Aquatic Invasive Plant Survey of Selected Montana Waters for 2012

A Final Report Submitted to the Montana Department of Natural Resources and Conservation

L. Gray Turnage[1], Celestine Duncan[2], and John D. Madsen[1]

[1]Geosystems Research Institute, Mississippi State University

[2]Weed Management Services, Helena, MT

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Preface

This report presents data collected by Mississippi State University and Weed Management Services in 2012 in five reservoirs and two rivers of Montana. Funding was provided by the Montana Department of Natural Resources and Conservation. We thank Alicia Stickney, Alice Stanley, and Ray Beck for assistance with planning and on the ground logistics. Field assistance was provided by Bradley Sartain, John Mark Curtis, and Marvin ‘Trey’ Higginbotham, Mississippi State University. Our survey of the Yellowstone River would not have been possible without the assistance of Scott Kaiser, Montana Department of Natural Resources Conservation, who guided us on the river in his personal boat.

Any errors in presentation or fact are the responsibility of the authors.

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The point of contact is:

Dr. John D. Madsen
Geosystems Research Institute
Box 9627
Mississippi State, MS 39762-9627
Ph. 662-325-2428
E-mail jmadsen@gri.msstate.edu

Executive Summary

Aquatic Invasive Plant Survey of Selected Montana Waters for 2012
L. Gray Turnage[1], Celestine Duncan[2], and John D. Madsen[1]

[1]Geosystems Research Institute, Mississippi State University
[2]Weed Management Services, Helena, MT.

Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curlyleaf pondweed (*Potamogeton crispus* L.) are two non-native, Montana-listed noxious aquatic plants that are increasingly spreading in Montana and the Pacific Northwest. Eurasian watermilfoil was identified in Noxon and Toston Reservoirs and the Jefferson River system in 2011; however, the source of the infestation was not determined. Curlyleaf pondweed was known to occur in the upper Missouri, Madison, East Gallatin, and Jefferson River systems, but limited data existed quantifying its actual distribution in the Missouri River watershed.

The Geosystems Research Institute and Weed Management Services conducted aquatic invasive plant surveys on five water bodies within Montana: Tongue River Reservoir, Bighorn Lake, Dailey Lake, Flathead Lake, and portions of the Flathead River and the Yellowstone River. In addition, we surveyed a portion of the Hungry Horse Reservoir. Surveys were conducted from July to August 2012 with 1042 individual points sampled for aquatic plant species.

Within the assigned survey area, Eurasian watermilfoil was not observed. Curlyleaf pondweed was observed growing in Flathead Lake, where it occurred at 1% of sample points and at two points on the Flathead River. This region of Montana has a number of natural lakes, man-made impoundments, and rivers with varying degrees of access which will influence the invasion potential for a given water body. Generally, the waters surveyed during this inventory had low community richness of native aquatic plants, except Flathead Lake, Hungry Horse Reservoir, and Flathead River.

Future surveys should continue to monitor existing Eurasian watermilfoil and curlyleaf pondweed populations and new surveys should be directed towards high risk water bodies in Montana. These include aquatic sites directly associated with infested waters and water bodies that have access points that support motorized boat traffic.

Project Introduction

Understanding the dynamics driving macrophyte populations in a given water body has become increasingly important due to the introduction and spread of numerous non-native plant species. Non-native plants affect aesthetics, drainage, fishing, water quality, fish and wildlife habitat, flood control, human and animal health, hydropower generation, irrigation, navigation, recreation, and ultimately land values (Pimental et al. 2000, Rockwell 2003). The spread of non-native aquatic plants also impacts native plant communities and primary production in littoral zone areas of waterbodies. Littoral areas in freshwater lakes are the most productive regions within a body of water, and an important component of high productivity is a diverse native aquatic plant community (Wetzel 2001). The importance of plants in these areas are paramount as they contribute to the structure, function, and diversity of aquatic ecosystems, aid in nutrient cycling, produce food for aquatic organisms, and provide habitat for invertebrates and fish (Carpenter and Lodge 1986, Ozimek et al. 1990, Madsen et al. 2001). Littoral areas, are however, more prone to invasion by non-native plants as they experience more disturbance than other parts of a water body.

Two non-native aquatic plants that are becoming problematic in Montana and the Pacific Northwest are Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curlyleaf pondweed *Potamogeton crispus* L.). Eurasian watermilfoil is an invasive vascular plant that has invaded freshwater lakes across the United States. The introduction of this species has likely resulted in the alteration of the complex interactions occurring in littoral habitats (Madsen 1997). Eurasian watermilfoil has been associated with declines in native plant species richness and diversity (Madsen et al. 1991a,b, Madsen et al. 2008), reductions in habitat complexity resulting in reduced macroinvertebrate abundance (Krull 1970, Keast 1984), and reductions in fish growth (Lillie and Budd 1992). Eurasian watermilfoil poses nuisance problems to humans by impeding navigation, limiting recreation opportunities, and increasing flood frequency and intensity (Madsen et al. 1991a). It is primarily spread by fragmentation and can be easily transported between water bodies by many vectors. Once established, it is very difficult to control. Curlyleaf pondweed also causes significant nuisance problems where it has become established (Bolduan et al. 1994, Catling and Dobson 1985, Woolf and Madsen 2003). It is widely considered to be an ecosystem transformer, like Eurasian watermilfoil, but this species tends to accelerate internal nutrient loading and eutrophication (James et al. 2002). Management of this species is often more difficult due to its life history strategy (turion production) and the limited availability of effective management options.

Both species are listed on Montana's noxious weed list and are spreading throughout the state. Eurasian watermilfoil was identified in Toston Reservoir in 2010 and 2011 and the Jefferson River system in 2010. Curlyleaf pondweed was known to occur in the upper Missouri, Madison, East Gallatin, and Jefferson River systems, but little data existed regarding its actual distribution in other Montana waterbodies. Pursuant to this, a systematic survey is needed to develop baseline information on the aquatic plant community. The survey would quantify the location and extent of Eurasian watermilfoil and curlyleaf pondweed within lakes/reservoirs of Montana and determine the presence of other non-native aquatic plants such as flowering rush (*Butomus umbellatus*). Data such as these are necessary to guide future management decisions, determine funding needs, and coordinate control efforts. Preliminary inventories have identified other submersed aquatic plants in these water bodies, which will also be a factor in developing management protocol.

Objectives

1. Conduct aquatic plant surveys on Bighorn Lake, Dailey Lake, Flathead Lake, Tongue River Reservoir, and Yellowtail Reservoir; and other water bodies as time permits, searching for Eurasian watermilfoil and curlyleaf pondweed.
2. Identify the presence of other invasive aquatic plants in these waters.
3. Collect quantitative data on the diversity of native plant species and the extent of invasive plant species.

Materials and Methods

Littoral zone point intercept surveys were conducted on Bighorn Lake, Dailey Lake, Flathead Lake, Tongue River Reservoir, and Yellowtail Reservoir (Figure 1). Surveys were designed and conducted using bathymetric data obtained by the Montana Department of Natural Resources and Conservation. Survey points were established in the littoral zone for each water body, which we designated as double the Secchi depth and were based on other surveys conducted in Montana. Survey methods followed those outlined by Madsen (1999), Madsen and Wersal (2009), Wersal and others (2009), and Wersal and others (2010); where a pre-determined grid of points at set distances from one another were surveyed in each water body. The grid spacing was dependent upon the total size of the reservoir. A systematic or random-systematic survey method is a better survey design when initially surveying a water body as it is more apt to find rare species, in contrast with a random design which will likely under-sample rare but ecologically important species such as Eurasian watermilfoil (Barbour et al. 1999). A systematic survey design also maximizes survey efficiency.

Surveys were conducted by boat using GPS (Global Positioning System) technology to navigate to each point. A Trimble YUMA® computer with integrated GPS receiver was used to conduct and store survey data. At each survey point, a weighted plant rake was deployed to determine the presence of all plant species. Spatial survey data were recorded electronically using FarmWorks Site Mate® software. Site Mate® allowed for the navigation to specific survey points, as well as, the displaying and collecting of geographic and attribute data while in the field. Collecting data in this fashion reduces data entry errors and reduces post survey data processing time. Collected data were recorded in database templates. Photos were taken of species from each lake.

In addition to plant presence/absence data, the depth at each point was recorded using a boat mounted depth finder or with a sounding rod in water depths of less than 10 ft. Water transparency was estimated using a Secchi disk at one to four locations throughout a given reservoir, depending on total size, between 1000 and 1400 hours (Madsen et al. 1999, Vershuur 1997).

Frequency of occurrence for each species in a water body was calculated by dividing the number of survey points that species was observed by the total number of points surveyed for a given water body, then multiplied by 100 to achieve a percent. Average species richness was estimated by calculating the sum of all species at a given survey point, and then calculating the mean across all survey points for a given water body. Species distributions are reported visually in a series of maps created for each water body surveyed.

Figure 1. The survey area for 2012 encompassing six waterbodies in Montana, with an additional survey in Wyoming. Surveys were conducted in July and August 2012.

Reservoir Results and Discussion

Lake Name: Bighorn Lake

Dates Surveyed: August 4, 2012

Secchi: 4.8 m (15 ft)

Points Surveyed: 35

Eurasian watermilfoil = Negative

Curlyleaf Pondweed = Negative

We only surveyed points less than 30 feet deep as this was the most likely area for aquatic vegetation to be found. Average survey depth was 18.9 ft with the deepest survey being 27.5 ft. Bighorn Lake is a narrow reservoir with steep sides so our focus was the waters along the shorelines. Due to the steepness of the sides of this reservoir, the littoral zone is a narrow band along the shore of the reservoir (Figure 2). Of the 35 points sampled, none were vegetated by any species of aquatic plant.

We also surveyed the afterbay area for aquatic plants, which is the small stilling basin below the main dam on Bighorn Lake. A small sign by the afterbay boatlaunch best defines why we did not find any plants growing in that waterbody: "Water may fluctuate 15 feet daily." The lake had a maximum depth of 15 feet.

Sign by the boat launch of the afterbay area, Bighorn Lake.

Figure 2. Survey points sampled during the littoral zone survey of Bighorn Lake conducted on August 4, 2012.

Lake Name: Bighorn River

Date Surveyed: July 18, 2012

Secchi: 2.3 m (7.5 ft)

Points Surveyed: N/A

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Negative

Bighorn River is at the base of a gorge or canyon with very steep sides (Photo below, and Figure 3). This river connects Bighorn Lake in Montana to Yellowtail Reservoir in Wyoming. The sides of the canyon are very steep often shading the water below. The littoral zone, where present is a narrow band along the canyon wall with a rock substrate. It is unlikely that aquatic plants would be able to colonize the water in the river. No aquatic plants were observed within the river adding support to this theory.

We surveyed the littoral zone around Bighorn River by boat. No aquatic plants were observed anywhere in the river.

The Bighorn River, between the "lake" portions in Wyoming and Montana.

Figure 3. Survey of the littoral zone in Bighorn Canyon conducted in July 2012.

Lake Name: Dailey Lake

Date Surveyed: August 5, 2012

Secchi: N/A

Points Surveyed: 82

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Negative

Dailey Lake was surveyed in its entirety (Figure 4). All points were surveyed in the lake. The maximum depth recorded was 21.2 ft with an average depth of 14 ft. Maximum observed depth of plant growth being 14 ft. Of the 82 points surveyed, 72% of these points were vegetated by some species of aquatic plant (Figure 5). Plant growth occurred across the lake. *Chara* was the most common species found in Dailey Lake, followed by *Schoenoplectus acutus*, *Stuckenia vaginatus*, and *Schoenoplectus tabernaemontani* respectively (Table 1).

Chara is a macroalgae that is associated with nutrient poor substrates and is usually an early colonizer at a site.

Table 1. Plant species list and percent occurrences for Dailey Lake, MT, July 2012.

Species	Common Name	Frequency of Occurrence (%)
***Chara* sp.**	Muskgrass	61
Schoenoplectus acutus	Hardstem bulrush	8.5
Stuckenia vaginatus	Sheathed Pondweed	6.1
Schoenoplectus tabernaemontani	Softstem bulrush	2.4
Average Survey Depth (ft)		14 ft
Species Richness (avg. number per vegetated point)		1.0

Figure 4. Survey points sampled on Dailey Lake during the littoral zone survey conducted in July 2012.

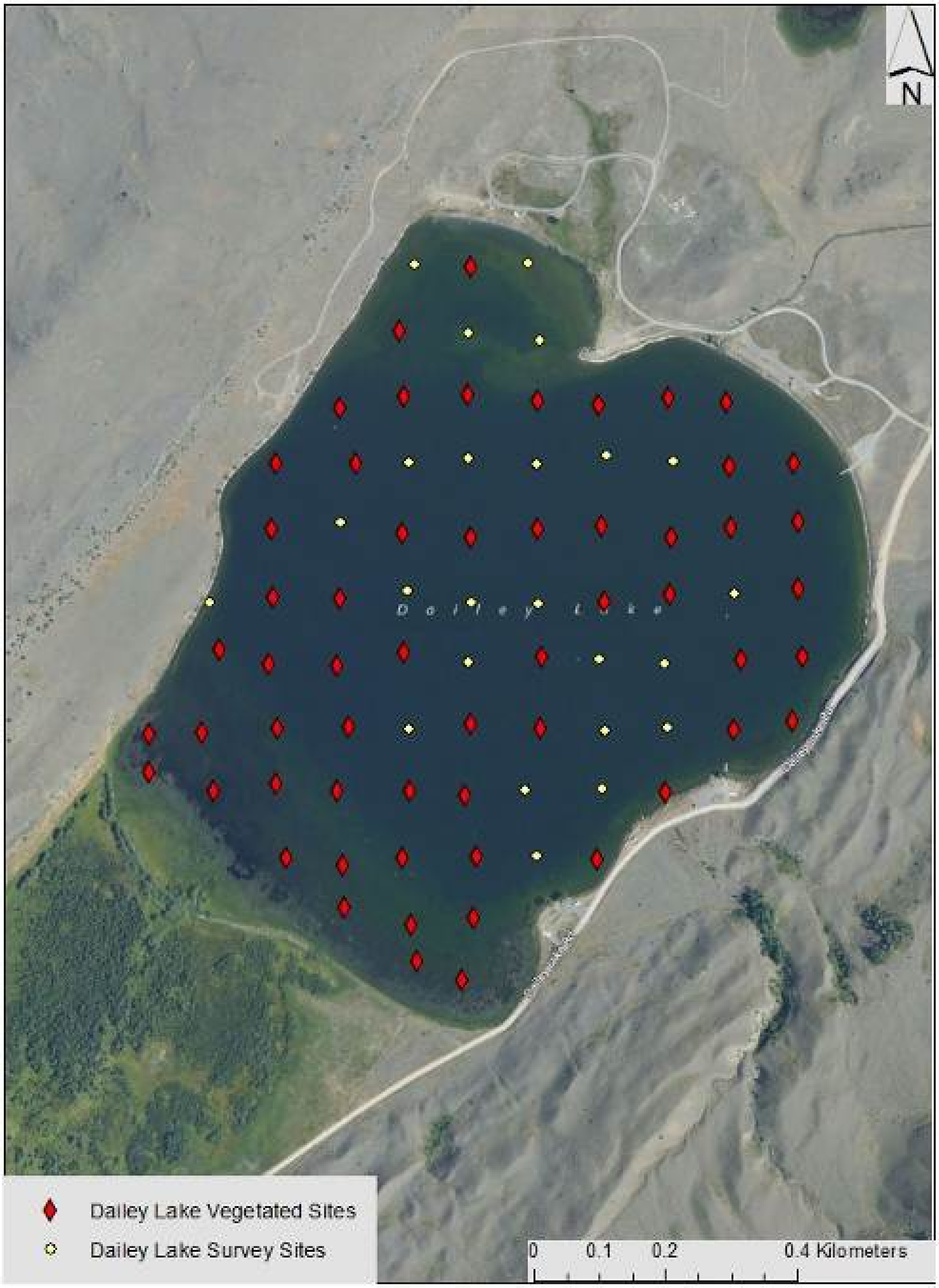

Figure 5. Survey points where aquatic plant species were observed during the littoral zone survey of Dailey Lake conducted in July 2012.

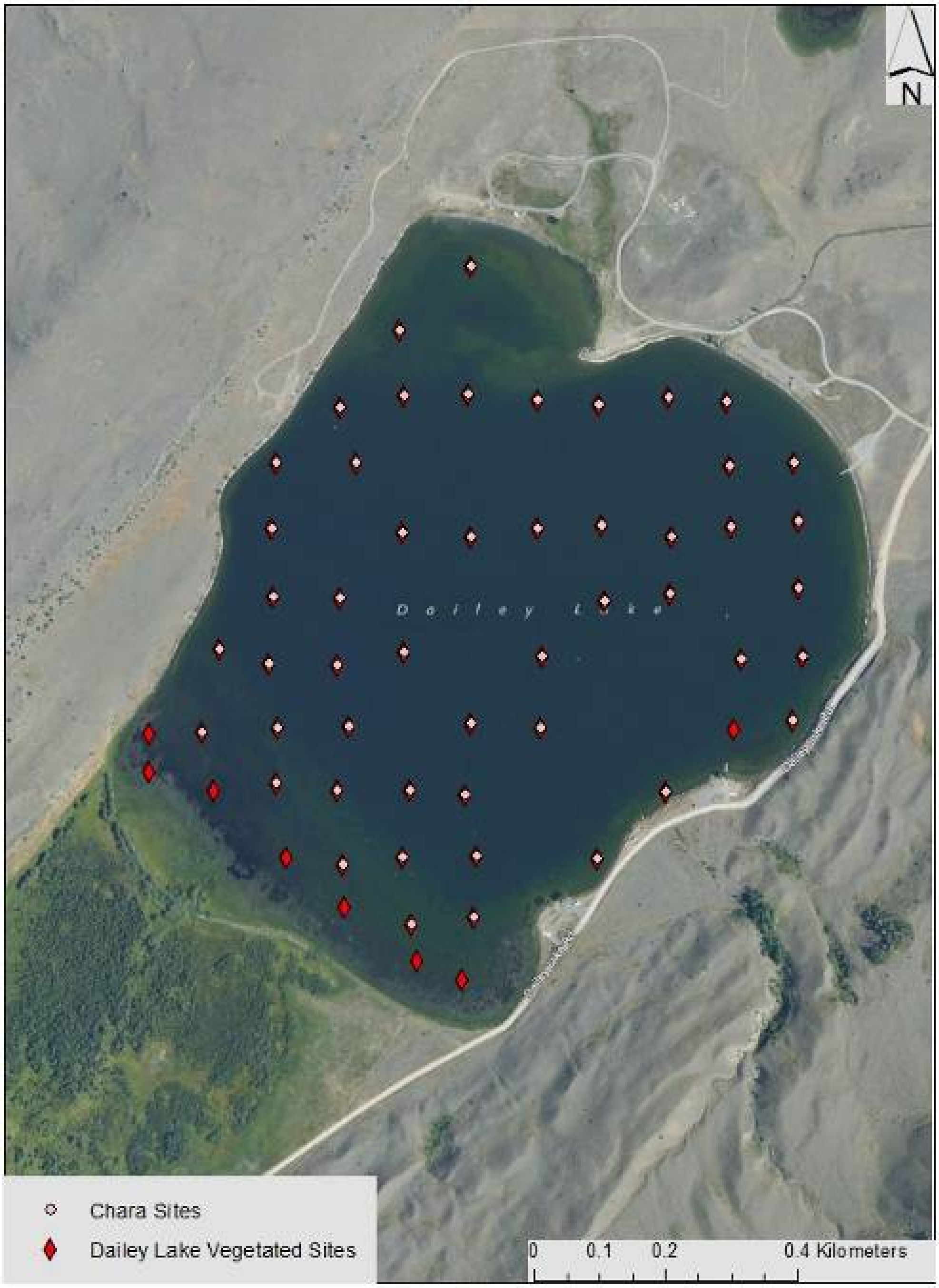

Figure 6. The distribution of *Chara* in Dailey Lake during the littoral zone survey conducted in July 2012.

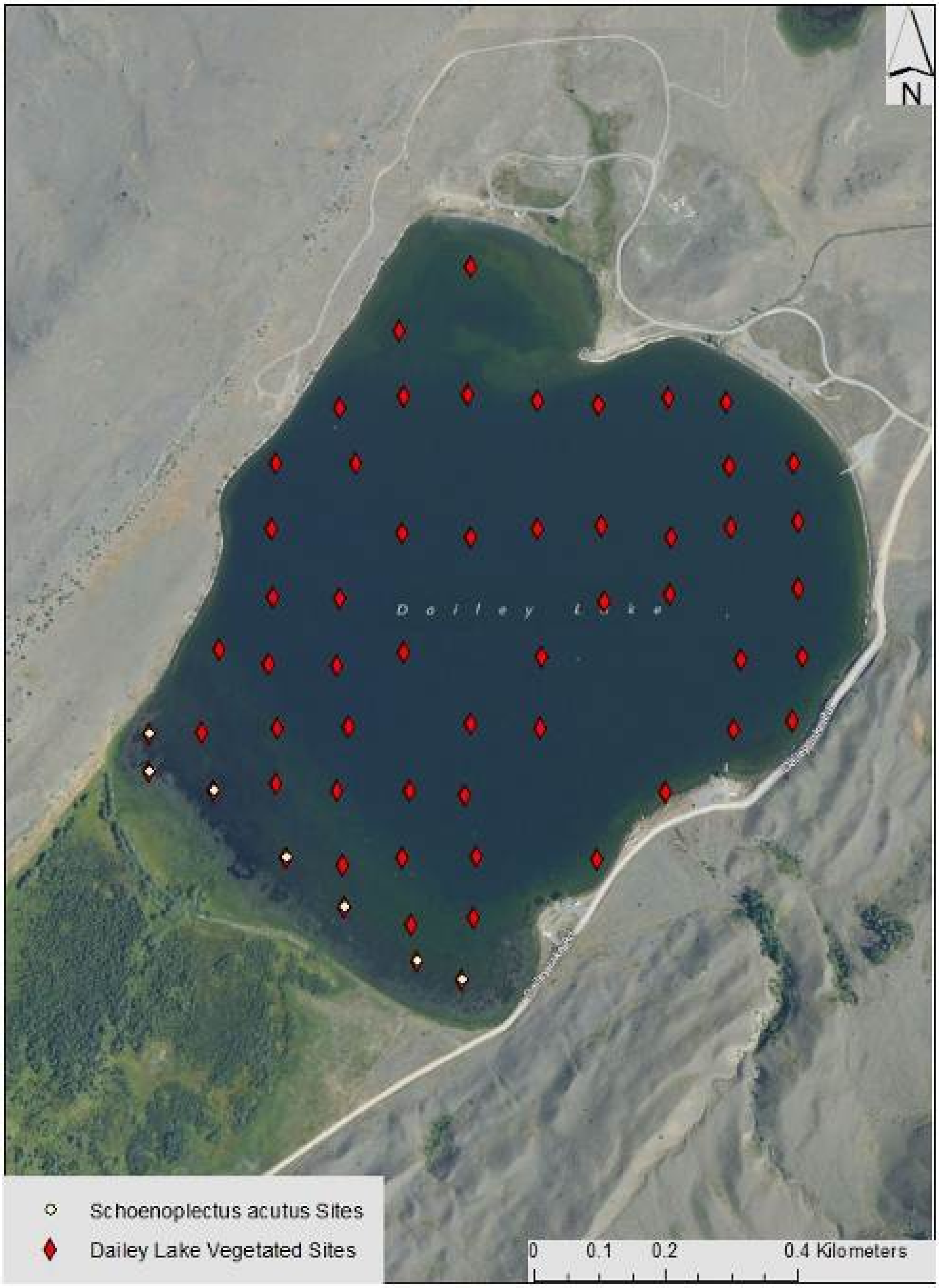

Figure 7. The distribution of *Schoenoplectus acutus* in Dailey Lake during the littoral zone survey conducted in July 2012.

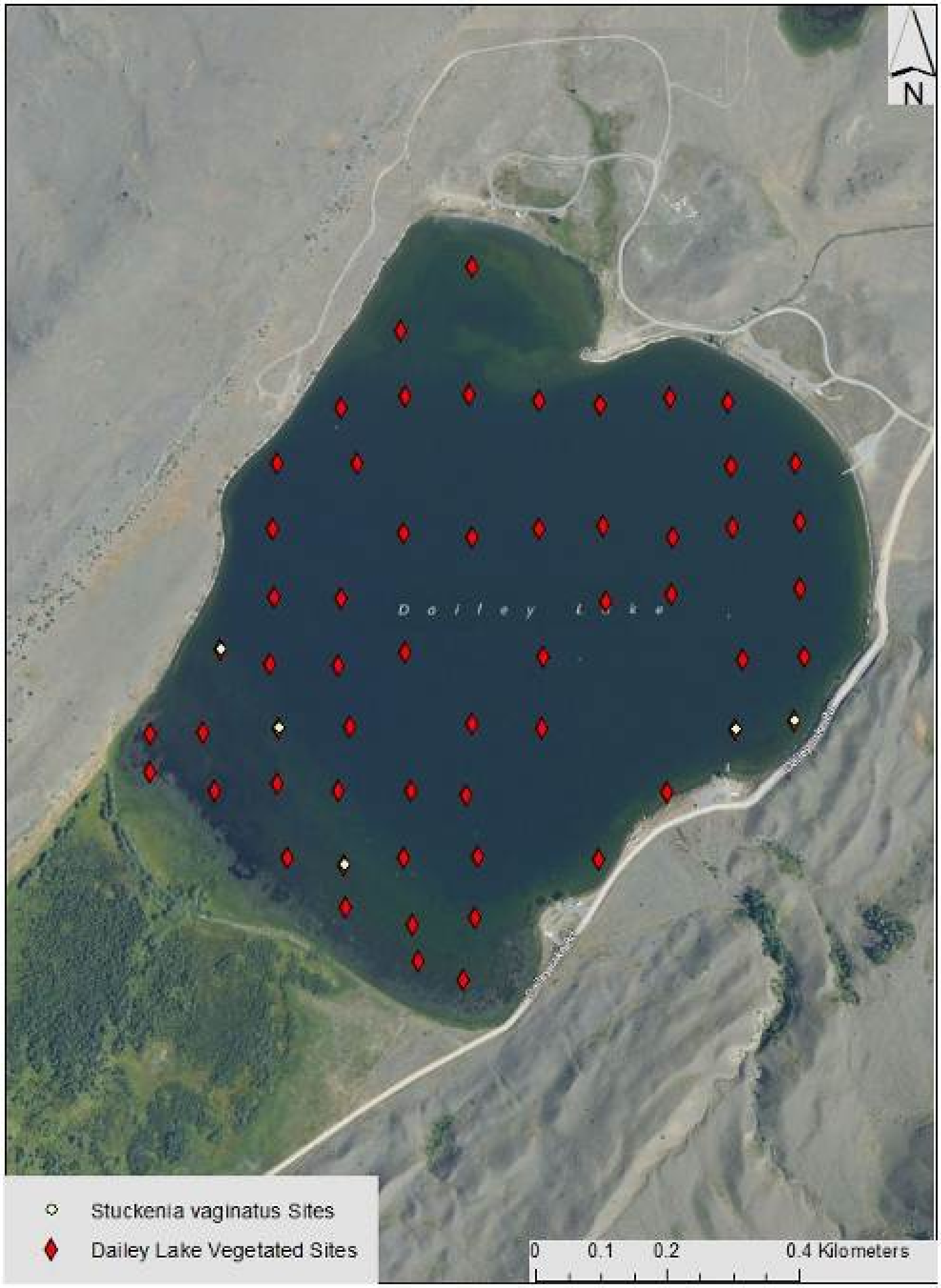

Figure 8. The distribution of *Stuckenia vaginatus* in Dailey Lake during the littoral zone survey conducted in July 2012.

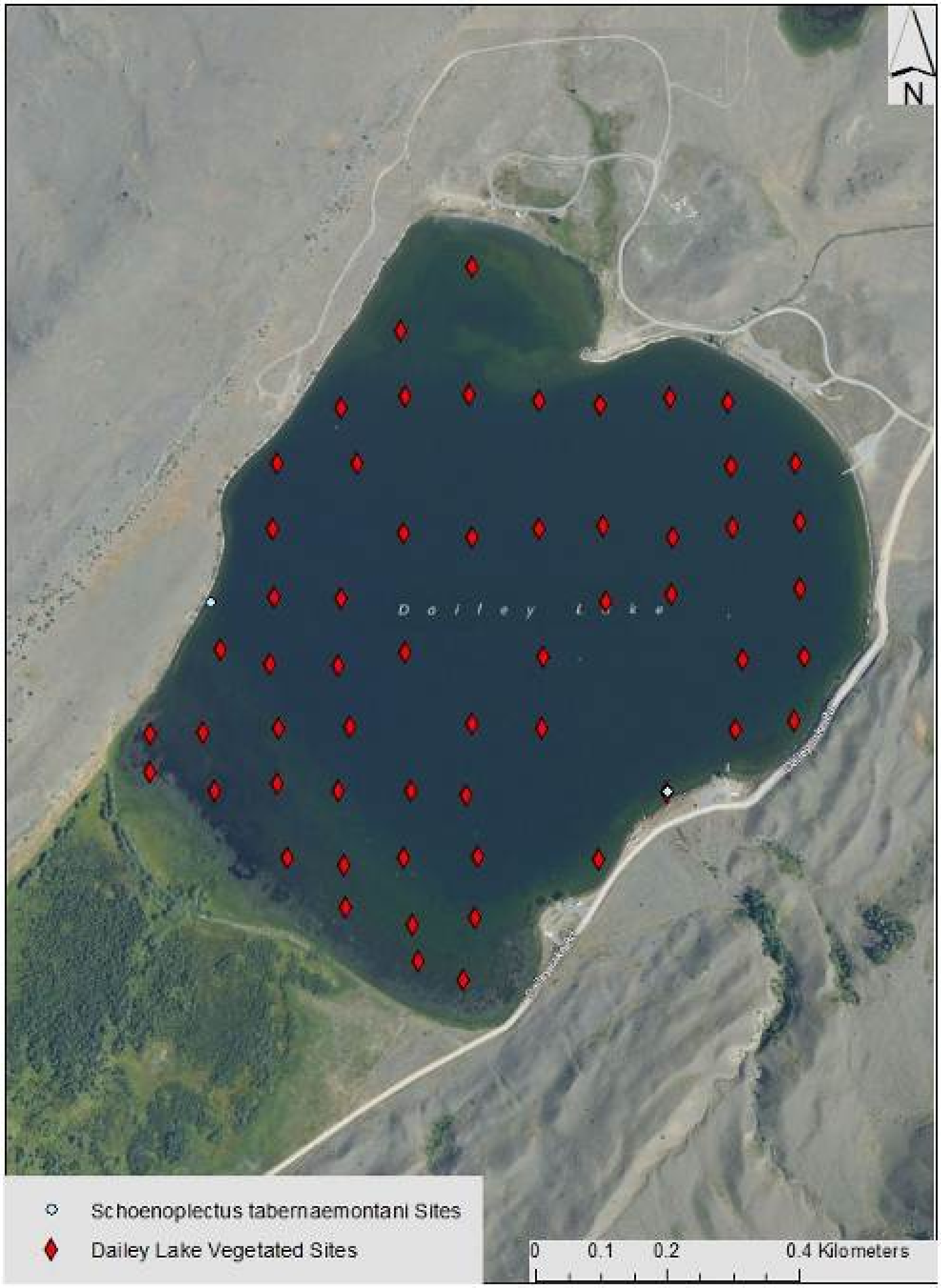

Figure 9. The distribution of *Schoenoplectus tabernaemontani* in Dailey Lake during the littoral zone survey conducted in July 2012.

Lake Name: Flathead Lake
Date Surveyed: August 6-12, 2012

Secchi: 5.4 m (17.5 ft)

Points Surveyed: 562

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Positive

Flathead Lake is very deep (>350 ft), thus a point intercept survey was conducted around the perimeter of the lake as well as the shallows at the mouth of the Flathead River to focus survey effort in the littoral zone where plants were most likely to occur (Figure 10). We did not survey parts of the lake on the Flathead Indian Reservation. Points were surveyed to a water depth of 40 ft. with the maximum observed depth of plant growth being 29 ft.

Of the 490 points surveyed, 13.3% of these points were vegetated by some species of aquatic plant (Figure 11). *Potamogeton richardsonii*, *Chara*, *Butomus umbellatus*, and *Stuckenia pectinata* were the most common plant species found during the survey, with each species being present at 7.1, 5.1, 4.1, and 2.4% (respectively) of the sampled points (Table 2).

Table 2. Plant species list and percent occurrences for Flathead Lake, MT, August 2012.

Species	Common Name	Frequency of Occurrence (%)
***Potamogeton richardsonii* (Ar. Benn.) Rydb.**	Clasping-leaved pondweed	7.1
***Chara* sp.**	Muskgrass	5.1
Butomus umbellatus	Flowering rush	4.1
***Stuckenia pectinata* (L.) Börner**	Sago pondweed	2.4
Potamogeton gramineus	Variable-leaved pondweed	1.8
Potamogeton nodosus	American pondweed	1.6
Potamogeton foliosus	Leafy pondweed	1
Potamogeton crispus	Curlyleaf pondweed	1
***Myriophyllum sibiricum* Komarov**	Northern watermilfoil	0.2
Potamogeton zosteriformis	Flatstem pondweed	0.2
Ranunculus aquatilis	White watercrowfoot	0.2
Elodea canadensis	Elodea	0.2
Potamogeton pusillus	Small pondweed	0.2
Zanichellia palustris	Horned pondweed	0.2
Average Survey Depth (ft)		11.7 ft
Species Richness (avg. number per vegetated point)		1.9

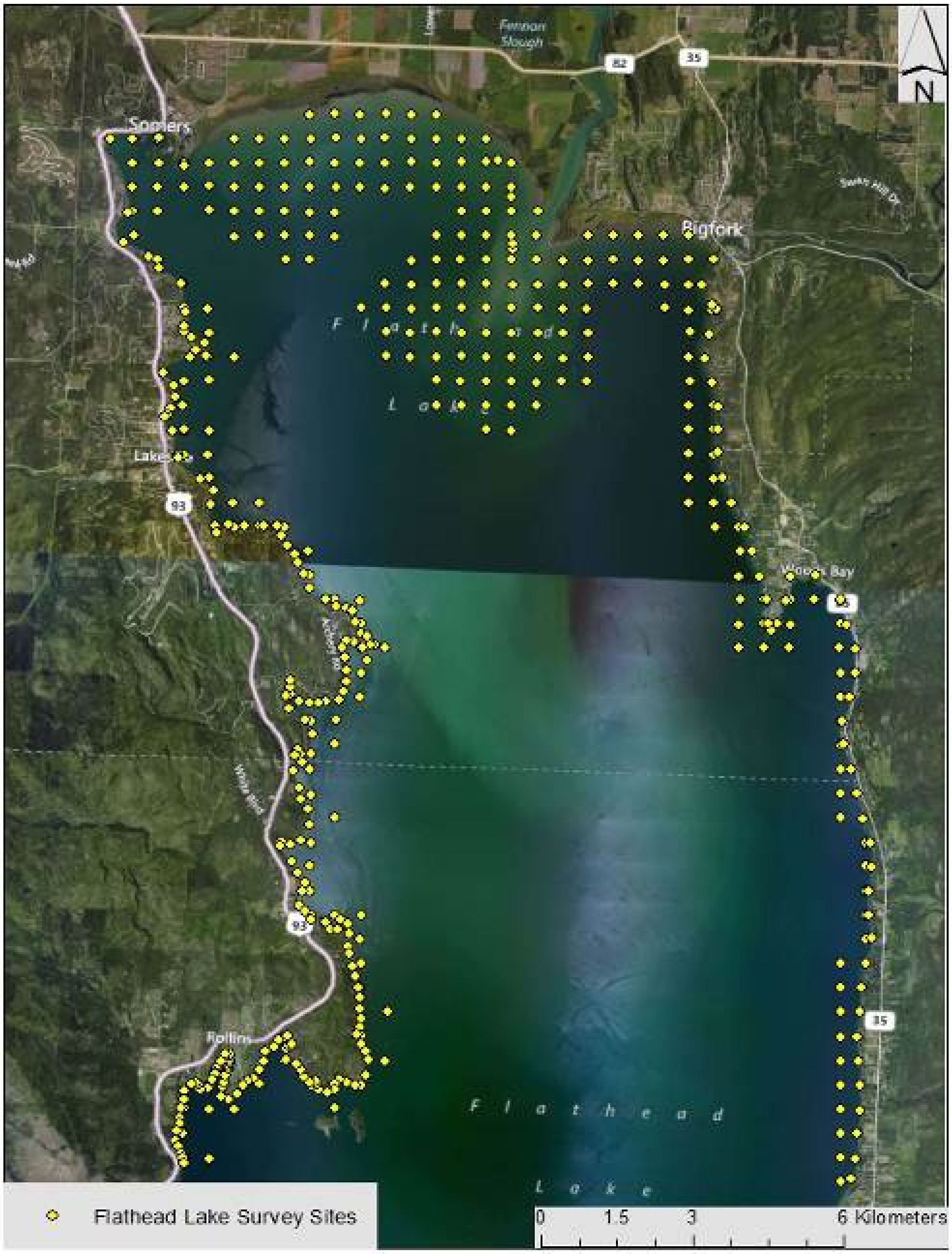

Figure 10. Survey points sampled on Flathead Lake during the littoral zone survey conducted in August 2012.

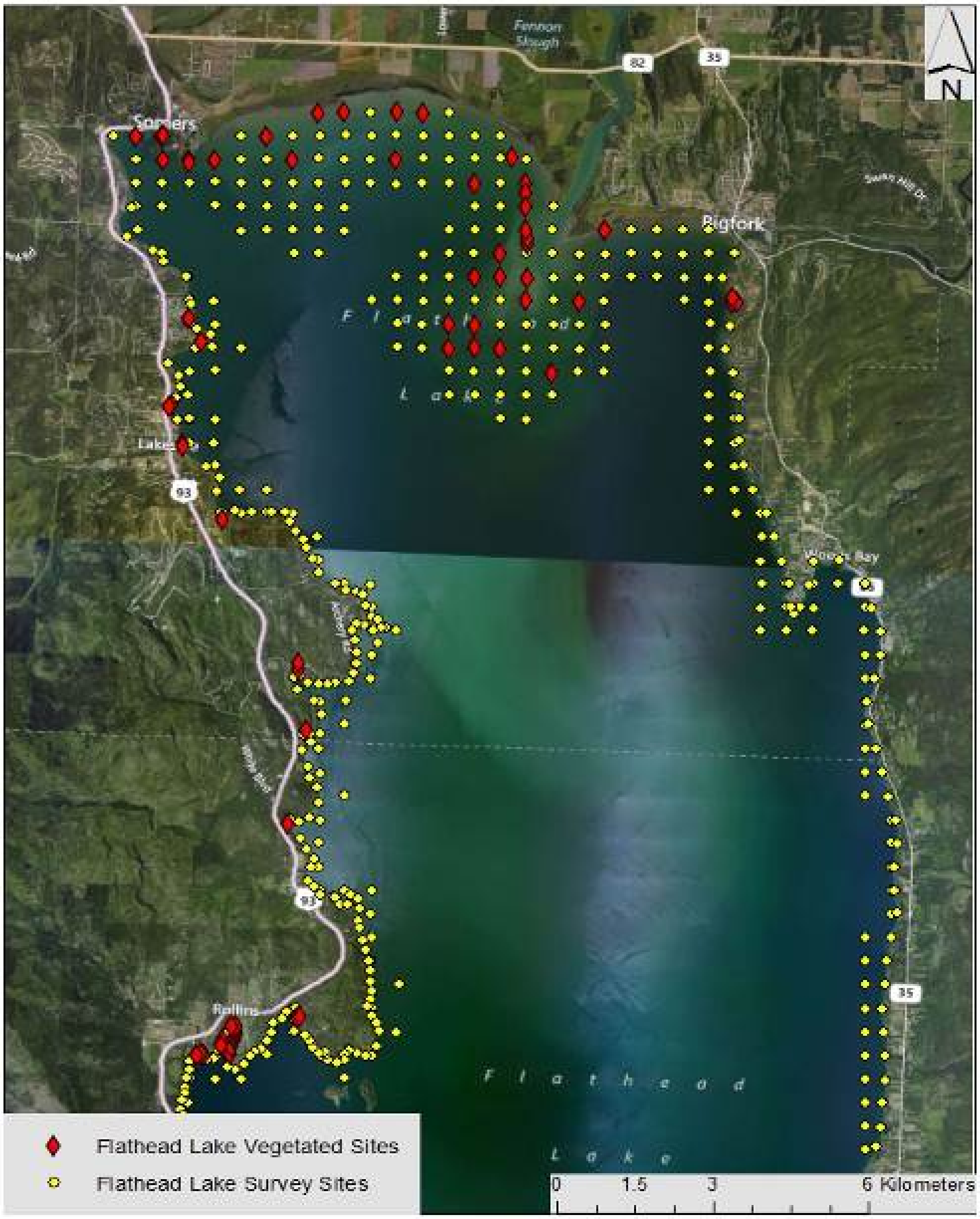

Figure 11. Survey points where aquatic plant species were observed during the littoral zone survey of Flathead Lake conducted in August 2012.

Figure 12. The distribution of *Potamogeton richardsonii* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 13. The distribution of *Chara* in Fathead Lake during the littoral zone survey conducted in August 2012.

Figure 14. The distribution of *Butomus umbellatus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 15. The distribution of *Stuckenia pectinata* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 16. The distribution of *Potamogeton gramineus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 17. The distribution of *Potamogeton nodosus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 18. The distribution of *Potamogeton foliosus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 19. The distribution of *Potamogeton crispus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 20. The distribution of *Myriophyllum sibiricum* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 21. The distribution of *Potamogeton zosteriformis* and *Ranunculus aquatilis* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 22. The distribution of *Elodea canadensis* and *Potamogeton pusillus* in Flathead Lake during the littoral zone survey conducted in August 2012.

Figure 23. The distribution of *Zanichellia palustris* in Flathead Lake during the littoral zone survey conducted in August 2012.

Lake Name: Tongue River Reservoir
Date Surveyed: August 2, 2012

Secchi: 2.6 m (8.45 ft)

Points Surveyed: 304

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Negative

Tongue River Reservoir was surveyed in its entirety (Figure 24). Points were surveyed to a water depth 20 ft. with the maximum observed depth of plant growth being 10.2 ft. Of the 304 points surveyed, 11.8% of these points had an aquatic plant species present (Figure 25).

Stuckenia pectinata was observed most often followed by *Ceratophyllum demersum*, *Potamogeton nodosus*, and *Potamogeton amphibium* (Table 3).

Table 3. Plant species list and percent occurrences for Tongue River Reservoir, MT, July 2012.

Species	Common Name	Frequency of Occurrence (%)
Stuckenia pectinata	Sago pondweed	9.9
Ceratophyllum demersum	Coontail	2.0
Potamageton nodosus	American pondweed	1.3
Polygonum amphibium	Longroot smartweed	1.0
Not determined	Filamentous algae	0.3
Average Survey Depth (ft)		10.3 ft
Species Richness (avg. number per vegetated point)		1.2

Figure 24. Survey points sampled on Tongue River Reservoir during the littoral zone survey conducted in July 2012.

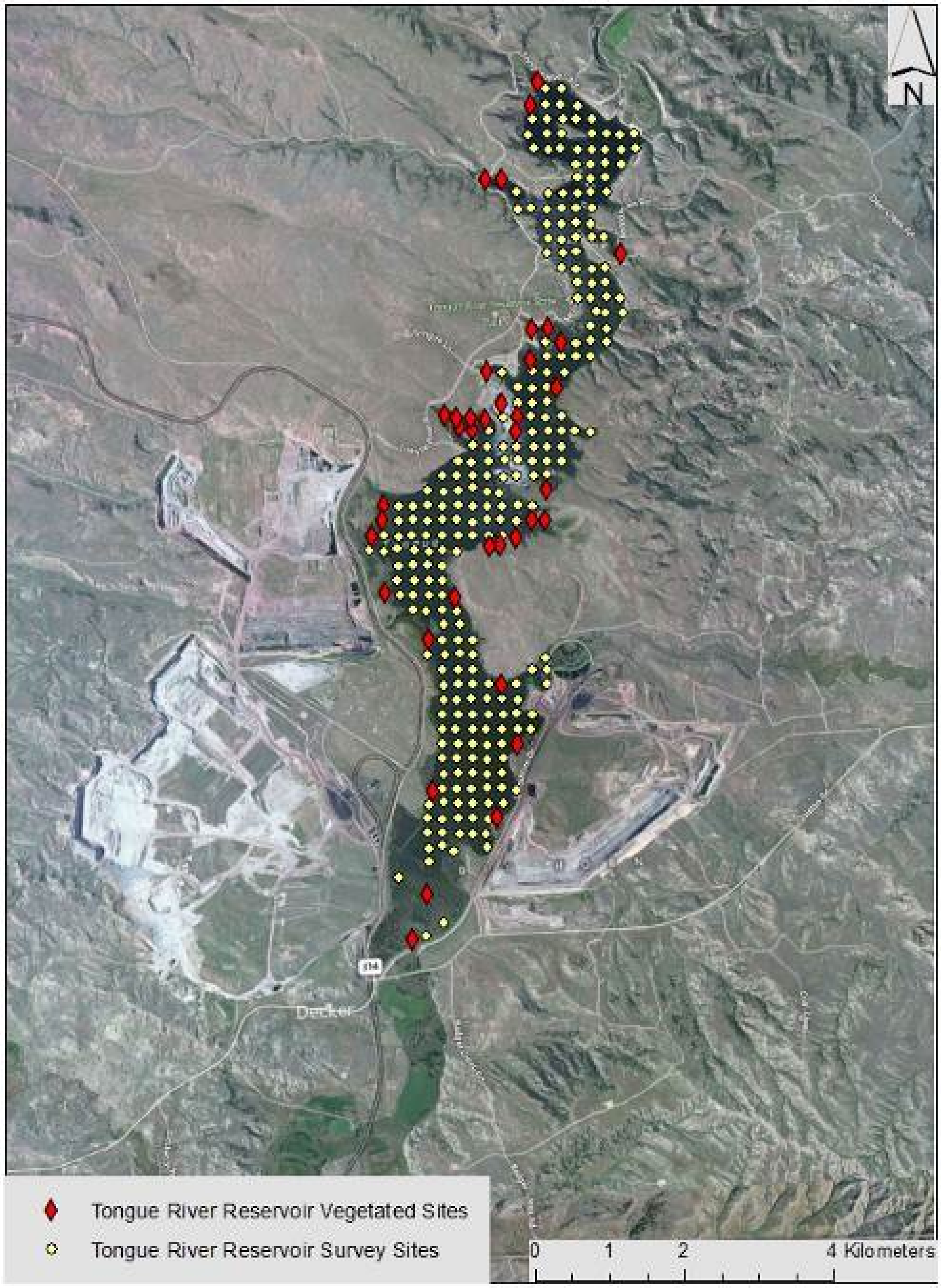

Figure 25. Survey points where aquatic plant species were observed during the littoral zone survey of Tongue River Reservoir conducted in July 2012.

Figure 26. The distribution of *Stuckenia pectinata* in Tongue River Reservoir during the littoral zone survey conducted in July 2012.

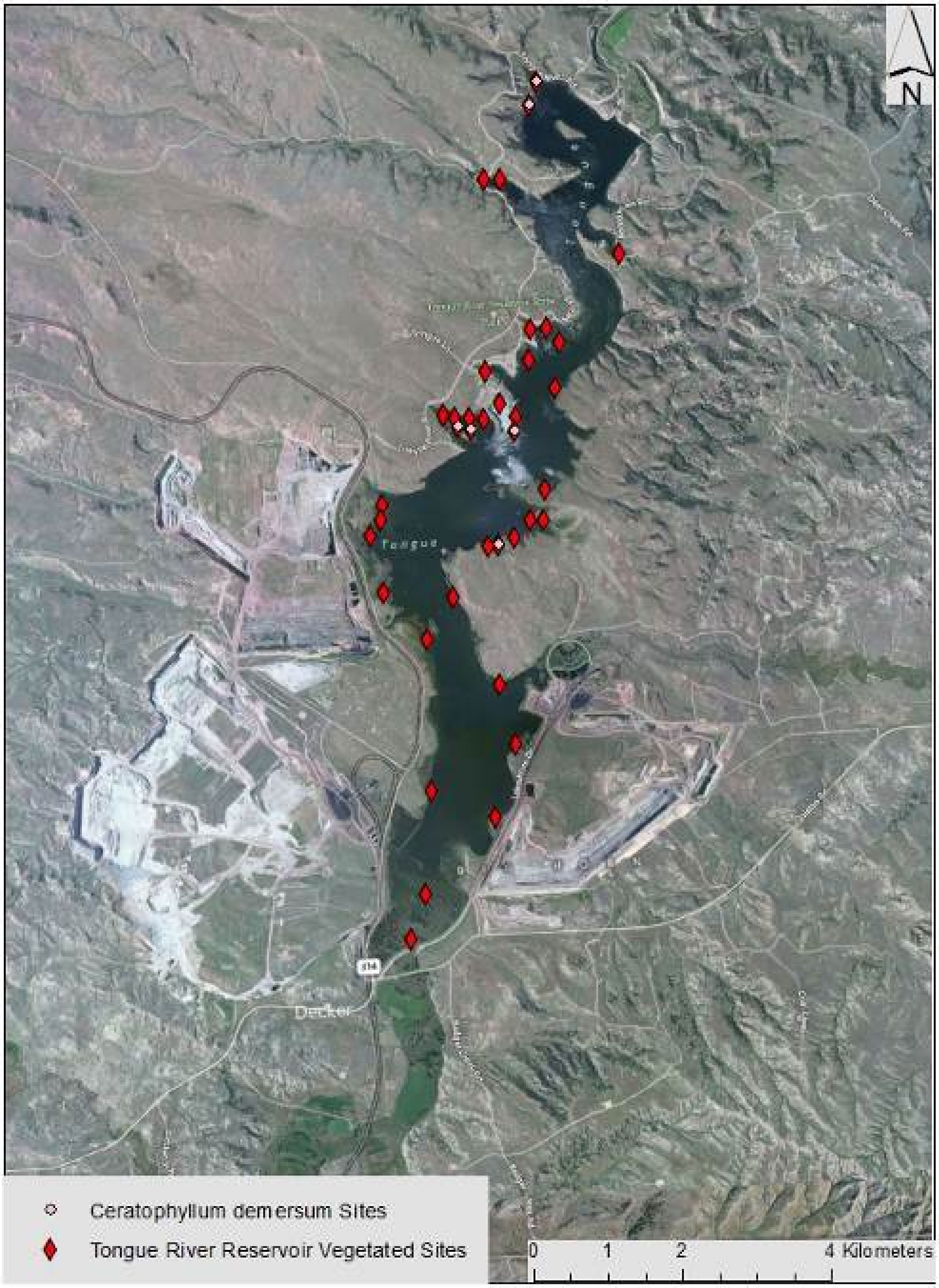

Figure 27. The distribution of *Ceratophyllum demersum* in Tongue River Reservoir during the littoral zone survey conducted in July 2012.

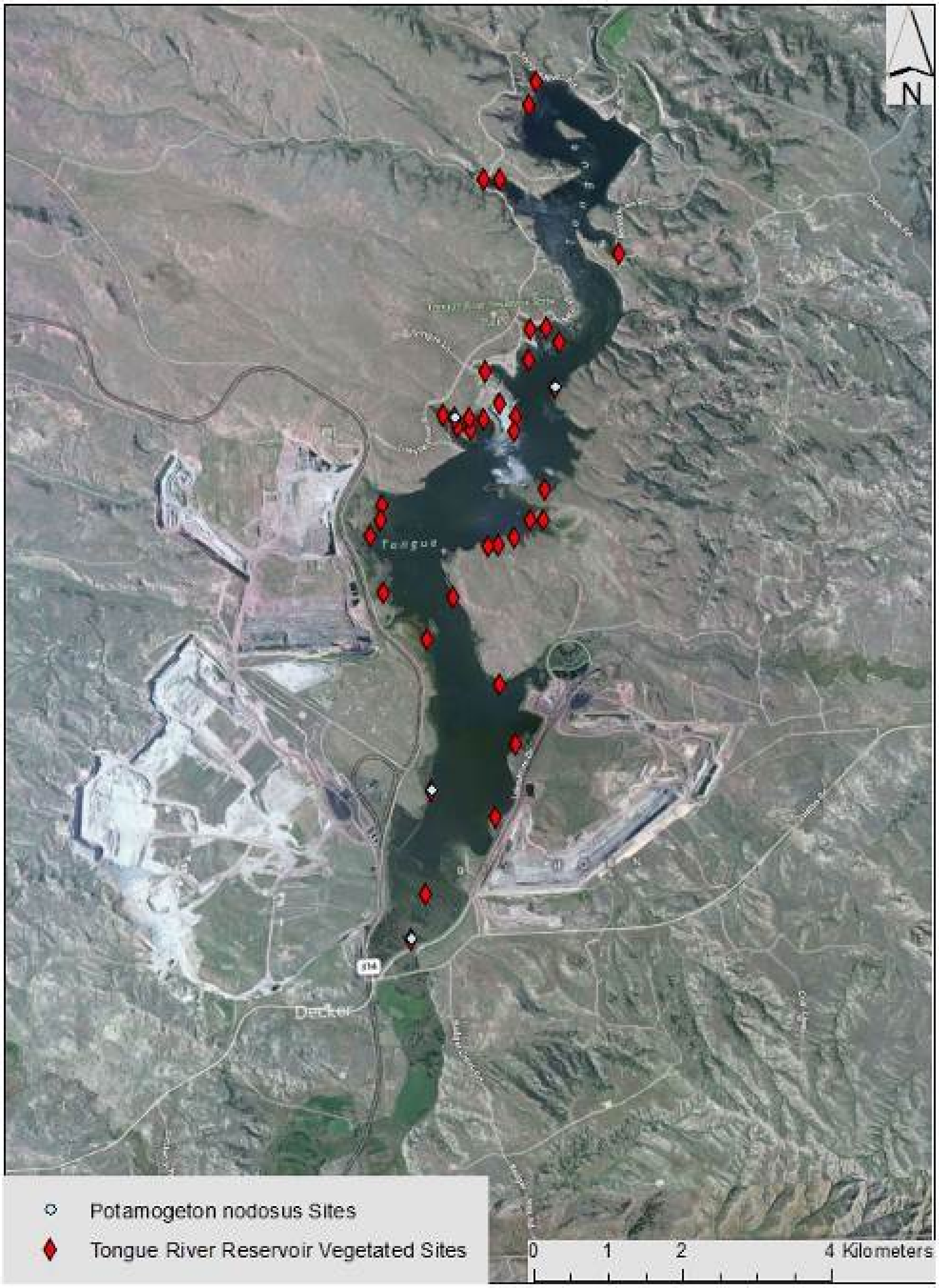

Figure 28. The distribution of *Potamogeton nodosus* in Tongue River Reservoir during the littoral zone survey conducted in July 2012.

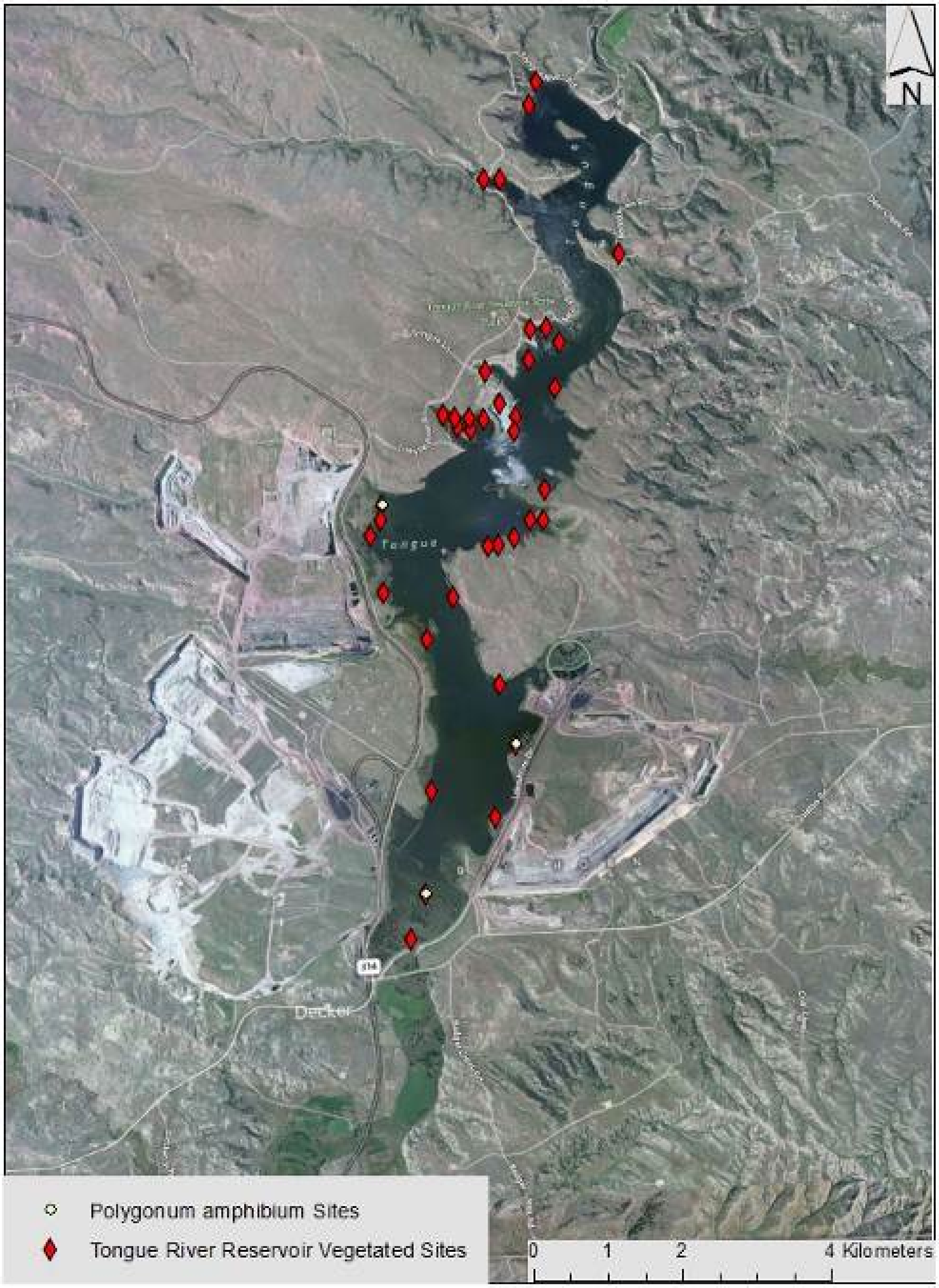

Figure 29. The distribution of *Polygonum amphibium* in Tongue River Reservoir during the littoral zone survey conducted in July 2012.

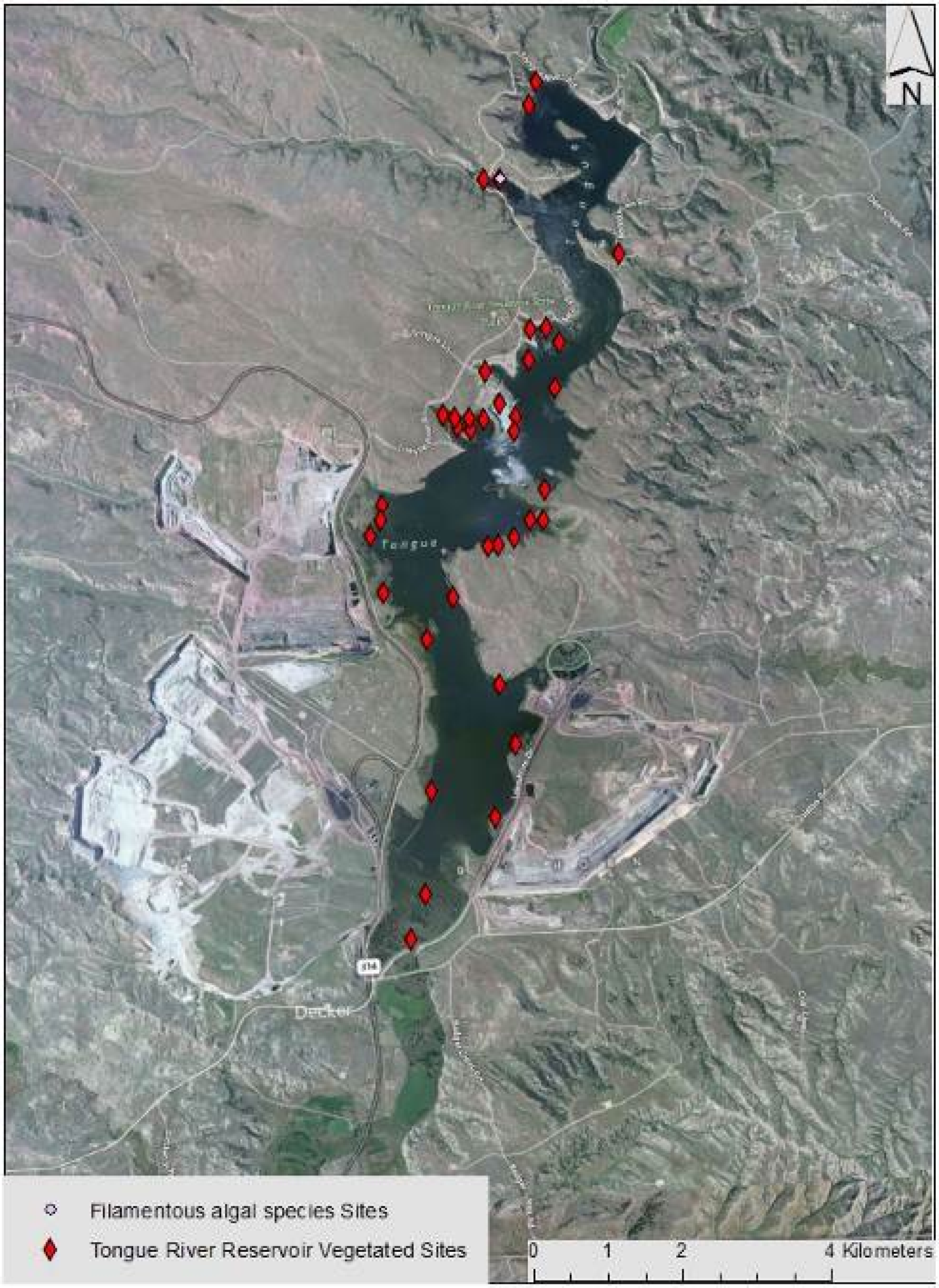

Figure 30. The distribution of Filamentous algal sp. in Tongue River Reservoir during the littoral zone survey conducted in July 2012.

Lake Name: Hungry Horse Reservoir

Date Surveyed: August 14, 2012

Secchi: 7.7 m (25 ft)

Points Surveyed: 59

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Negative

A random-systematic littoral survey of Hungry Horse Reservoir was conducted in August 2012. This survey was conducted on the northern 1/4 of the reservoir (Figure 31). This is a deep reservoir with the littoral zone existing as a narrow band around the perimeter of the reservoir and where streams and rivers empty into the reservoir. Out of 59 survey sites, 47.5% had aquatic vegetation present (Figure 32).

Eurasian watermilfoil and curlyleaf pondweed were not found in the reservoir. However, *Butomus umbellatus* (Flowering Rush), another non-native that is becoming established in Montana was present (Figure 34). It was found at 13.6% of surveyed sites and was only surpassed in prevalence by *Potamageton foliosis* (Table 5).

Table 5. Plant species list and percent occurrences for Hungry Horse Reservoir, MT, August 2012.

Species	Common Name	Frequency of Occurrence (%)
Potamageton foliosis	Leafy pondweed	16.9
Butomus umbellatus	Flowering rush	13.6
Ranunculus flabellaris	Yellow crowfoot	10.1
Potamageton gramineus	Variable leaf pondweed	8.5
Drepanocladus sp.	Aquatic moss	5.1
Polygonum amphibium	Longroot smartweed	5.1
Schoenoplectus tabernaemontani	Softstem bulrush	1.7
Potamogeton illinoensis	Illinois pondweed	1.7
Average Survey Depth (ft)		11.6 ft
Species Richness (avg. number per vegetated point)		1.4

Figure 31. Hungry Horse Reservoir Survey Sites. Surveys were conducted on the northern 1/4 of the reservoir in August 2012.

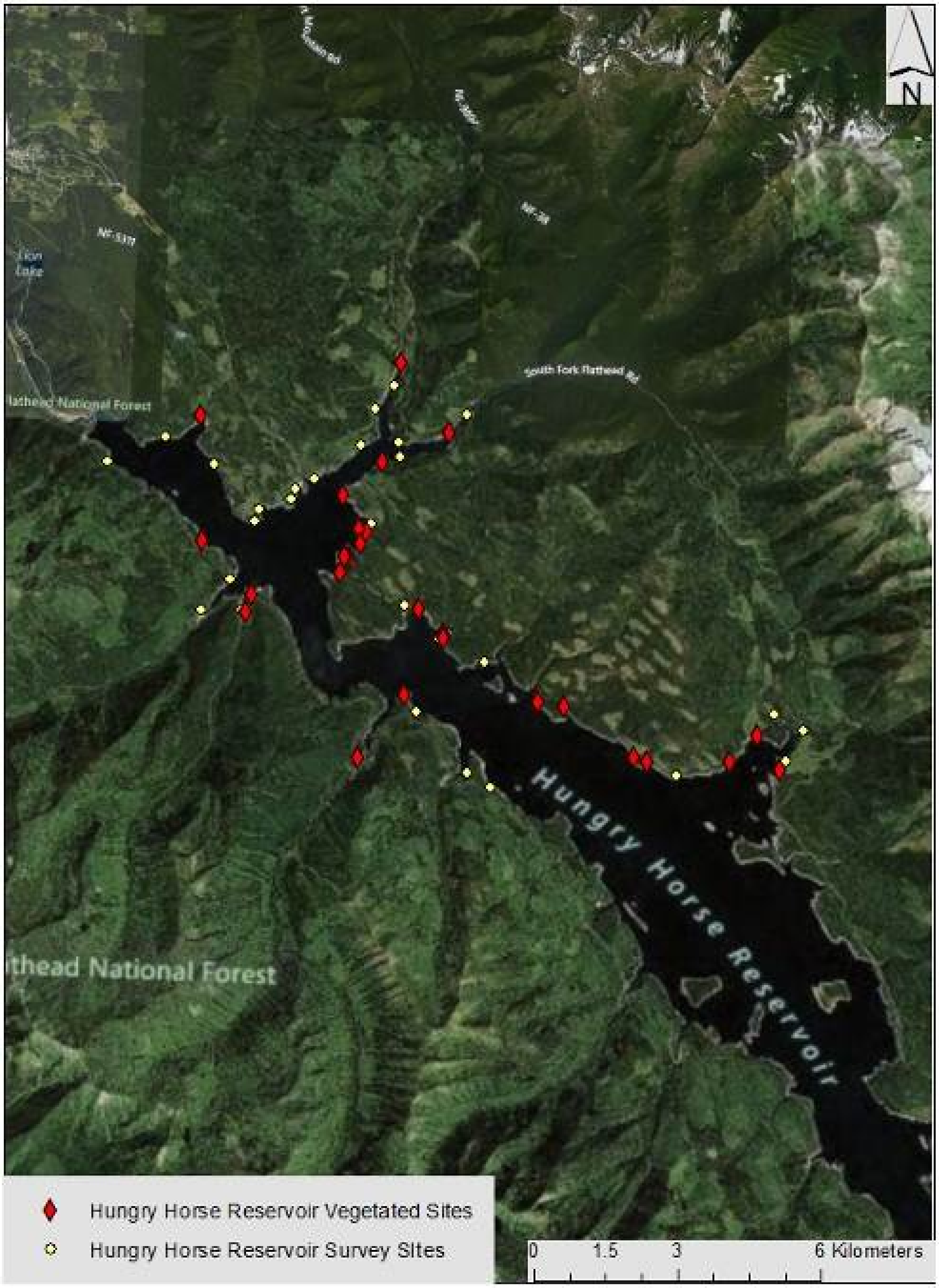

Figure 32. Hungry Horse Reservoir Survey Sites and vegetated sites. Surveys were conducted on the northern 1/4 of the reservoir in August 2012.

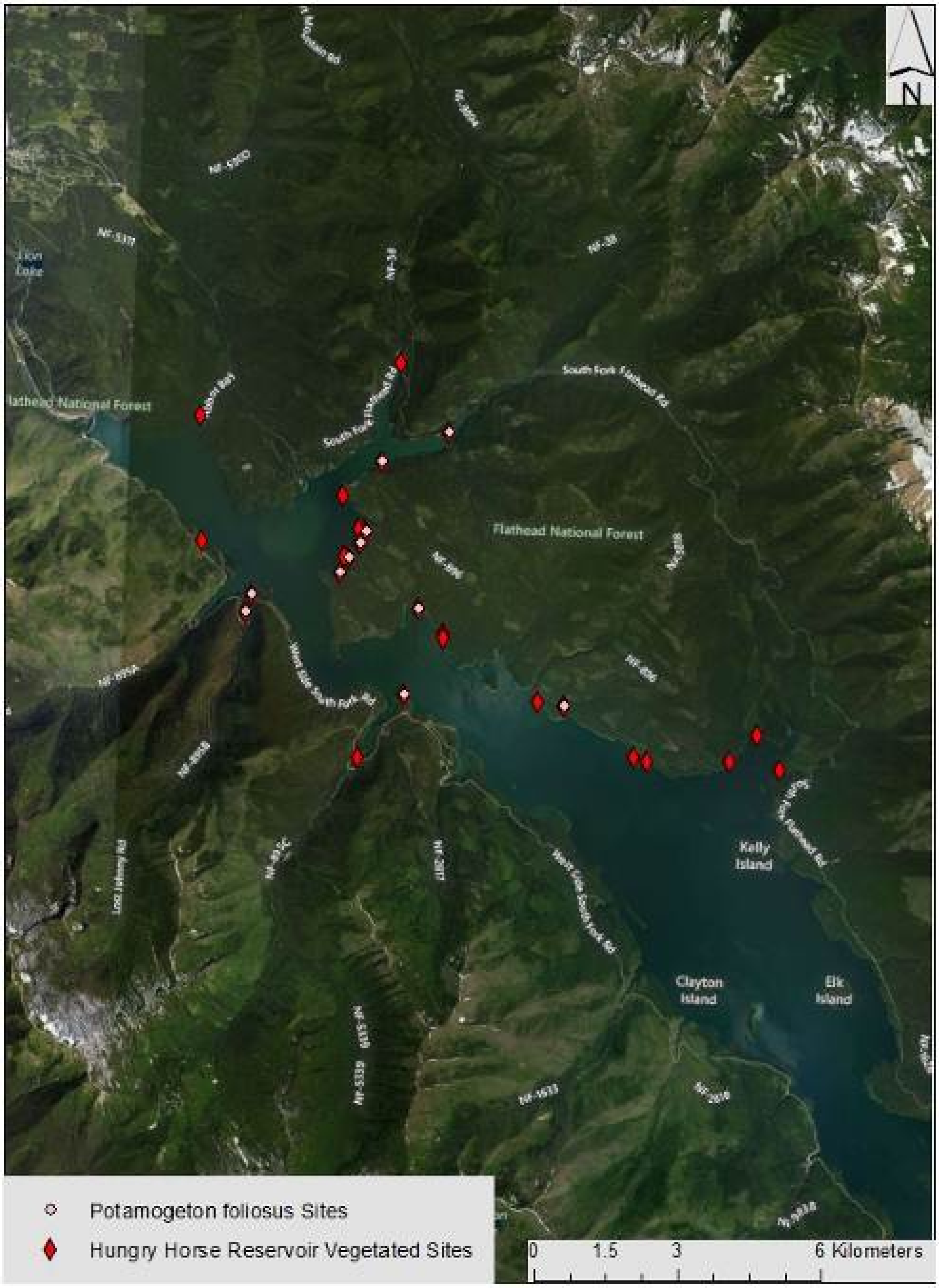

Figure 33. The distribution of *Potamogeton foliosus* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

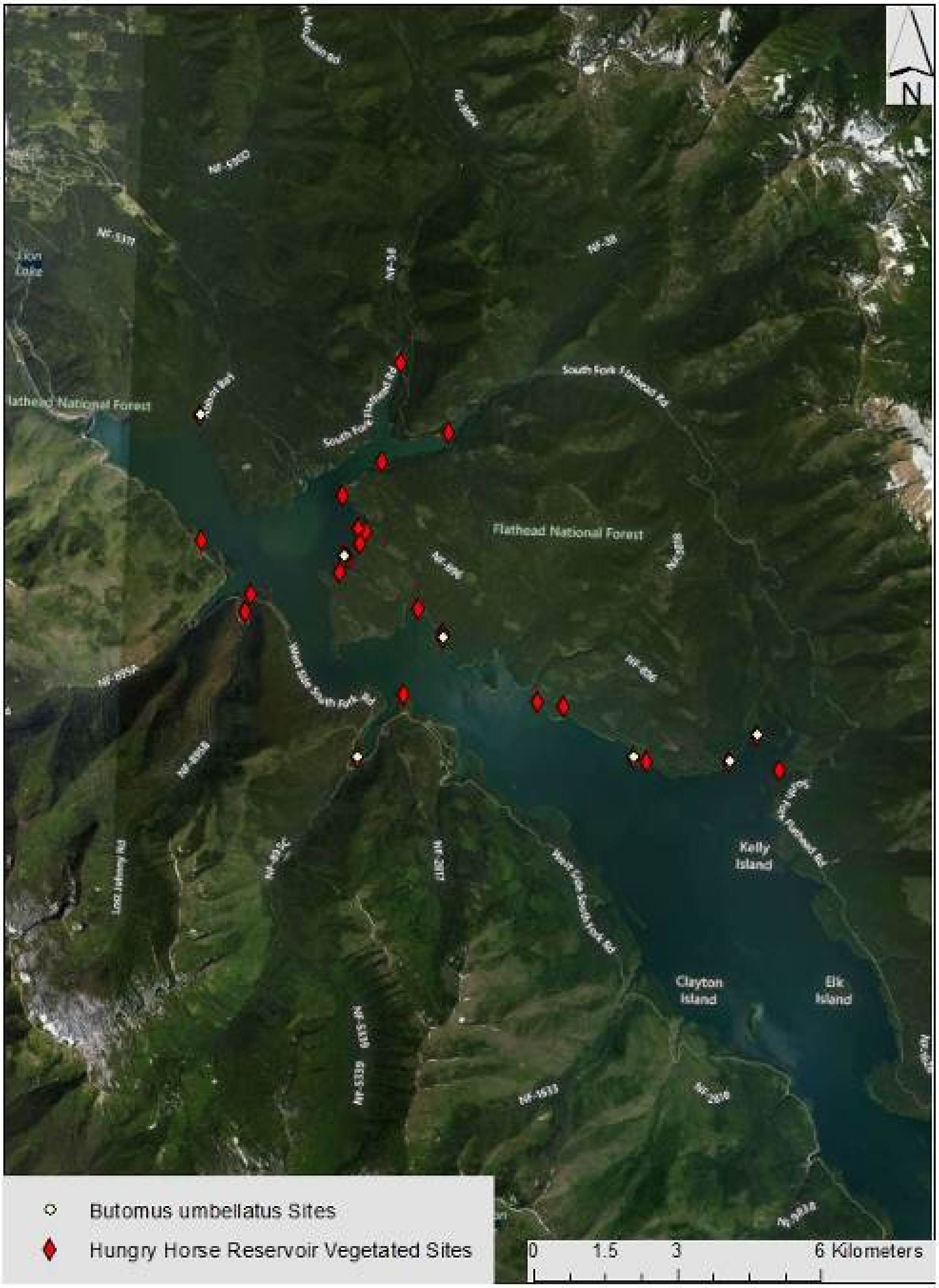

Figure 34. The distribution of flowering rush (*Butomus umbellatus*) in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

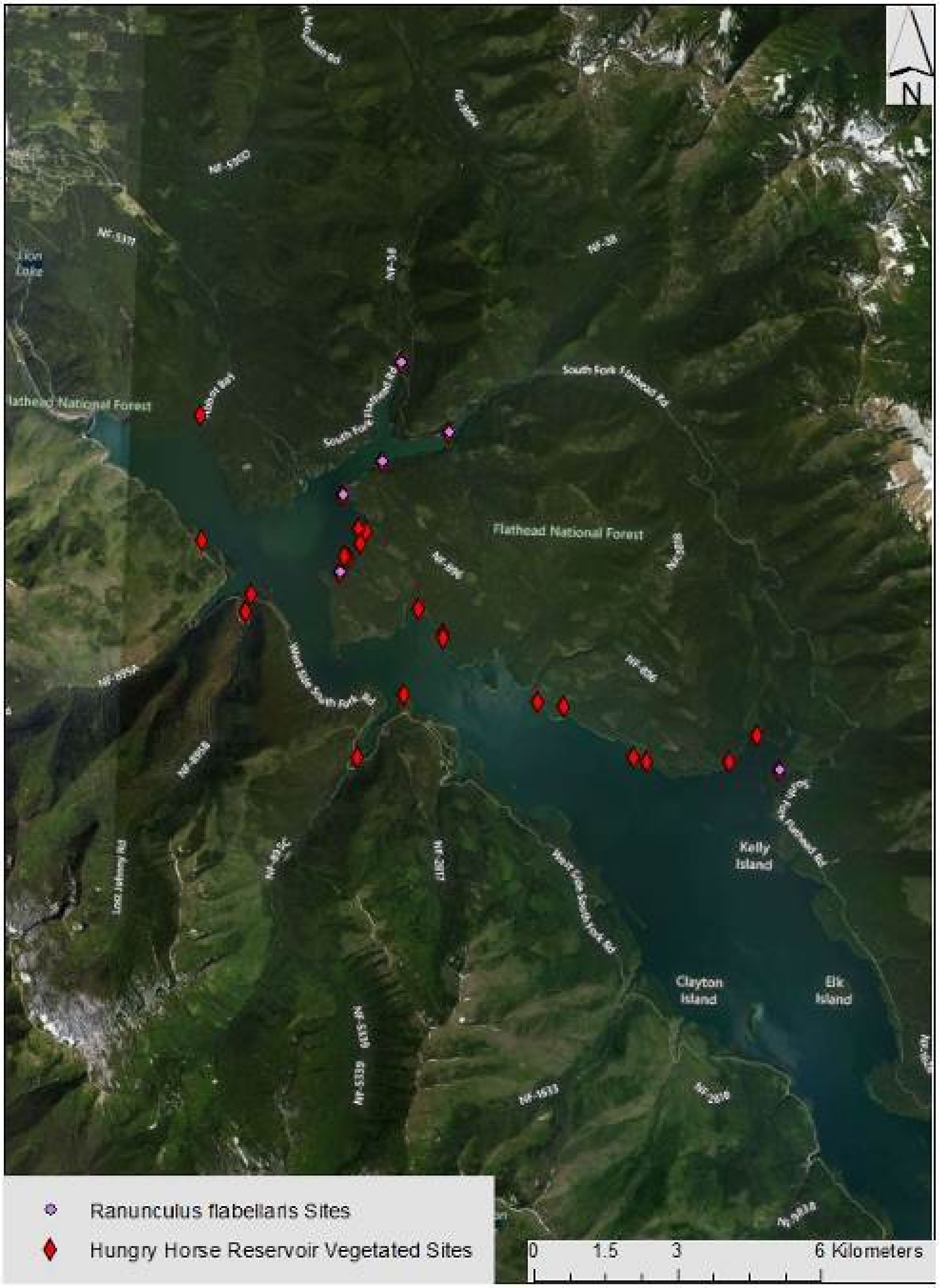

Figure 35. The distribution of *Ranunculus flabellaris* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

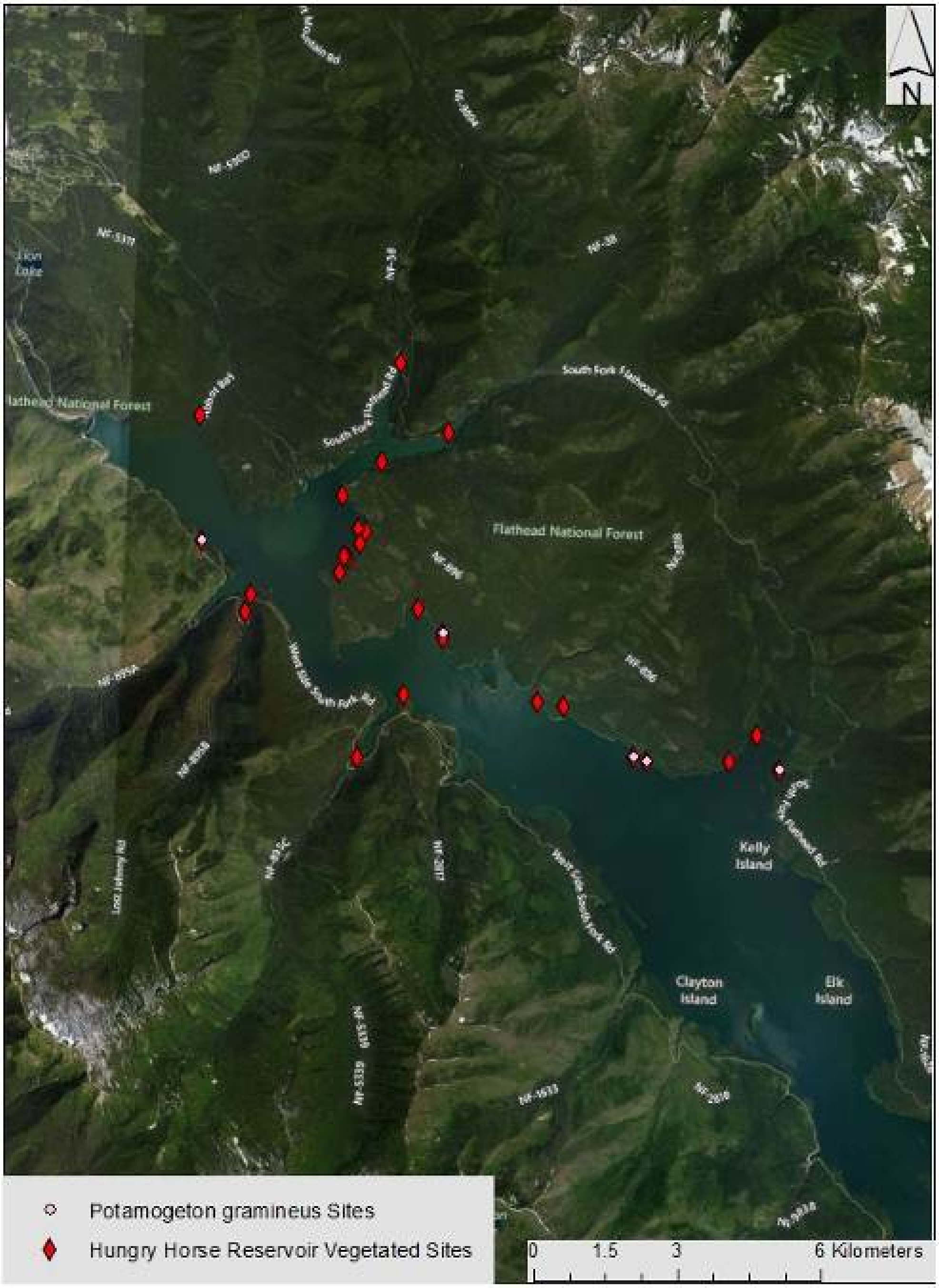

Figure 36. The distribution of *Potamogeton gramineus* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

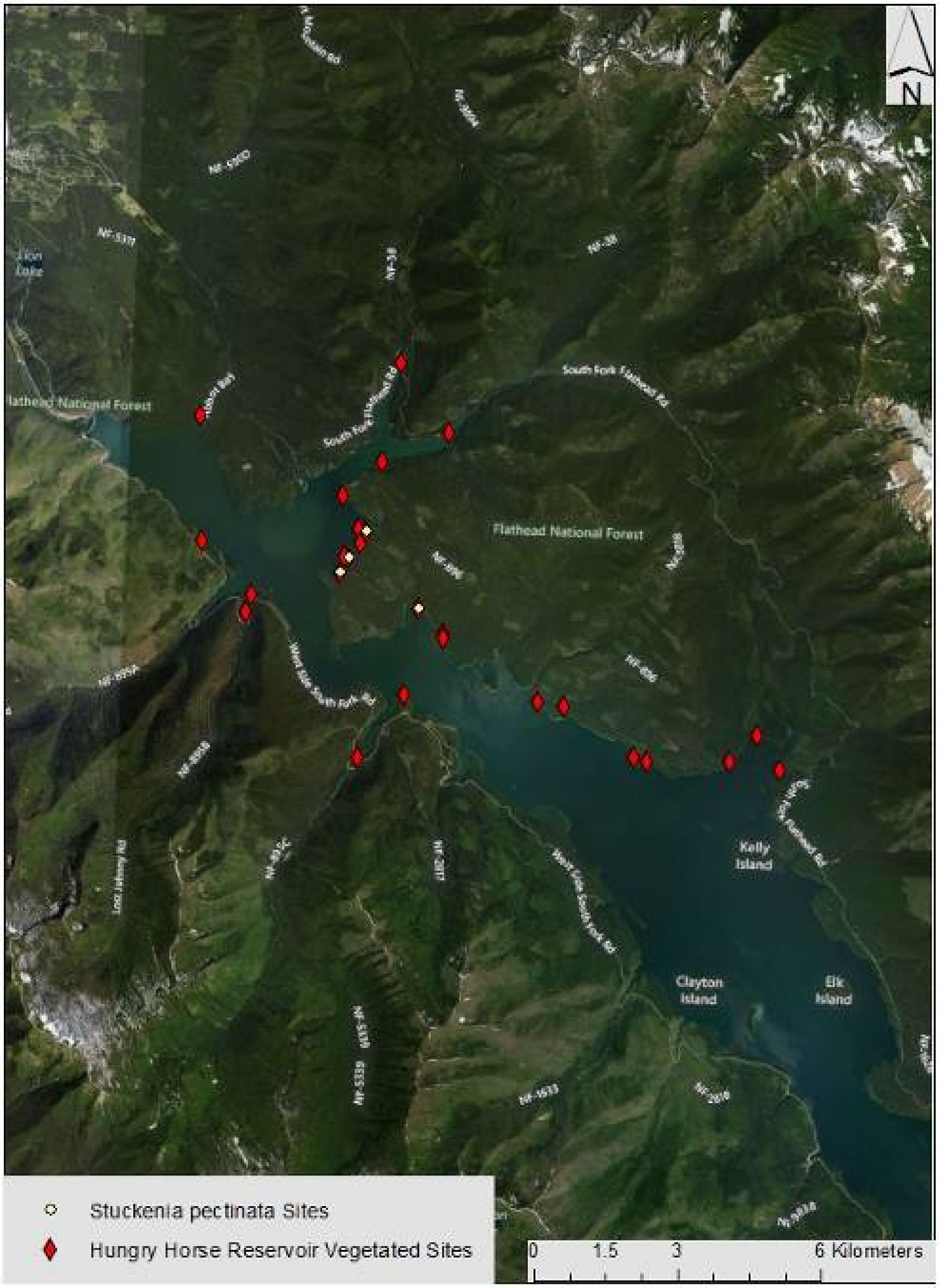

Figure 37. The distribution of *Stuckenia pectinata* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

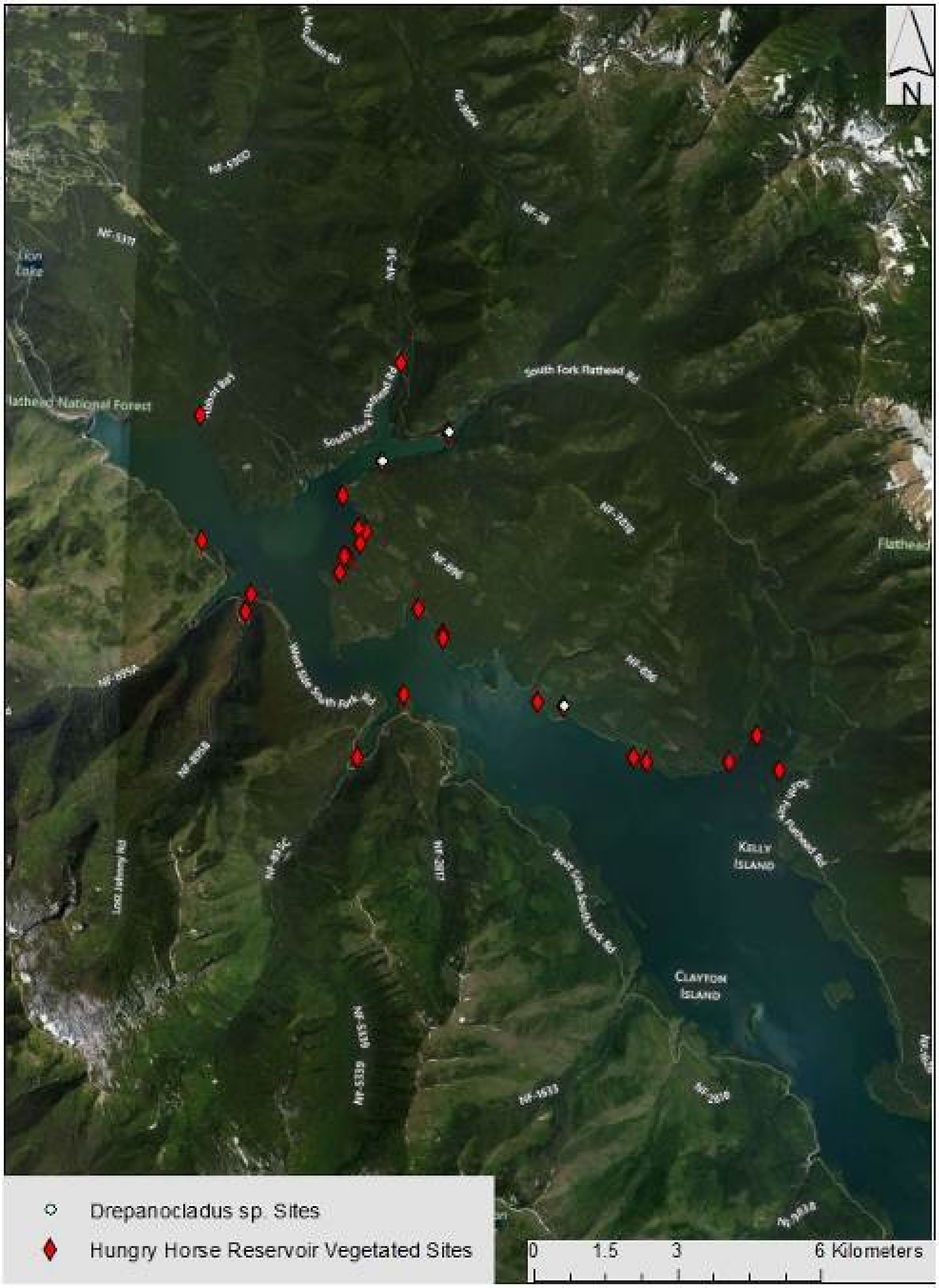

Figure 38. The distribution of *Drepanocladus* sp. in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

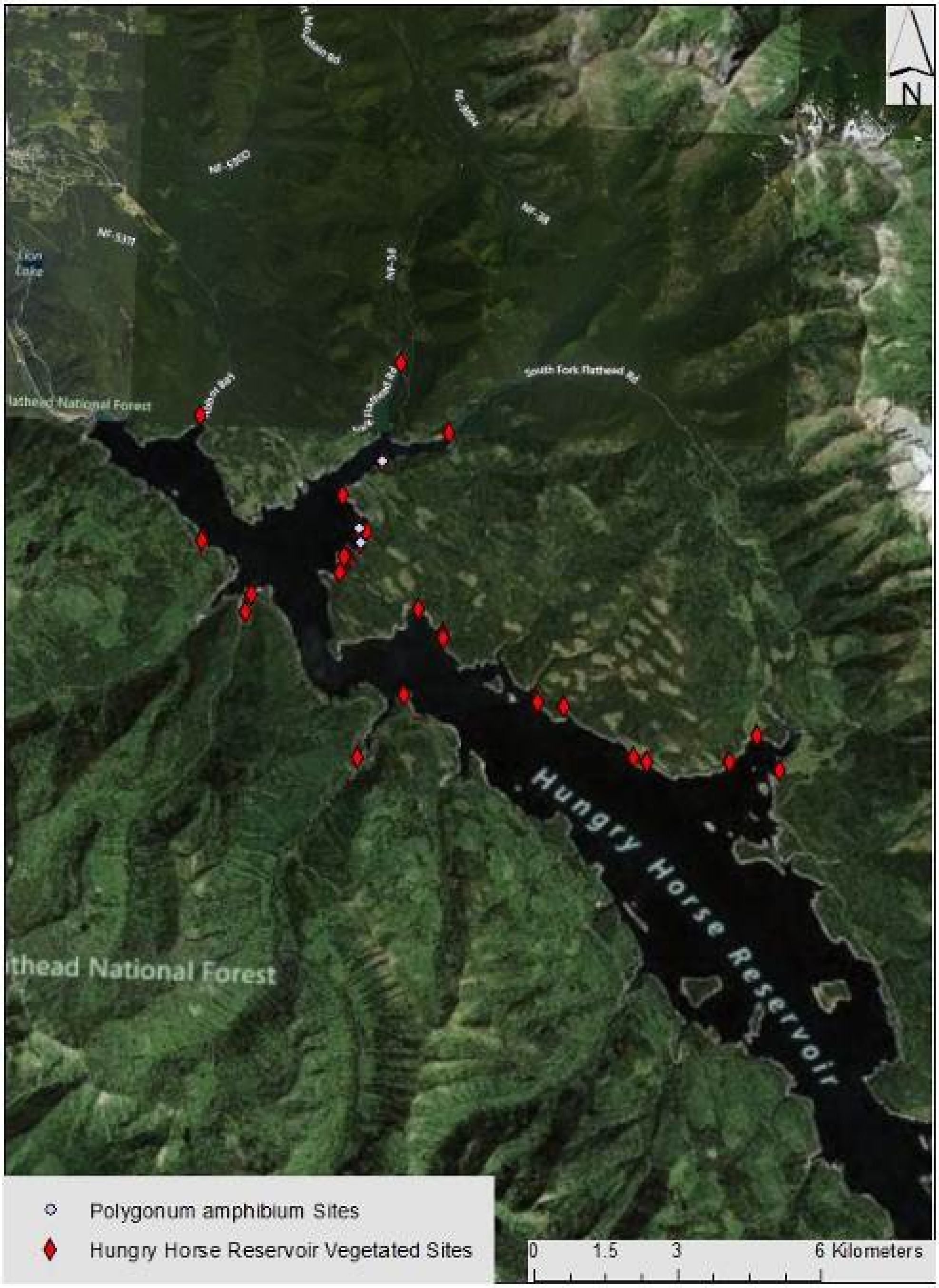

Figure 39. The distribution of *Polygonum amphibium* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

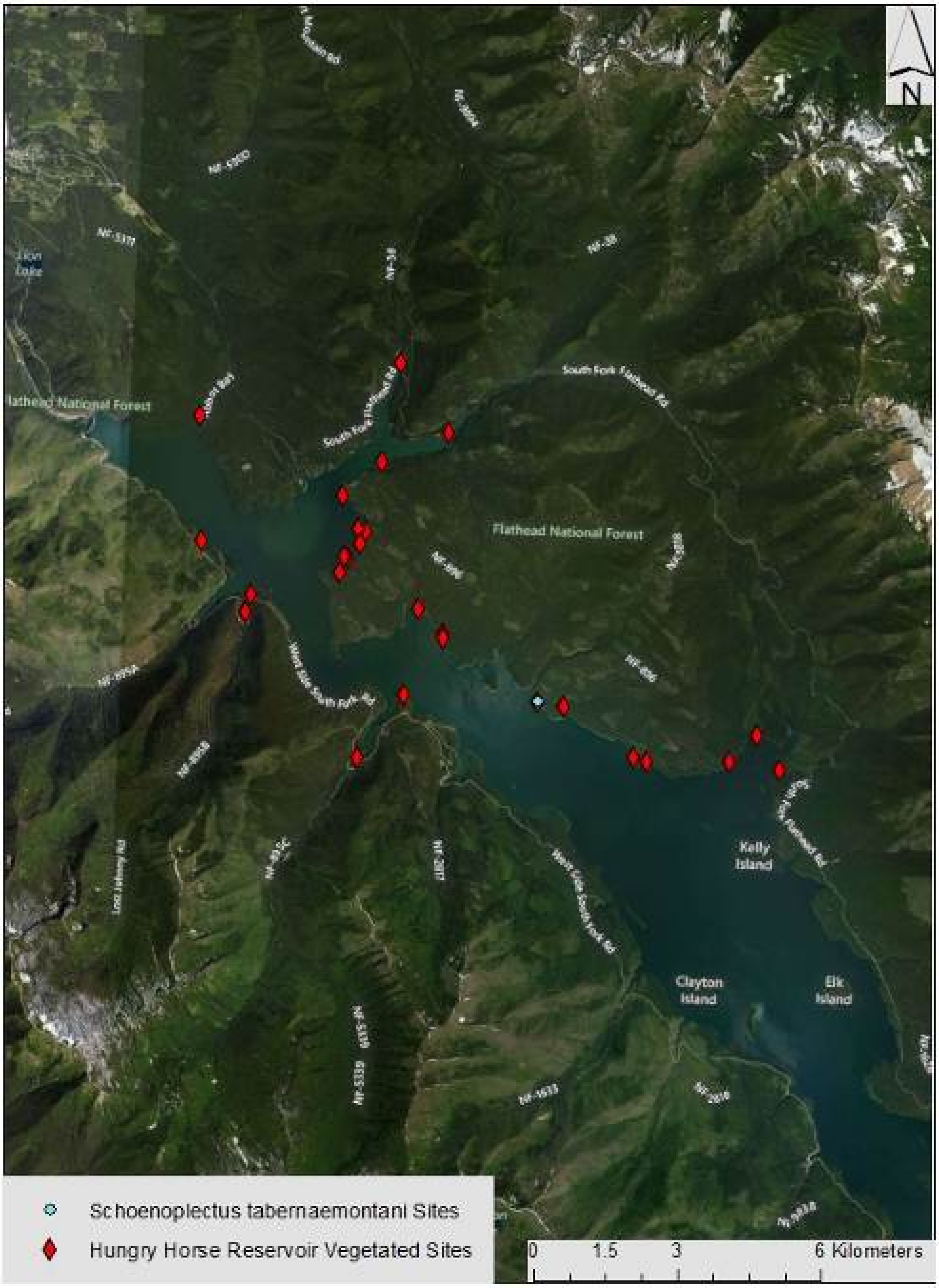

Figure 40. The distribution of *Schoenoplectus tabernaemontani* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

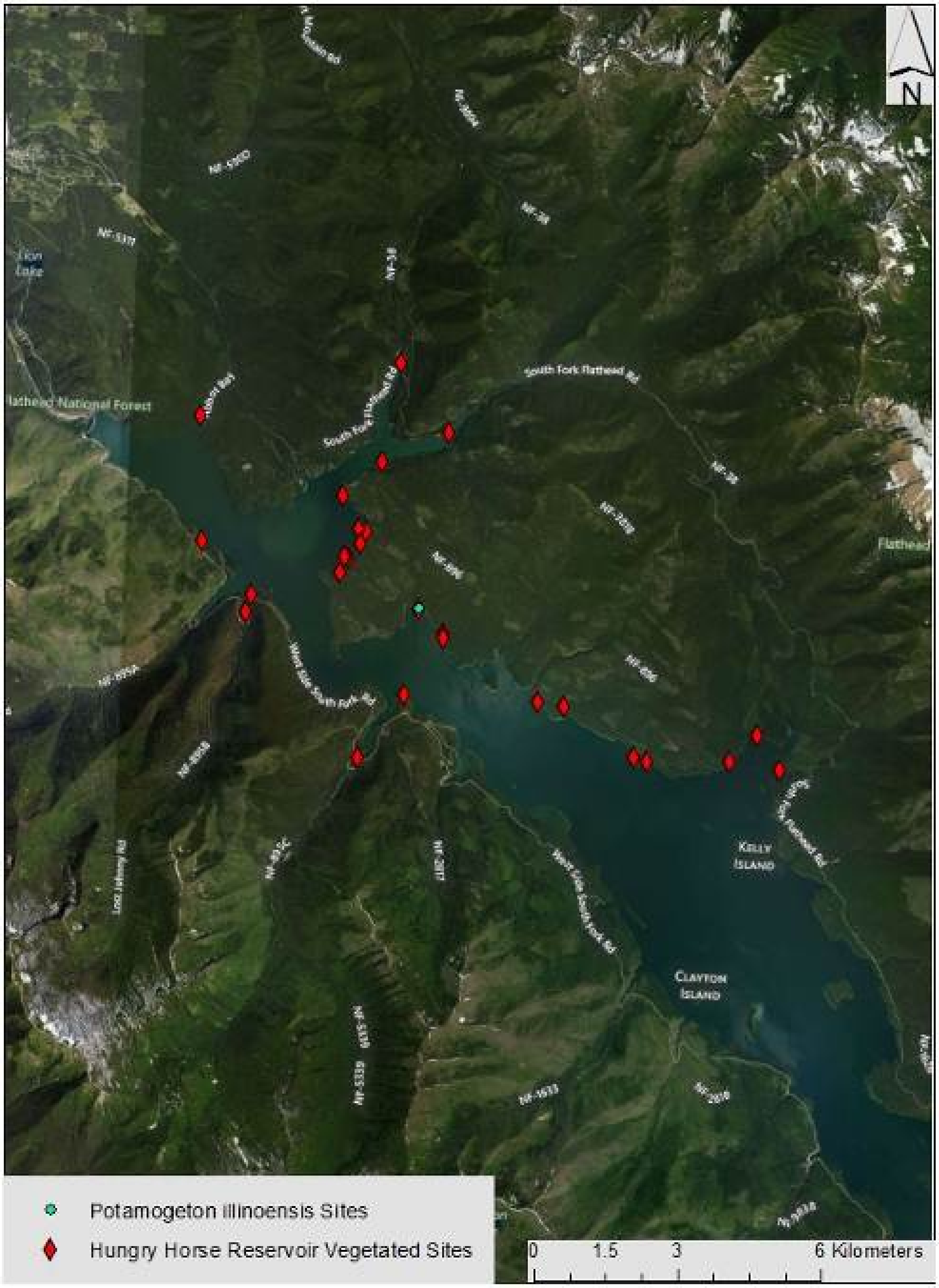

Figure 41. The distribution of *Potamogeton illinoensis* in Hungry Horse Reservoir during the littoral zone survey conducted in August 2012.

Lake Name: Flathead River

Date Surveyed: August 13, 2012

Secchi: N/A

Points Surveyed: 72

Eurasian watermilfoil = Negative

Curlyleaf pondweed = Positive

The lower reaches of Flathead River are lentic and backwater sloughs and coves are common. We surveyed four miles upstream of the river mouth and attempted to sample in all accessible backwater areas. The survey was conducted taking a sample every 0.5 km along the banks of the river. Any backwater areas between river sites were entered and randomly sampled (Figure 42).

Of the 72 sites sampled, 67 sites (93.1 %) had a species of aquatic plant present (Figure 43). *Potamogeton richardsonii*, *Stuckenia pectinata*, *Elodea canadensis*, and *Chara* were the most abundant species with each occurring at more the 25% of the sampled sites (Table 6). *Butomus umbellatus*, a non-native plant (Figure 48), was found at 16 sites (22.2 %) and was only surpassed in abundance by the fore mentioned species. *Potamogeton crispus* was found at two sites on the river (Figure 58).

Table 6. Plant species list and percent occurrences for Flathead River, MT, August 2012.

Species	Common Name	Frequency of Occurrence (%)
***Potamogeton richardsonii* (Ar. Benn.) Rydb.**	Clasping-leaf pondweed	69.4
***Stuckenia pectinata* (L.) Börner**	Sago pondweed	56.9
Elodea canadensis	Elodea	34.7
***Chara* sp.**	Chara	26.4
Butomus umbellatus	Flowering rush	22.2
Myriophyllum sibiricum	Northern watermilfoil	19.4
Potamogeton foliosus	Leafy pondweed	12.5
Potamogeton gramineus	Variable-leaf pondweed	12.5
***Ranunculus aquatilis* L.**	Whitewater crowfoot	11.1
Hippuris vulgaris	Mares tail	8.3
Nymphaea odorata	Whitewater lily	5.6
Potamogeton nodosus	American pondweed	4.2
Myriophyllum hippuroides	Western watermilfoil	4.2
Ceratophyllum demersum	Coontail	2.7
Potamogeton crispus	Curlyleaf pondweed	2.7
***Nitella* sp.**	Nitella	2.7
***Polygonum* sp.**	Smartweed	1.4
Average Survey Depth (ft)		6.2 ft
Species Richness (avg. number per vegetated point)		3.2

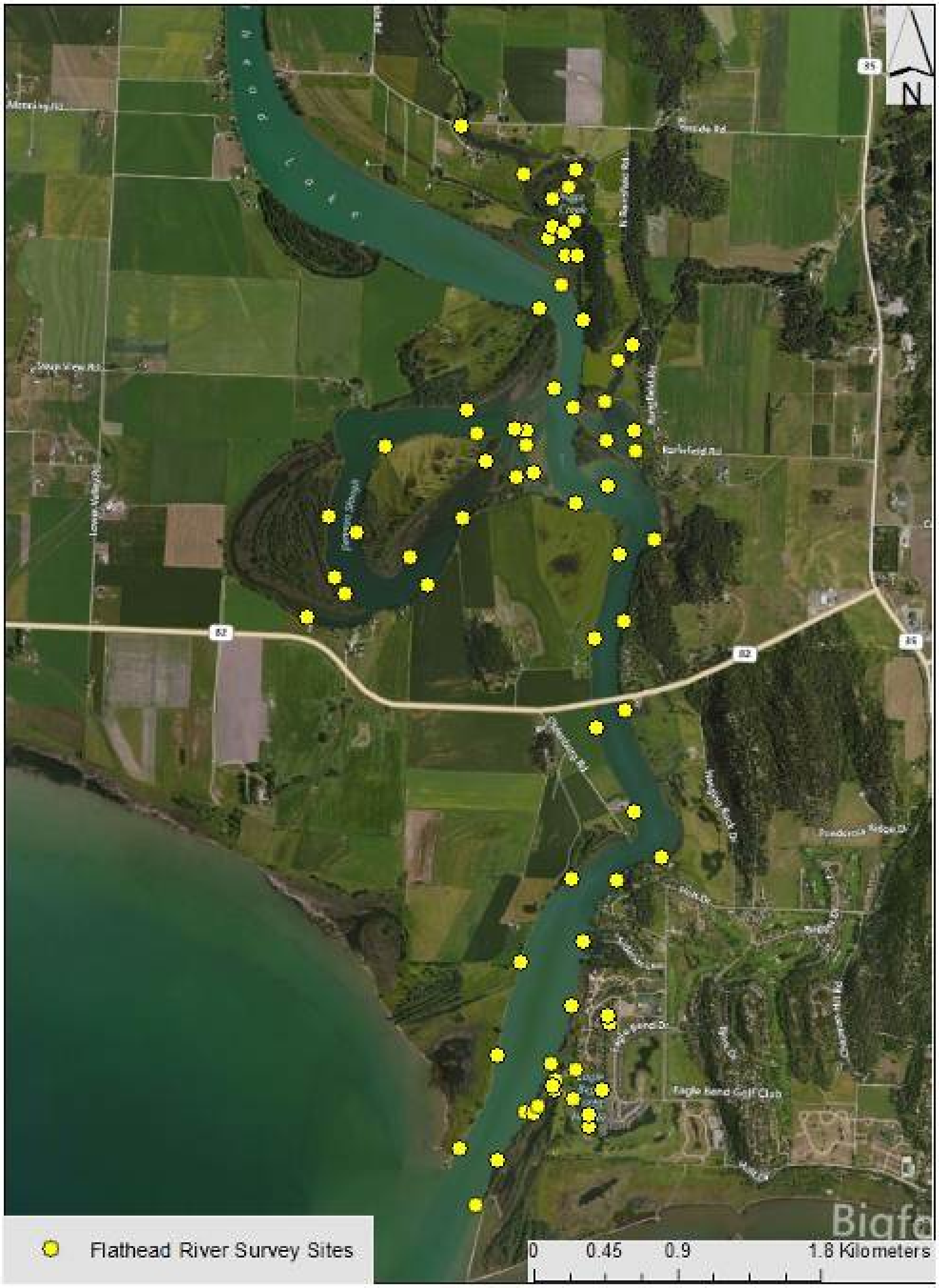

Figure 42. Flathead River Survey Sites. Sites were surveyed in August 2012.

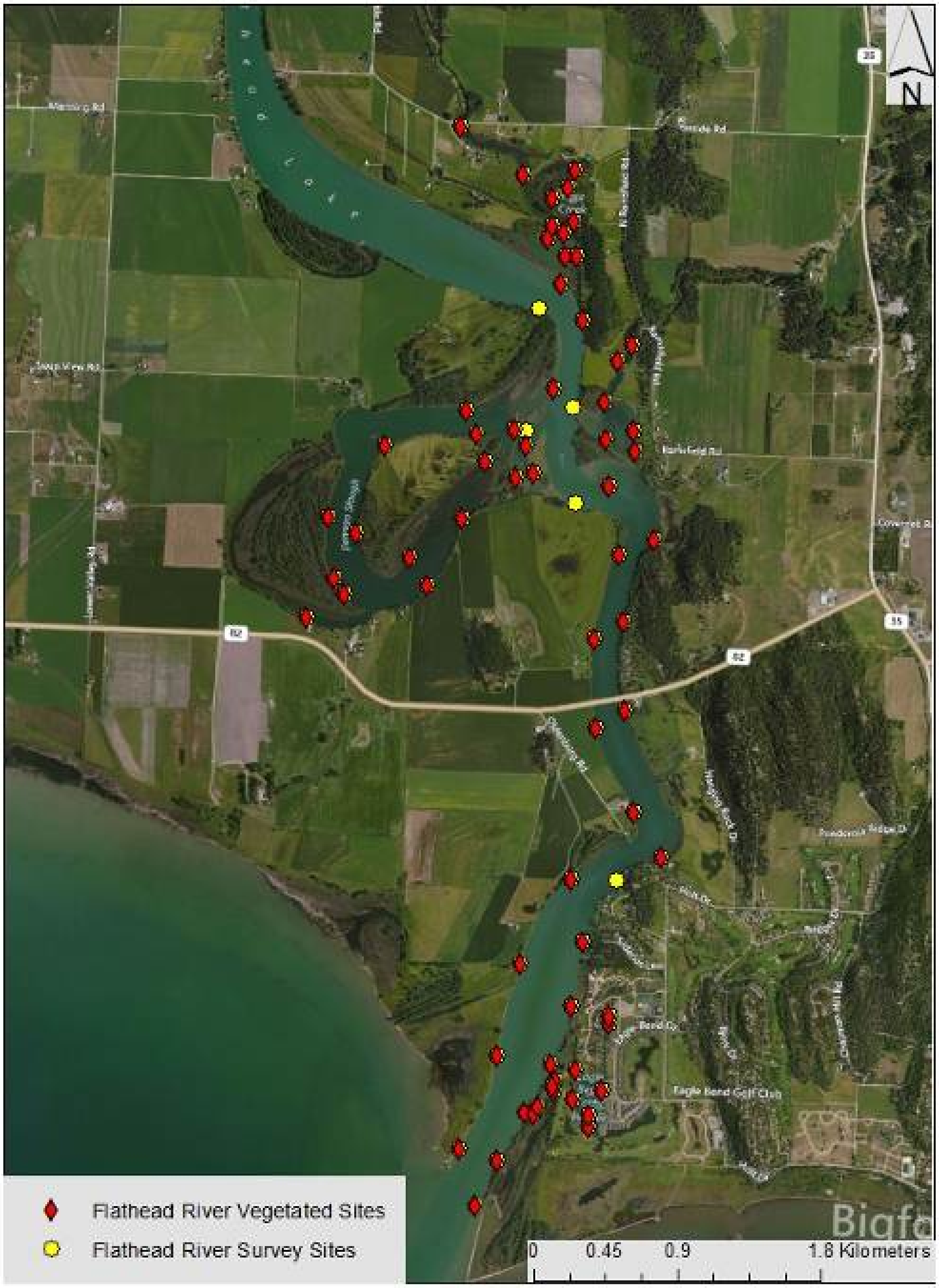

Figure 43. Flathead River Survey Sites and vegetated sites. Surveys were conducted on the northern 1/4 of the reservoir in August 2012.

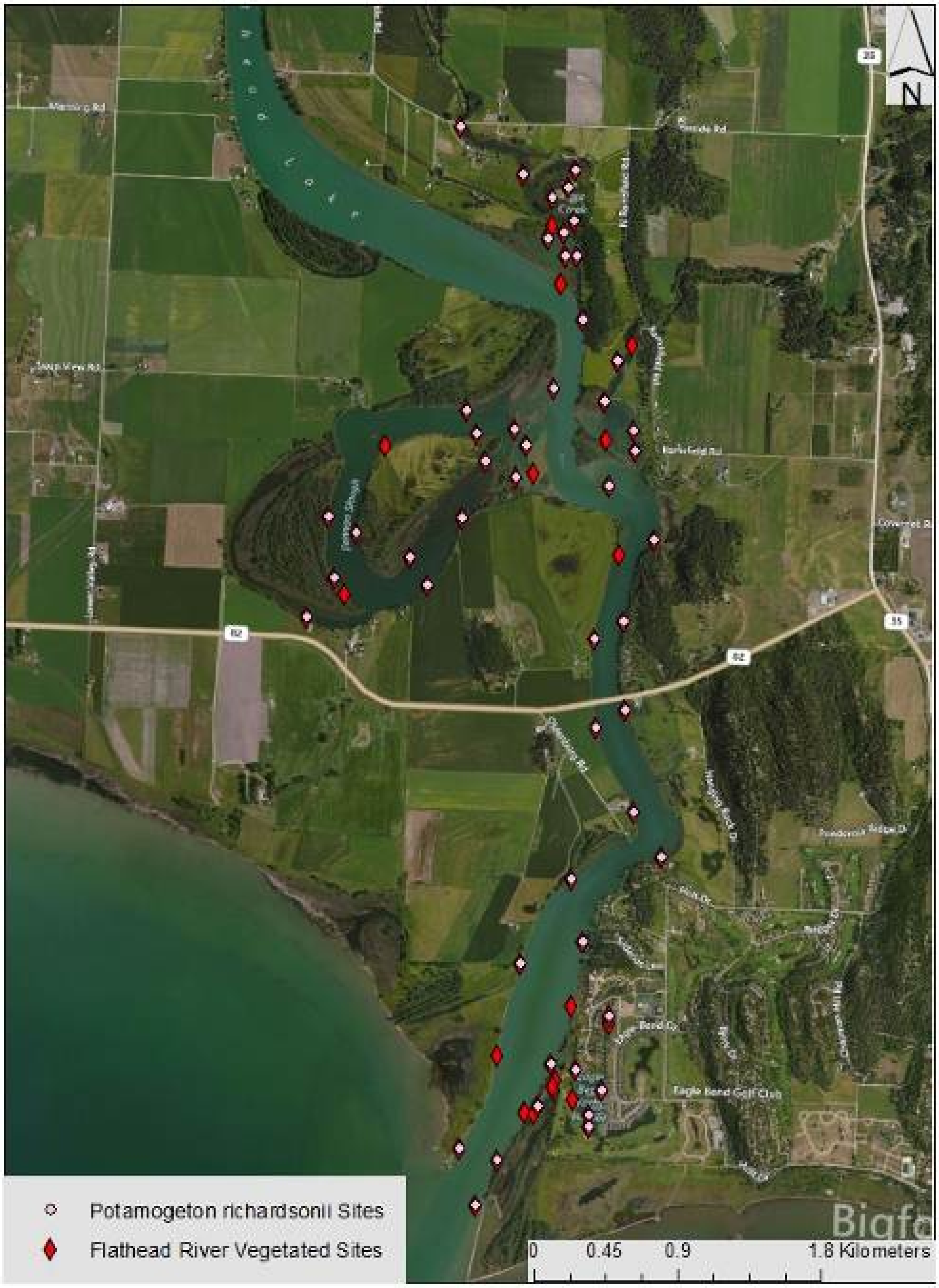

Figure 44. The distribution of *Potamogeton richardsonii* in Flathead River during the littoral zone survey conducted in July 2012.

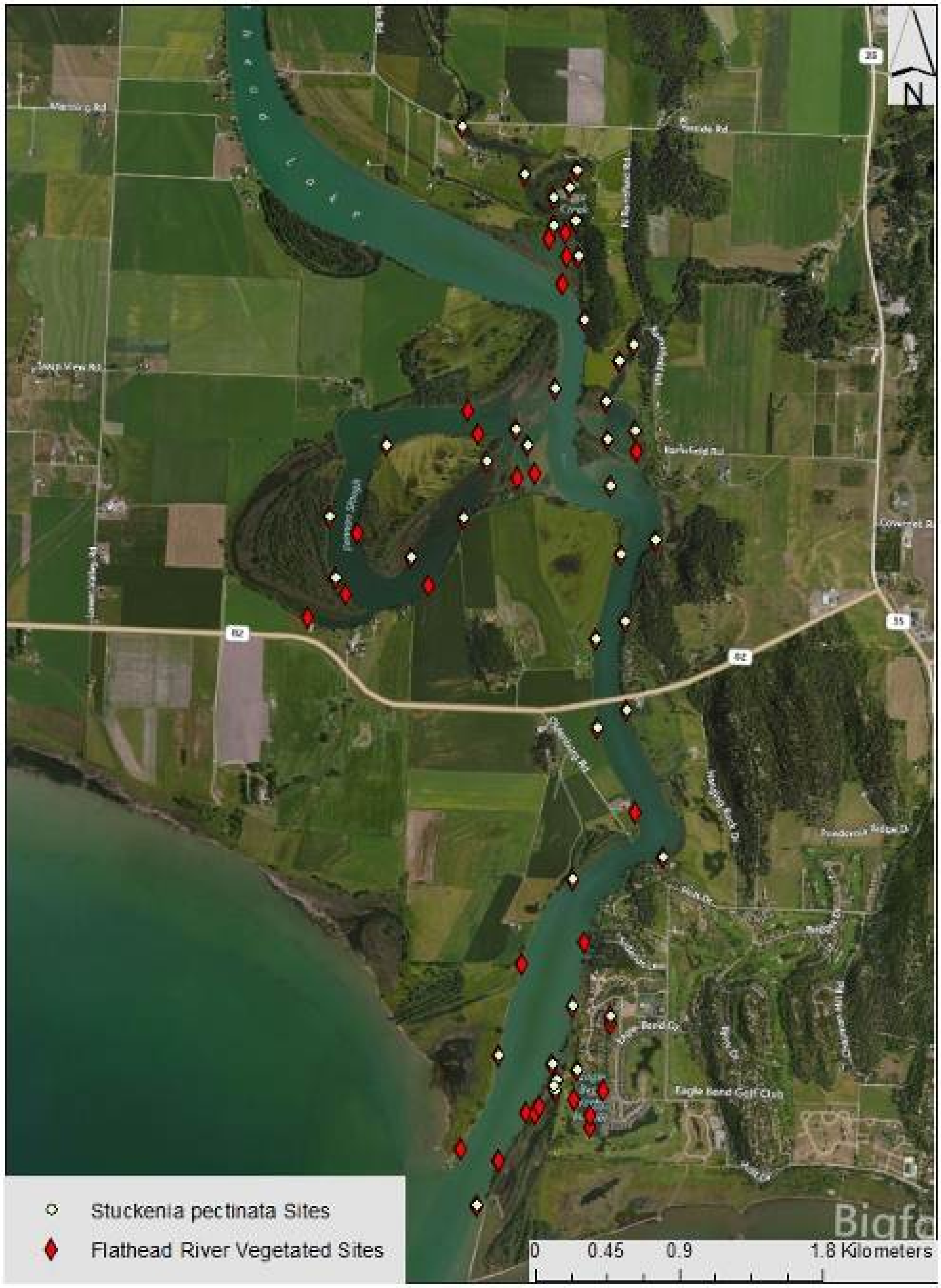

Figure 45. The distribution of *Stuckenia pectinata* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 46. The distribution of *Elodea canadensis* in Flathead River during the littoral zone survey conducted in July 2012.

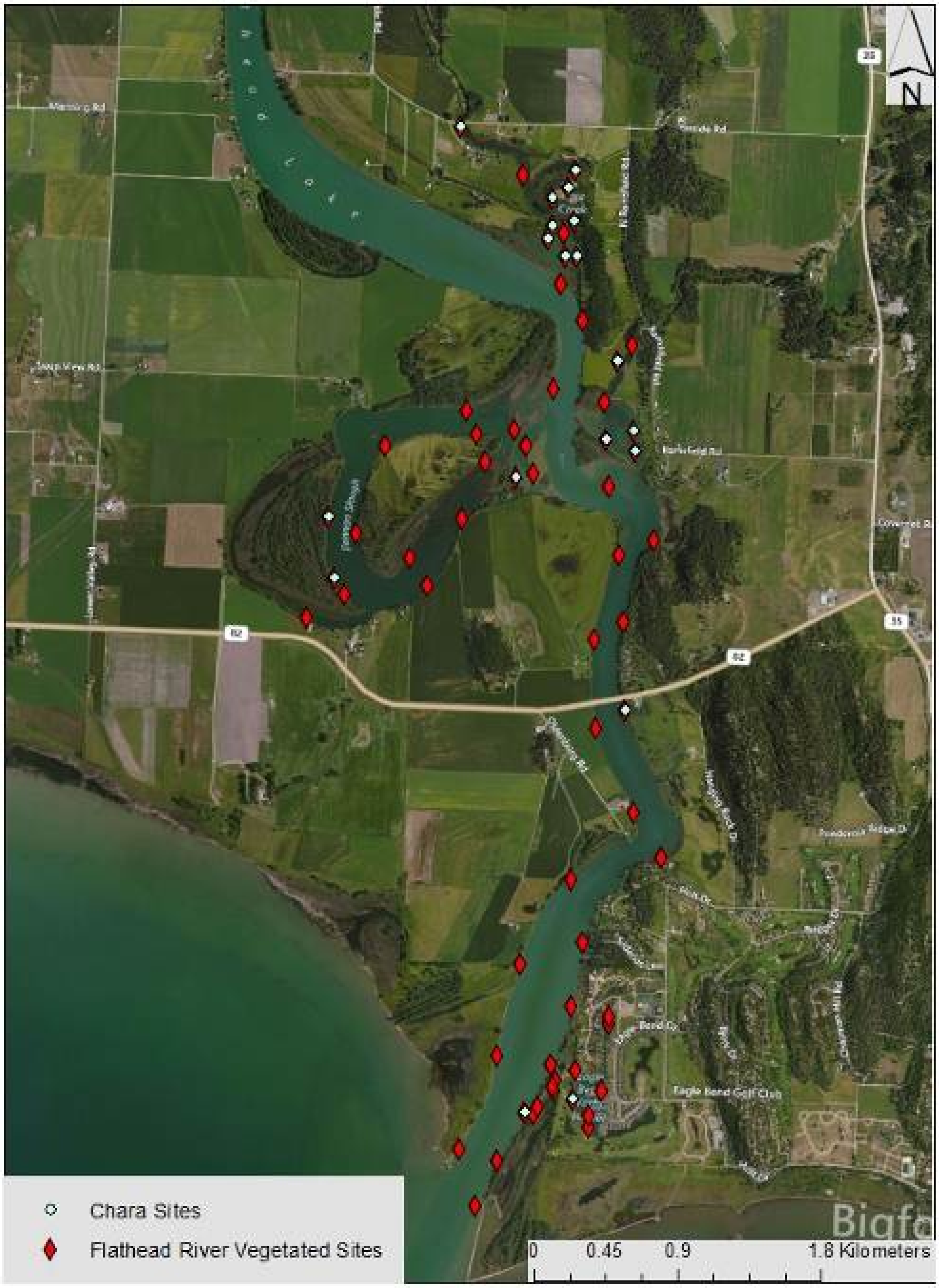

Figure 47. The distribution of *Chara* sp. in Flathead River during the littoral zone survey conducted in July 2012.

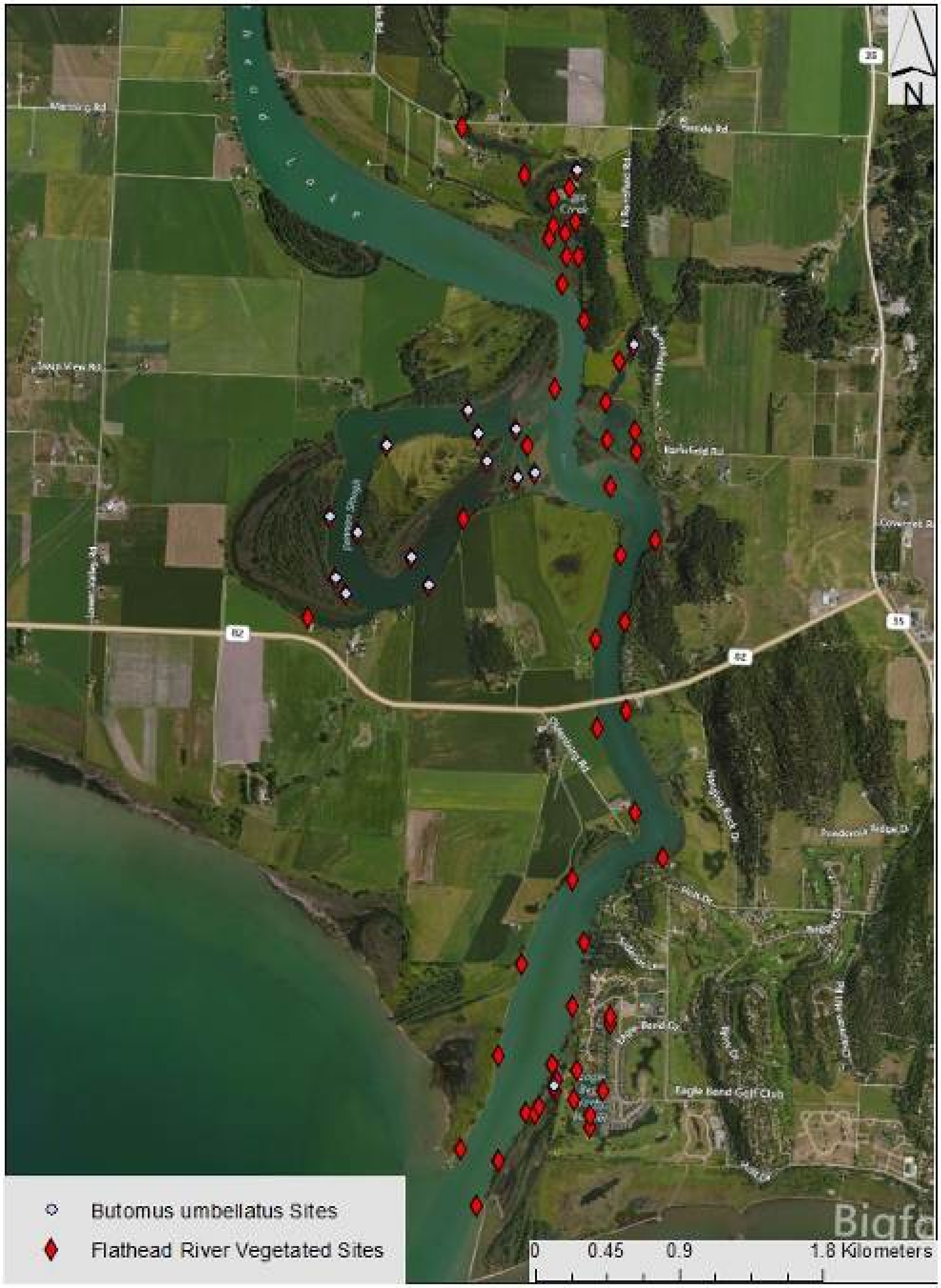

Figure 48. The distribution of *Butomus umbellatus* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 49. The distribution of *Myriophyllum sibiricum* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 50. The distribution of *Potamogeton foliosus* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 51. The distribution of *Potamogeton gramineus* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 52. The distribution of *Ranunculus aquatilis* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 53. The distribution of *Hippuris vulgaris* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 54. The distribution of *Nymphaea odorata* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 55. The distribution of *Potamogeton nodosus* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 56. The distribution of *Myriophyllum hippuroides* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 57. The distribution of *Ceratophyllum demersum* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 58. The distribution of *Potamogeton crispus* in Flathead River during the littoral zone survey conducted in July 2012.

Figure 59. The distribution of *Nitella* sp. in Flathead River during the littoral zone survey conducted in July 2012.

Figure 60. The distribution of *Polygonum* sp. in Flathead River during the littoral zone survey conducted in July 2012.

Conclusions and Recommendations

The waterbodies surveyed, with the exception of Flathead Lake, Hungry Horse Reservoir, and Flathead River, had relatively poor species richness for the aquatic plant community. Bighorn Lake did not appear to have aquatic plants. Eurasian watermilfoil (*Myriophyllum spicatum*) was not found in any of the waterbodies surveyed. Curlyleaf pondweed (*Potamogeton crispus*) was found in Flathead Lake and Flathead River but not in any of the other waterbodies. In Flathead Lake, *Potamogeton crispus* was relatively sparse and covered approximately 24.5 acres of substrate. In Flathead River a single plant was observed at one site. Flowering rush (*Butomus umbellatus*), another non-native aquatic species that is spreading in Montana, was found in Flathead Lake, Hungry Horse Reservoir, and Flathead River. Utilizing the point intercept survey method to survey the littoral zone of each waterbody allowed for a more direct, quantitative approach in areas more likely to support aquatic plant growth.

Given the remoteness of the majority of these water bodies and the lack of access points, the probability of invasion by *Myriophyllum spicatum* is low. The primary means of spreading *Myriophyllum spicatum* between water bodies is by motorized watercraft. Therefore, priority should be given to waterbodies that have improved access for motorized watercraft and are important recreation areas. Of the current waterbodies surveyed, priority should be given to Flathead Lake, Hungry Horse Reservoir, and Flathead River; as these waterbodies already have non-native aquatic plant species present, and use patterns and/or suitable habitat increases invasion potential. Continued surveys and monitoring should be conducted on these waterbodies.

Management techniques should be identified and implemented in these reservoirs to control both *Myriophyllum spicatum* and *Potamogeton crispus* while populations are small. In considering appropriate management techniques, it is recommended that only methods that have been shown to be effective via peer-reviewed literature and under similar use patterns should be evaluated. If data do not exist it may be necessary to conduct the necessary research to develop use patterns for a specific management technique in a given water body. It is much more cost efficient to manage a non-native species when the population is small; an approach widely practiced in terrestrial invasive plant management as Early Detection and Rapid Response.

Recommendations

- Develop a statewide survey protocol, similar to Idaho, to direct state agency personnel, contractors, or volunteers on a standardized survey method that is easily repeatable and quantifiable; and provide consistency between agencies.

- Continued monitoring will assist in determining the spread of Eurasian watermilfoil and Curlyleaf pondweed, likely habitats for its infestation, and locations for active management.

- It is recommended that all aquatic plant management and natural resource management personnel, including divers, dive supervisors, herbicide applicators, and site scouts be required to undergo periodic aquatic plant identification training, specifically to differentiate between Eurasian watermilfoil and northern watermilfoil. As part of this training, it must be reinforced that no one can differentiate between northern watermilfoil and Eurasian watermilfoil from a boat unless the plants are topped out; proper identification requires a sample in the hand for analysis.

- An agreement should be established with a nationally recognized laboratory to verify watermilfoil identifications. This is important given the number of people that have been involved with surveys in Montana waters. The lab should have expertise in genetic assays of watermilfoil species and the ability to offer rapid identification.

- Appropriate research and demonstration projects should be identified that will improve the management of Eurasian watermilfoil, curlyleaf pondweed, and flowering rush in waters of Montana. Suitable funding, internal or external, to the program can then be sought for research support. Other state programs have found that appropriate applied research is critical to management.

- Assessment is critical in identifying which management techniques are effective in controlling Eurasian watermilfoil and curly-leaf pondweed, and which techniques are not effective. This determination should be done objectively, quantitatively, and using statistical analysis.

- A regular assessment program will, over time, assist in selecting herbicides or other management techniques that are both effective in controlling aquatic plants, and cost-effective.

- We recommend that the State of Montana develop a decision matrix or decision tree that gives guidance on control techniques that are appropriate for a given set of site characteristics, size of plant infestation, and use restrictions. An example is shown in Table 7. While this may not be required in all situations, it will assist in developing management plans. Alternatively, the state could rely on the ongoing versions of the AERF aquatic plant best management practices manual as a resource for planning management activity (Gettys et al. 2009). These steps might reduce the time required between invasive plant discovery and management at that site.

Table 7. Example of a decision matrix for management of Eurasian watermilfoil. Be advised that this is an example only, to demonstrate the concept (Madsen and Wersal 2008). A working decision matrix or decision tree should be developed by Montana agencies in cooperation with external expertise.

Site water exchange characteristics	**Target plant (Eurasian watermilfoil) colony characteristic**				
	Scattered individual plants	**Small dense beds less than 2 acres**	**Dense beds from 2-5 acres**	**Dense beds from 5 to 25 acres**	**Dense beds over 25 acres**
Very Short exposure time (<12 h)	Hand pulling Diver dredge	Diver dredge Benthic barrier Diquat Endothall	Diquat Endothall	Diquat Endothall	Drawdown 2,4-D Triclopyr
Short exposure time (12 – 24 h)	Hand pulling Diver dredge	Diver dredge Benthic barrier Diquat Endothall 2,4-D Triclopyr	Diquat Endothall 2,4-D Triclopyr	2,4-D Triclopyr	Drawdown 2,4-D Triclopyr
Moderate exposure time (24-72 h)	Hand pulling Diver dredge	Diver dredge Benthic barrier Diquat Endothall 2,4-D Triclopyr	Diquat Endothall 2,4-D Triclopyr	Diquat Endothall 2,4-D Triclopyr	Drawdown Diquat Endothall 2,4-D Triclopyr
Long exposure time (> 72 h)	Hand pulling Diver dredge 2,4-D Triclopyr	Diver dredge Benthic barrier Diquat Endothall 2,4-D Triclopyr	Diquat Endothall 2,4-D Triclopyr	Diquat Endothall 2,4-D Triclopyr	Drawdown Diquat Endothall 2,4-D Triclopyr Fluridone

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