comparison of July 2013 EWM with 2013 Treatment Area in Norwegian Bay (Whole Bay Treatment in 2013)**

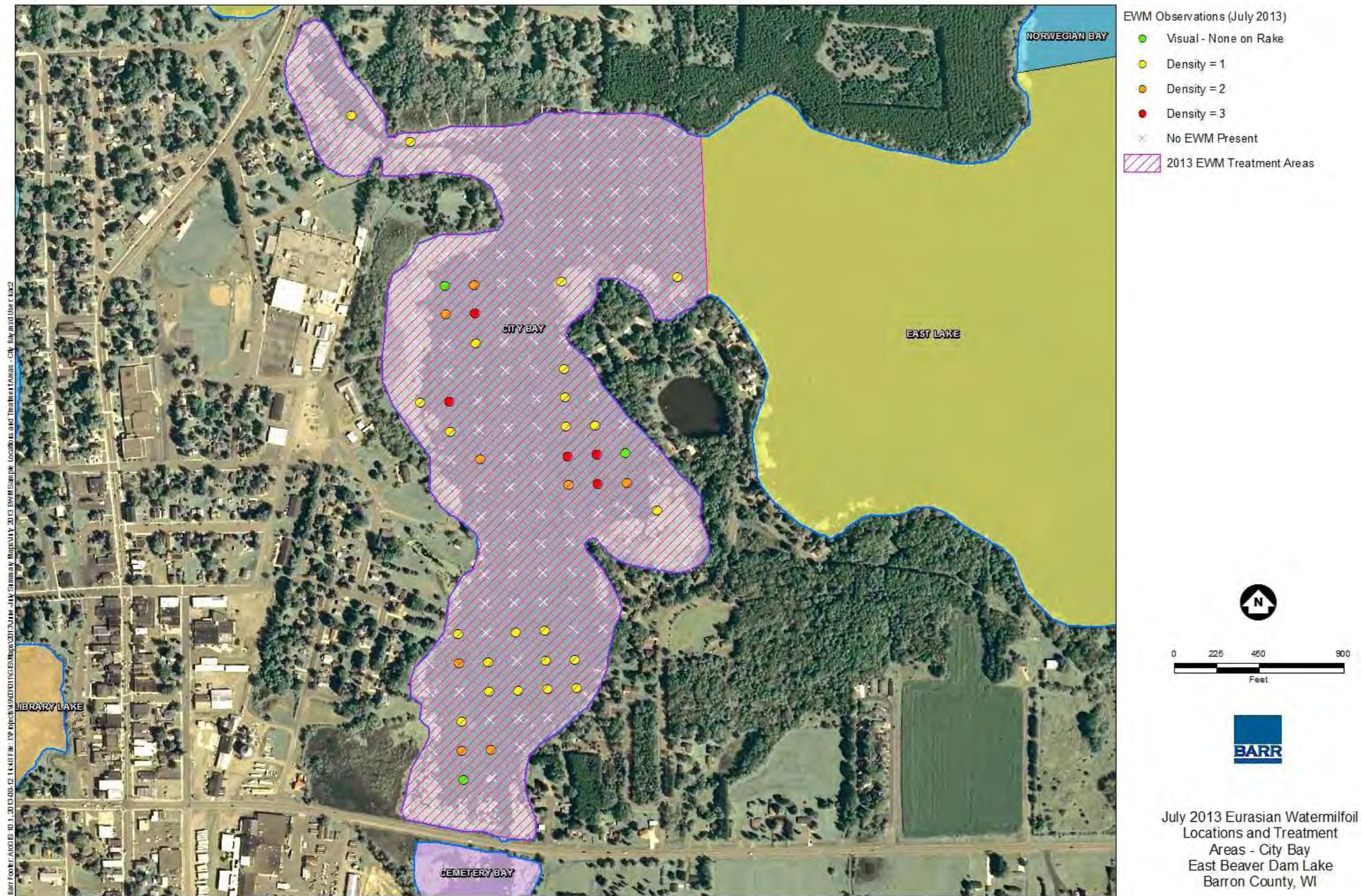


**To:** Beaver Dam Lake Management District (Board of Commissioners)  
**From:** Barr Engineering Company (Meg Raffel)  
**Subject:** 2013 EWM Treatment Results  
**Date:** August 21, 2013  
**Page:** 25  
**Project:** 49030011.12  
**c:** Kevin Kretsch (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist working with WDNR)



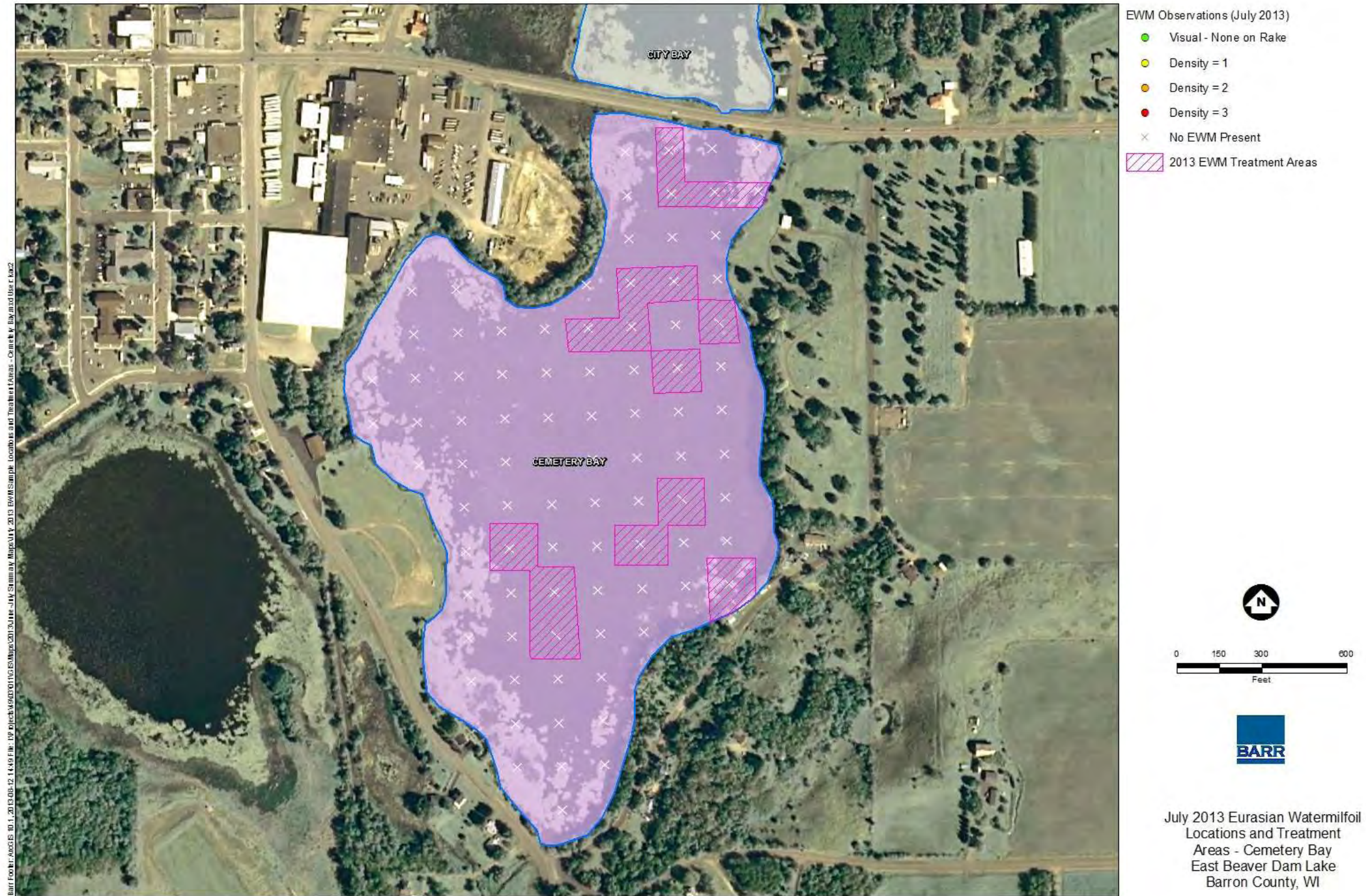
**Figure 16. Comparison of July 2013 EWM with 2013 Treatment Areas in East Lake**

**To:** Beaver Dam Lake Management District (Board of Commissioners)  
**From:** Barr Engineering Company (Meg Raffel)  
**Subject:** 2013 EWM Treatment Results  
**Date:** August 21, 2013  
**Page:** 26  
**Project:** 49030011.12  
**c:** Kevin Kretsch (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist working with WDNR)



**Figure 17. Comparison of July 2013 EWM with 2013 Treatment Areas in City Bay (Whole Bay Treatment in 2013)**

**To:** Beaver Dam Lake Management District (Board of Commissioners)  
**From:** Barr Engineering Company (Meg Raffel)  
**Subject:** 2013 EWM Treatment Results  
**Date:** August 21, 2013  
**Page:** 27  
**Project:** 49030011.12  
**c:** Kevin Kretsch (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist working with WDNR)



**Figure 18. Comparison of July 2013 EWM with 2013 Treatment Areas (No EWM Observed in July 2013)**