Littoral Survey of Noxon and Cabinet Gorge Reservoirs, Montana, 2013

Gray Turnage and John D. Madsen

Geosystems Research Institute, Mississippi State University, Mississippi State, MS

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Preface

This report presents data collected by the Geosystems Research Institute, Mississippi State University in 2013 on Noxon and Cabinet Gorge Reservoirs. Funding was provided by Sanders County, Montana through the Eurasian Watermilfoil Task Force.

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Author contact information:

Gray Turnage, gturnage@gri.msstate.edu

John Madsen, jmadsen@gri.msstate.edu

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Introduction

Aquatic plants are important to lake ecosystems (Madsen et al. 1996, Wetzel 2001) and are essential in promoting the diversity and function of an aquatic system (Carpenter and Lodge 1986). Littoral zone habitat and associated plants may be responsible for a significant proportion of primary production for the entire lake (Ozimek et al. 1990, Wetzel 2001). Littoral zone habitats are prime areas for the spawning of most fish species, including many species important to sport fisheries (Savino and Stein 1989). Furthermore, aquatic plants anchor soft sediments, stabilize underwater slopes, remove suspended particles, and remove nutrients from overlying waters (Barko et al. 1986, Doyle 2000, Madsen et al. 2001). The introduction of non-native plants into littoral zone habitats often alters the complex interactions occurring in these areas (Madsen 1998). Dense stands of non-native plants are often responsible for reduction in oxygen exchange, depletion of dissolved oxygen, increases in water temperatures, increased sedimentation, and internal nutrient loading (Madsen 1998).

Eurasian watermilfoil (*Myriophyllum spicatum* L.), curlyleaf pondweed (*Potamogeton crispus* L.), and flowering rush (*Butomus umbellatus* L.) are non-native invasive species that, when present, have been associated with declines in native plant species richness and diversity (Madsen et al. 1991, 2008, 2012, 2013). These species also pose nuisance problems to humans in the form of increasing flood frequency and intensity, impeding navigation, and limiting recreation opportunities (Madsen et al. 1991, 2012, 2013). The establishment of Eurasian watermilfoil and subsequent spread is likely perpetuated by the ease of fragmentation (both physical and physiological) of this plant. Establishment of curlyleaf pondweed is primarily driven by turion production; while flowering rush primarily establishes by rhizome bud production. Water movement within the reservoir and high watercraft traffic moves Eurasian watermilfoil fragments, curlyleaf pondweed turions, and flowering rush buds to new areas.

Although the impacts from Eurasian watermilfoil, curlyleaf pondweed, and flowering rush are numerous, controlling these species is often difficult and unpredictable. Flowing water, such as the Lower Clark Fork River, further complicates the use of herbicides as water flow will increase the dilution and dissipation of the herbicides. Herbicide applications in run of the river reservoirs are often subject to more extreme perturbations than those of natural lakes. Run of the river reservoirs have variable water-exchange patterns, typically tied to dam operations, which will impact aqueous distribution of herbicides resulting in reduced chemical exposure times against target plants and unacceptable effectiveness (Getsinger et al. 1997).

By systematically surveying an infested reservoir, locations and intensities of infestations will become evident. This will give reservoir managers starting criteria to narrow down management options until a suitable control method is found.

Materials and Methods

Point Intercept Assessments. Point intercept surveys were conducted on August 29 through September 2, 2013 to assess the aquatic plant community in the Noxon and Cabinet Gorge Reservoirs littoral zones. A 150 m grid was used for the Noxon assessment (Figure 1) and a 125 m grid was used for the Cabinet Gorge assessment. Survey methods were similar to those utilized during recent projects in the Pacific Northwest (Madsen and Wersal 2008, Madsen and Wersal 2009, Wersal et al. 2010a, Wersal et al. 2010b, Wersal & Madsen 2011a, Wersal & Madsen 2011b, Turnage et al. 2012).

Additionally, we mapped dense beds of Eurasian watermilfoil. This was done by marking the edge of a bed and then running transects across the bed until the other edge of the bed was encountered. Next, the ends of transects were joined thereby outlining an entire bed. This method did not include areas with scattered or sparse occurrences of Eurasian watermilfoil, thus actual area inhabited by this species is greater than the area of the beds that were mapped.

Surveys and bed mapping were conducted by boat using Global Positioning System (GPS) technology to navigate to each point. Survey accuracy was 1-3 m (3-10 ft) depending on satellite reception. At each survey point, a weighted thatch rake was deployed to determine the presence of plant species. Spatial data were recorded electronically using FarmWorks Site Mate® software (Hamilton, IN). The software allowed for in-field geographic and attribute data collection. Data were recorded in database templates using specific pick lists constructed exclusively for this project. Site Mate® provided an environment for displaying geographic and attribute data and enabled navigation to specific locations on the lake.

Statistical Analyses. Plant species presence was averaged over all points sampled and multiplied by 100 to calculate percent frequency. Acreages of Eurasian watermilfoil bed areas were calculated using the X-tools function in ArcGIS 10.0 (ESRI 2011). Changes in the occurrence of non-native plant species between annual littoral surveys for each reservoir were determined using the Chi-square test (Statistix 9.0, Analytical Software, Tallahassee, FL). The Chi-square test was also used to analyze changes in total vegetated cover within the littoral zone of each reservoir.

Results and Discussion

Noxon Reservoir

Noxon Reservoir had an aquatic plant species richness of 19 (Table 1). The non-native species Eurasian watermilfoil, curlyleaf pondweed, and flowering rush were found at 14.3, 14.7, and 0.7 percent of surveyed points, respectively, within the littoral zone of the reservoir (Table 1, Figs 5-7 and 17-21). Observed curlyleaf pondweed frequency is likely lower than actual frequency because the survey time fell within this species dormancy period. The most common species observed were *Elodea canadensis* (23.7%) *Ceratophyllum demersum* (22.8%), and

Myriophyllum sibiricum (19.6%), all of which are native species (Table 1). Locations of native species that covered more than 10% of the littoral survey sites in Noxon reservoir and non-native species are shown in Figures 1 – 24.

There are 1,942 acres of littoral habitat in Noxon Reservoir covering 25% of the reservoir (Wersal et al. 2010a). In 2008, initial estimates of dense Eurasian watermilfoil beds were 247 acres (Table 2, Figs 25-30, Wersal et al. 2010a). In 2009, the estimate had increased to 323 acres (Table 2, Wersal et al. 2010a). Beds were not mapped in 2010, 2011, or 2012. In 2013, there were 11 dense beds of Eurasian watermilfoil found in Noxon reservoir totaling 96.6 acres of littoral habitat (Table 3). This accounts for approximately 5% and 1.3% of littoral and total reservoir acreages, respectively (Table 2). This has decreased from the highest acreage reported, 323 acres in 2009 (Wersal et al. 2010a), by 70.1%. This represents a decrease of 60.7% in Eurasian watermilfoil bed acreage from the initial 2008 estimate.

Secchi readings were taken at 10 sites within Noxon Reservoir starting at Noxon dam and ending near the Flat Iron access (Table 4, Fig 31). Secchi readings were shallowest in the upstream reaches of Noxon Reservoir, especially Secchi points 7, 8, and 9 in the vicinity of Finley Flats boat access (Table 4, Fig 31). Finley Flats is a widening in the riverine section of the reservoir that has a dense plant bed over much of the area (Fig 32). This would slow down water currents allowing much of the suspended sediment to drop out of the water column and be deposited in this area. Furthermore Finley Flats is surrounded by high cliff faces, many of which are exposed sediments that wash into the reservoir during rain events further increasing the sediment load in this portion of the river (Fig 33 and 34). The deepest Secchi readings came from sites 5 and 6 in the riverine reaches of the reservoir (Table 4). Secchi sites 1 through 4 tended to have shallower readings (Table 4). These sites were in the more lacustrine section of the reservoir (Fig 31).

Chi-square analysis shows an increase in the percentage of vegetated littoral zone points in Noxon Reservoir over time (Table 5 and 6). Of these points, Eurasian watermilfoil points significantly increased from 2009 to 2010 and then decreased due to herbicide application in the reservoir (Table 6). Presence of curlyleaf pondweed in the reservoir decreased from 2008-2009 but has since remained fairly constant (Table 6). However, surveys in 2013 were later in the summer which coincides with this species dormant period. More than likely curlyleaf pondweed is present at more sites than we observed and thus should be monitored closely. Presence of flowering rush has significantly increased from 2008-2013 to the point where monitoring and management goals need to be implemented for this species as well (Table 6). Future surveys should occur earlier in the year so as to not coincide with dormant periods for curlyleaf pondweed.

<u>Cabinet Gorge Reservoir</u>

Cabinet Gorge Reservoir had an aquatic plant species richness of 17 (Table 7). The non-native species Eurasian watermilfoil, curlyleaf pondweed, and flowering rush were found at 1.8, 31.3, and 10.7 percent of surveyed points, respectively, within the littoral zone of the reservoir (Table 7, Figs 38, 39, and 44-46). Observed curlyleaf pondweed frequency is likely lower than actual frequency because the survey time fell within this species dormancy period. The most common species observed were elodea (35.2%), Eurasian watermilfoil (31.3%), and coontail (25.1%) (Table 7). All of these except Eurasian watermilfoil are native species. Figures 35-52 show frequency of non-native species and each native species found at more than 10% of the survey sites in Cabinet Gorge Reservoir.

There are 1,121 acres of littoral habitat in Cabinet Gorge Reservoir covering 38% of the reservoir (Wersal et al. 2010a). In 2008, initial estimates of dense Eurasian watermilfoil beds were 78 acres (Table 8, Fig 53, Wersal et al. 2010a). In 2010, the estimate had increased to 328 acres (Table 8, Wersal et al. 2010a). Beds were not mapped in 2009, 2011, or 2012. In 2013, there were seven dense beds of Eurasian watermilfoil found in Cabinet Gorge Reservoir totaling 205.2 acres of littoral habitat (Table 9, Fig 53). This accounts for approximately 18.3% and 7% of littoral and total reservoir acreages, respectively (Table 8). This has decreased from the highest acreage reported, 328 acres in 2009, by 37.4% (Wersal et al. 2010a). This represents an increase of 62% in Eurasian watermilfoil bed acreage from the initial 2008 estimate. The water level was lower in while we surveyed in 2013, thus exposing some of the littoral habitat that had been mapped in 2010. This probably accounts for some of the decline in acreage covered by Eurasian watermilfoil from 2010 to 2013. To our knowledge, no Eurasian watermilfoil control efforts have been implemented on Cabinet Gorge Reservoir.

Secchi readings were taken at five sites within Cabinet Gorge Reservoir starting at downstream end and ending below Noxon dam (Table 10, Fig 54). Secchi readings were shallowest in the upstream reaches of Cabinet Gorge Reservoir (Table 10, Fig 54). The largest Eurasian watermilfoil beds were located in the upstream portion of the reservoir which are also some of the widest reaches of reservoir (Fig 54). These two factors combined most likely slowed the water current allowing the suspended sediment to drop out of the water column. This would explain the deeper Secchi readings in the downstream end of the reservoir (Table 10).

Chi-square analysis shows an increase in the percentage of vegetated littoral zone points in Cabinet Gorge Reservoir over time (Table 11 and 12). Of these points, Eurasian watermilfoil points significantly increased from 2008 to 2013 (Table 12). Presence of curlyleaf pondweed in the reservoir decreased from 2008 to 2013 (Table 12). However, surveys in 2013 were later in the summer which coincides with this species dormant period. More than likely curlyleaf pondweed is present at more sites than we observed and thus should be monitored closely. Presence of flowering rush has significantly increased from 2008-2013 (Table 12). Monitoring and management goals need to be implemented for this species. Future surveys should occur earlier in the year so as to not coincide with dormant periods for curlyleaf pondweed.

Conclusions. Management efforts should focus on controlling Eurasian watermilfoil, curlyleaf pondweed, and flowering rush in both reservoirs. Herbicide applications that were effective at reducing the presence of Eurasian watermilfoil in Noxon Reservoir should be considered for use in Cabinet Gorge Reservoir as well. Future studies should also note whether these treatments are effective at controlling curlyleaf pondweed and flowering rush. Water exchange times should be studied in areas of infestation in Cabinet Gorge Reservoir. This will allow us to see if herbicide treatments previously used in Noxon will be effective in new areas of infestation in Cabinet Gorge Reservoir. Control of nuisance aquatic plants is achievable in flowing water systems if there is an understanding of water exchange characteristics at a given site. Water exchange is likely to be site specific within Cabinet Gorge Reservoir (as it was in Noxon Reservoir) so additional studies are needed, especially upstream of infestations, to develop a water exchange data set for portions of the reservoir to base management decisions on.

Previous studies indicate that Eurasian watermilfoil was selectively removed from areas of Noxon, and that native species will rapidly re-colonize areas once inhabited by Eurasian watermilfoil (Wersal & Madsen 2011a, 2011b). Furthermore, these studies suggested that Eurasian watermilfoil control can be maintained for at least two growing seasons with a single herbicide application (Wersal & Madsen 2011b). Achieving multiple year control would allow for the treatment of additional areas without having to continually re-treat in the same plots. Though this will depend upon site location, water flow, and distance from other infestations that would re-colonize an already treated area.

The potential short term impacts of herbicide applications on the native plant community should not overshadow the long-term effects that Eurasian watermilfoil, curlyleaf pondweed, and flowering rush will have if left unmanaged. Species such as leafy pondweed (*Potamogeton foliosus*) and elodea (*Elodea canadensis*) which are widespread in Noxon Reservoir recovered two years later to levels similar or greater than what was observed during pretreatment surveys (Wersal & Madsen 2011b). There is a native propagule bank present in both Cabinet Gorge and Noxon that will allow the native plant communities to recover following management efforts.

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Table 1. Percent frequency of aquatic plant species in the Noxon Reservoir littoral zone in 2013. There were 448 littoral zone points located 150 meters apart. Of these points, 317 (70.7%) were vegetated.

Scientific Name	Common Name	Points	% Occurrence
Butomus umbellatus	Flowering rush	64	14.3
Ceratophyllum demersum	Coontail	102	22.8
Chara spp.	Chara	42	9.4
Elodea canadensis	Elodea	106	23.7
Heteranthera dubia	Water stargrass	32	7.1
Lemna minor	Lesser duckweed	2	0.4
Myriophyllum sibiricum	Northern watermilfoil	88	19.6
Myriophyllum spicatum	Eurasian watermilfoil	66	14.7
Najas flexilis	Slender naiad	1	0.1
Potamogeton crispus	Curlyleaf pondweed	3	0.7
Potamogeton foliosus	Leafy pondweed	33	7.4
Potamogeton illinoensis	Illinois pondweed	9	2.0
Potamogeton praelongis	White-stem pondweed	2	0.4
Potamogeton richardsonii	Clasping-leaf pondweed	36	8.0
Potamogeton zosterformis	Flat-stem pondweed	6	1.3
Ranunculus aquatilis	White watercrowfoot	44	9.8
Sagittaria cuneata	Arum-leaf arrowhead	3	0.7
Stuckenia pectinata	Sago pondweed	51	11.4
Vallisneria americana	Water celery	1	0.1

Table 2. Estimates of littoral zone and total reservoir covered in dense Eurasian watermilfoil beds in Noxon Reservoir from 2008 to 2013. Noxon Reservoir littoral zone is 1,942 acres in size and covers 25% of the reservoir (Wersal et al. 2010). No mapping was done by us in 2011 or 2012. A graph of these values is presented in Figure 55.

YEAR	ACREAGE	% LITTORAL	% TOTAL RES
2008	247	12.7	3.2
2009	323	16.6	4.2
2010	150	7.8	1.9
2011	-	-	-
2012	-	-	-
2013	96.6	5	1.3

Table 3. Acreage covered by Eurasian watermilfoil beds in Noxon Reservoir in 2013. A total of 96.6 acres was covered in Eurasian watermilfoil beds. Total littoral zone in Noxon Reservoir is 1,942 acres. Maps shown in Figure 25-30.

Eurasian watermilfoil Bed #	Acreage (Acres)	% Littoral Zone
1	74.8	3.9
2	1.8	0.09
3	12.1	0.6
4	2.0	0.1
5	0.2	0.01
6	2.3	0.12
7	1.1	0.06
8	0.5	0.03
9	1.1	0.06
10	0.6	0.03
11	0.1	0.005

Table 4. Secchi disk readings (in feet) in Noxon Reservoir. Measurements were recorded in feet. A map of these locations is presented in Figure 31.

Site	Secchi Down (ft)	Secchi Up (ft)	Average (ft)
1	20.2	19.0	19.6
2	19.8	17.9	18.9
3	21.0	19.8	20.4
4	19.2	18.4	18.8
5	26.5	24.8	25.7
6	25.1	23.0	24.1
7	11.5	9.9	10.7
8	14.9	13.0	14.0
9	15.5	13.9	14.7
10	16.0	13.9	15.0

Table 5. Percentage of Noxon Reservoir littoral zone vegetated by all species (ALL), Eurasian watermilfoil, curlyleaf pondweed, and flowering rush during littoral surveys. A graph of these values is presented in Figure 56.

Year	Species	% Littoral Vegetated
2008	ALL	68.2
2009	ALL	60.0
2010	ALL	63.4
2013	ALL	70.7
2008	Eurasian watermilfoil	12.3
2009	Eurasian watermilfoil	14.0
2010	Eurasian watermilfoil	26.2
2013	Eurasian watermilfoil	20.1
2008	Curlyleaf pondweed	20.0
2009	Curlyleaf pondweed	10.7
2010	Curlyleaf pondweed	15.4
2013	Curlyleaf pondweed	12.3
2008	Flowering rush	2.3
2009	Flowering rush	1.3
2010	Flowering rush	0.4
2013	Flowering rush	18.5

Table 6. Change in the percentage of Noxon Reservoir littoral zone covered by all species (ALL), Eurasian water milfoil (Eurasian watermilfoil), Curlyleaf pondweed (curlyleaf pondweed), and Flowering rush (flowering rush) between littoral surveys. Percentages in bold are statistically significant changes.

Species	Year 1	Year 2	p-value	%-Change
ALL	2008	2009	$p = 0.1489$	-8.2
ALL	2009	2010	$p = 0.4828$	3.4
ALL	2010	2013	$p < 0.05$	**7.3**
Eurasian watermilfoil	2008	2009	$p = 0.6065$	10.7
Eurasian watermilfoil	2009	2010	$p < 0.05$	**12.2**
Eurasian watermilfoil	2010	2013	$p < 0.05$	**-6.1**
Curlyleaf pondweed	2008	2009	$p < 0.05$	**-9.3**
Curlyleaf pondweed	2009	2010	$p = 0.1498$	4.7
Curlyleaf pondweed	2010	2013	$p = 0.1718$	-3.1
Flowering rush	2008	2009	$p = 0.5951$	1.0
Flowering rush	2009	2010	$p = 0.2101$	-0.9
Flowering rush	2010	2013	$p < 0.05$	**18.1**

Table 7. Percent frequency of aquatic plant species in the Cabinet Gorge Reservoir littoral zone in 2013. There were 335 Littoral Zone points located 125 meters apart. Of these points, 182 (54.3%) were vegetated.

Scientific Name	Common Name	Points	% Occurrence
Butomus umbellatus	Flowering rush	6	1.8
Ceratophyllum demersum	Coontail	84	25.1
Chara spp.	Chara	8	2.4
Elodea canadensis	Elodea	118	35.2
Heteranthera dubia	Water stargrass	3	0.9
Myriophyllum hippuroides	Western watermilfoil	1	0.3
Myriophyllum sibiricum	Northern watermilfoil	33	9.9
Myriophyllum spicatum	Eurasian watermilfoil	105	31.3
Potamogeton crispus	Curlyleaf pondweed	36	10.7
Potamogeton foliosus	Leafy pondweed	48	14.3
Potamogeton illinoensis	Illinois pondweed	18	5.4
Potamogeton nodosus	Longleaf pondweed	1	0.3
Potamogeton praelongis	White-stem pondweed	1	0.3
Potamogeton richardsonii	Clasping-leaf pondweed	56	16.7
Potamogeton zosterformis	Flat-stem pondweed	37	11.0
Ranunculus aquatilis	White watercrowfoot	27	8.1
Stuckenia pectinata	Sago pondweed	16	4.8

Table 8. Estimates of littoral zone and total reservoir covered in dense *Myriophyllum spicatum* beds in Cabinet Gorge Reservoir from 2008 to 2013. Cabinet Gorge Reservoir littoral zone is 1,121 acres in size an covers 38% of the reservoir (Wersal et al. 2010). No mapping was done in 2009, 2011, or 2012. A graph of this data is found in Figure 57.

YEAR	ACREAGE (Acres)	% LITTORAL	% TOTAL RES
2008	78	7	2.6
2009	-	-	-
2010	328	29.3	11.1
2011	-	-	-
2012	-	-	-
2013	205.2	18.3	7

Table 9. Acreage covered by *Myriophyllum spicatum* beds in Cabinet Gorge Reservoir in 2013. A total of 205.2 acres were covered by *M. spicatum* beds. Total littoral zone in Cabinet Gorge Reservoir is 1,121 acres. Maps of these beds are found in Figure 53.

Myriophyllum spicatum Bed #	Acreage (acres)	% Littoral Zone
1	72.5	6.5
2	60.6	5.4
3	21.7	1.9
4	19.4	1.7
5	8.9	0.8
6	11.4	1.0
7	10.7	0.9

Table 10. Secchi disk readings (in feet) in Cabinet Gorge Reservoir. Measurements were recorded in feet. A map of these sites is found in Figure 54.

Site	Secchi Down (ft)	Secchi Up (ft)	Average (ft)
1	22.3	20.0	21.2
2	20.7	19.7	20.2
3	17.4	14.5	16.0
4	16.0	13.9	15.0
5	15.0	13.9	14.5

Table 11. Percentage of Cabinet Gorge Reservoir littoral zone vegetated by all species (ALL), Eurasian watermilfoil, curlyleaf pondweed, and flowering rush during littoral surveys. A graph of these results is found in Figure 58.

Year	Species	% Littoral Vegetated
2008	ALL	51.1
2010	ALL	42.5
2013	ALL	62.4
2008	Eurasian watermilfoil	15.1
2010	Eurasian watermilfoil	14.0
2013	Eurasian watermilfoil	39.8
2008	curlyleaf pondweed	25.2
2010	curlyleaf pondweed	25.7
2013	curlyleaf pondweed	8.8
2008	flowering rush	0
2010	flowering rush	0.3
2013	flowering rush	7.4

Table 12. Change in the percentage of Cabinet Gorge Reservoir littoral zone covered by all species (ALL), Eurasian water milfoil (Eurasian watermilfoil), Curlyleaf pondweed (curlyleaf pondweed), and Flowering rush (flowering rush) between littoral surveys. Percentages in bold are significant changes.

Species	Year 1	Year 2	p-value	%-Change
ALL	2008	2010	p = 0.0931	-8.6
ALL	2010	2013	p < 0.05	**19.9**
Eurasian watermilfoil	2008	2010	p = 0.7680	-1.1
Eurasian watermilfoil	2010	2013	p < 0.05	**25.8**
Curlyleaf pondweed	2008	2010	p = 0.9105	0.5
Curlyleaf pondweed	2010	2013	p < 0.05	**-16.9**
Flowering rush	2008	2010	p = 0.4897	0.3
Flowering rush	2010	2013	p < 0.05	**7.1**

Table 13. Comparison of Eurasian watermilfoil bed depths between depth at time of survey time and depth at full pool in Noxon Reservoir.

BED #	SURVEY TIME	MEAN SURVEY BED DEPTH (FT)	GAUGE DEPTH (FT)	FULL POOL MINUS GUAGE DEPTH (FT)	MEAN BED DEPTH AT FULL POOL (FT)
1	9/2/2013 7:00	1.5	30.07	0.93	2.43
2	9/2/2013 8:00	5.5	30.11	0.89	6.39
3	9/2/2013 9:00	3	30.19	0.81	3.81
4	9/2/2013 10:00	2.2	30.23	0.77	2.97
5	9/2/2013 11:00	1.5	30.22	0.78	2.28
6	9/2/2013 12:00	7.8	30.24	0.76	8.56
7	9/2/2013 13:00	5.4	30.25	0.75	6.15
8	9/2/2013 14:00	9.1	30.18	0.82	9.92
9	9/2/2013 15:00	7.3	30.1	0.9	8.2
10	9/2/2013 16:00	9	30.07	0.93	9.93
11	9/2/2013 17:00	4.7	29.94	1.06	5.76

Table 14. Comparison of Eurasian watermilfoil bed depths between depth at time of survey time and depth at full pool in Cabinet Gorge Reservoir.

BED #	SURVEY TIME	MEAN SURVEY BED DEPTH (FT)	GAUGE DEPTH (FT)	FULL POOL MINUS GUAGE DEPTH (FT)	MEAN BED DEPTH AT FULL POOL (FT)
1	9/1/2013 12:00	4.7	70.8	4.2	8.9
2	9/1/2013 12:40	5.6	70.72	4.28	9.88
3	9/1/2013 13:20	5.9	70.81	4.19	10.09
4	9/1/2013 14:00	4.7	70.9	4.1	8.8
5	9/1/2013 14:40	6.4	71	4	10.4
6	9/1/2013 15:20	5.1	71.2	3.8	8.9
7	9/1/2013 16:00	3.5	71.4	3.6	7.1

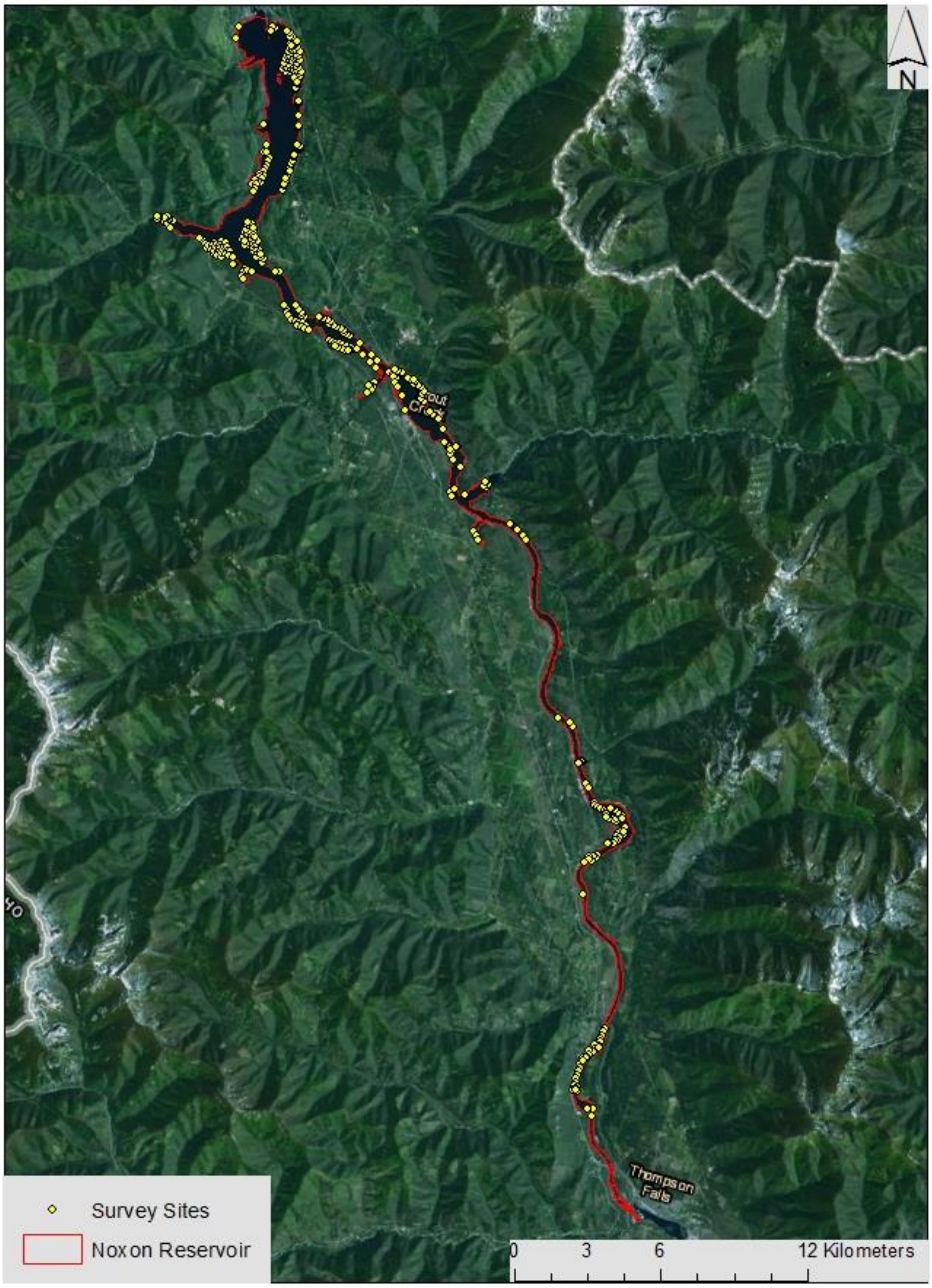

Figure 1. Littoral zone survey sites on Noxon Reservoir in 2013.

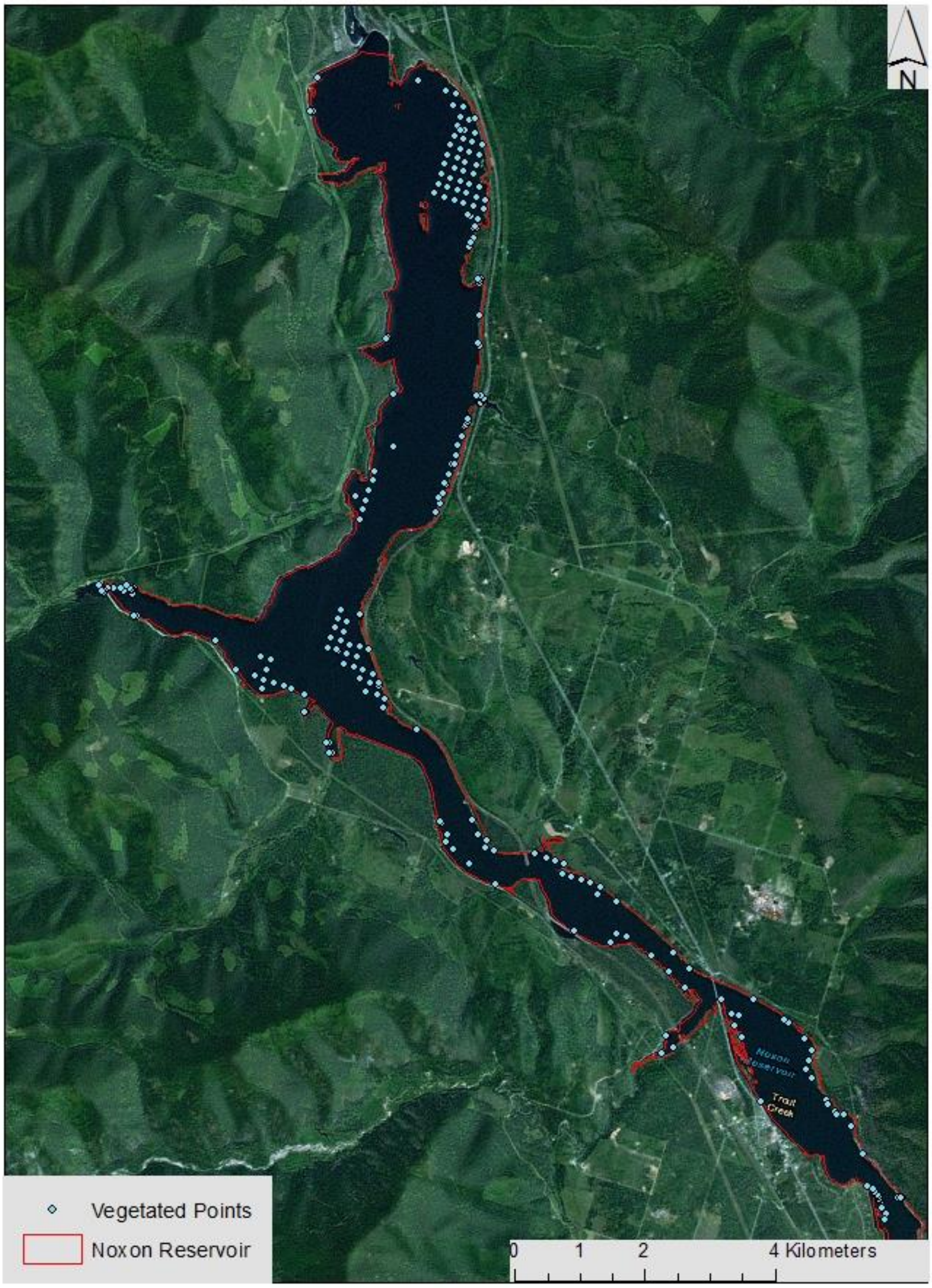

Figure 2. Vegetated littoral zone survey sites on lower Noxon Reservoir in 2013.

Figure 3. Vegetated littoral zone survey sites on middle Noxon Reservoir in 2013.

Figure 4. Vegetated littoral zone survey sites on upper Noxon Reservoir in 2013.

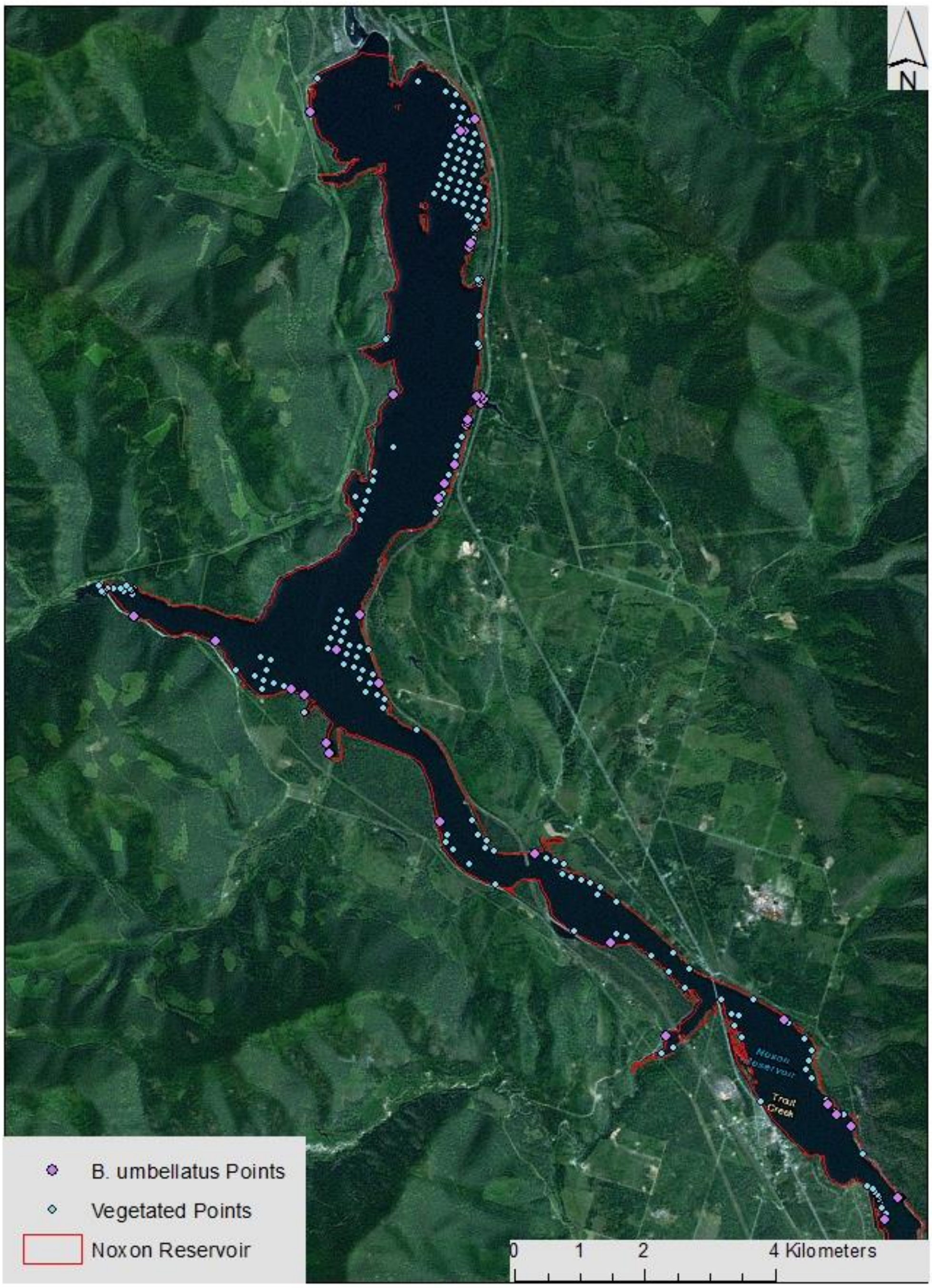

Figure 5. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had flowering rush (*Butomus umbellatus)* present.

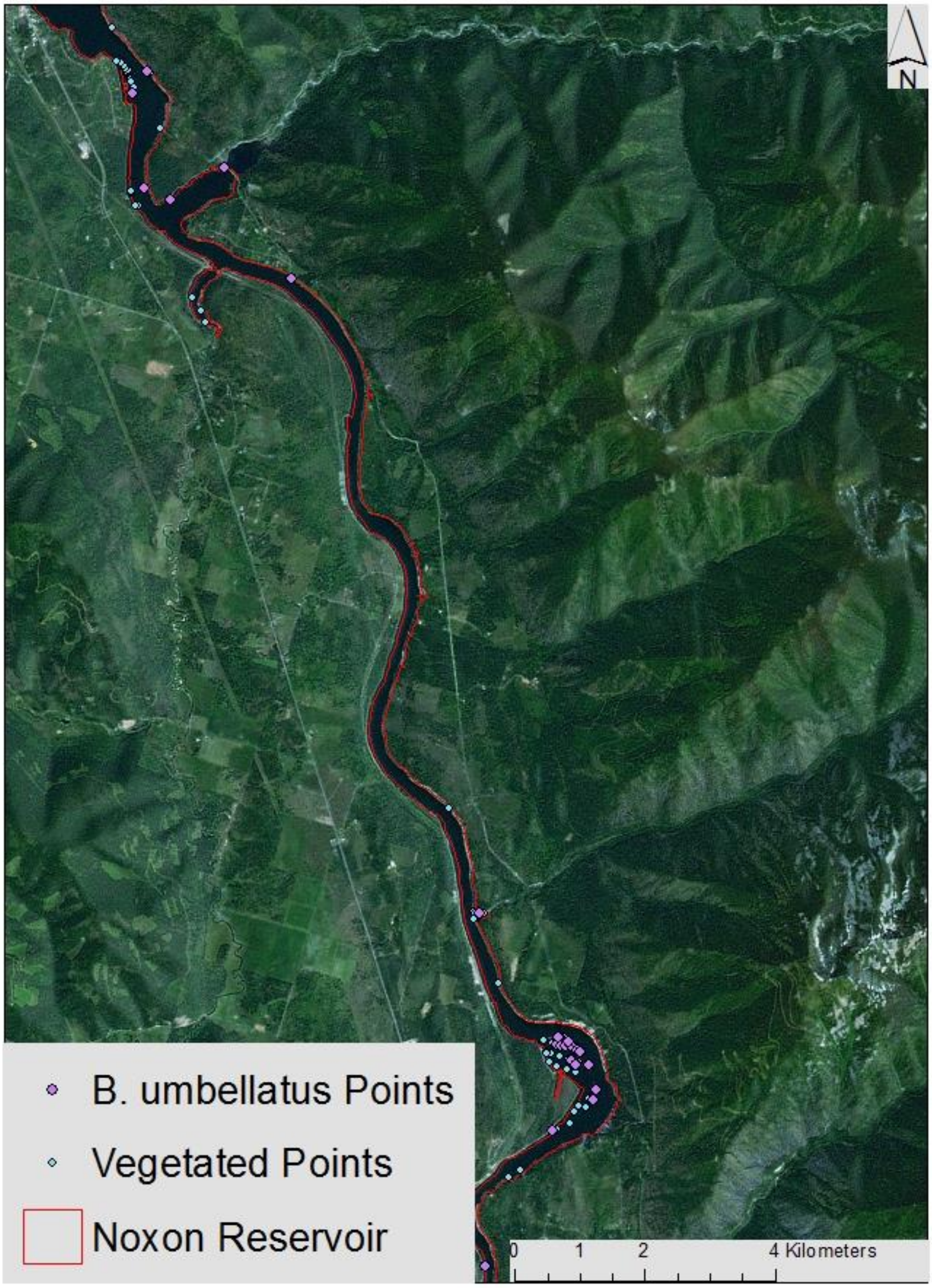

Figure 6. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had flowering rush (*Butomus umbellatus)* present.

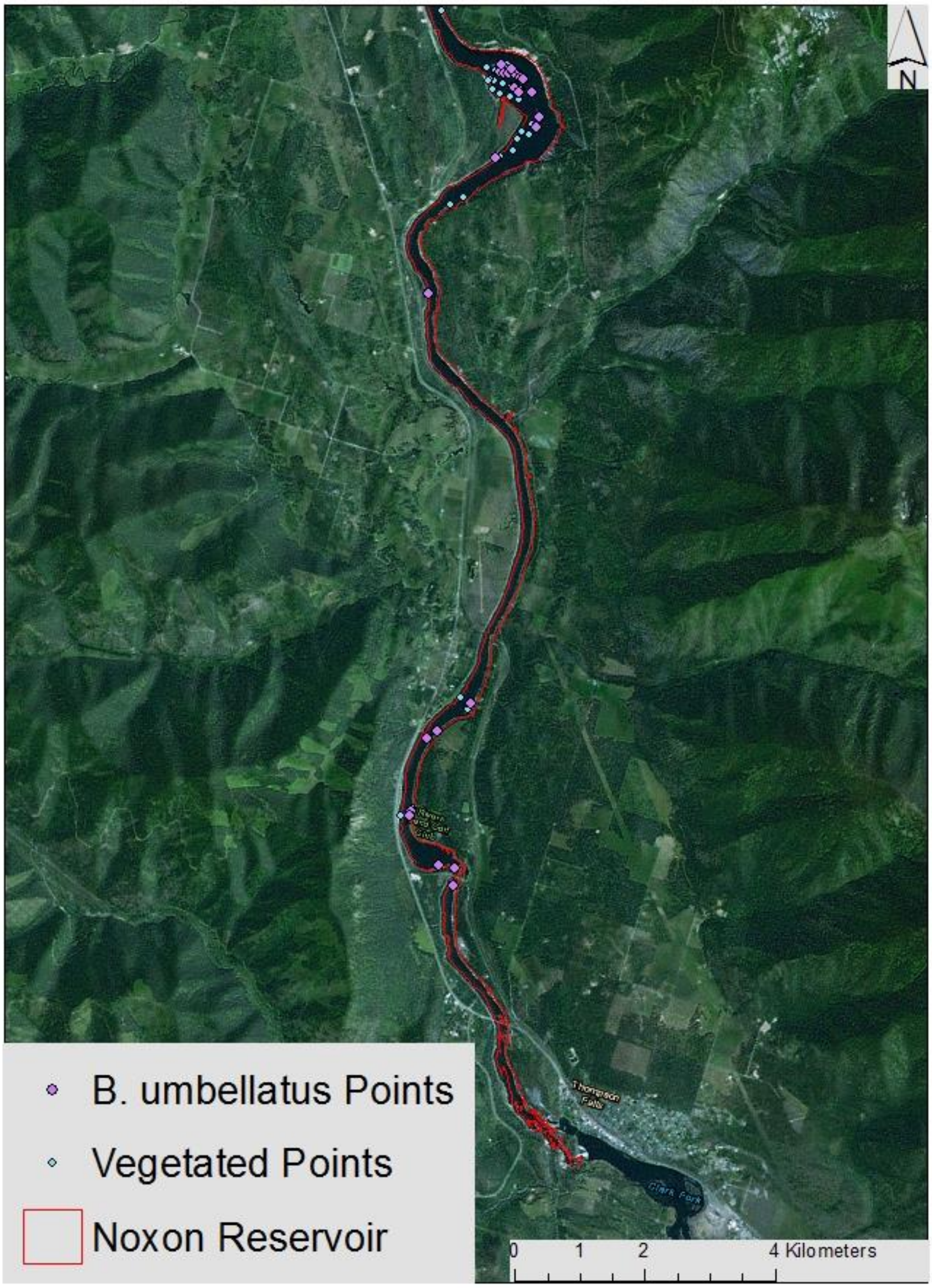

Figure 7. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had flowering rush (*Butomus umbellatus)* present.

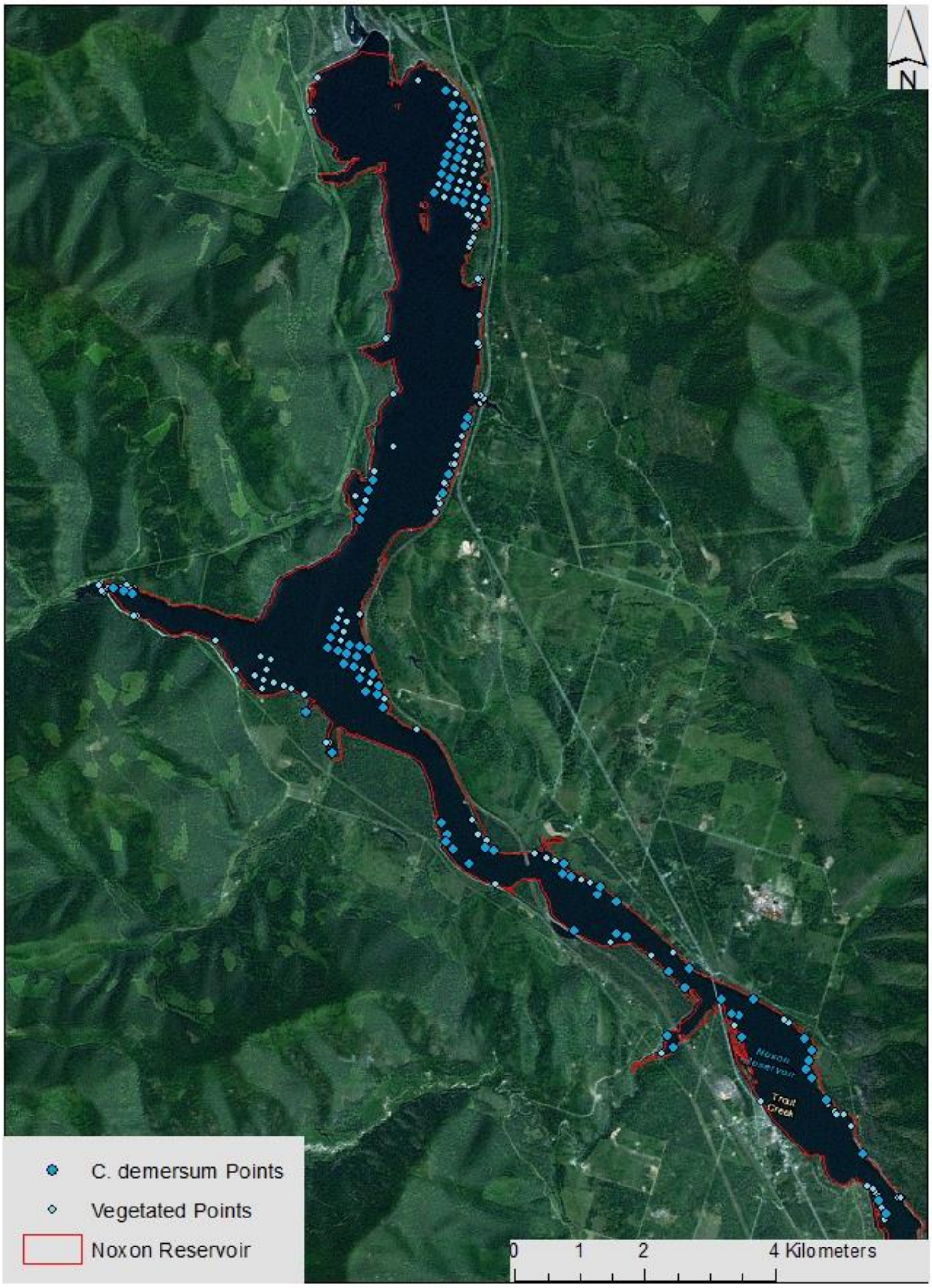

Figure 8. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had coontail (*Ceratophyllum demersum)* present.

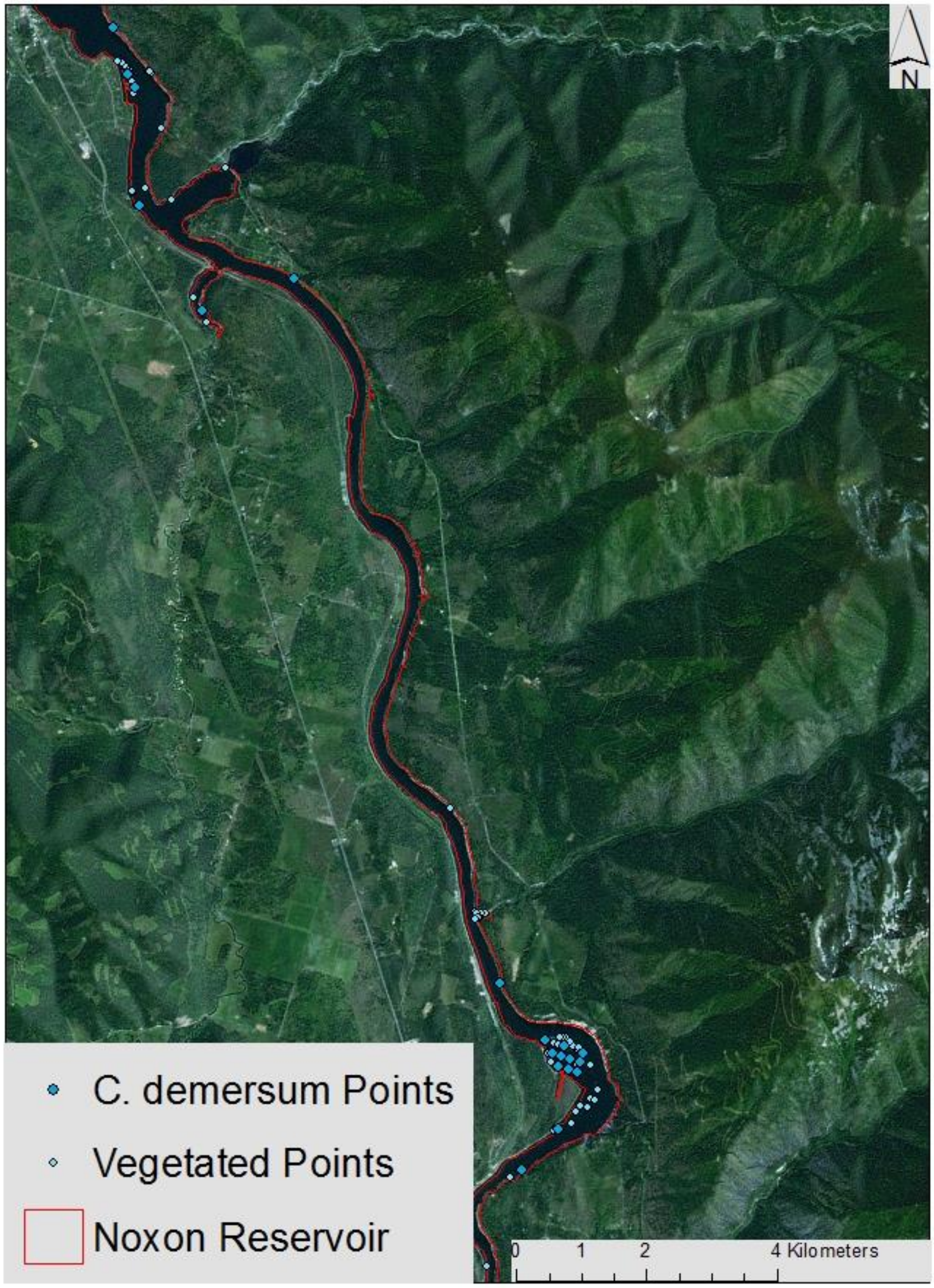

Figure 9. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had coontail (*Ceratophyllum demersum)* present.

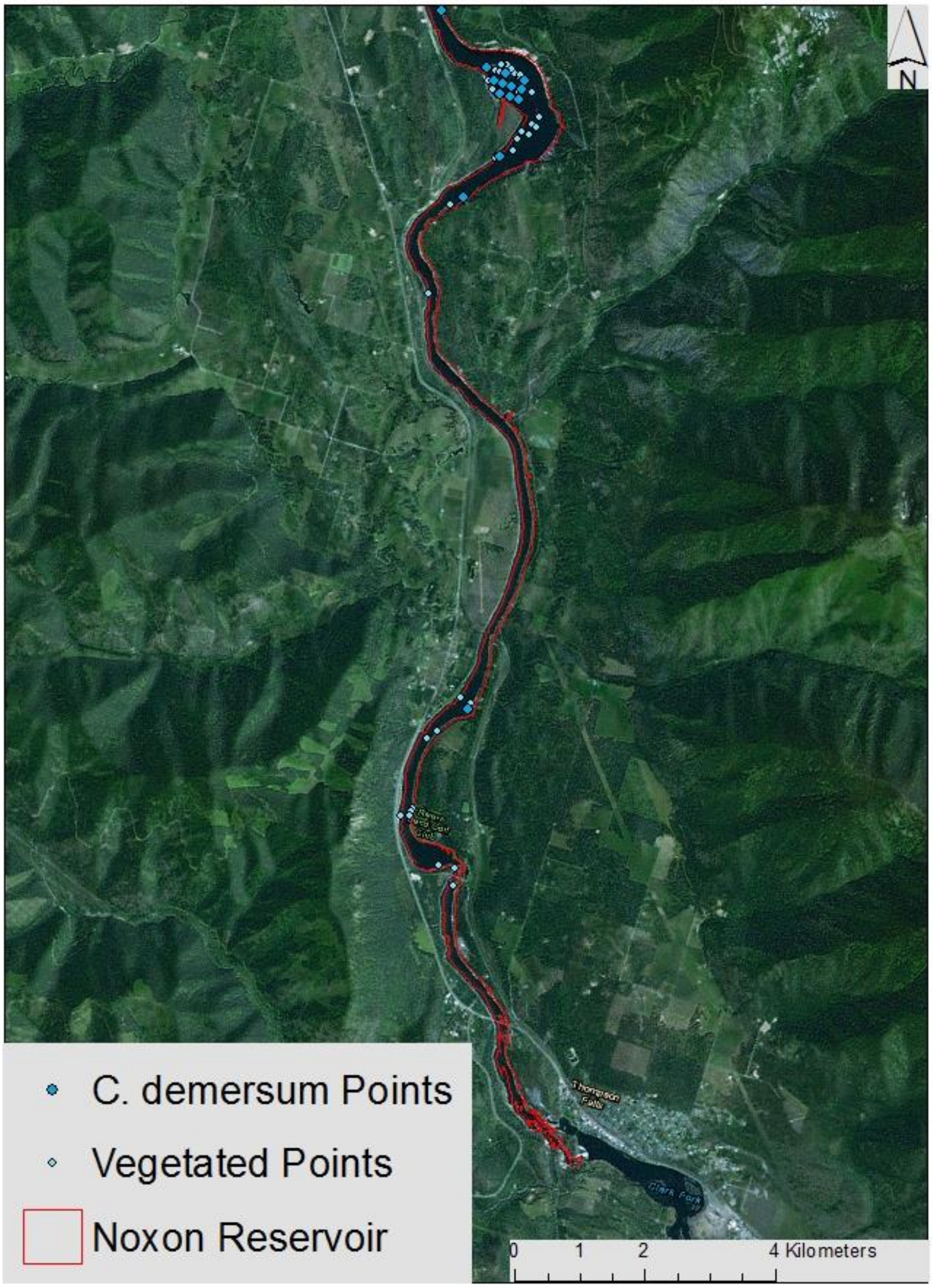

Figure 10. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had coontail (*Ceratophyllum demersum)* present.

Figure 11. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had elodea (*Elodea canadensis)* present.

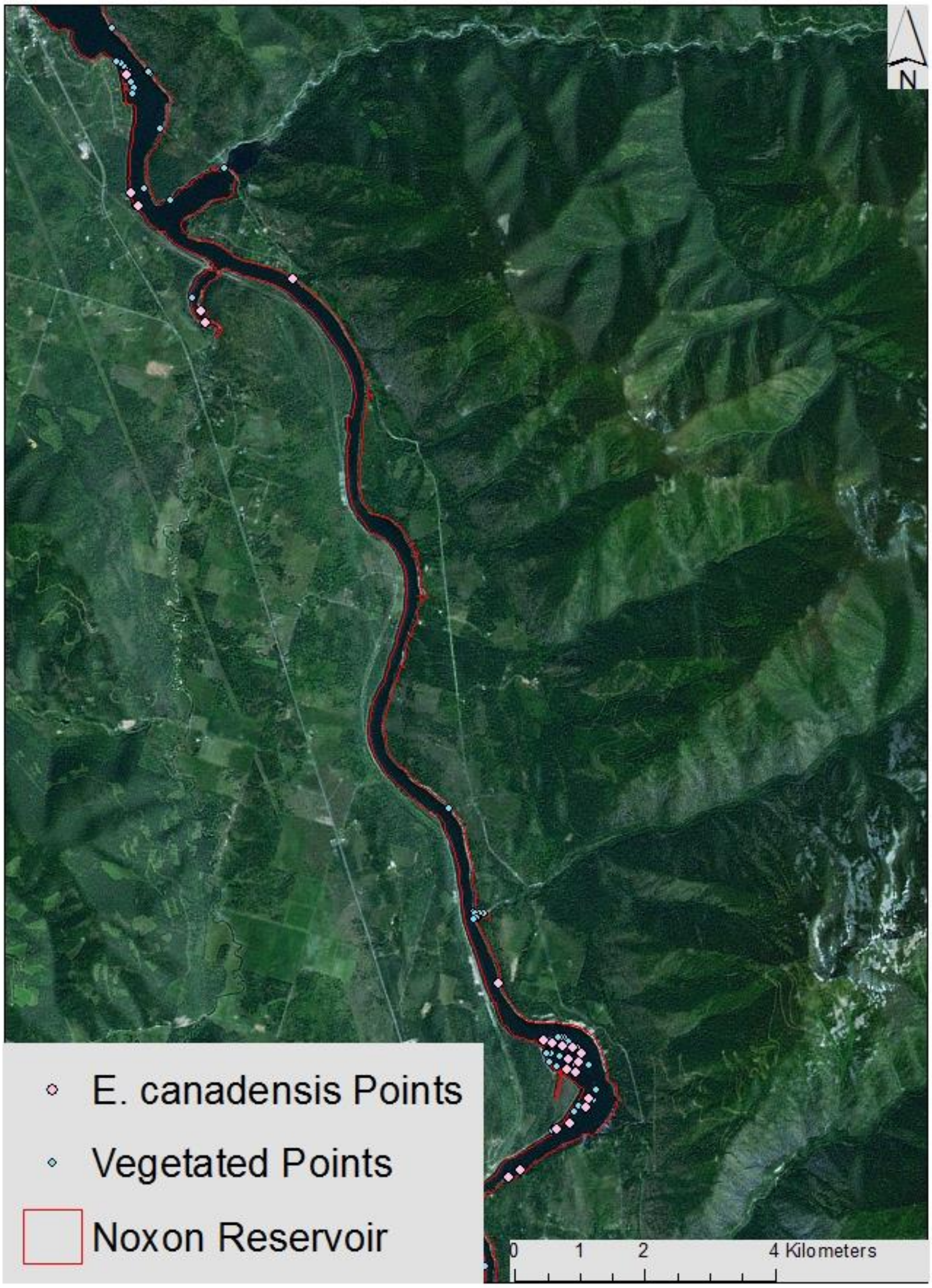

Figure 12. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had *Elodea canadensis* present.

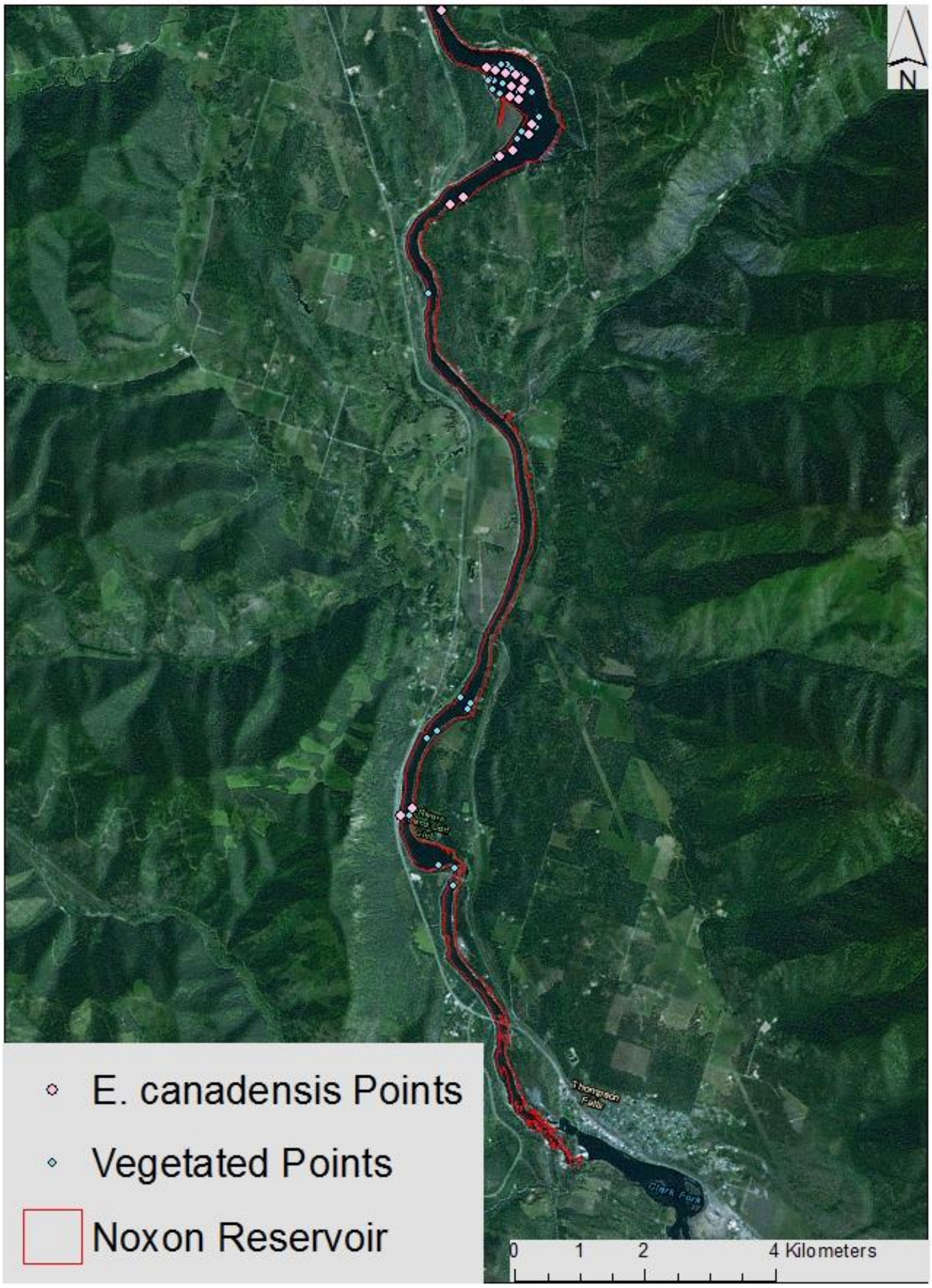

Figure 13. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had *Elodea canadensis* present.

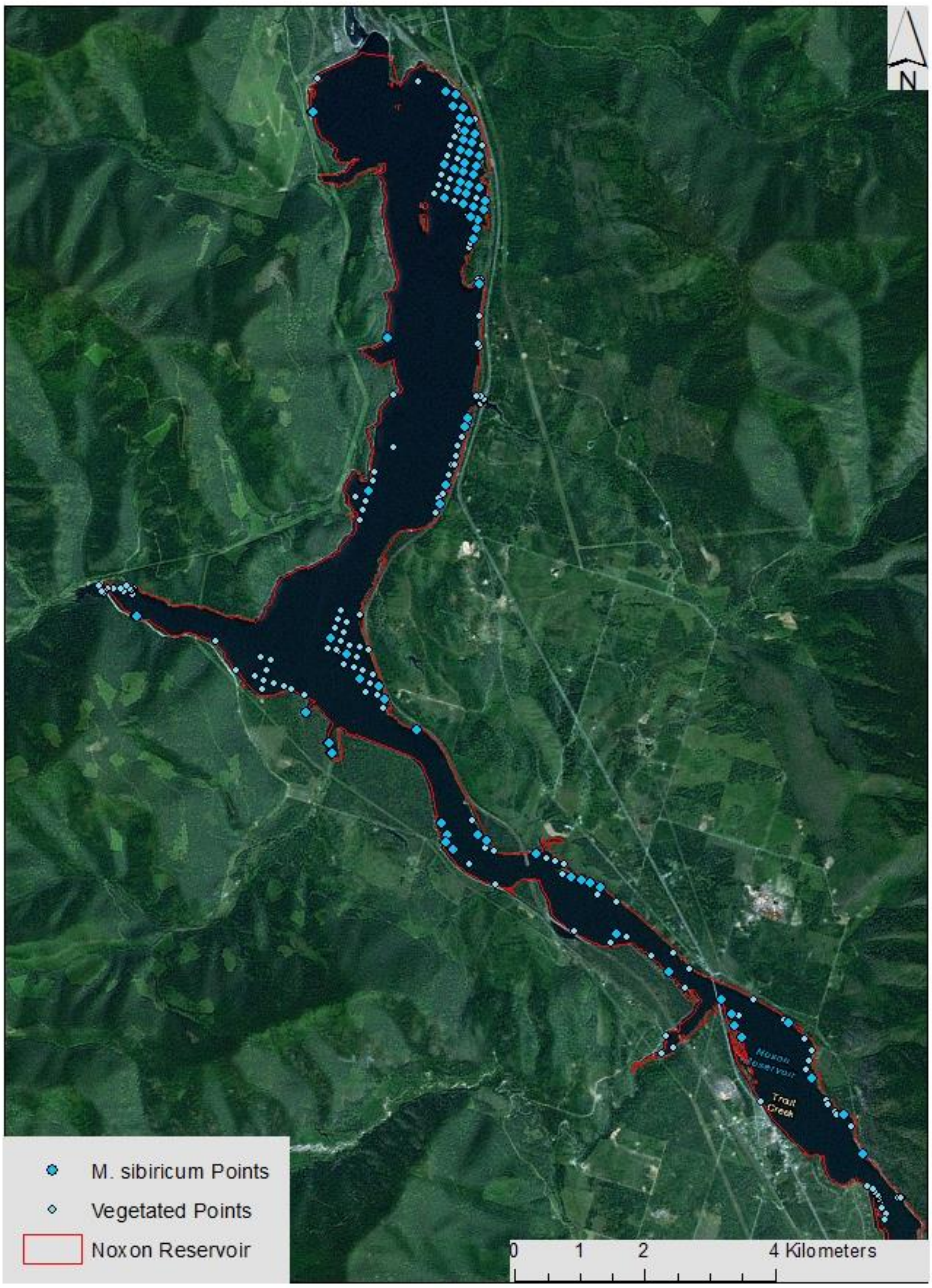

Figure 14. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had *Myriophyllum sibiricum* present.

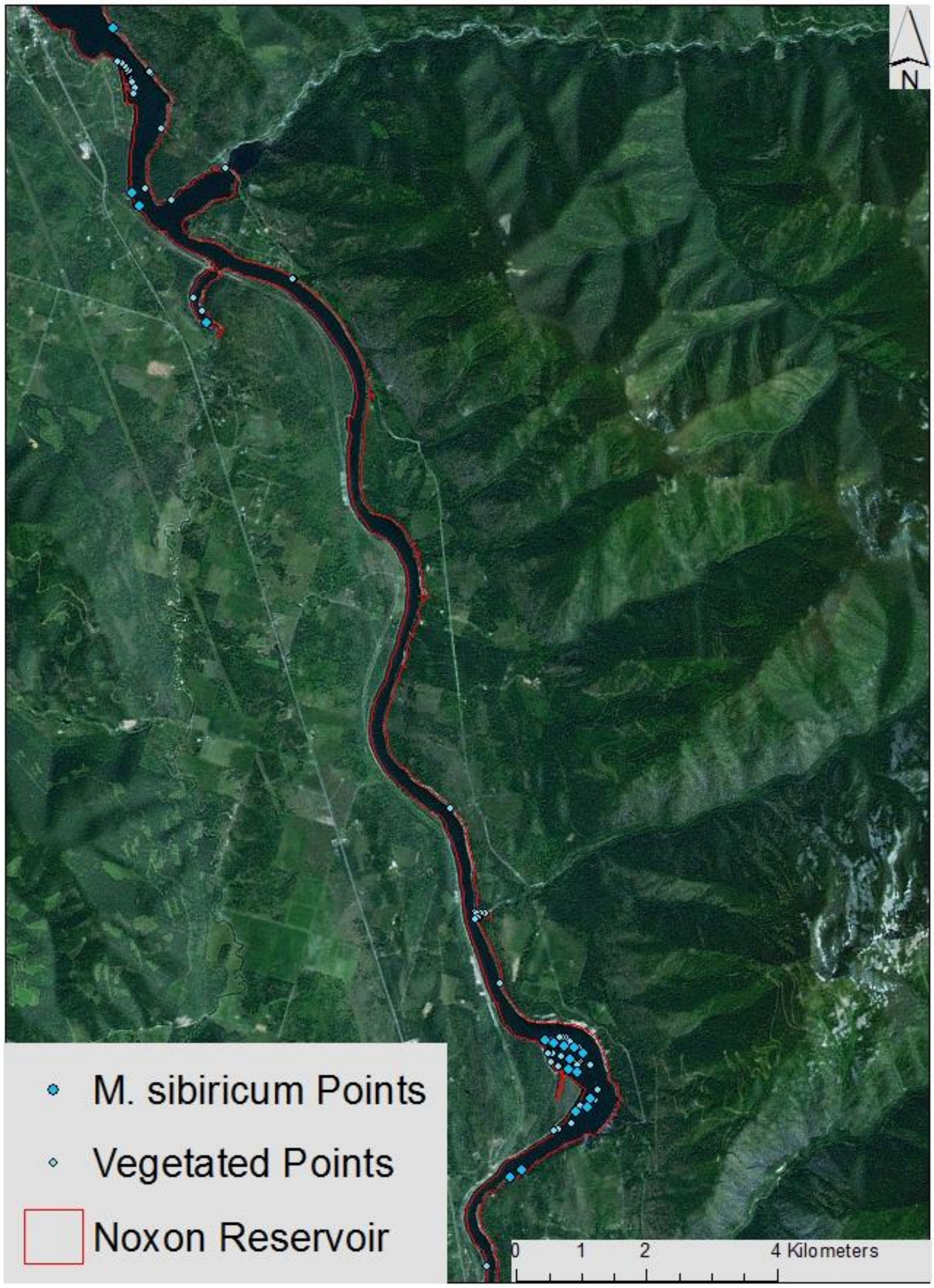

Figure 15. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had *Myriophyllum sibiricum* present.

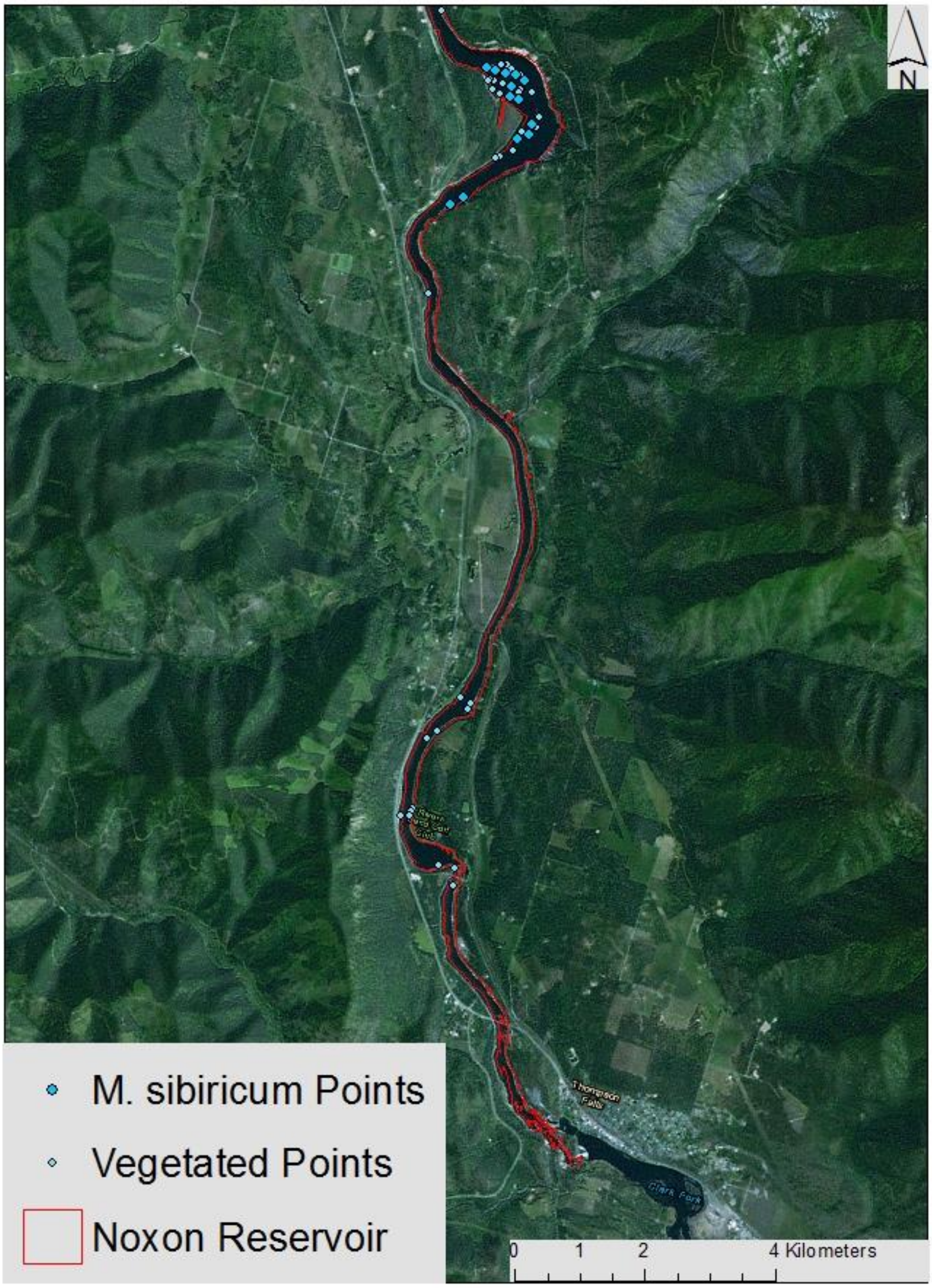

Figure 16. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had *Myriophyllum sibiricum* present.

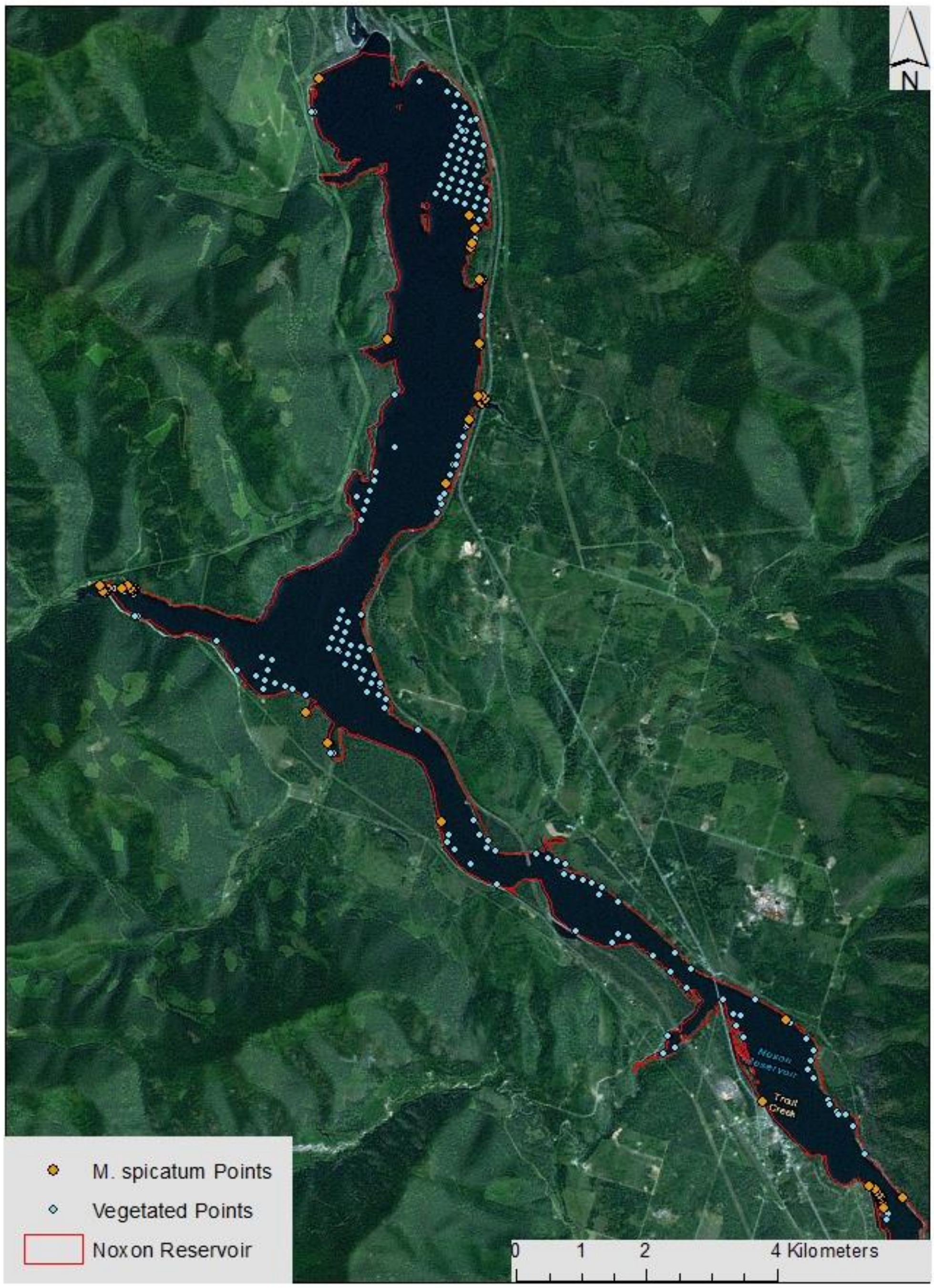

Figure 17. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had *Myriophyllum spicatum* present.

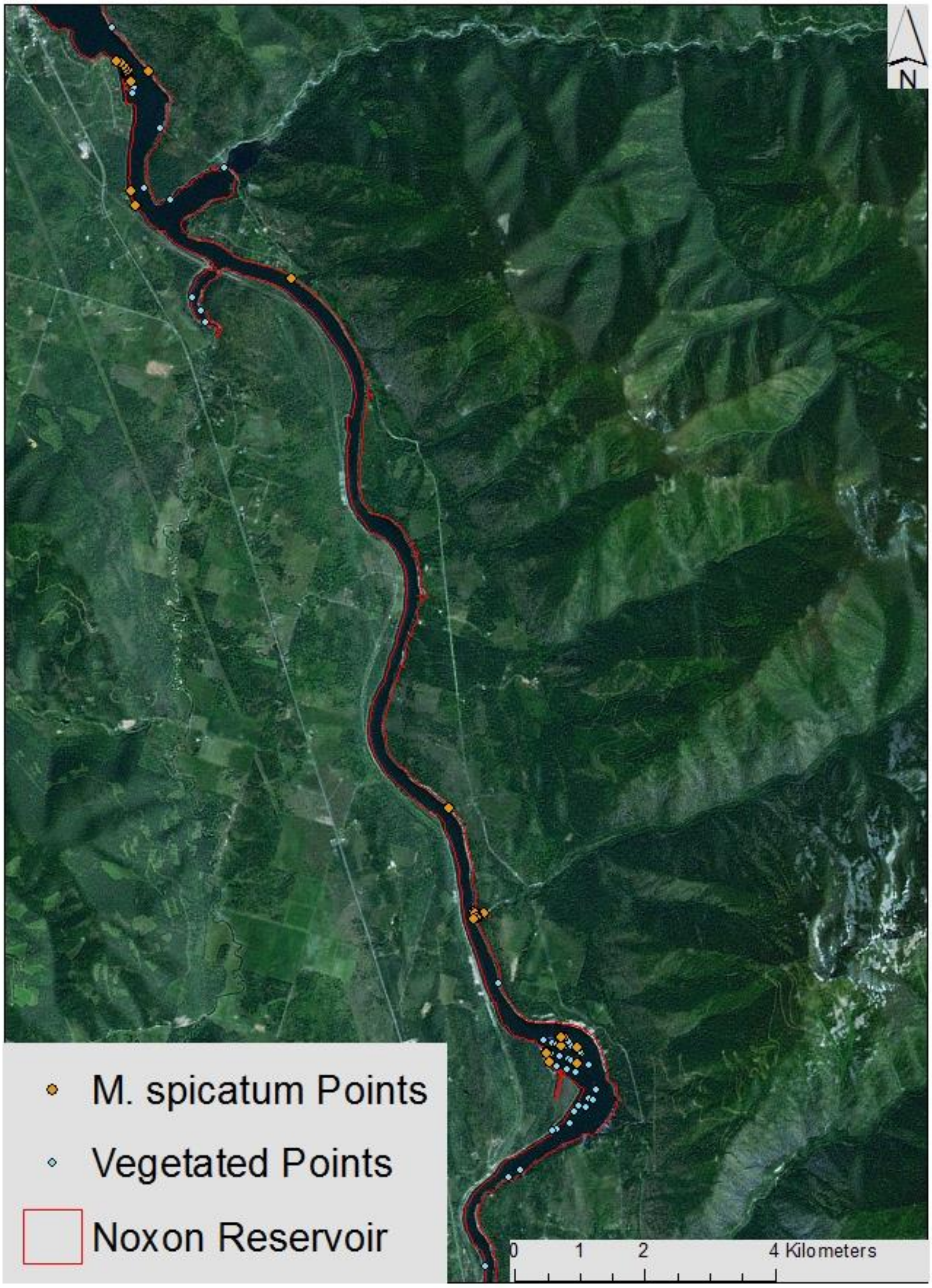

Figure 18. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had *Myriophyllum spicatum* present.

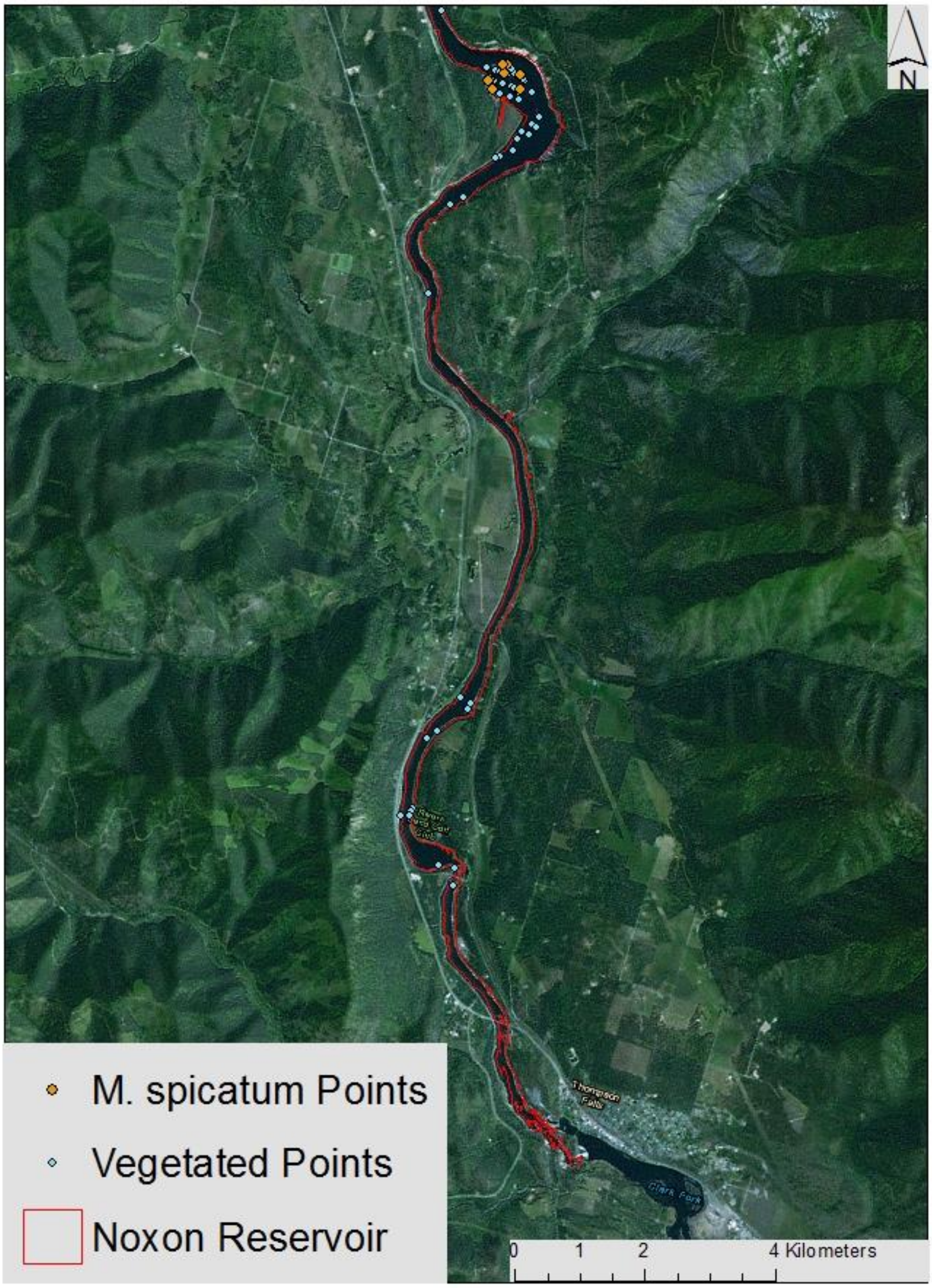

Figure 19. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had *Myriophyllum spicatum* present.

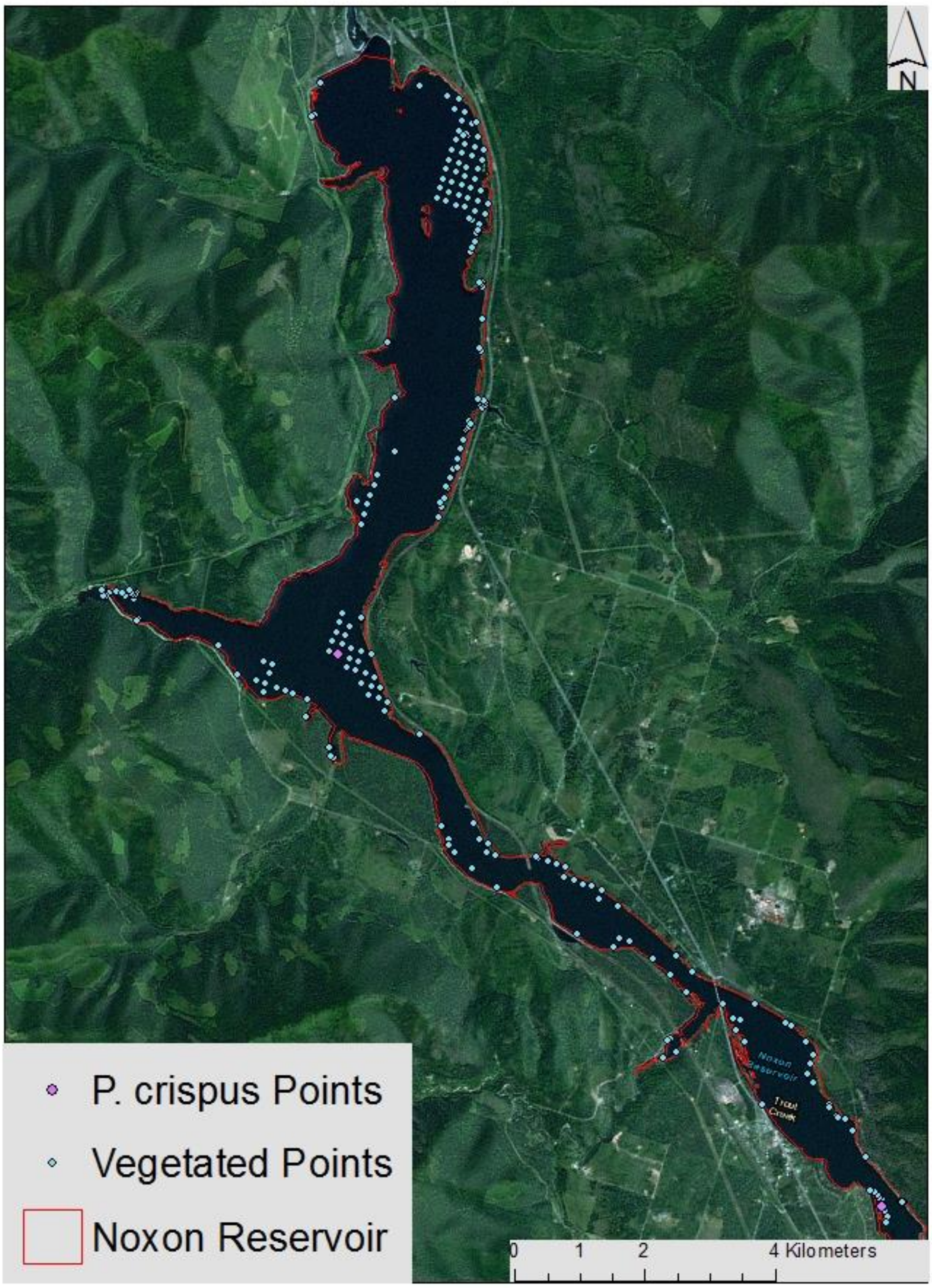

Figure 20. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had *Potamogeton crispus* present.

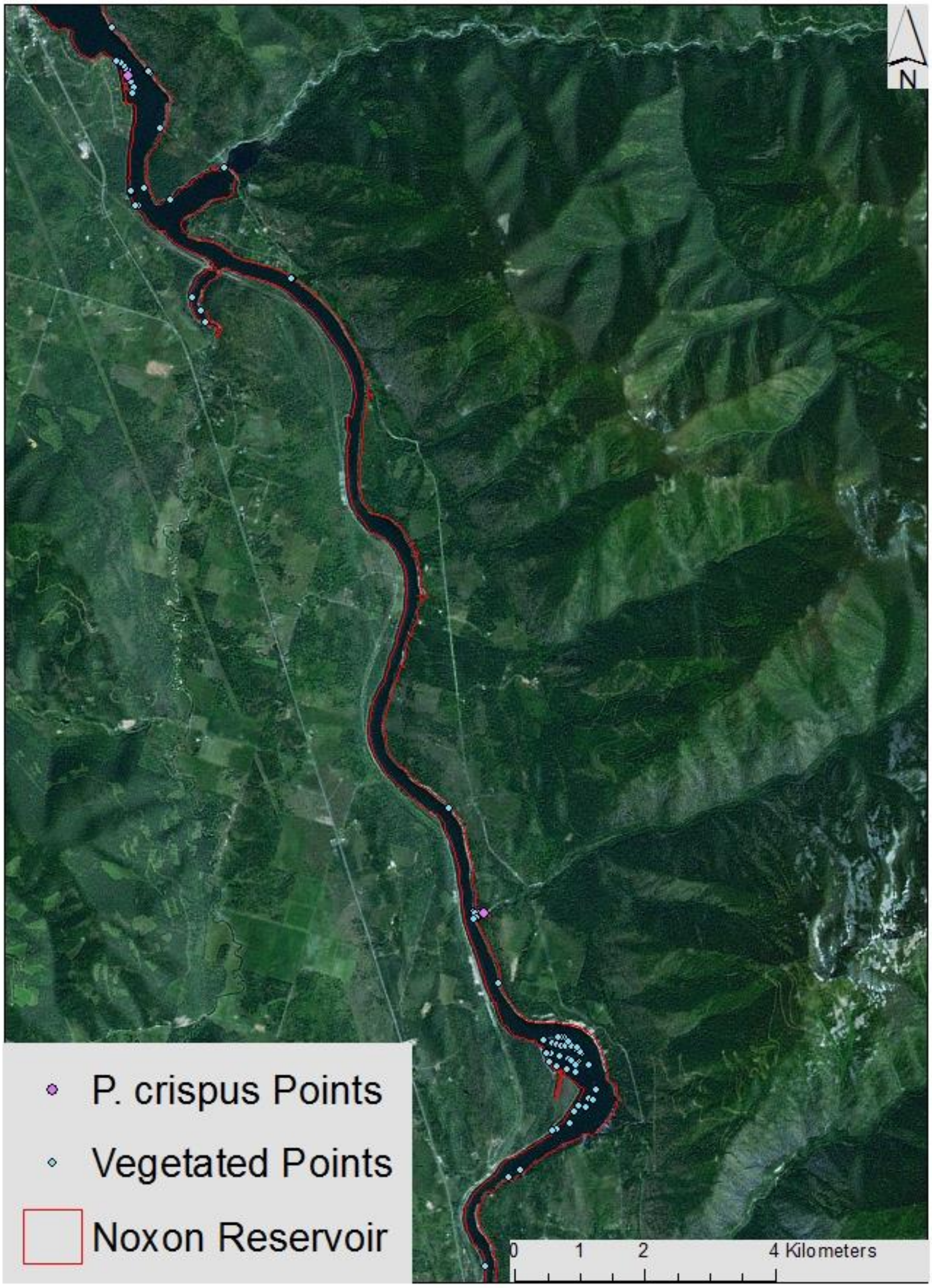

Figure 21. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had *Potamogeton crispus* present.

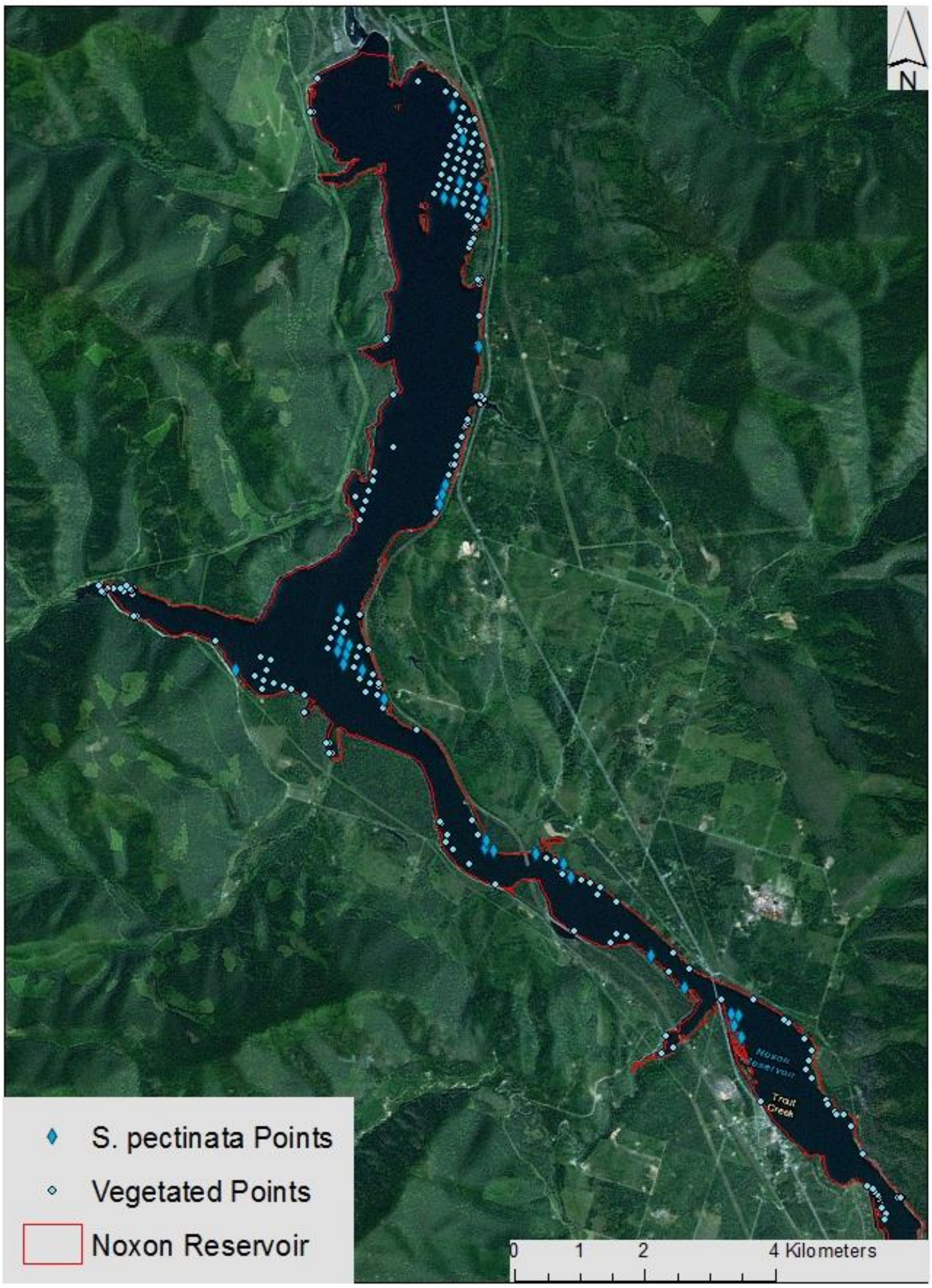

Figure 22. Littoral zone survey sites on lower Noxon Reservoir in 2013 that had *Stuckenia pectinata* present.

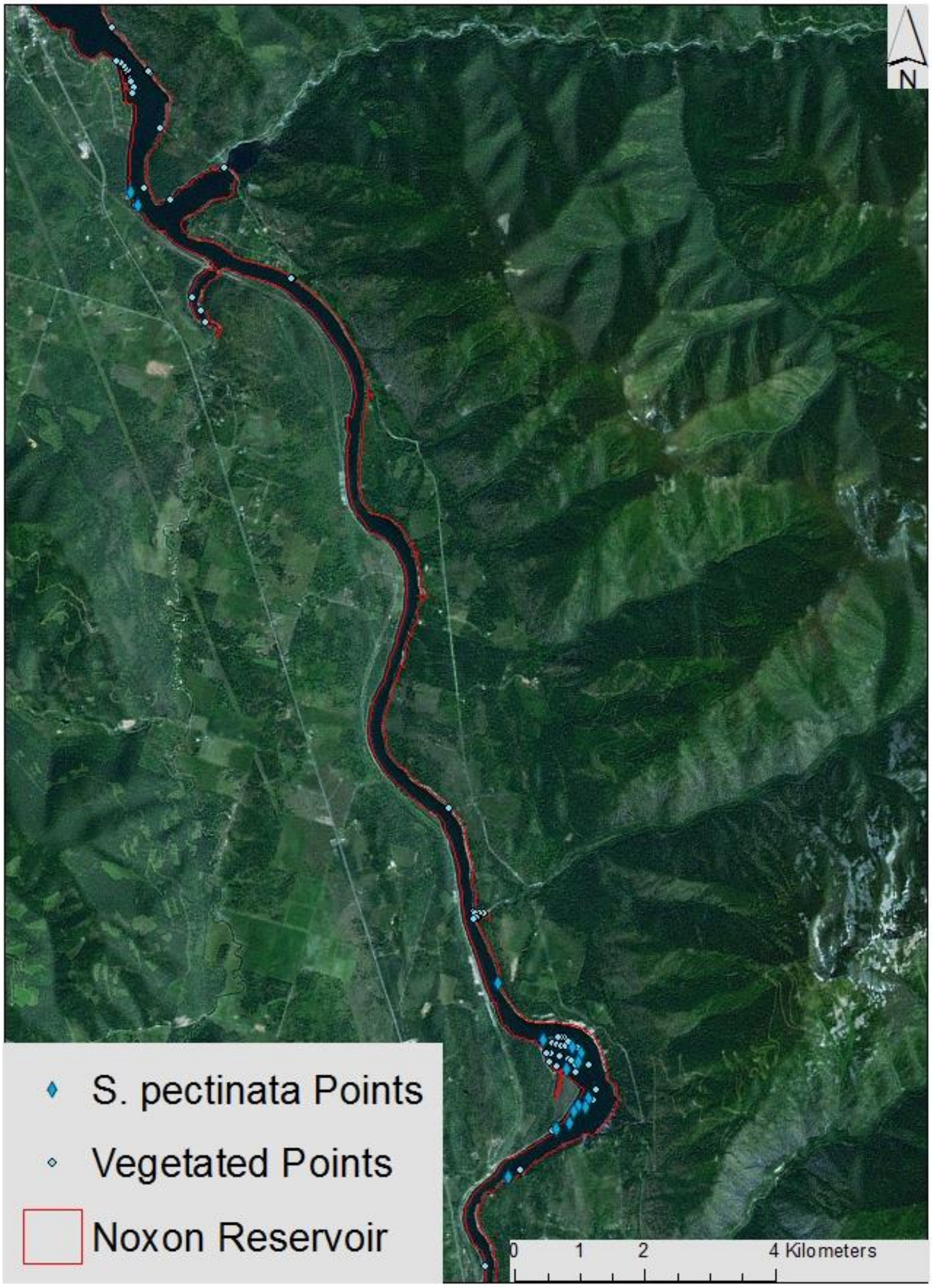

Figure 23. Littoral zone survey sites on middle Noxon Reservoir in 2013 that had *Stuckenia pectinata* present.

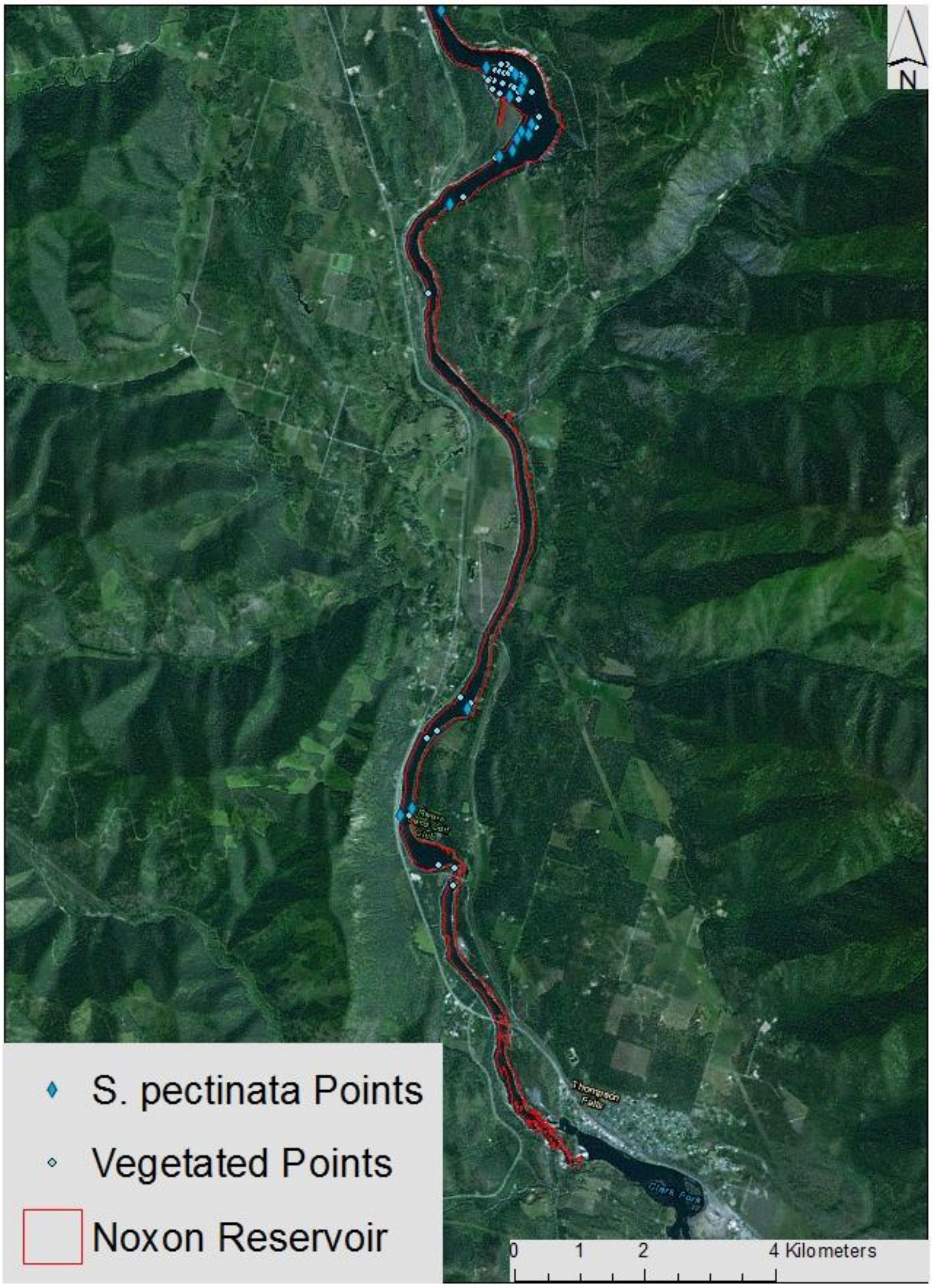

Figure 24. Littoral zone survey sites on upper Noxon Reservoir in 2013 that had *Stuckenia pectinata* present.

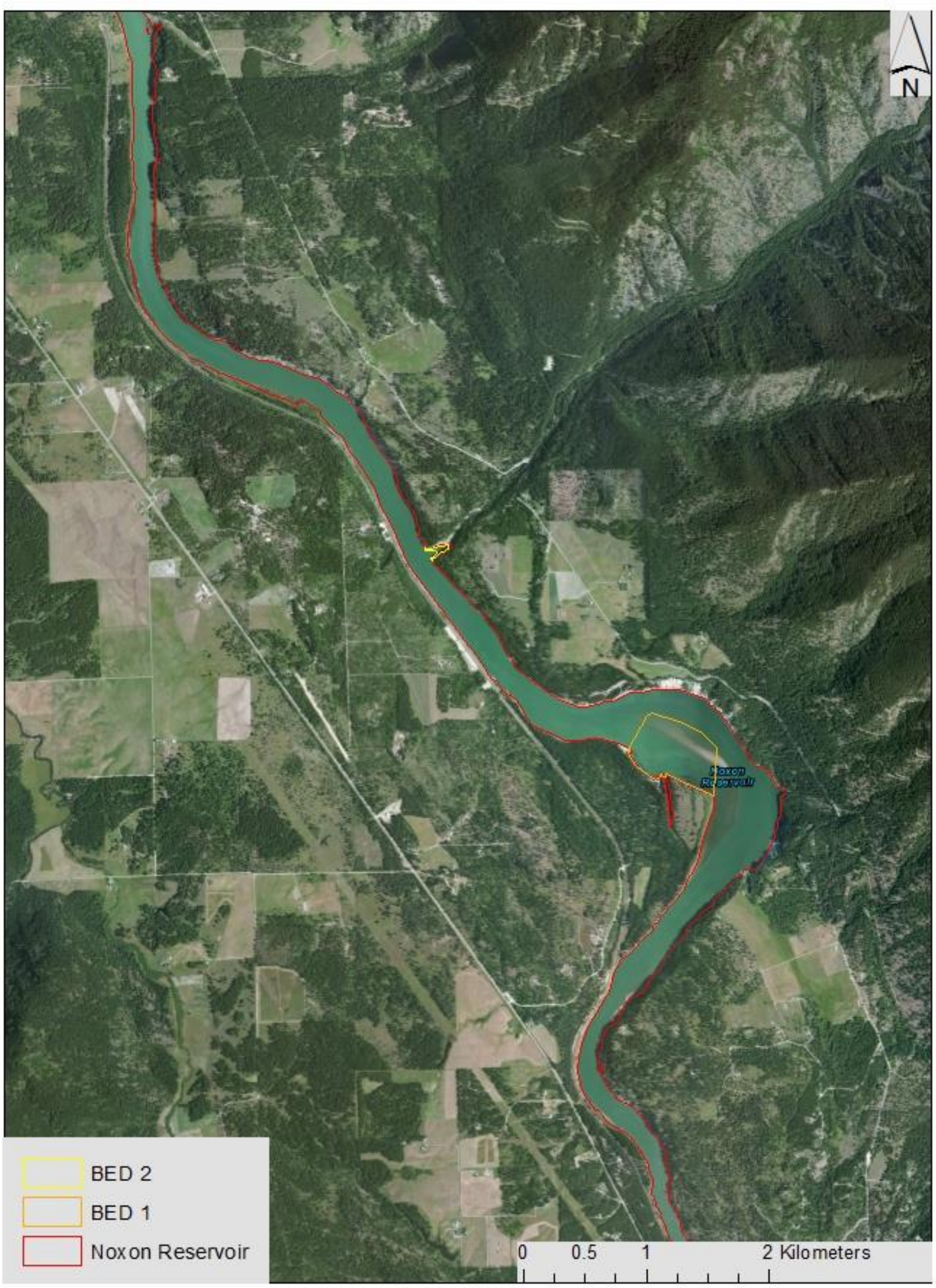

Figure 25. *Myriophyllum spicatum* beds one and two in Noxon Reservoir in 2013.

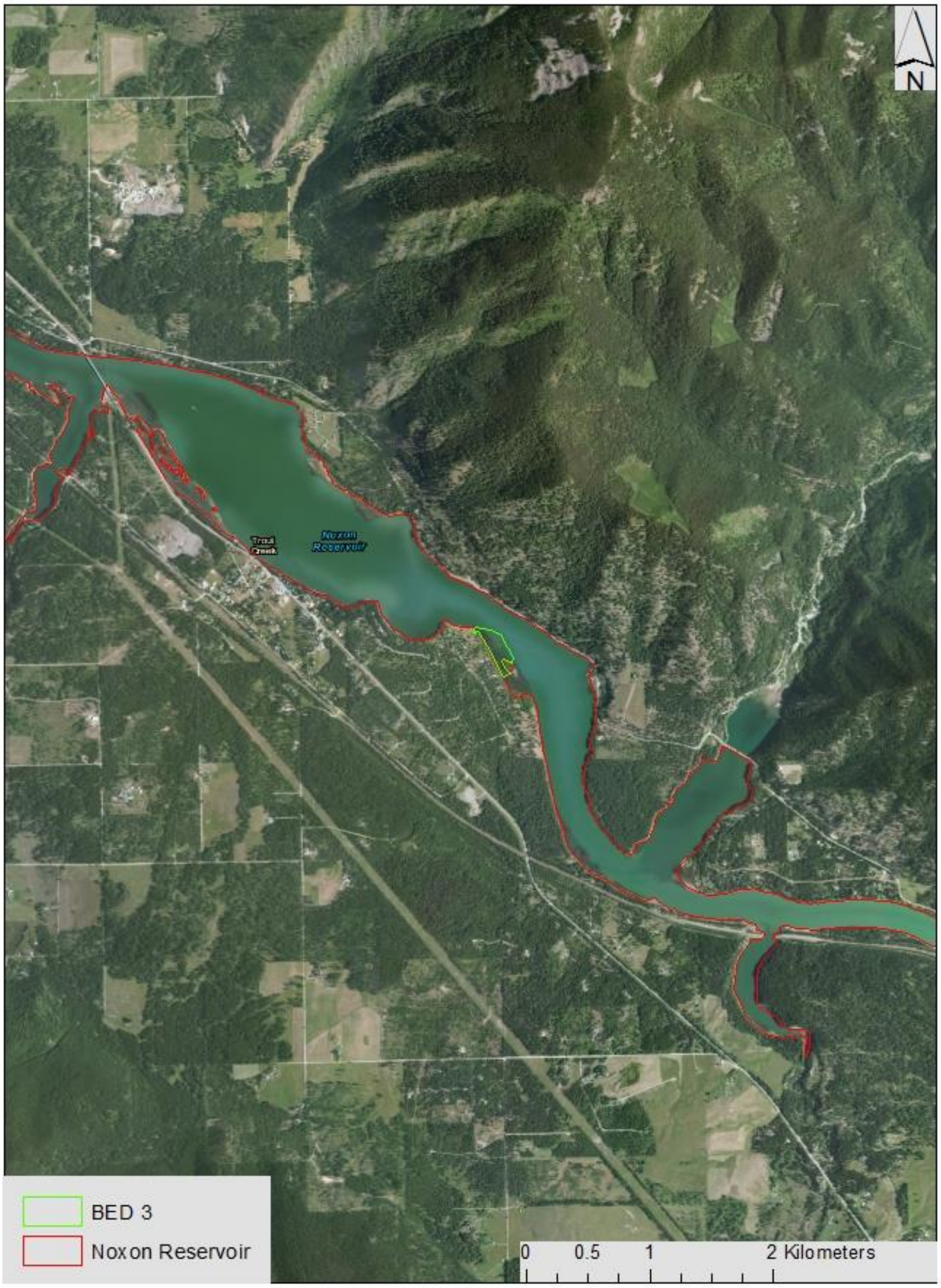

Figure 26. *Myriophyllum spicatum* bed three in Noxon Reservoir in 2013.

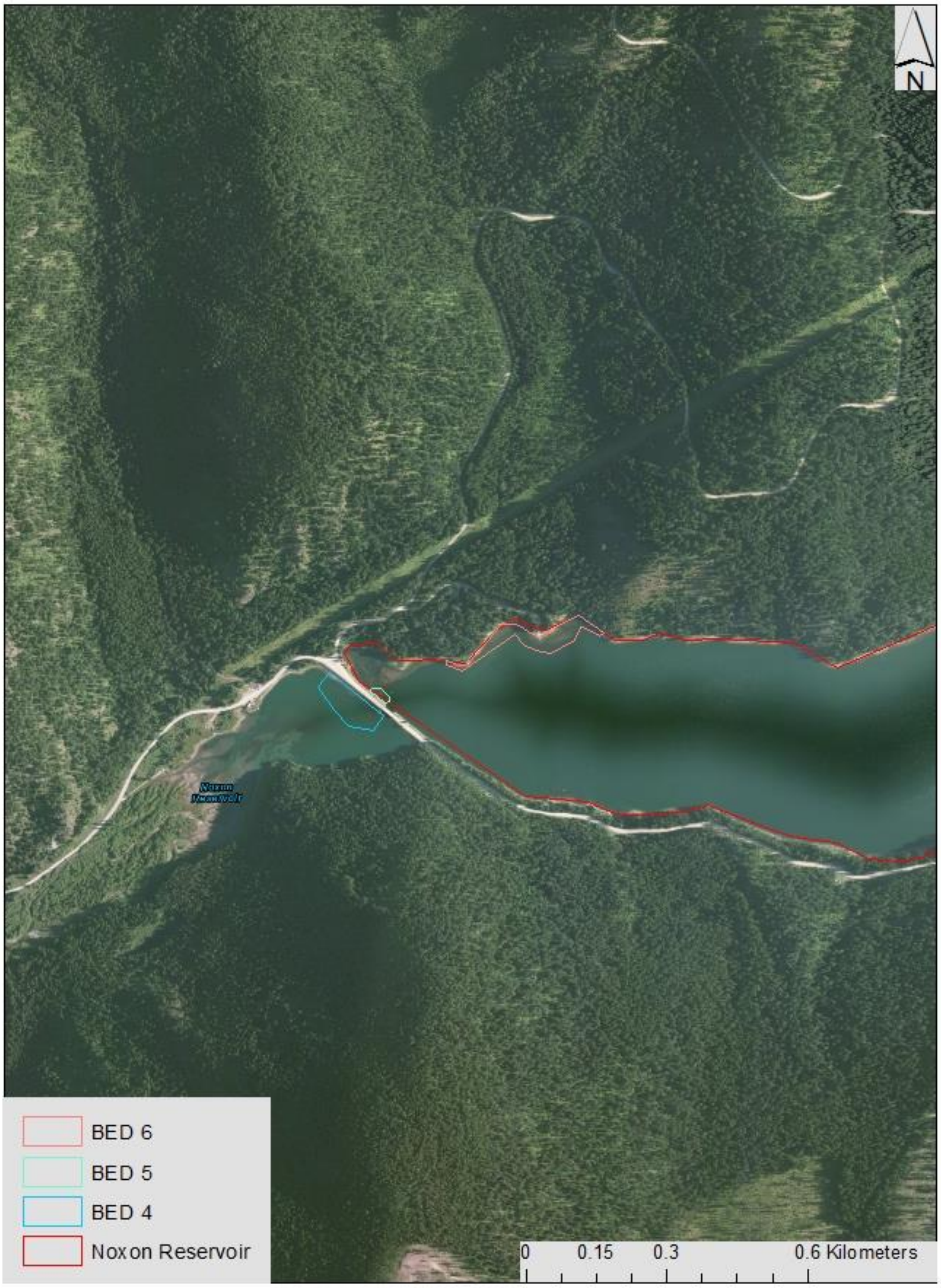

Figure 27. *Myriophyllum spicatum* beds four, five, and six in Noxon Reservoir in 2013.

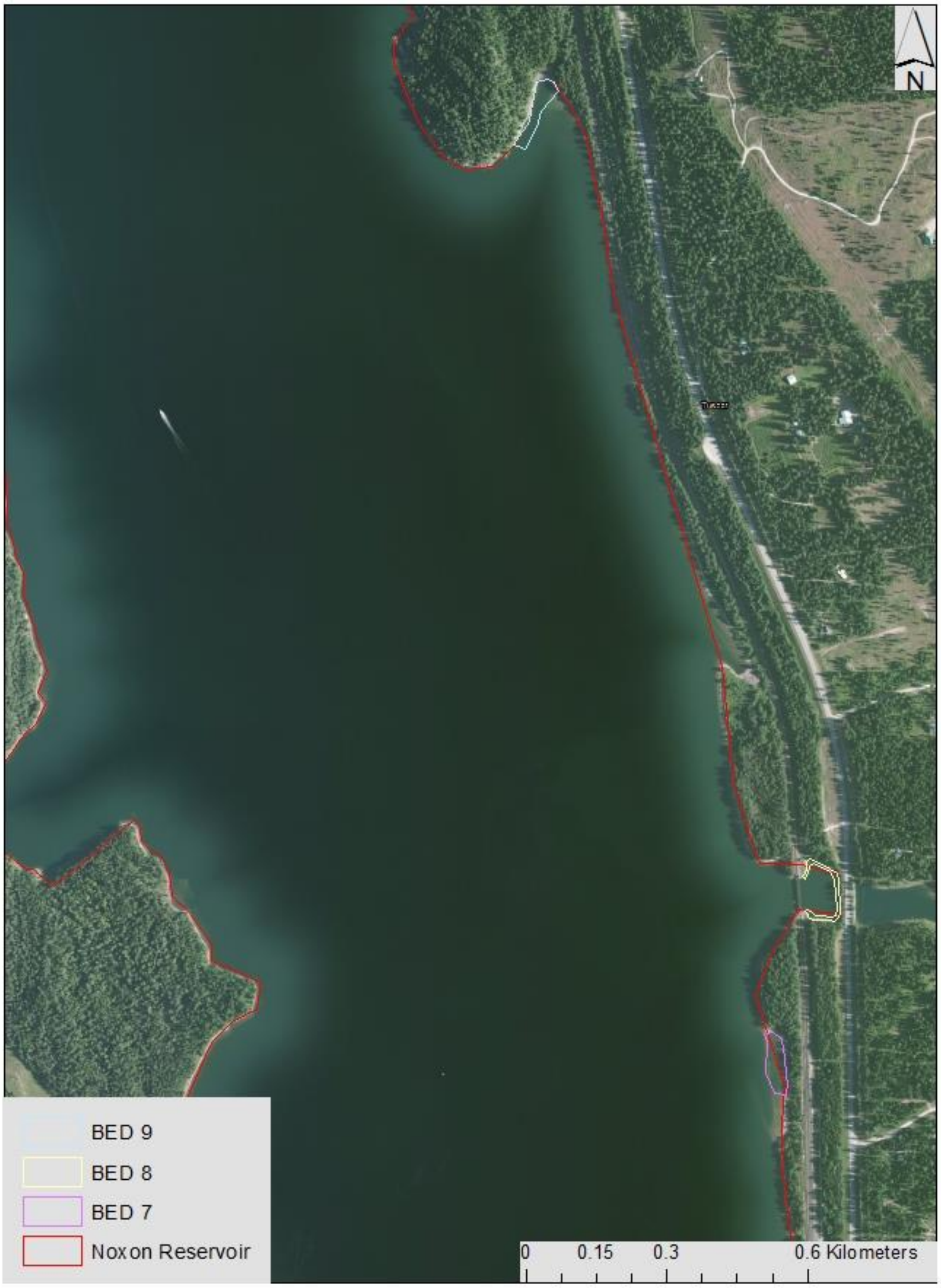

Figure 28. *Myriophyllum spicatum* beds seven, eight, and nine in Noxon Reservoir in 2013.

Figure 29. *Myriophyllum spicatum* bed ten in Noxon Reservoir in 2013.

Figure 30. *Myriophyllum spicatum* bed eleven in Noxon Reservoir in 2013.

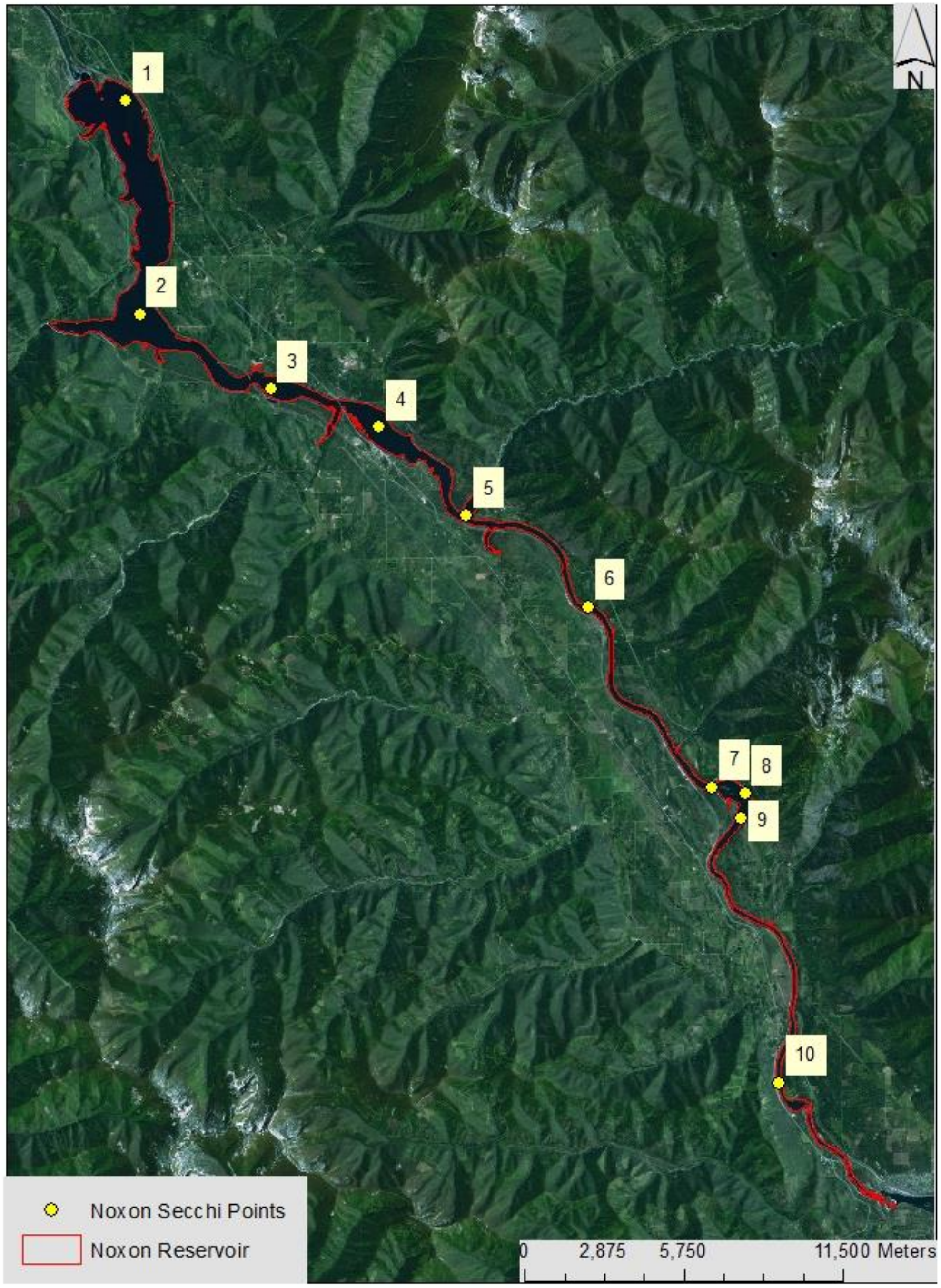

Figure 31. Sites where Secchi depth was recorded on Noxon Reservoir in 2013.

Figure 32. Photograph of Finley Flats on Noxon Reservoir in 2013.

Figure 33. Exposed cliff faces overlooking Finley Flats on Noxon Reservoir in 2013.

Figure 34. Exposed cliff faces overlooking Finley Flats on Noxon Reservoir in 2013.

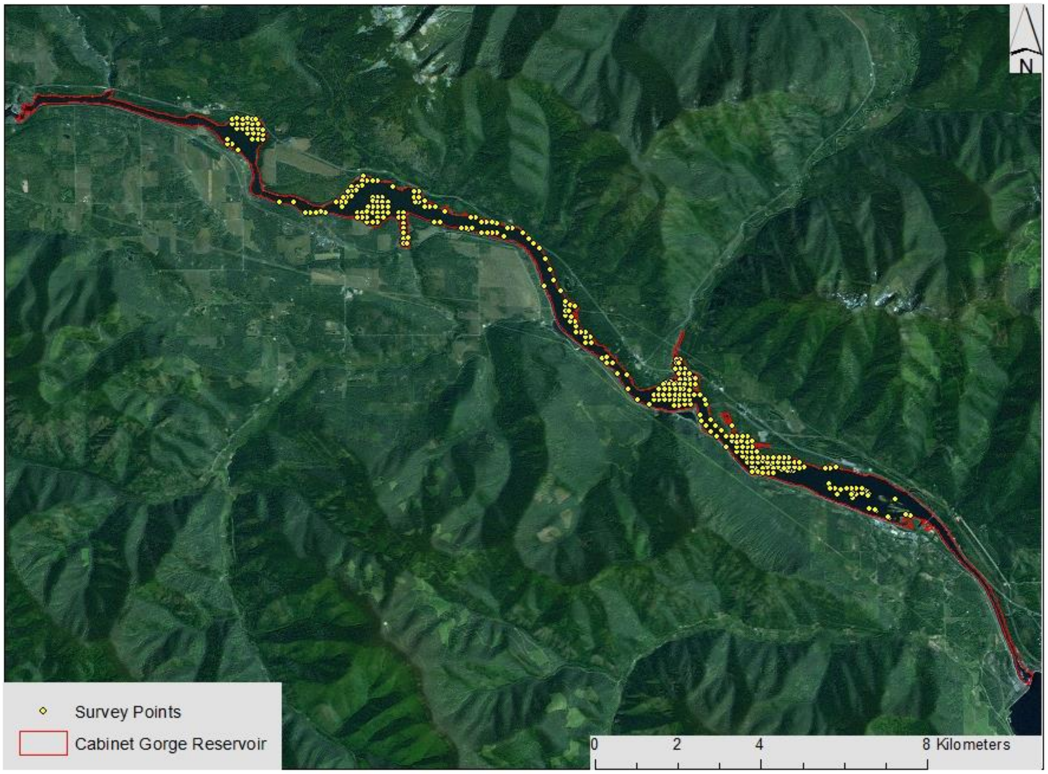

Figure 35. Littoral zone survey sites on Cabinet Gorge Reservoir in 2013.

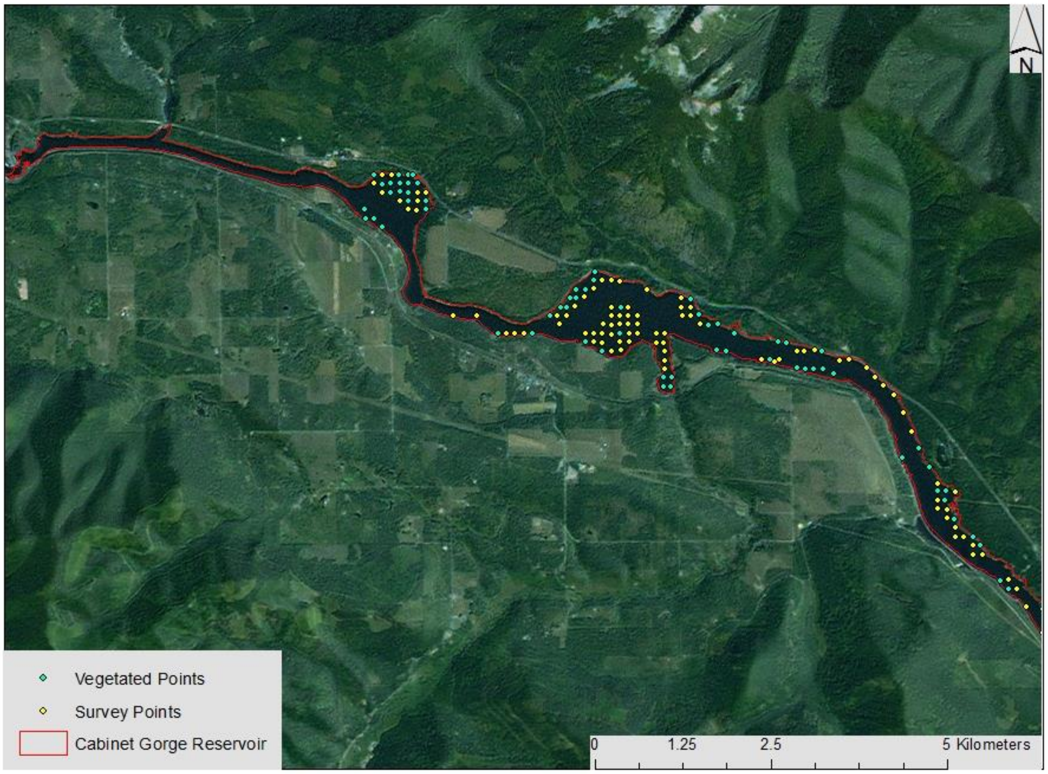

Figure 36. Vegetated littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013.

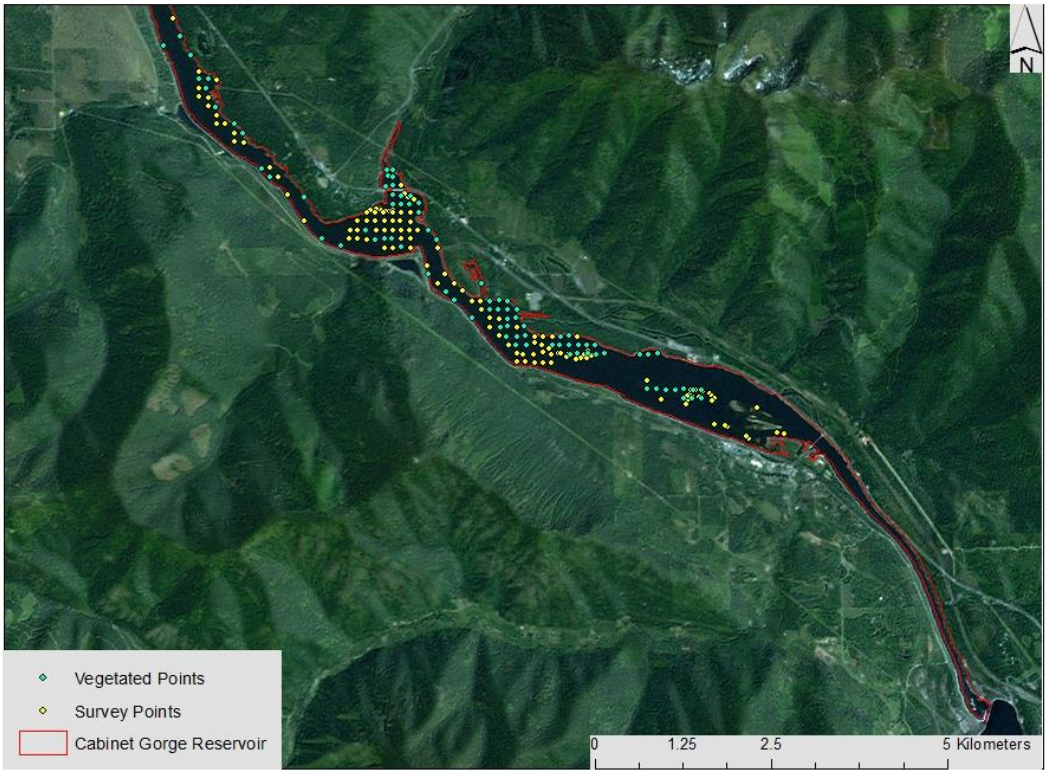

Figure 37. Vegetated littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013.

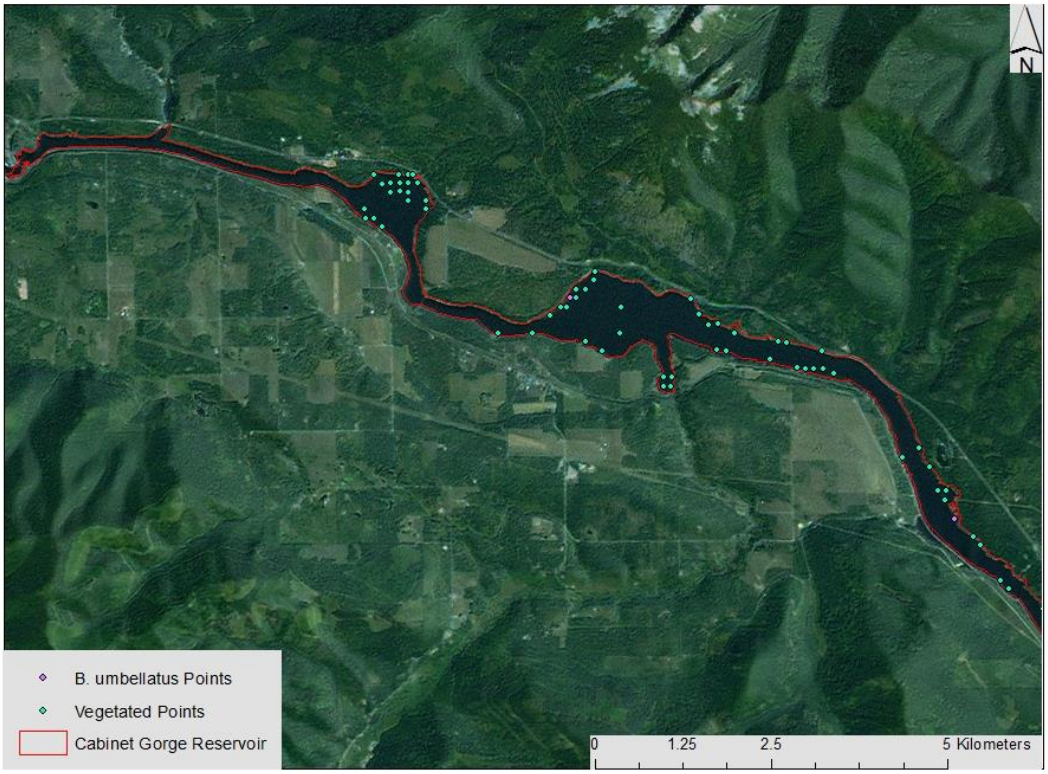

Figure 38. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Butomus umbellatus* present.

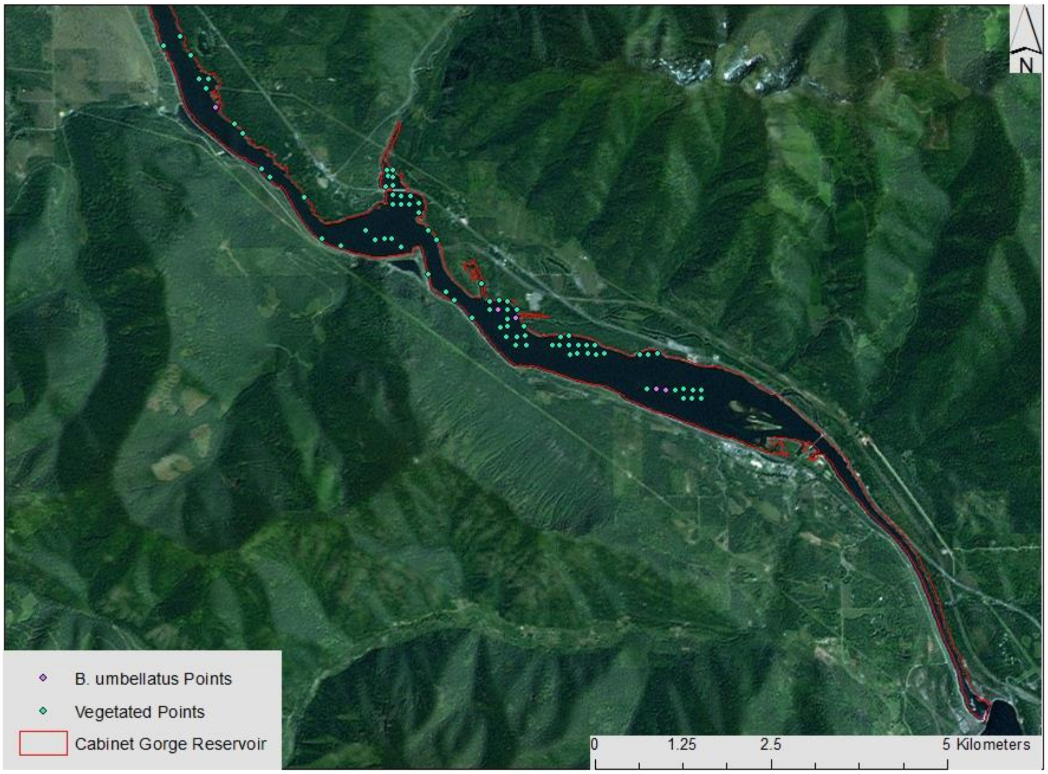

Figure 39. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Butomus umbellatus* present.

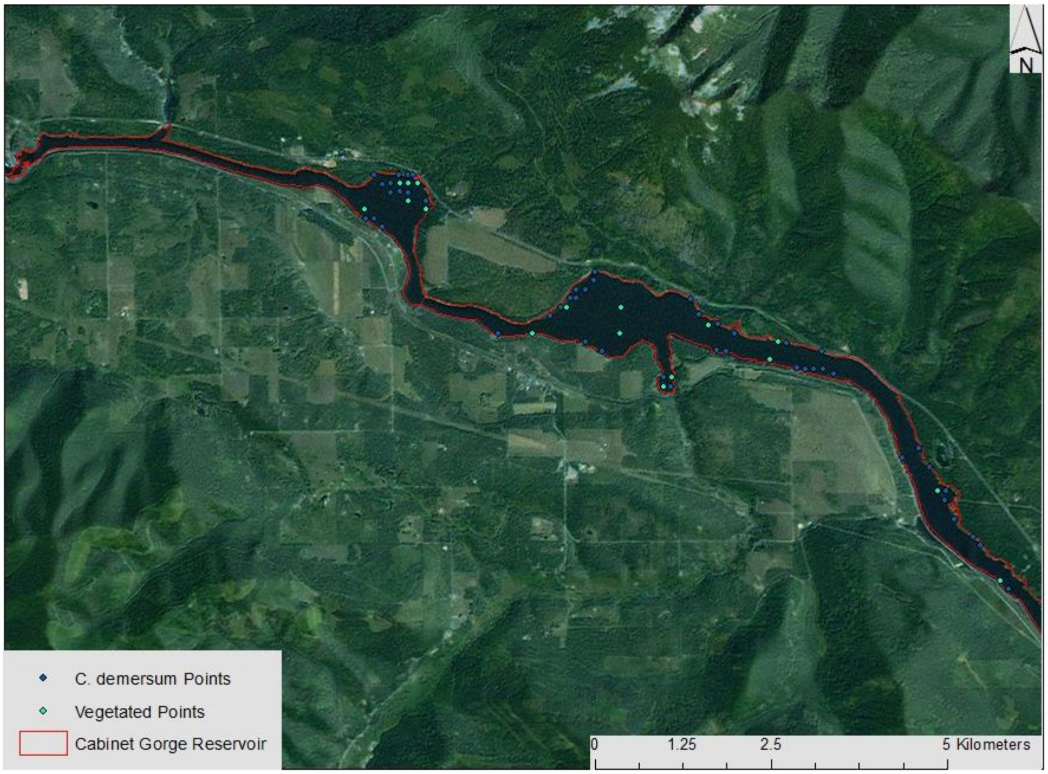

Figure 40. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Ceratophyllum demersum* present.

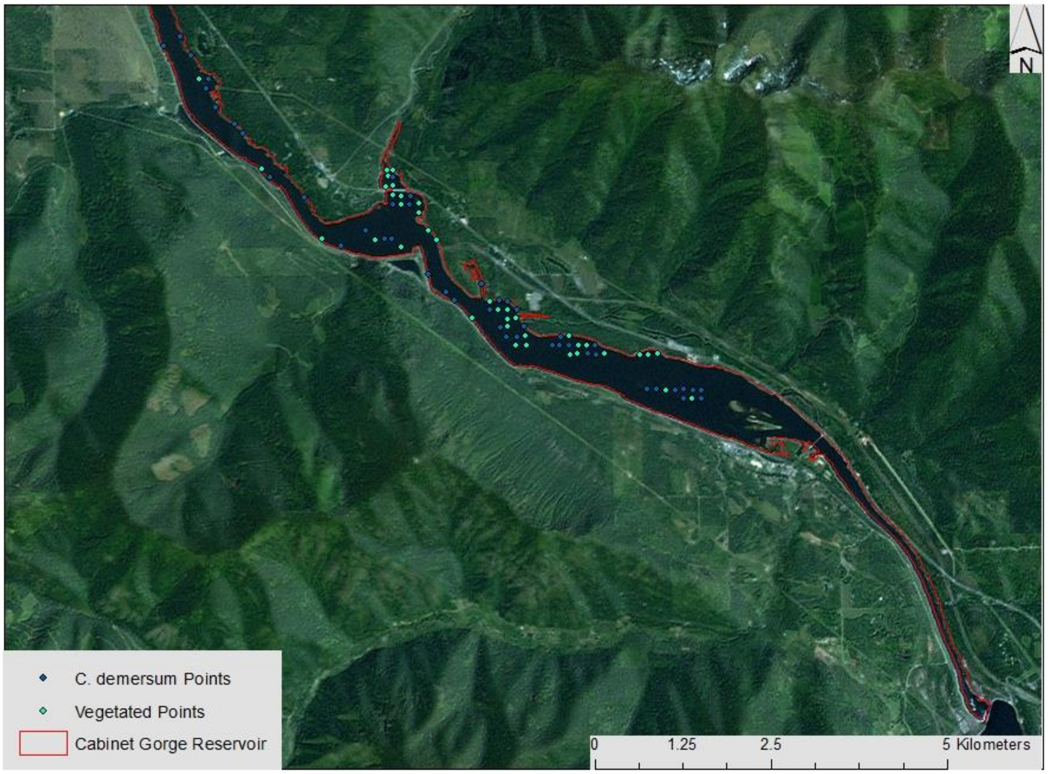

Figure 41. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Ceratophyllum demersum* present.

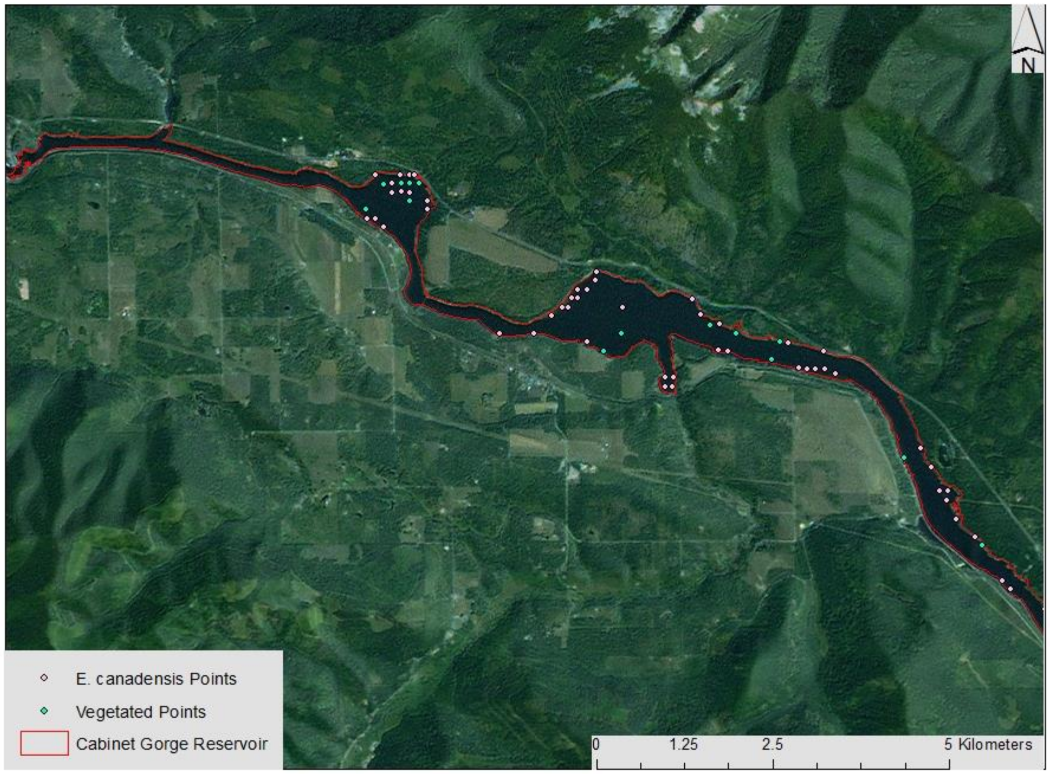

Figure 42. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Elodea canadensis* present.

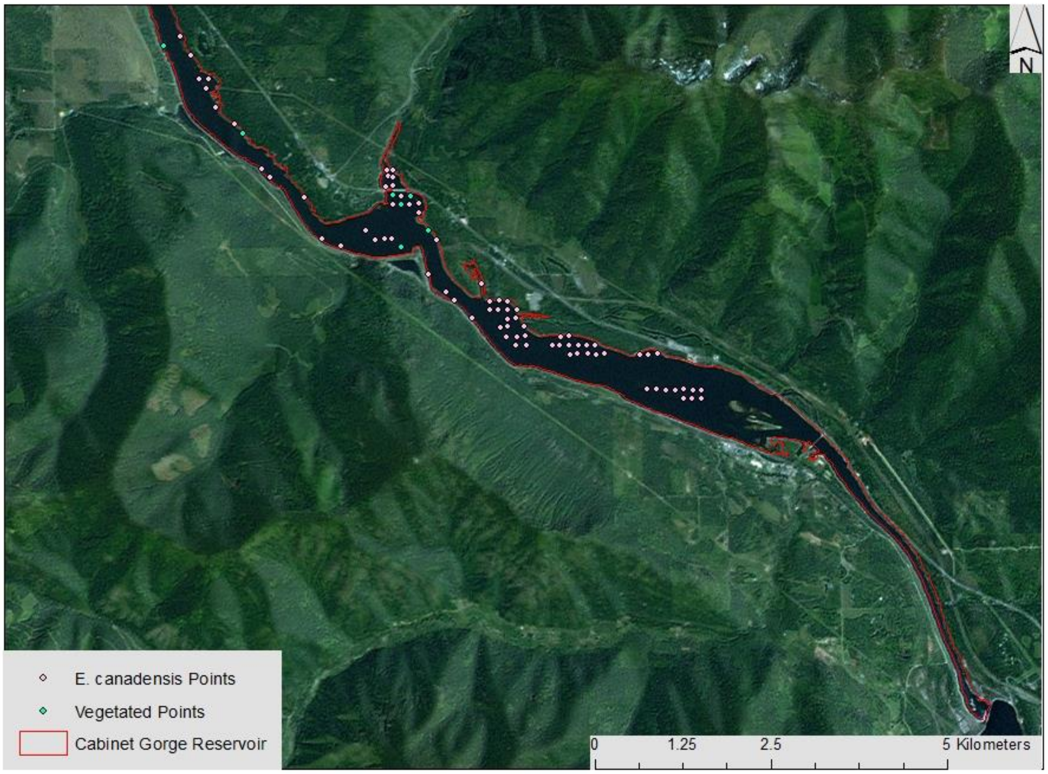

Figure 43. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Elodea canadensis* present.

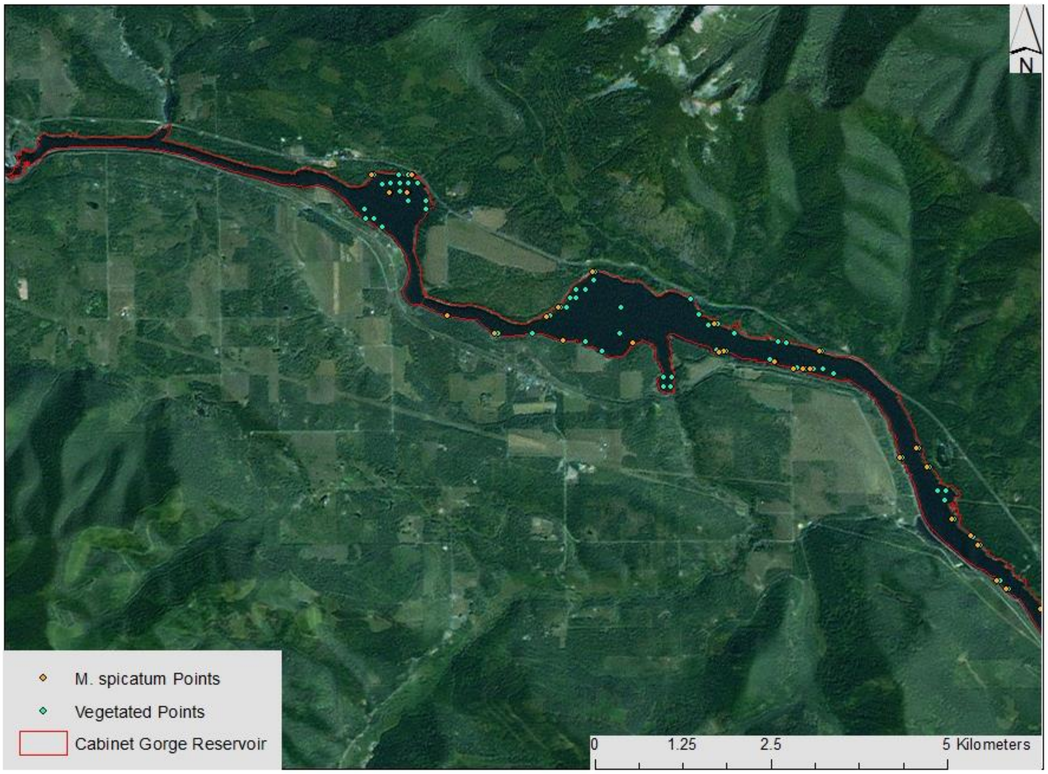

Figure 44. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Myriophyllum spicatum* present.

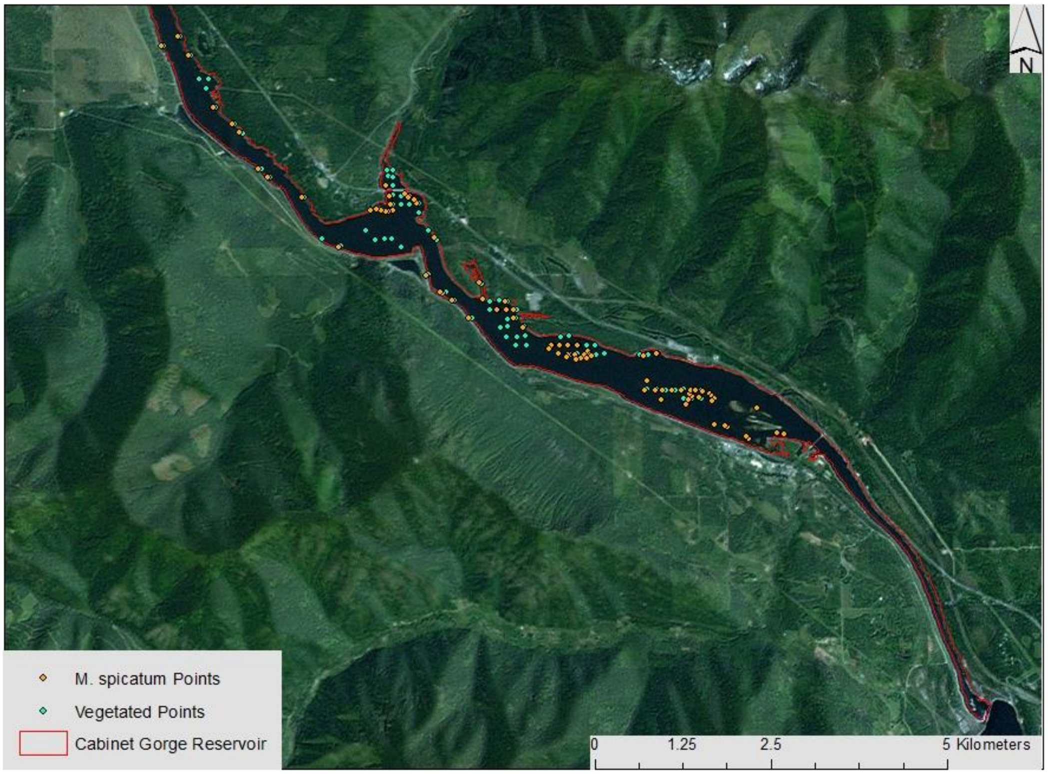

Figure 45. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Myriophyllum spicatum* present.

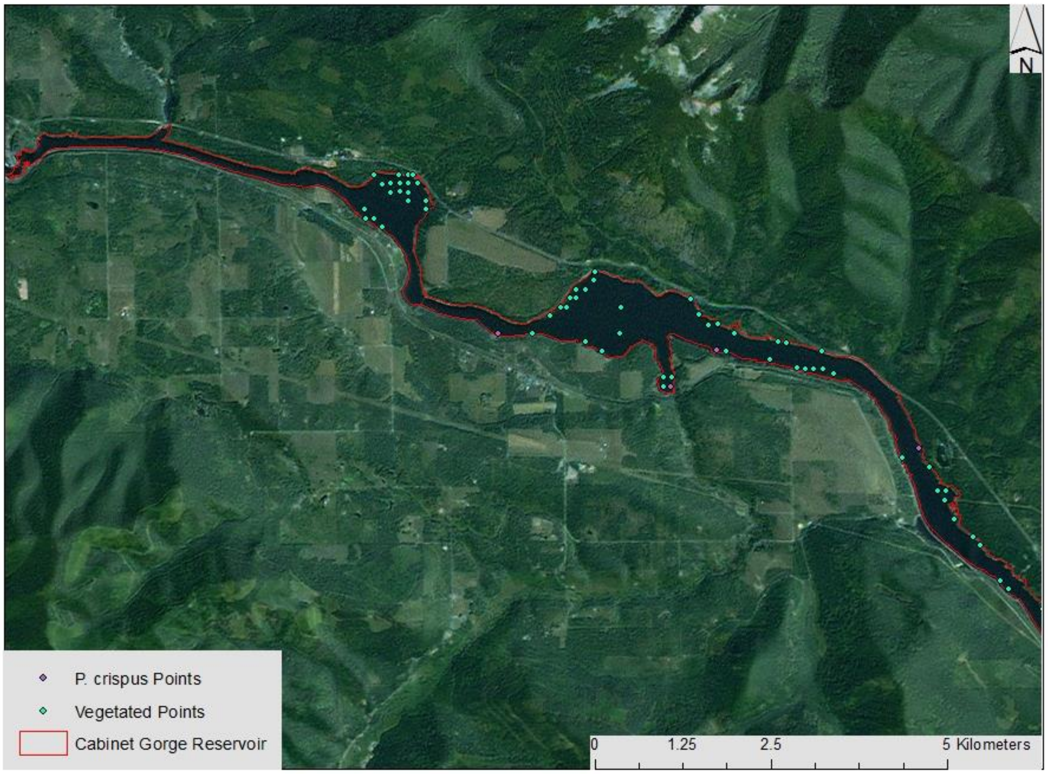

Figure 46. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Potamogeton crispus* present.

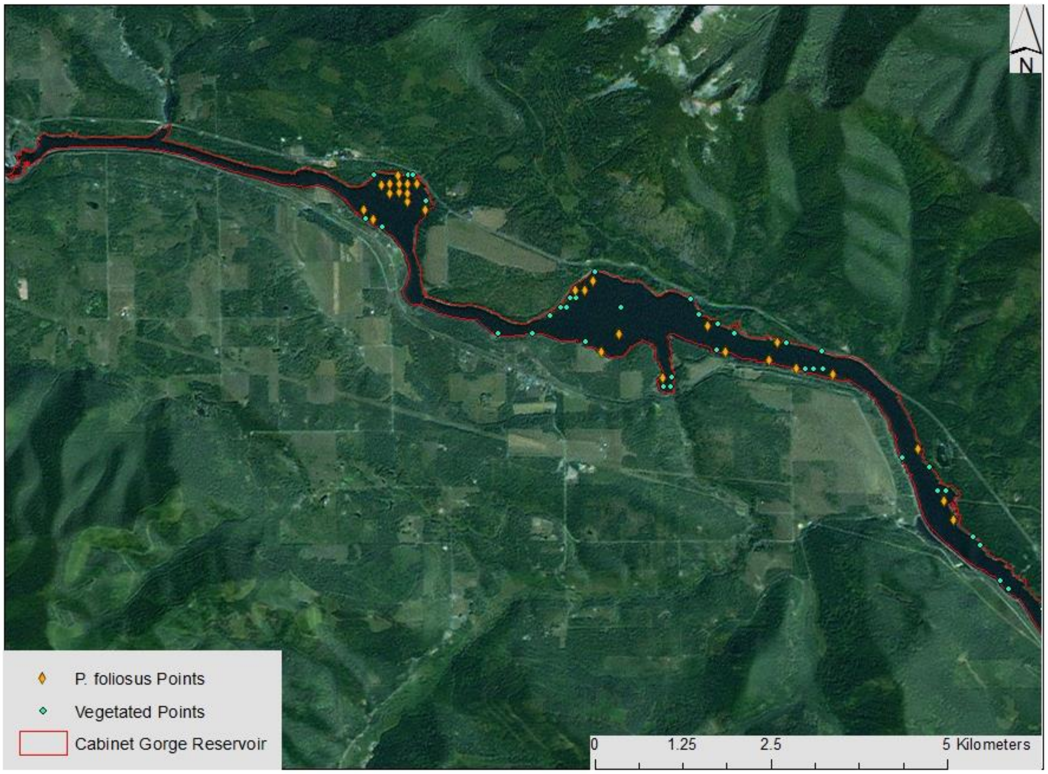

Figure 47. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Potamogeton foliosus* present.

Figure 48. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Potamogeton foliosus* present.

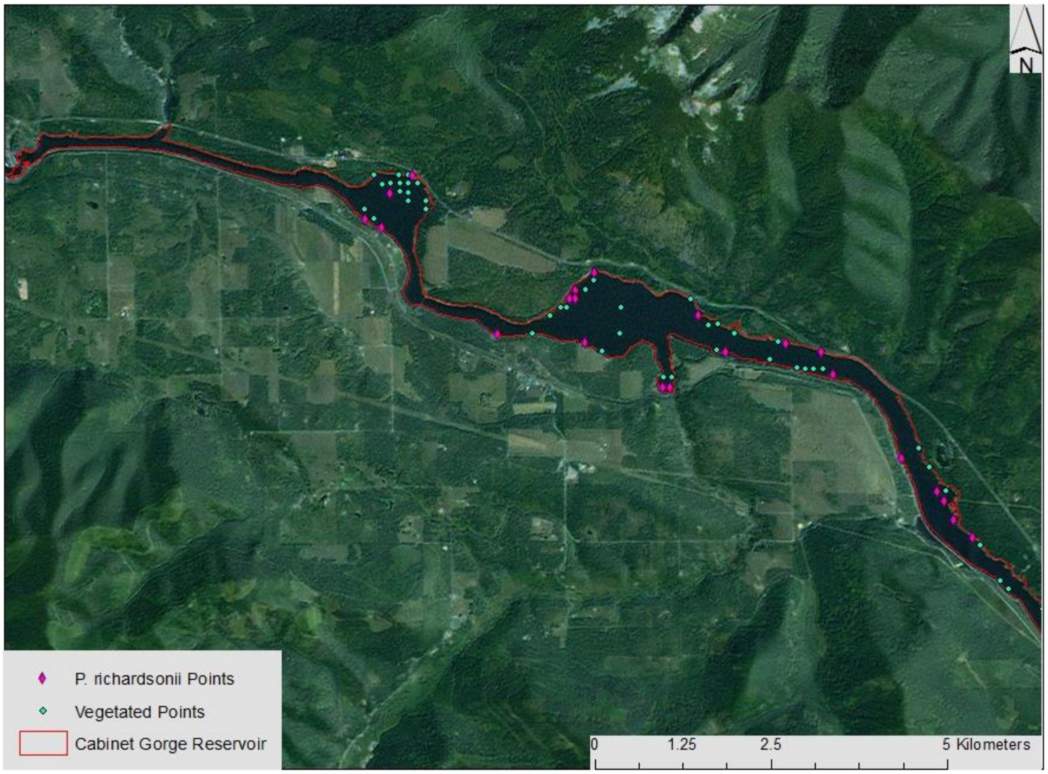

Figure 49. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Potamogeton richardsonii* present.

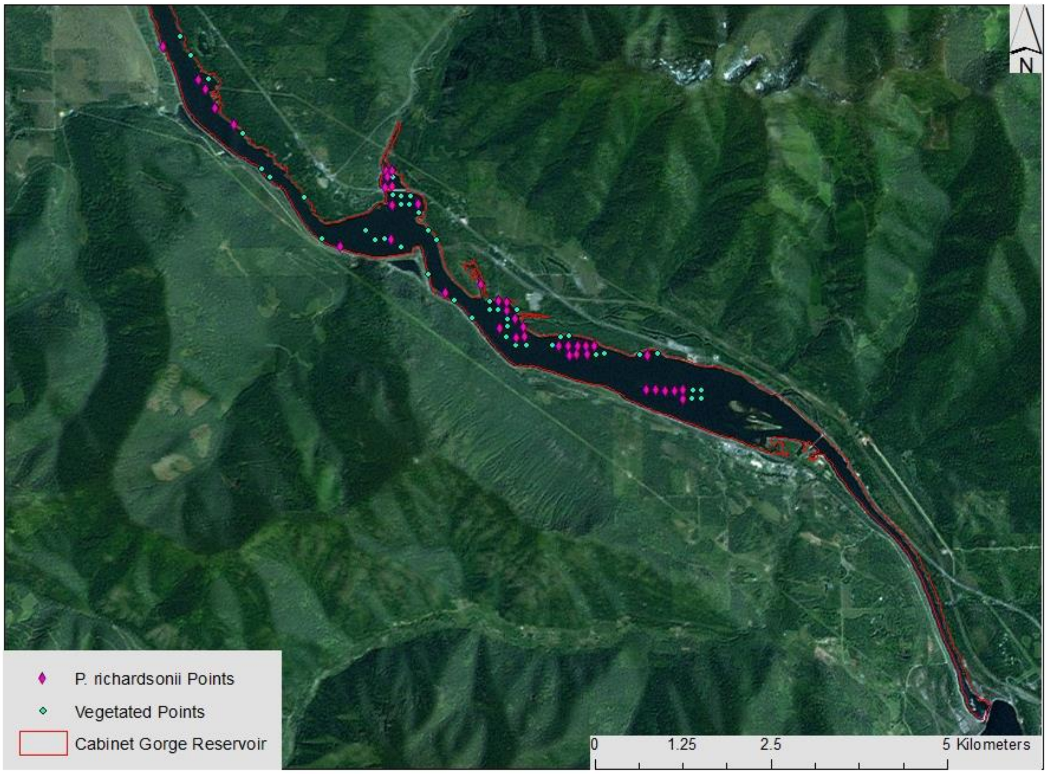

Figure 50. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Potamogeton richardsonii* present.

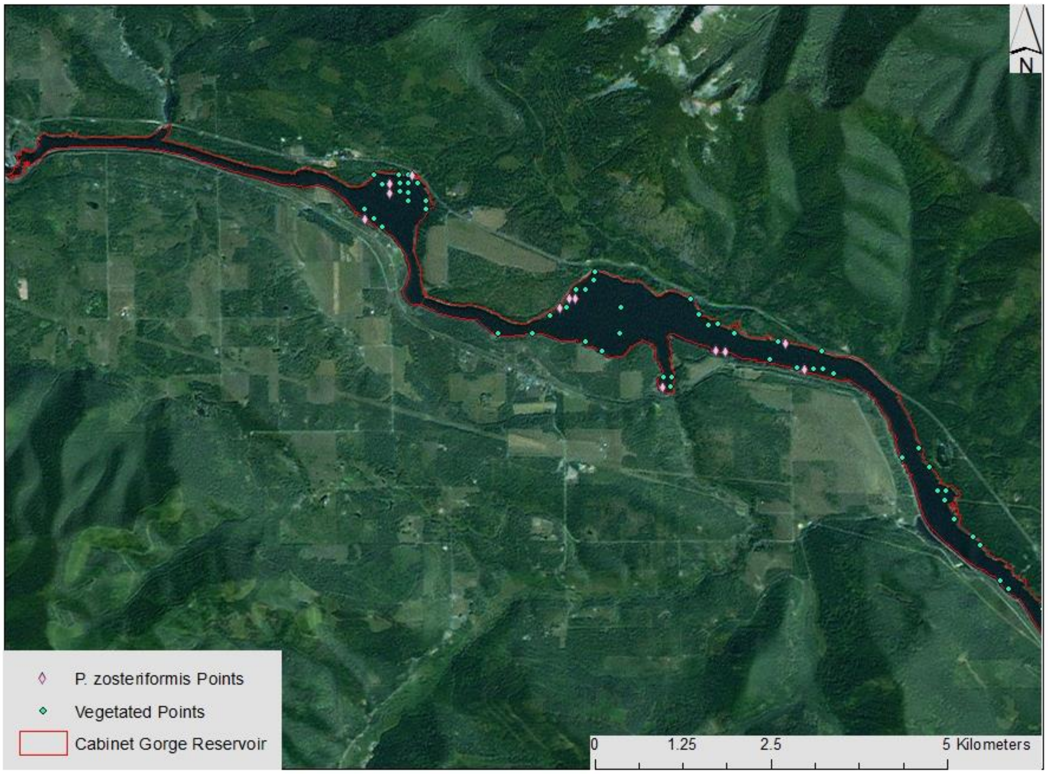

Figure 51. Littoral zone survey sites on lower Cabinet Gorge Reservoir in 2013 that had *Potamogeton zosteriformis* present.

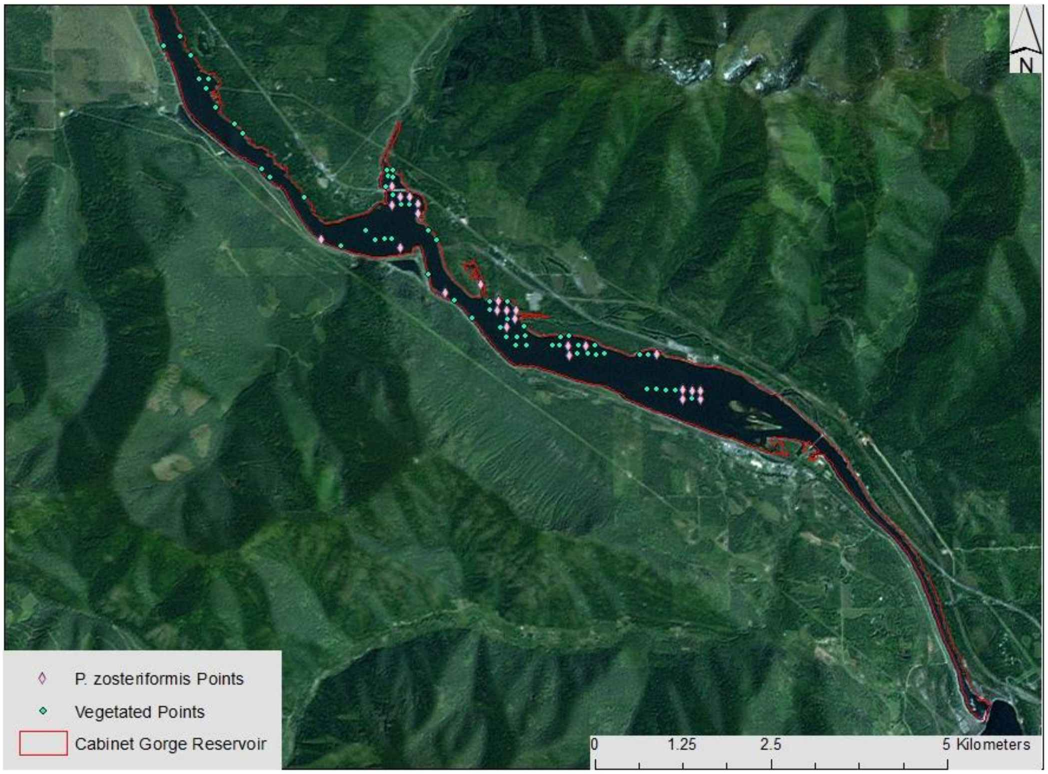

Figure 52. Littoral zone survey sites on upper Cabinet Gorge Reservoir in 2013 that had *Potamogeton zosteriformis* present.

Figure 53. *Myriophyllum spicatum* beds in Cabinet Gorge Reservoir in 2013.

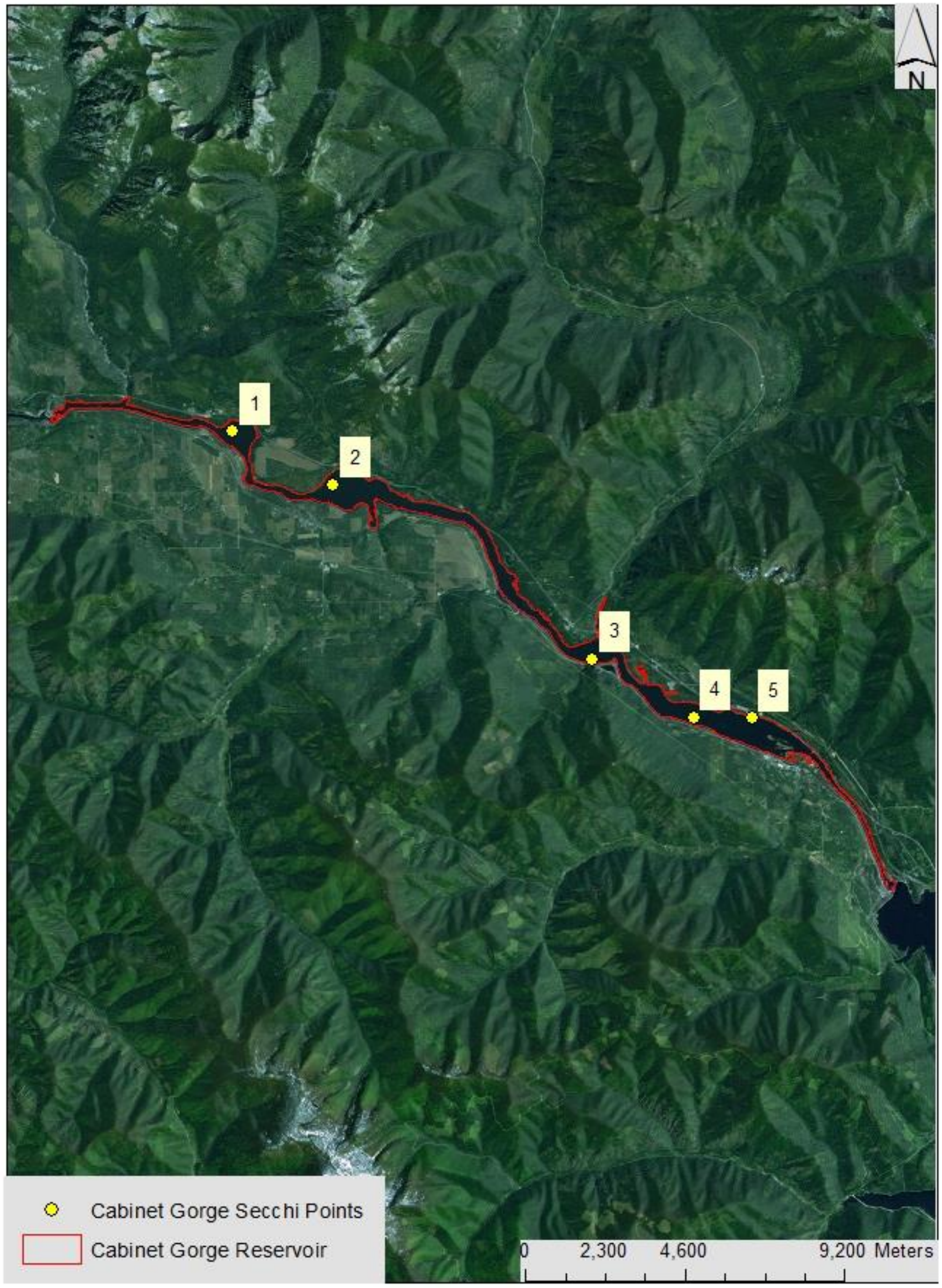

Figure 54. Sites where Secchi depth was recorded on Cabinet Gorge Reservoir in 2013.

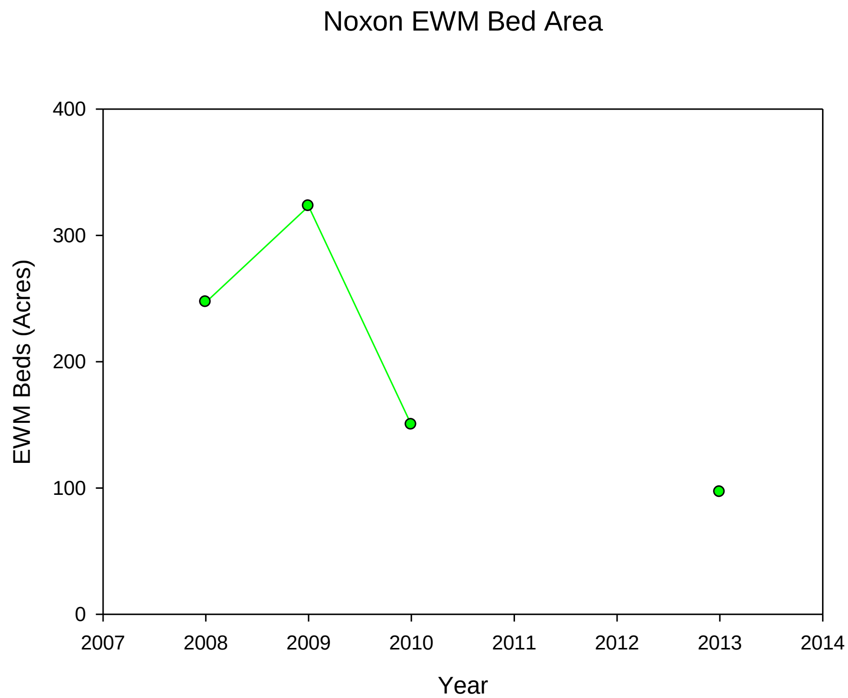

Figure 55. Eurasian watermilfoil mapped bed area for 2008 through 2013 in Noxon Rapids Reservoir, Montana.

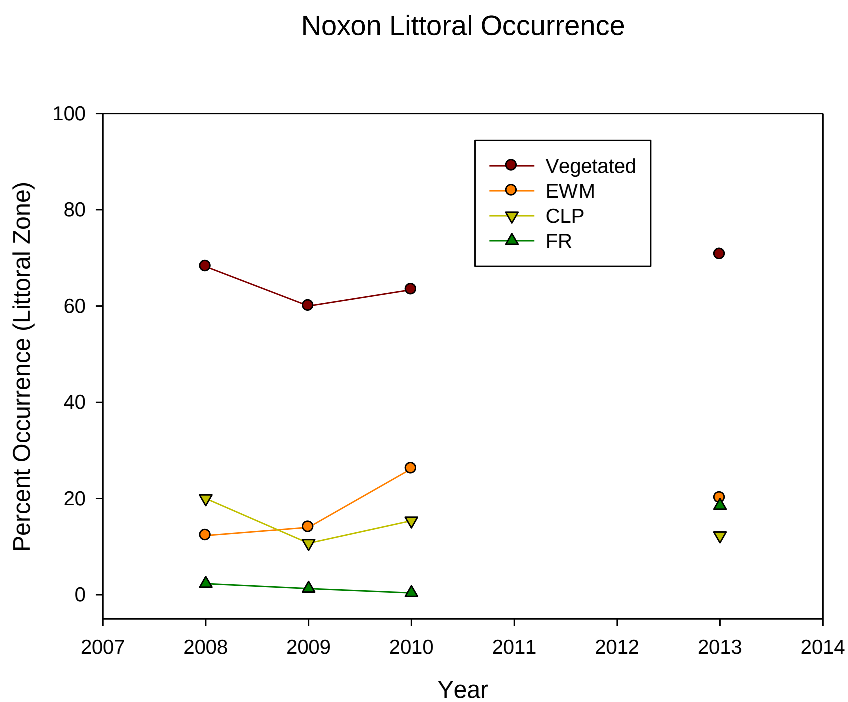

Figure 56. Percent occurrence of vegetation of any species (vegetated), Eurasian watermilfoil (EWM), curlyleaf pondweed (CLP), and flowering rush (FR) in Noxon Reservoir from whole-lake littoral surveys in Noxon Rapids Reservoir.

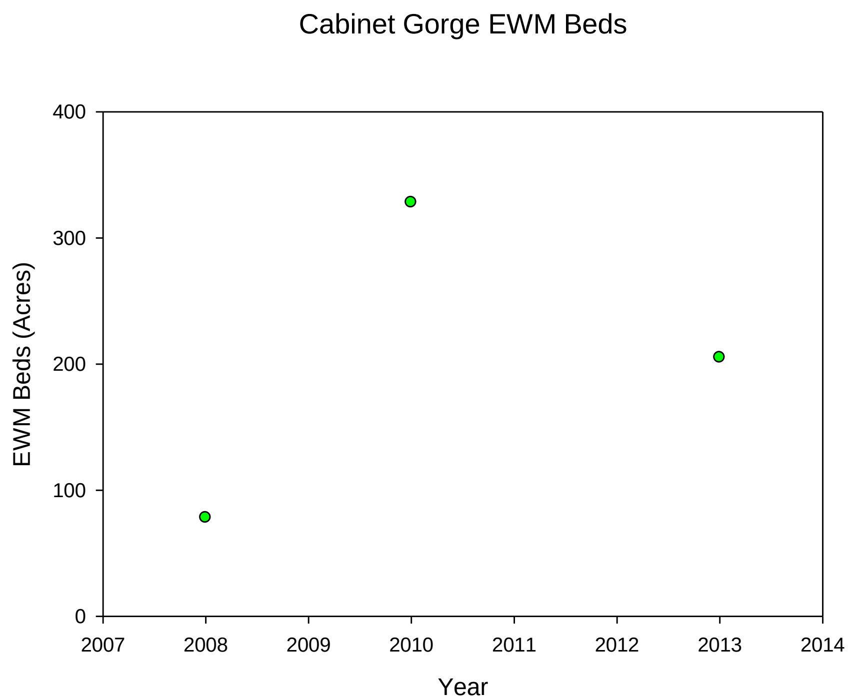

Figure 57. Total area of Eurasian watermilfoil beds mapped in Cabinet Gorge Reservoir in 2008, 2010, and 2013.

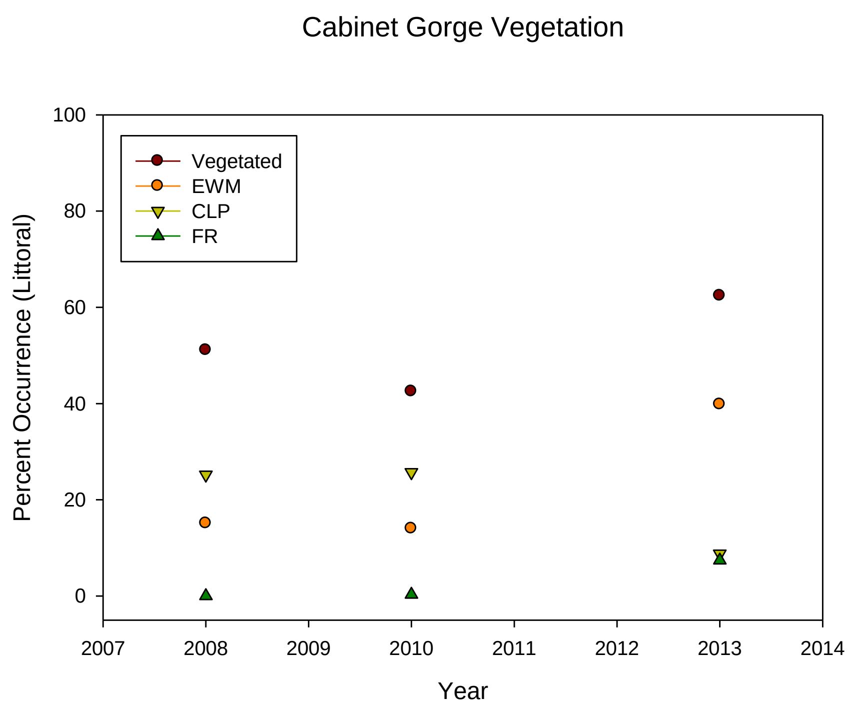

Figure 58. Percent occurrence of vegetation of any species (vegetated), Eurasian watermilfoil (EWM), curlyleaf pondweed (CLP), and flowering rush (FR) in Cabinet Gorge from whole-lake point intercept surveys.

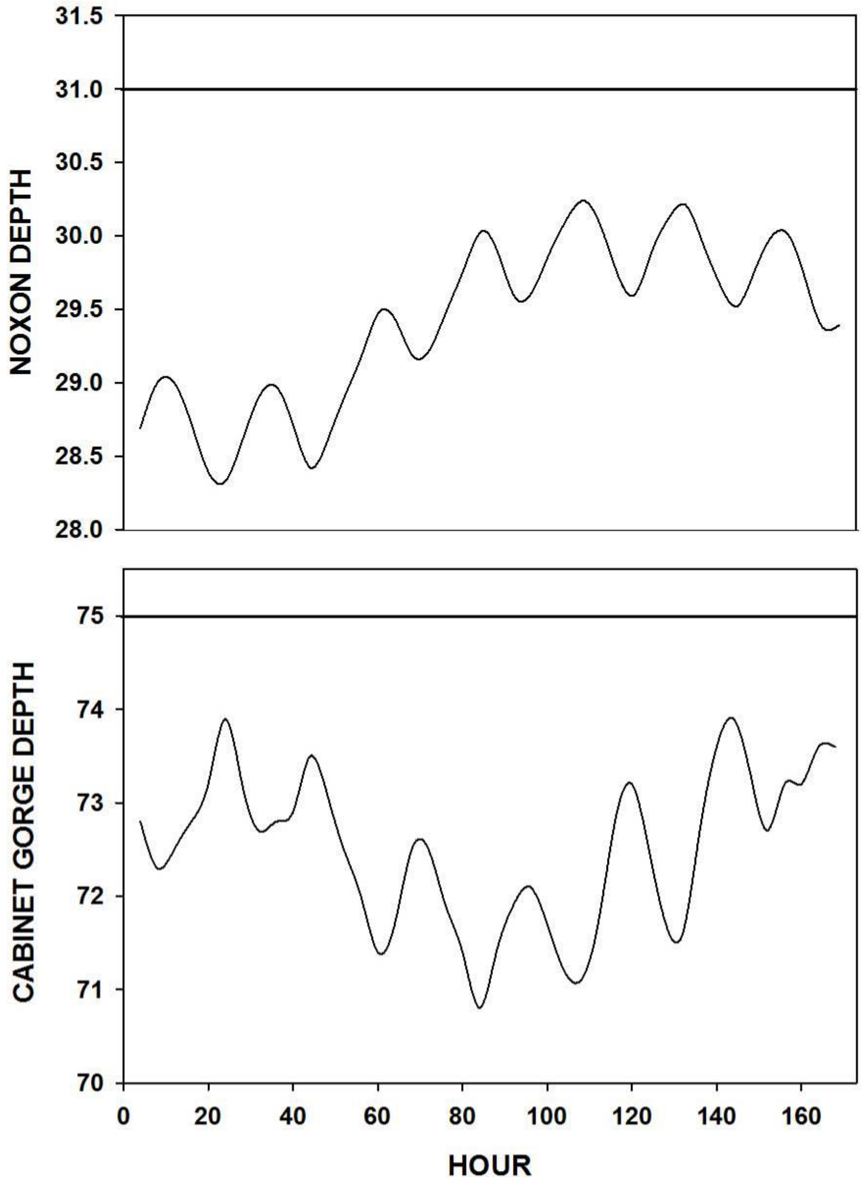

Figure 59. Depths of Noxon and Cabinet Gorge Reservoirs during survey period, 8/29 – 9/4 of 2013. Solid lines in each panel represent full pool depths of each reservoir.