An Assessment of the Aquatic Plant Community in Response to Flumioxazin Treatments in Becker County, MN

A Data Summary Submitted to the Pelican River Watershed District

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Background

Curlyleaf pondweed is a submersed aquatic plant that was introduced to the US in the 1800s (Catling and Dobson 1985). Originally from Eurasia, Africa, and Australia, it has since spread to all 48 continental states. Curlyleaf pondweed is capable of outcompeting native species and forming large monospecific beds (Tobiessen et al. 1992). It is widely considered to be an ecosystem transformer, accelerating internal nutrient loading and eutrophication (James et al. 2003). Curlyleaf pondweed can impact ecological balance by altering habitat structure, lowering species diversity, nutrient cycling, lowering dissolved oxygen, and affecting pH and temperature gradients (Tobiessen et al. 1992, Cheruvelil et al. 2002, James et al. 2003). Curlyleaf pondweed primarily reproduces vegetatively via turion production or rhizome elongation (Bolduan et al. 1994, Woolf and Madsen 2003, Wells and Sytsma 2006). Turions are vegetative structures capable of surviving extreme conditions (i.e. droughts, freezing temperatures, and herbicide treatments) and producing a viable plant capable of reproduction (Madsen 2000). These structures are typically produced in the weeks prior to plant senescence (Bolduan et al. 1994, Woolf and Madsen 2003, Wells and Sytsma 2006). In northern populations, curlyleaf pondweed has an atypical growth cycle. It senesces in early summer after turion formation. Turions then fall to the substrate and are dormant throughout the summer. Turions then sprout in mid to late fall and plants begin to grow. Plants remain viable under the ice throughout winter. When ice melts, plants start to grow again producing more turions in the spring (Woolf and Madsen 2003).

Curlyleaf pondweed is typically managed with herbicides such as fluridone, endothall, and diquat (Johnson et al. 2012, Bugbee at al. 2015). However, herbicide resistance is a growing concern as the use of herbicides to manage aquatic plants continues. Repeat applications of an herbicide, or multiple herbicides with the same mode of action, can lead to resistant populations (Richardson 2008). By alternating the type of herbicide being used in an area, herbicide resistance can be avoided. Flumioxazin is an herbicide that was registered for aquatic use in 2011. It is a contact herbicide that inhibits proto-porphyrinogen oxidase (PPO), an enzyme essential to the production of chlorophyll (Ortiz et al, 2020). Small scale studies have applied flumioxazin to aquatic plants in growth chambers and found that curlyleaf pondweed was susceptible to treatments (Glomski and Netherland 2013). However, field studies to determine effective rates of flumioxazin have not been completed.

The lakes used in this study include Detroit Lake, Lake Melissa, Lake Sallie, and Floyd Lake of Becker County, MN. All four of these lakes are used extensively for fishing and recreation. Detroit lake is a 3,067 acre lake that is known to be infested with curlyleaf pondweed, zebra mussels, flowering rush, and Chinese mystery snails. Lake Melissa is a 1,846 acre lake that is known to be infested with curlyleaf pondweed, zebra mussels, and flowering rush. Lake Sallie is a 1,330 acre lake that is known to be infested with curlyleaf pondweed, zebra mussels, and flowering rush. Floyd lake is a 862 acre lake that is known to be infested with curlyleaf pondweed and zebra mussels. No previous attempts to control the curlyleaf pondweed populations on these lakes have been made. The main objectives for this project are (1) to reduce the presence of curlyleaf pondweed vegetation, (2) to reduce the curlyleaf pondweed turion bank, (3) develop rate recommendations of flumioxazin for control of curlyleaf pondweed under field conditions, and (4) to quantify native species response to the treatments.

Materials and Methods

Field sampling occurred between May and October of 2024. Plant presence data was collected using the point-intercept method covering each plot in a grid dependent on the size of the plot: 30 meters for Floyd, 45 meters for Melissa and Detroit Lake plot 2, and 50 meters for Sallie and Detroit Lake plot 1. The plot sizes were as follows: Floyd was 18.2 acres, Melissa was 11.2 acres, Detroit Lake plot 2 was 13.5 acres, Lake Sallie was 16.7 acres, and Detroit Lake plot 1 was 18.2 acres. A rake was tossed at each point and identification occurred in the field. Unknown plant samples were placed in a plastic resealable bag and labelled properly for further identification in the lab. Plant surveys were conducted prior to treatment (pretreatment) on May 1 and 6, 3 weeks after treatment (3WAT) on May 10 and 11, and 6 weeks after treatment (6WAT) on July 9 and 10. Water depth data was collected at each point during the pretreatment surveys. Flumioxazin treatments were applied on May 20, 2024 at a rate of 75 µg L^{-1} (Floyd Lake), 100 µg L^{-1} (Lake Sallie and Detroit Lake plot 1), and 150 µg L^{-1} (Lake Melissa and Detroit Lake plot 2). Lake George (Blue Earth Co.) and Schilling Lake (Sibley Co) were included in the study as non-treated reference lakes.

Twenty sediment samples were harvested monthly at each treatment site from May to September with an Eckman dredge (0.02 m^2) to determine turion densities at each plot. The sediment samples were placed in a littoral wash bucket to isolate and count the turions. Spatial data were recorded using the FarmWorks Site Mate Software on a Trimble Yuma tablet PC.

Statistical Analysis

Species percent occurrence was calculated by dividing the number of points that species was present by the total number of points and multiplied by 100. Species richness was calculated by using the mean number of species found in that survey for each point. An ANOVA was run to determine if there was a significant difference in species richness between surveys. If a difference was determined, then a Tukey's HSD test was used to separate those differences. Turion densities were calculated by multiplying the number of turions in each sample by the area of the Eckman dredge (0.02 m^2). An ANOVA was used to determine differences. All analyses were conducted at an $\alpha \leq 0.05$.

Results and Discussion

Curly Leaf Pondweed Assessment

Lake Melissa and plot 2 on Detroit Lake were treated with flumioxazin at a rate of 150 µg L^{-1}. Plot 2 on Detroit Lake had an initial pretreatment occurrence rate of 36% for curlyleaf pondweed (Table 1). The 3WAT survey occurrence rate was 4%, with some regrowth occurring by the 6WAT survey where curlyleaf was observed at 12% of sample points. The pretreatment survey at Lake Melissa showed a 52% occurrence rate of curlyleaf pondweed (Table 2). The 3WAT and 6WAT surveys found no curlyleaf. These initial results indicate that the rate of 150 µg L^{-1} will reduce curlyleaf pondweed populations for at least 6WAT.

Lake Sallie and plot 1 on Detroit Lake were treated with flumioxazin at a rate of 100 µg L^{-1}. There was a 32% occurrence of curlyleaf pondweed in Detroit Lake plot 1 during the pretreatment survey (Table 3). The 3WAT and 6WAT had occurrences of 18% and 4% respectively. Lake Sallie had a low initial occurrence of curlyleaf pondweed at 4%, 7% at the 3WAT and 0% at 6WAT (Table 4). These initial results also show promise when using a rate of 100 µg L^{-1} to control curlyleaf pondweed under field conditions.

Floyd Lake was treated with flumioxazin at a rate of 75 µg L^{-1}. Curlyleaf pondweed occurrence was 13% prior to treatment and remained the same through the 3WAT survey (Table 5). The 6WAT survey indicated that curlyleaf pondweed was beginning to regrow after the application as it was found at 33% of sample points. Based on this plot, flumioxazin applied at 75 µg L^{-1} will not provide longer-term curlyleaf pondweed control.

Schilling Lake and Lake George did not undergo an herbicide treatment. Curlyleaf pondweed occurrence at Schilling quickly decreased from pretreatment to the 3WAT survey, with no curlyleaf found in the 6WAT survey (Table 6). Previous research at this site has shown similar trends of early senescence due to poor light availability. Lake George maintained a high occurrence of curlyleaf pondweed throughout the study indicating that reductions in treatment plots were a result of the herbicide treatments (Table 7).

Turion densities at plot 1 on Detroit Lake had a wide range between 0.0 and 102.5 turions m^{-2} (Table 8). Plot 2 had a narrower range of 5.0 to 37.5 turions m^{-2}, remaining consistent throughout the summer. Lake Melissa varied between 57.0 and 202.5, ending with a similar number of turions in September as in May. Turion densities in Lake Sallie remained consistent, ranging from 25.0 to 62.5 turions m^{-2}. Floyd lake had relatively low turion densities, ranging from 0.0 to 10.0 turions m^{-2}. Lakes with no treatments exhibited consistent high turion densities or an increase in turion densities by August. Significant differences were found at Lake George, a control plot, with a large increase in turion densities in July and August ($p < 0.05$). No significant differences were observed between months at any of the other lakes suggesting the flumioxazin treatments were limiting in-season turion production.

Native Plant Assessment

Species richness remained constant between the pretreatment and the 6WAT surveys at Lake Melissa (Table 2), Detroit Lake plot 1 (Table 3), and Lake Sallie (Table 4). Plot 2 on Detroit Lake experienced an increase in species richness between the pretreatment and 6WAT surveys (Table 2), and Floyd Lake also had an increase in species richness during the 6WAT survey (Table 5). Overall species richness remained high at all treated lakes, ranging from 2.13 species $point^{-1}$ during the pretreatment survey at Detroit Lake plot 1 and 5.13 species $point^{-1}$ during the 6WAT survey at Floyd Lake. Detroit lake plot 2 gained seven species but lost white-stem pondweed (*Potamogeton praelongus*) between the pretreatment and 6WAT surveys (Table 1). Lake Melissa gained 7 species between the pretreatment and 6WAT surveys (Table 2). Detroit Lake plot 1 gained six plant species between the pretreatment and 6WAT surveys. Six more species were found in the 6WAT survey at Lake Sallie with the loss of white water crowfoot (*Ranunculus aquaticus*) (Table 4). Floyd Lake gained 7 species between the pretreatment and 6WAT surveys (Table 5). Species richness data at the nontreated plots were much lower, ranging from 0.04 species $point^{-1}$ during the 6WAT survey at Schilling Lake and 1.22 species $point^{-1}$ during the pretreatment survey at Lake George. A decrease in species richness was observed at Schilling Lake by the 3WAT survey, this can be attributed to the loss of curlyleaf pondweed in the plot (Table 6). No significant changes in species richness were observed at Lake George (Table 7).

Native plants that were observed to have a decrease in their percent occurrence included white water crowfoot (*Ranunculus aquaticus*), common elodea (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*). White water crowfoot that was found during the pretreatment survey was not found during the 6WAT survey of that same plot (Tables 2 and 4). Elodea had small decreases in several of the plots (Tables 1, 2, and 3), and coontail had small decreases in two of the plot s (Tables 1 and 4) and disappeared entirely during the 3WAT survey at Detroit Lake plot 1 (Table 3). It is important to note that coontail is a floating plant that does not root to the sediment. It is possible that it drifted away from the plot and was not susceptible to the treatment. White stem pondweed (*Potamogeton praelongus*) was found during the pretreatment survey at Detroit Lake plot 2 but not found during the 3WAT or 6WAT surveys (Table 1). Native plants were largely unaffected by the 75 µg L^{-1} treatment rate. Overall, there were no significant deleterious effects of the flumioxazin treatments on native species richness, and in fact, in a two plots species richness increased post treatment.

Summary

- Applying flumioxazin at a rate of 100 to 150 µg L^{-1} effectively decreased curlyleaf pondweed presence but magnitude of control will be site specific.
- Applying flumioxazin at a rate of 75 µg L^{-1} did not reduce the presence of curlyleaf pondweed.
- Mean species richness (species $point^{-1}$) did not change in the treatment plots after herbicide applications with the exception of Detroit Lake plot 1 and Floyd Lake, for which both plots experienced an increase.
- Subsequent treatments will be necessary to maintain control and to decrease the number of turions in the sediment, though flumioxazin treatments likely prevented new turions from being produced as there was not a increase in turions in any treatment plot.

Acknowledgements

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Table 1. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in plot 2 of Detroit Lake in Becker County, MN following a flumioxazin herbicide treatment applied at a rate of 150 $\mu g\ L^{-1}$. Surveys occurred on May 1, June 10, and July 10, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	36	4	12
Ceratophyllum demersum	Coontail	44	42	31
Myriophyllum sibiricum	Northern watermilfoil	24	15	12
Stuckenia pectinata	Sago pondweed	0	8	4
Elodea canadensis	Common elodea	16	12	12
Lemna trisulca	Star duckweed	56	62	85
Potamogeton zosteriformis	Flatstem pondweed	36	54	50
Drepanocladus sp.	Water moss	4	62	85
Potamogeton richardsonii	Clasping leaf pondweed	0	50	8
Potamogeton illinoensis	Illinois pondweed	0	0	4
Potamogeton praelongus	White-stem pondweed	24	0	0
Vallisneria americana	Wild celery	0	12	46
Ranunculus aquaticus	White water-crowfoot	0	4	8
Utricularia sp.	Bladderwort	0	8	15
Najas flexilis	Nodding waternymph	0	0	15
	Mean Species Richness	2.40 ± 0.35**a**	3.31 ± 0.26**ab**	3.65 ± 0.28**b**

Table 2. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in Lake Melissa in Becker County, MN following a flumioxazin herbicide treatment applied at a rate of 150 µg L^{-1}. Surveys occurred on May 6, June 11, and July 9, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	52	0	0
Ceratophyllum demersum	Coontail	57	57	57
Myriophyllum sibiricum	Northern watermilfoil	52	39	48
Chara Sp.	Chara	0	26	22
Elodea canadensis	Common elodea	9	4	4
Lemna trisulca	Star duckweed	43	83	83
Potamogeton zosteriformis	Flatstem pondweed	4	39	35
Drepanocladus sp.	Water moss	13	22	35
Potamogeton richardsonii	Clasping leaf pondweed	0	35	22
Potamogeton illinoensis	Illinois pondweed	0	0	4
Potamogeton praelongus	White-stem pondweed	0	0	4
Vallisneria americana	Wild celery	0	0	9
Ranunculus aquaticus	White water-crowfoot	22	9	0
Utricularia sp.	Bladderwort	0	0	9
Najas flexilis	Nodding waternymph	22	0	43
Hippuris vulgaris	Marestail	0	0	4
	Mean Species Richness	2.74 ± 0.33**a**	3.13 ± 0.32**a**	3.78 ± 0.29**a**

Table 3. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in plot 1 of Detroit Lake in Becker County, MN following a flumioxazin herbicide treatment applied at a rate of 100 µg L^{-1}. Surveys occurred on May 1, June 10, and July 10, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	32	18	4
Ceratophyllum demersum	Coontail	29	0	4
Myriophyllum sibiricum	Northern watermilfoil	26	18	29
Chara Sp.	Chara	90	96	89
Elodea canadensis	Common elodea	19	0	4
Lemna trisulca	Star duckweed	0	4	4
Potamogeton zosteriformis	Flatstem pondweed	16	21	32
Drepanocladus sp.	Water moss	0	50	50
Potamogeton richardsonii	Clasping leaf pondweed	0	43	21
Potamogeton illinoensis	Illinois pondweed	0	0	11
Vallisneria americana	Wild celery	0	0	14
Utricularia sp.	Bladderwort	0	0	7
Najas flexilis	Nodding waternymph	0	0	11
	Mean Species Richness	2.13 ± 0.19**a**	2.50 ± 0.22**a**	2.79 ± 0.29**a**

Table 4. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in Lake Sallie in Becker County, MN following a flumioxazin herbicide treatment applied at a rate of 100 µg L^{-1}. Surveys occurred on May 6, June 10, and July 9, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	4	7	0
Ceratophyllum demersum	Coontail	37	30	22
Myriophyllum sibiricum	Northern watermilfoil	63	48	48
Chara Sp.	Chara	33	26	41
Stuckenia pectinata	Sago pondweed	0	0	7
Lemna trisulca	Star duckweed	78	85	85
Potamogeton zosteriformis	Flatstem pondweed	37	19	26
Drepanocladus sp.	Water moss	44	67	56
Potamogeton richardsonii	Clasping leaf pondweed	0	11	19
Potamogeton illinoensis	Illinois pondweed	0	0	15
Potamogeton praelongus	White-stem pondweed	0	0	11
Vallisneria americana	Wild celery	0	4	22
Ranunculus aquaticus	White water-crowfoot	7	4	0
Utricularia sp.	Bladderwort	0	0	11
	Mean Species Richness	3.04 ± 0.30**a**	3.00 ± 0.24**a**	3.63 ± 0.26**a**

Table 5. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in Floyd Lake in Becker County, MN following a flumioxazin herbicide treatment applied at a rate of 75 µg L^{-1}. Surveys occurred on May 1, June 11, and July 10, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	13	13	33
Ceratophyllum demersum	Coontail	20	13	33
Myriophyllum sibiricum	Northern watermilfoil	53	60	40
Chara Sp.	Chara	7	0	40
Stuckenia pectinata	Sago pondweed	0	0	13
Elodea canadensis	Common elodea	20	20	20
Lemna trisulca	Star duckweed	73	73	67
Potamogeton zosteriformis	Flatstem pondweed	7	20	67
Drepanocladus sp.	Water moss	33	0	0
Potamogeton richardsonii	Clasping leaf pondweed	0	13	40
Potamogeton illinoensis	Illinois pondweed	7	0	0
Vallisneria americana	Wild celery	0	7	0
Ranunculus aquaticus	White water-crowfoot	0	27	67
Potomageton natans	Floating pondweed	0	33	13
Nuphar variegata	Yellow water lily	7	20	47
Nymphea odorata	White water lily	0	0	20
Typha sp.	Cattail	0	7	7
Schoenoplectus acutus	Hardstem bulrush	0	7	7
	Mean Species Richness	2.40 ± 0.34**a**	3.13 ± 0.31**a**	5.13 ± 0.62**b**

Table 6. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in Schilling Lake in Sibley County, MN with no herbicide treatments. Surveys occurred on May 9, June 3, and June 24, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	81	4	0
Stuckenia pectinata	Sago pondweed	0	7	4
	Mean Species Richness	0.81 ± 0.08**a**	0.11 ± 0.06**b**	0.04 ± 0.04**b**

Table 7. The percent occurrence and mean species richness (± 1 SEM) of aquatic plants found in Lake George in Blue Earth County, MN with no herbicide treatments. Surveys occurred on May 8, May 30, and June 19, 2024. Values sharing a letter are not different according to a Tukey test at $p \leq 0.05$ significance level.

		% Occurrence		
Scientific Name	Common Name	Pretreatment	3WAT	6WAT
Potamogeton crispus	Curlyleaf pondweed	89	72	56
Ceratophyllum demersum	Coontail	22	11	39
Chara sp.	Chara	6	0	6
Elodea canadensis	Common elodea	6	0	11
Lemna minor	Common duckweed	0	28	0
	Mean Species Richness	1.22 ± 0.21**a**	1.11 ± 0.20**a**	1.11 ± 0.25**a**

Table 8. The average turion density at plots located in lakes within the Pelican River watershed in Becker County, MN following flumioxazin herbicide treatments. There were no significant differences between months ($p > 0.05$) except for Lake George, for which letters designate those differences ($p < 0.05$).

	Average Turion Density (turions/m^2)						
	Detroit Plot 1	Detroit Plot 2	Melissa	Sallie	Floyd	Schilling*	George**
May	0.0	5.0	95.0	62.5	7.5	212.5	150.0 **a**
June	2.5	22.5	57.5	25.0	0.0	142.5	495.0 **ab**
July	102.5	37.5	202.5	55.0	0.0	192.5	667.5 **b**
August	10.0	7.5	137.5	62.5	10.0	170.0	647.5 **b**
September	5.0	27.5	100.0	27.5	10.0	172.5	317.5 **ab**

* Lake Schilling is a non-treated lake located in Sibley County, MN.

**Lake George is a non-treated lake located in Blue Earth County, MN.

Figure 1. Detroit lake plot 1 curlyleaf pondweed occurrence prior to being treated with flumioxazin at a rate of 100 μg L^{-1}. Sampling occurred on May 1, 2024.

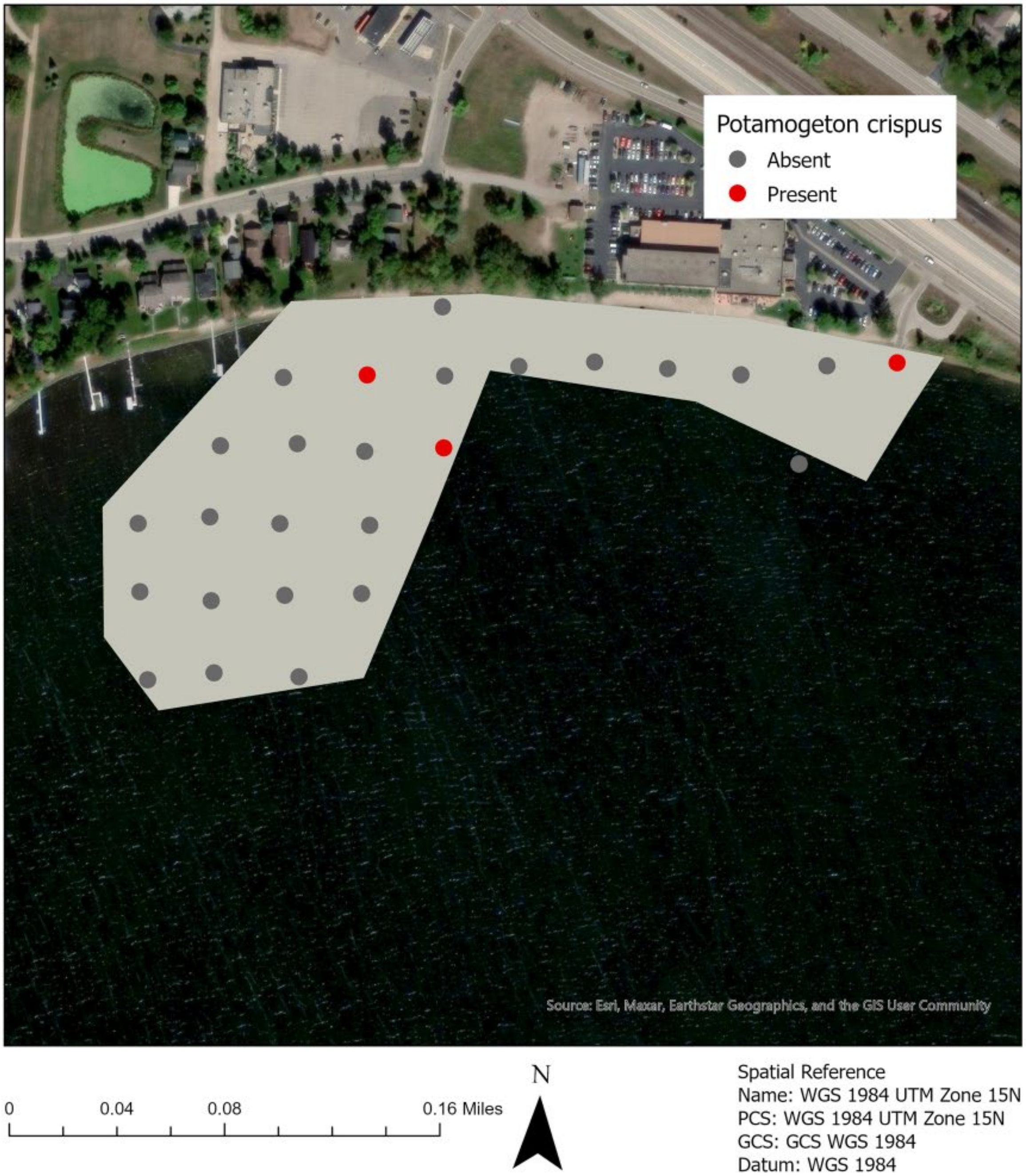
Figure 2. Detroit lake plot 1 curlyleaf pondweed occurrence 3 weeks after being treated with flumioxazin at a rate of 100 µg L^{-1}. Sampling occurred on June 10, 2024. Treatment occurred on May 20th, 2024.

Figure 3. Detroit lake plot 1 curlyleaf pondweed occurrence 6 weeks after being treated with flumioxazin at a rate of 100 µg L^{-1}. Sampling occurred on July 10, 2024. Treatment occurred on May 20th, 2024.

Figure 4. Detroit lake plot 2 curlyleaf pondweed occurrence prior to being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on May 1, 2024.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 5. Detroit lake plot 2 curlyleaf pondweed occurrence 3 weeks after being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on June 10, 2024. Treatment occurred on May 20th, 2024.


Detroit Lake Plot 2 6WAT 2024

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 6. Detroit lake plot 2 curlyleaf pondweed occurrence 6 weeks after being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on July 10, 2024. Treatment occurred on May 20th, 2024.


Lake Melissa Pretreatment 2024

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Spatial Reference
Name: WGS 1984 UTM Zone 15N
PCS: WGS 1984 UTM Zone 15N
GCS: GCS WGS 1984
Datum: WGS 1984

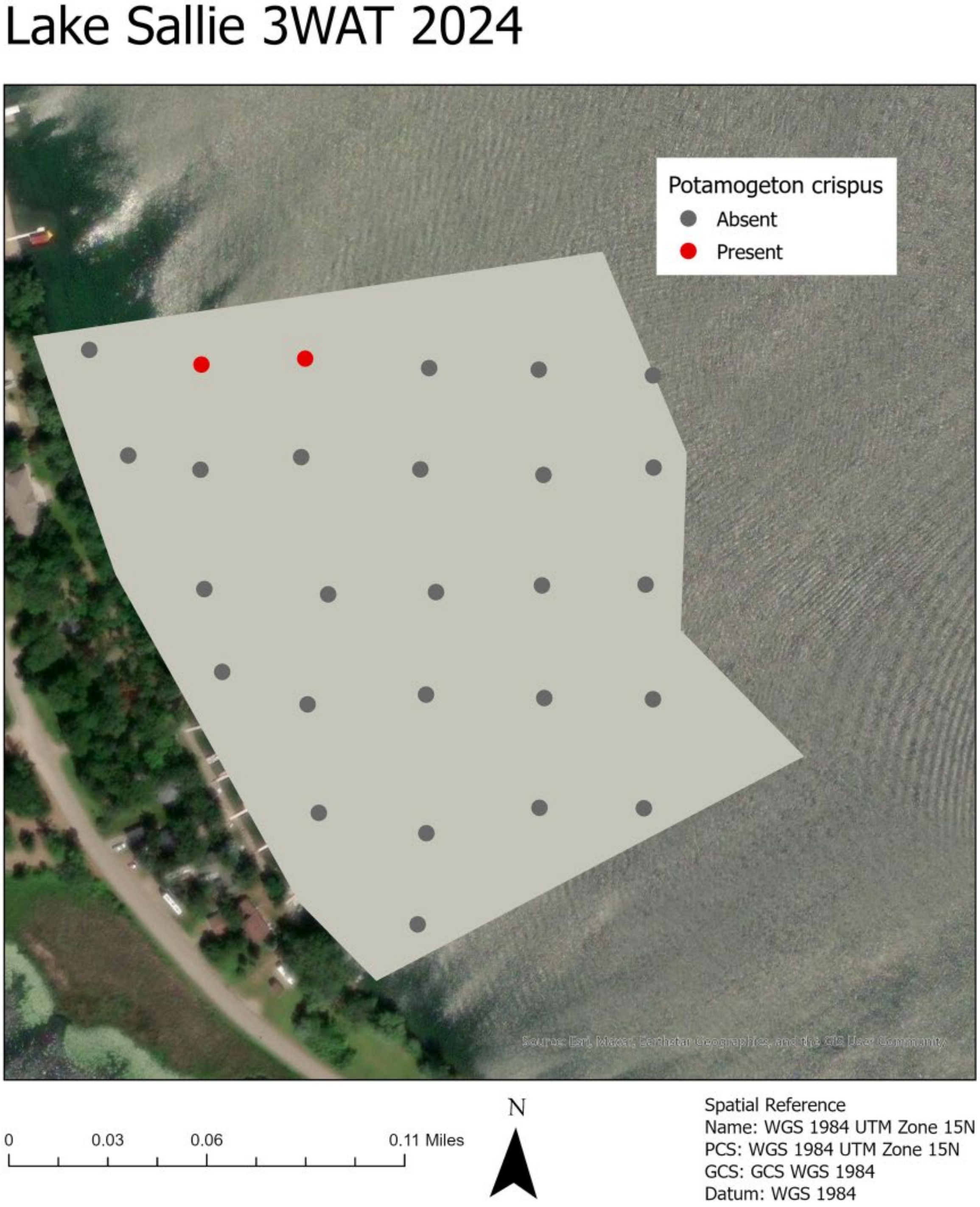
Figure 7. Lake Melissa curlyleaf pondweed occurrence prior to being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on May 6, 2024.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 8. Lake Melissa curlyleaf pondweed occurrence 3 weeks after being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on June 11, 2024. Treatment occurred on May 20th, 2024.

Figure 9. Lake Melissa curlyleaf pondweed occurrence 6 weeks after being treated with flumioxazin at a rate of 150 µg L^{-1}. Sampling occurred on July 9, 2024. Treatment occurred on May 20th, 2024.

Figure 10. Lake Sallie curlyleaf pondweed occurrence prior to being treated with flumioxazin at a rate of 100 µg L^{-1}. Sampling occurred on May 6, 2024.

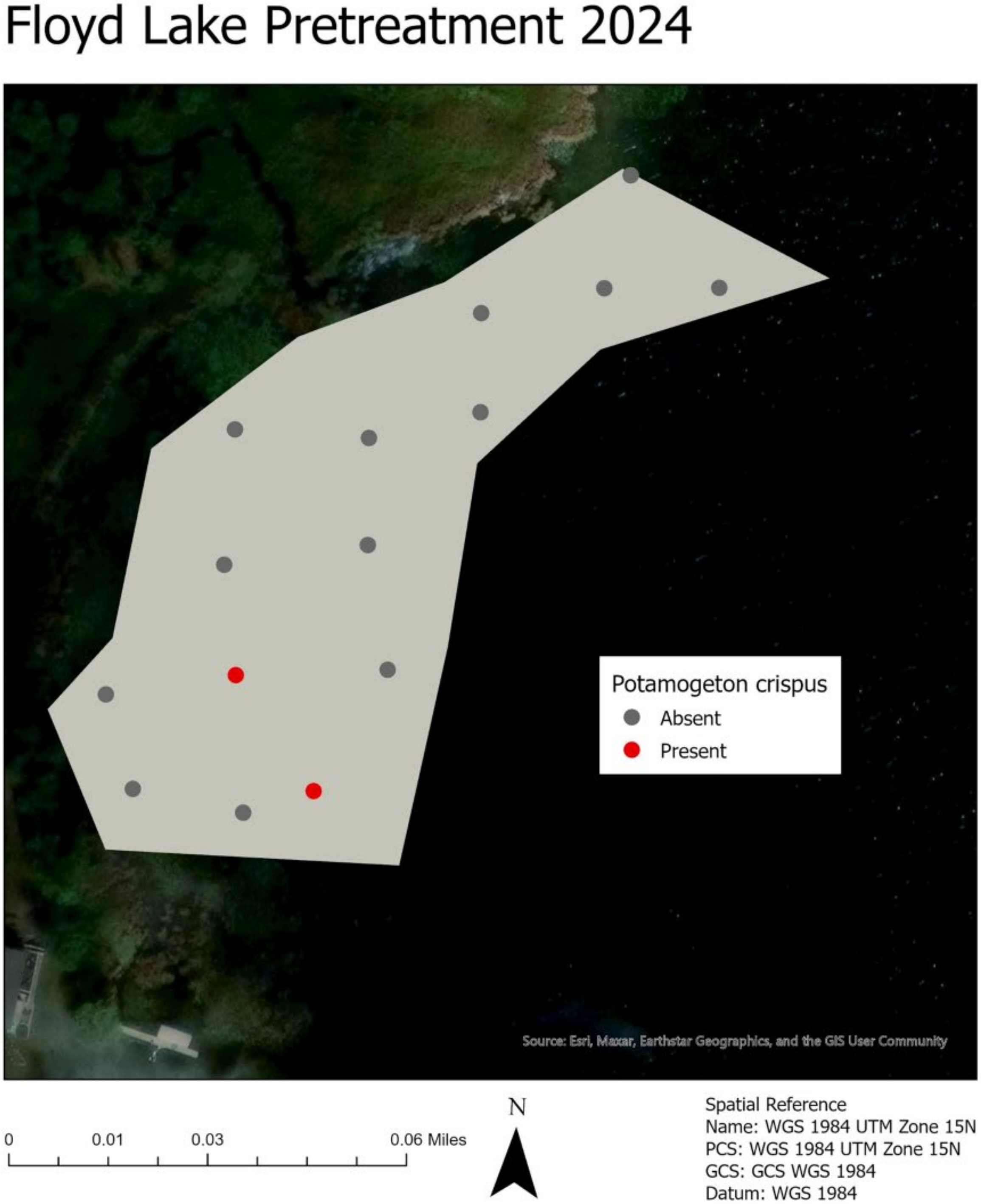


Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Spatial Reference
Name: WGS 1984 UTM Zone 15N
PCS: WGS 1984 UTM Zone 15N
GCS: GCS WGS 1984
Datum: WGS 1984

Figure 11. Lake Sallie curlyleaf pondweed occurrence 3 weeks after being treated with flumioxazin at a rate of 100 µg L^{-1}. Sampling occurred on June 10, 2024. Treatment occurred on May 20th, 2024.

Figure 12. Lake Sallie curlyleaf pondweed occurrence 6 weeks after being treated with flumioxazin at a rate of 100 µg L^{-1}. Sampling occurred on July 9, 2024. Treatment occurred on May 20th, 2024.



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Spatial Reference
Name: WGS 1984 UTM Zone 15N
PCS: WGS 1984 UTM Zone 15N
GCS: GCS WGS 1984
Datum: WGS 1984

Figure 13. Floyd Lake curlyleaf pondweed occurrence prior to being treated with flumioxazin at a rate of 75 µg L^{-1}. Sampling occurred on May 1, 2024.

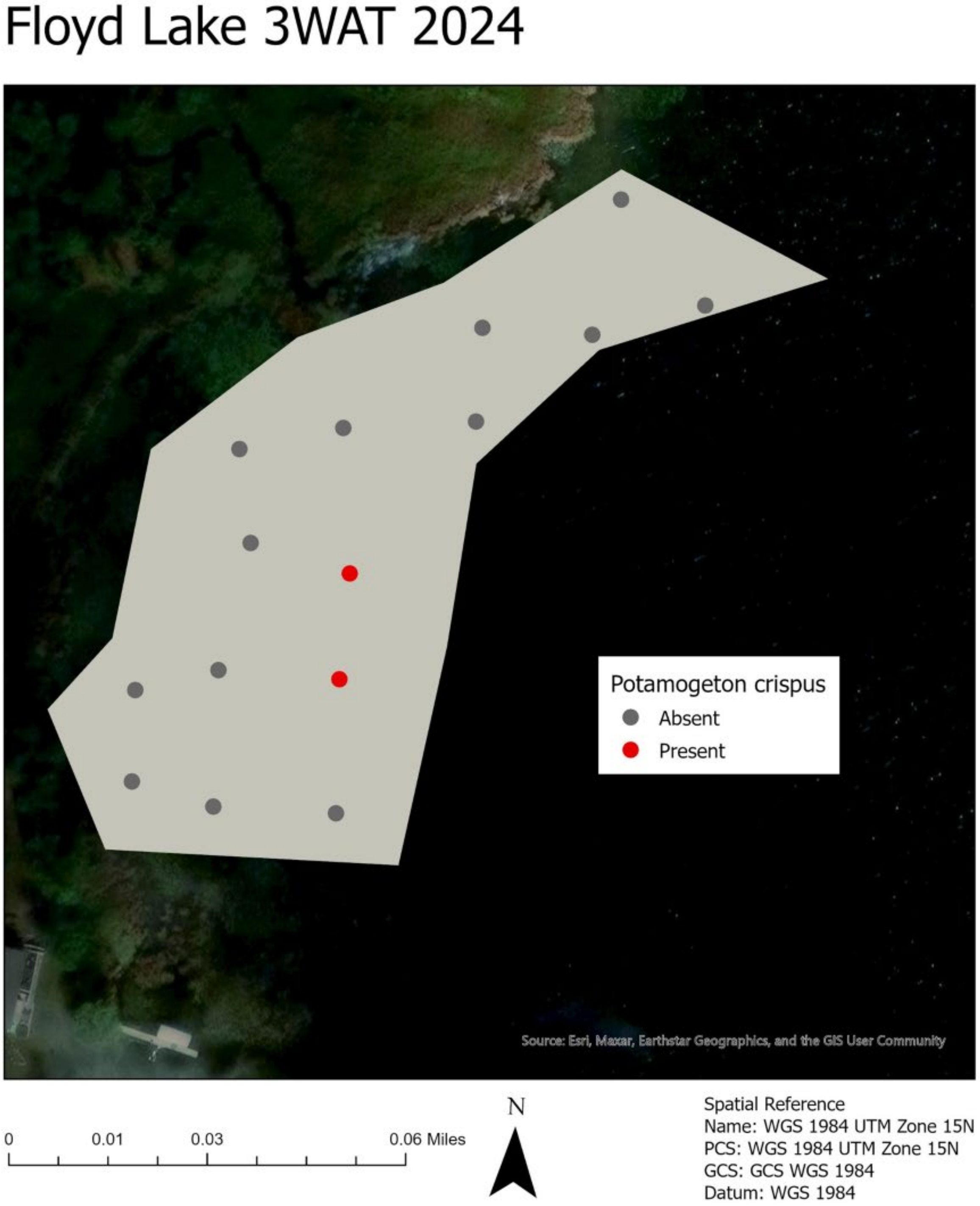

Floyd Lake 3WAT 2024

Figure 14. Floyd Lake curlyleaf pondweed occurrence 3 weeks after being treated with flumioxazin at a rate of 75 µg L^{-1}. Sampling occurred on June 11, 2024. Treatment occurred on May 20th, 2024.

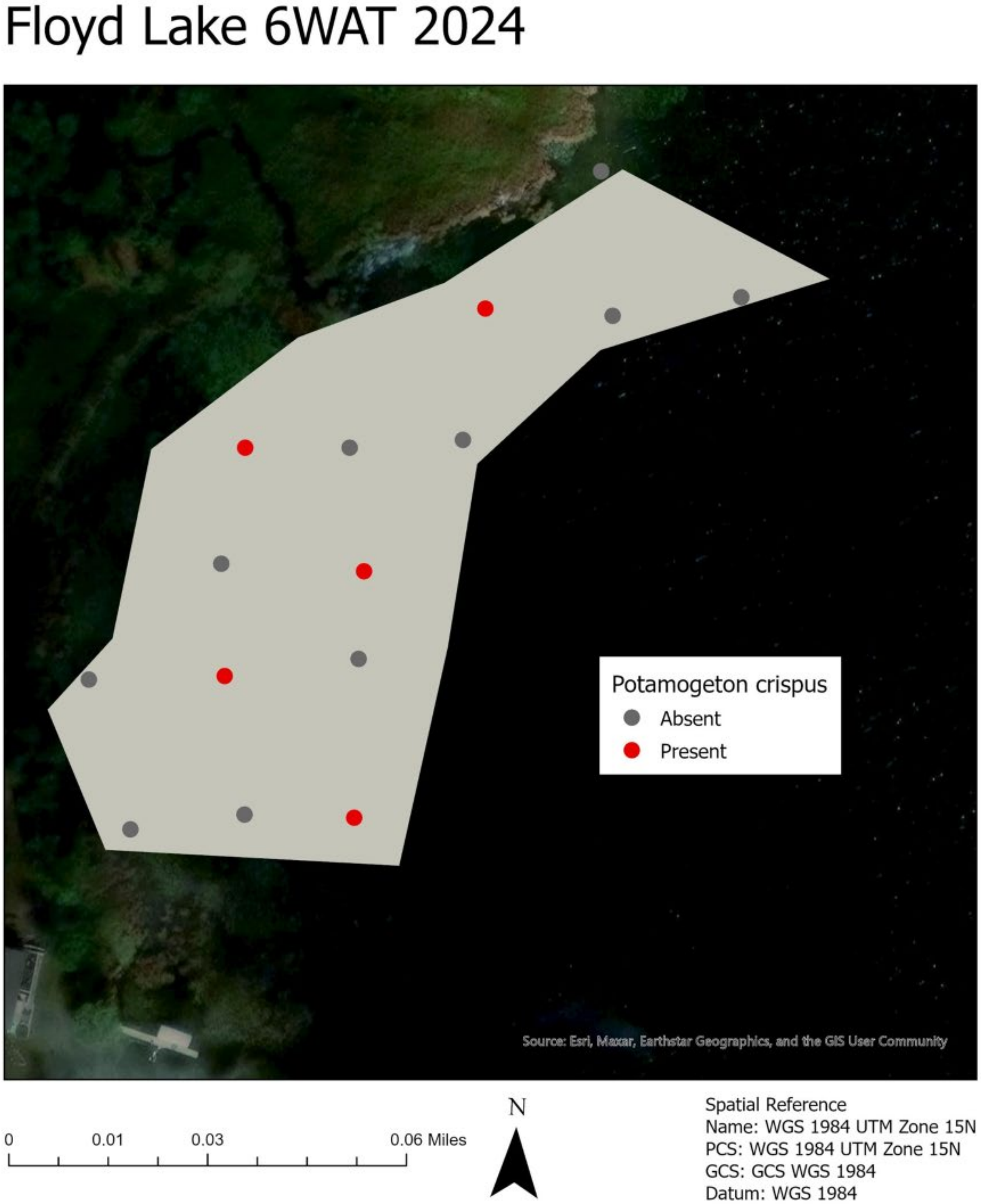


Figure 15. Floyd Lake curlyleaf pondweed occurrence 6 weeks after being treated with flumioxazin at a rate of 75 µg L^{-1}. Sampling occurred on July 10, 2024. Treatment occurred on May 20th, 2024.