Aquatic Plant Monitoring In
Noxon Rapids Reservoir and Cabinet Gorge Reservoir for 2010

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Introduction

Understanding the dynamics of macrophyte populations in a given water body has become increasingly important due to the introduction and spread of numerous non-native 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 species 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).

Eurasian watermilfoil (*Myriophyllum spicatum* L.) populations were surveyed and mapped for the first time in 2008 in the major reservoirs of the Lower Clark Fork River (Madsen and Cheshier 2009). During this initial survey, Eurasian watermilfoil was observed at 12% of all littoral zone points in Noxon Rapids Reservoir (Noxon) with an areal coverage of 247 acres. Eurasian watermilfoil also occurred at 15% of all littoral zone point in Cabinet Gorge Reservoir (Cabinet) with an areal coverage of 117 acres. At that time, it was recommended that aggressive management of Eurasian watermilfoil be implemented as quickly as possible to prevent further spread of this species downstream. Research and demonstration studies utilizing herbicides for control of Eurasian watermilfoil were initiated in the summer of 2009 and continued through 2010 in Noxon on small (< 30 acre) populations of Eurasian watermilfoil. While extensive monitoring and assessments were conducted within the treatment areas, there was considerable concern expressed by some stakeholders regarding off-target effects of herbicides to the plant community throughout Noxon; most notably the concern that complete removal of aquatic vegetation might occur. Additional surveys and mapping were conducted in 2009 (Wersal et al. 2009).

Therefore, littoral zone surveys were conducted in 2008, 2009, and 2010 to assess changes in the aquatic plant community throughout Noxon simultaneous to Eurasian watermilfoil management efforts. Pursuant to this, similar surveys were conducted in Cabinet in 2008 and again in 2010 to determine changes in the Eurasian watermilfoil population, as Cabinet has not undergone any management for Eurasian watermilfoil. Cabinet is also downstream from Noxon and receives any Eurasian watermilfoil fragments that escape from upstream sources. The littoral zone survey approach has been successful in monitoring plant community dynamics in a number of large waterbodies across the United States (Wersal et al. 2006, Wersal et al. 2008, Madsen et al. 2008, Madsen and Wersal 2009, Wersal et al. 2010). This method is cost effective and efficient to survey large areas and collect large quantities of data on the distribution and abundance of aquatic macrophytes. These surveys also provide a quantitative approach by collecting presence/absence data that can then be statistically analyzed.

The results from 2008 through 2010 for both Reservoirs are presented in this report.

Materials and Methods

Point Intercept Surveys. Point intercept surveys were conducted in July/August of 2010 on Noxon Rapids Reservoir and Cabinet Gorge Reservoir. The survey intensity was increased on both reservoirs compared to previous surveys (Madsen and Cheshier 2009, Wersal et al. 2009) by increasing the number of points surveyed within the littoral zone. A 150 m grid was used to survey the littoral zone of Noxon which resulted in 314 sample points. A 125 m grid was used to survey Cabinet which resulted in 212 survey points. Survey methods were similar to those utilized during similar projects in the northwest (Madsen and Wersal 2008, 2009). Surveys were conducted by boat using GPS (Global Positioning System) technology. A Dell Latitude E 6400 XFR ruggedized computer (Round Rock, Texas) outfitted with a Trimble AgGPS106^{tm} (Sunnyvale, California) GPS receiver was used to navigate to each point. Survey accuracy was 3-10 feet (1-3 m) depending on satellite reception. At each survey point, a weighted plant rake was deployed twice to determine the presence of plant species and water depth was recorded at this time as well.

Plant and spatial data were recorded electronically using FarmWorks Site Mate® software (Hamilton, Indiana). Collected data were recorded in database templates using specific pick lists constructed for this project. The software allowed for displaying spatial geographic information as well as navigation to specific points.

Plant species presence was averaged over all points sampled and multiplied by 100 to obtain percent frequency of occurrence for each species. To assess changes in the occurrence of plant species across years, data was subjected to a Cochran-Mantel-Haenszel test (Stokes et al. 2000). Total species richness (average number of species per point), as well as non-native species richness and native species richness were calculated for both Noxon and Cabinet. Richness data for Noxon were subjected to a general linear model to determine if differences exist among years. A t test was used to assess differences in richness data for Cabinet because there were only two years of survey data. All analyses were conducted using SAS® (Cary, NC) analytical software at a $p < 0.05$ level of significance.

Cabinet Gorge Eurasian watermilfoil Bed Mapping. Eurasian watermilfoil beds were mapped in 2008 using a combination of visual identification and hydroacoustic sensing (Lowrance LCX-28C depth finder) (Madsen and Cheshier 2009). Similar mapping was done again in 2010 to determine the areal extent of Eurasian watermilfoil throughout Cabinet as compared to 2008 data. This technique offers finer-resolution point mapping to outline locations of Eurasian watermilfoil beds. During both years the entire circumference of the reservoir was mapped. Mapping of submersed aquatic plants is much more difficult than that of mapping terrestrial weeds, especially when plants are growing in 20 to 30 feet of water depth and finding every individual is unlikely. Eurasian watermilfoil mapping in Noxon from 2009 is also reported in this document.

Results and Discussion

Noxon Rapids Reservoir. In general, the aquatic plant community changed little over the three years of surveying (Table 1). Eurasian watermilfoil was found at 10, 13, and 8% of points surveyed in 2008, 2009, and 2010 respectively, though these differences were not significant. The locations of Eurasian watermilfoil are depicted in Figures 1 to 3. The native plant community has remained stable over the last three years which indicates current research and demonstration projects have had little large scale impact to the littoral zone plant community. Species richness (the average number of species per point) has not changed for each metric measured over the last three years.

The most notable change that has occurred, which should cause concern, is the increase in curlyleaf pondweed throughout Noxon. The presence of curlyleaf pondweed has increased by 65% from 2008. Though the increase in curlyleaf pondweed is not exclusive to the Lower Clark Fork system, as increases were also reported in Lake Pend Oreille, ID between 2007 and 2008 (Wersal and Madsen 2009). Curlyleaf pondweed, like Eurasian watermilfoil, causes significant nuisance problems (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). Control of this species would take an effort equivalent to or greater than that of Eurasian watermilfoil, though available control options are going to be limited. Currently, curlyleaf pondweed is more widespread than Eurasian watermilfoil in Noxon (Figures 4 and 5)

Cabinet Gorge Reservoir. Changes in the plant community in Cabinet were observed between surveys conducted in 2008 and 2010 (Table 2). These changes were in large part due to increases in elodea, curlyleaf pondweed, leafy pondweed, and white water-buttercup. Increases in the occurrence of these species may be attributed to more favorable growing conditions. Water levels in Cabinet were lower than those reported in Noxon, which would lead to greater light availability resulting in increased plant growth (Barko et al. 1986). Eurasian watermilfoil was observed at 15 and 19% of survey points in 2008 and 2010 respectively, and its distribution is depicted in Figure 6. Mapping of Eurasian watermilfoil in 2008 recorded approximately 78.1 acres, however the acreage of Eurasian watermilfoil increased to 327.9 in 2010 (Figures 7 and 8). Curlyleaf pondweed was observed at 25 and 35% of survey in points in 2008 and 2010 respectively, which represents a 40% increase in its occurrence throughout the reservoir. The current distribution of curlyleaf pondweed in Cabinet is depicted in Figure 9.

Total species richness increased from 1.7 to 2.2 species per point due to the increased occurrence of the plant species previously reported. Native species richness and non-native species richness did not change between years. It would be expected though, as curlyleaf pondweed and Eurasian watermilfoil spread within the reservoir, the presence of native plants will be reduced (Madsen et al. 1991, Madsen et al. 2008)

Conclusions. A total of 17 aquatic plant species were observed in both Noxon and Cabinet between surveys conducted in 2008 and 2010. The research and demonstration projects that have been ongoing since 2009 have not had significant negative impacts to the littoral zone plant community in Noxon. In fact, there have been some localized increases in native plant species after Eurasian watermilfoil has been removed. It is recommended that large scale management be conducted to prevent the further spread of Eurasian watermilfoil to new areas of Noxon, and to slow propagule dispersal into Cabinet. Also, research needs to be conducted to determine the seasonal

life history of curlyleaf in the Lower Clark Fork River system to try to identify appropriate management techniques to address this rapidly expanding problem.

Eurasian watermilfoil and curlyleaf pondweed continue to spread in Cabinet; however, effective control will not be achieved until the infestations in Noxon are first addressed. Both reservoirs have a fairly large littoral zone relative to their total size. The estimated littoral areas encompass approximately 1,942 (25%) and 1,121 (38%) acres for Noxon and Cabinet, respectively; assuming a littoral zone depth of 25'. Given growth requirements, life history strategies, and current use patterns of both reservoirs; Eurasian watermilfoil and curlyleaf pondweed are likely to become a severe problem if not adequately addressed.

It is recommended that point intercept surveys be conducted at least every year in June or July to continue to monitor these species. A more directed mapping approach can also be implemented in areas where these species already exist to further delineate the population and track expansion. The populations of both species are still at a level that could be controlled, so it is critical to develop and implement a management plant a quickly as possible.

Acknowledgements

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Table 1. Frequency of occurrence of aquatic plant species in the littoral zone of Noxon Rapids Reservoir from 2008 to 2010.

Plant Species	Common Name	2008 % (n=150)	2009 % (n=150)	2010 % (n=314)	P-value
Butomus umbellatus	Flowering rush	2	1	1	0.41
Ceratophyllum demersum	Coontail	20	23	24	0.62
***Chara* sp.**	Muskgrass	19	21	19	0.84
Elodea canadensis	Elodea	32	37	30	0.28
Heteranthera dubia	Water stargrass	5	7	6	0.73
Myriophyllum sibiricum	Northern watermilfoil	19	22	21	0.77
Myriophyllum spicatum	Eurasian watermilfoil	10	13	8	0.14
***Nitella* sp.**		2	4	0	<0.01
Potamogeton crispus	Curlyleaf pondweed	17	11	28	<0.01
Potamogeton foliosus	Leafy pondweed	21	19	18	0.64
Potamogeton illinoensis	Illinois pondweed	1	3	0	0.02
Potamogeton praelongus	Whitestem pondweed	0	1	1	0.40
Potamogeton richardsonii	Clasping-leaved pondweed	11	17	11	0.15
Potamogeton zosteriformis	Flat-stemmed pondweed	2	1	1	0.33
Ranunculus aquatilis	White water-buttercup	2	7	21	<0.01
Stuckenia pectinata	Sago pondweed	27	15	20	0.03
Vallisneria americana	Water celery	1	1	0	0.14
Non-Native Species Richness (No. per point)		0.3	0.3	0.4	0.11
Native Species Richness (No. per point)		1.6	1.7	1.7	0.78
Total Species Richness (No. per point)		1.9	2.0	2.1	0.76
Water Depth (ft)		14.9	16.1	18.8	

Table 2. Frequency of occurrence of aquatic plant species in the littoral zone of Cabinet Gorge Reservoir for 2008 and 2010.

Plant Species	Common Name	2008 % (n=139)	2010 % (n=212)	P-value
Butomus umbellatus	Flowering rush	0	0.4	0.41
Ceratophyllum demersum	Coontail	35	27	0.16
***Chara* sp.**	Muskgrass	1	5	0.09
Elodea canadensis	Elodea	38	55	<0.01
Juncus pelocarpus	Brown fruitrush	1	0	0.21
Myriophyllum sibiricum	Northern watermilfoil	12	12	0.93
Myriophyllum spicatum	Eurasian watermilfoil	15	19	0.23
***Nitella* sp.**		1	3	0.16
Potamogeton crispus	Curlyleaf pondweed	25	35	0.04
Potamogeton foliosus	Leafy pondweed	6	15	<0.01
Potamogeton gramineus	Variableleaf pondweed	2	0	0.03
Potamogeton illinoensis	Illinois pondweed	6	1	0.01
Potamogeton praelongus	Whitestem pondweed	0	0.4	0.41
Potamogeton richardsonii	Clasping-leaved pondweed	14	20	0.11
Potamogeton zosteriformis	Flat-stemmed pondweed	7	4	0.15
Ranunculus aquatilis	White water-buttercup	2	19	<0.01
Stuckenia pectinata	Sago pondweed	4	7	0.28
Non-Native Species Richness (No. per point)		0.4	0.6	0.24
Native Species Richness (No. per point)		1.3	1.7	0.07
Total Species Richness (No. per point)		1.7	2.2	0.04
Water Depth (ft)		14.9	13.5	

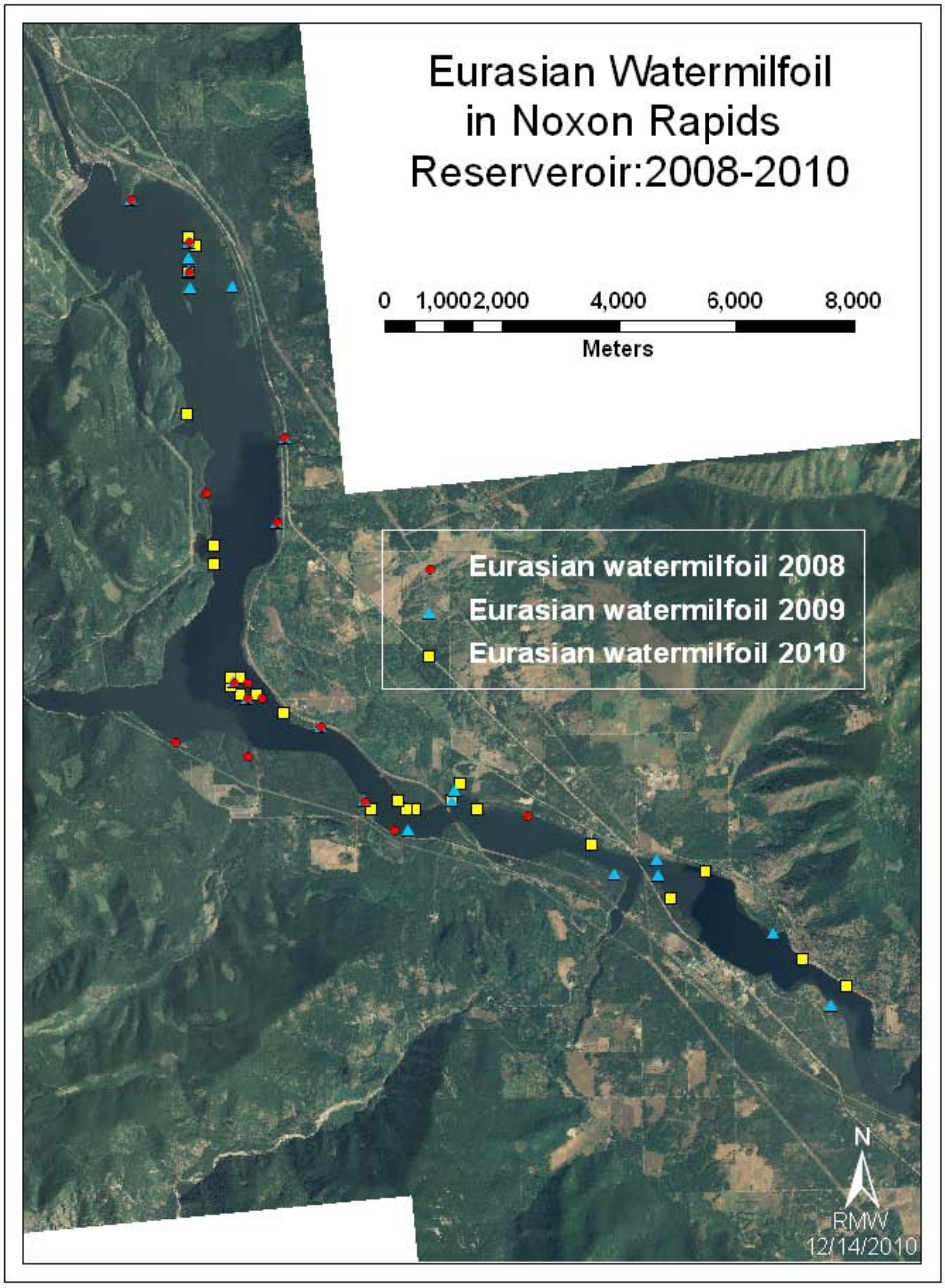

Figure 1. The locations of Eurasian watermilfoil in Noxon Rapids Reservoir during littoral zone surveys conducted in 2008, 2009, and 2010.

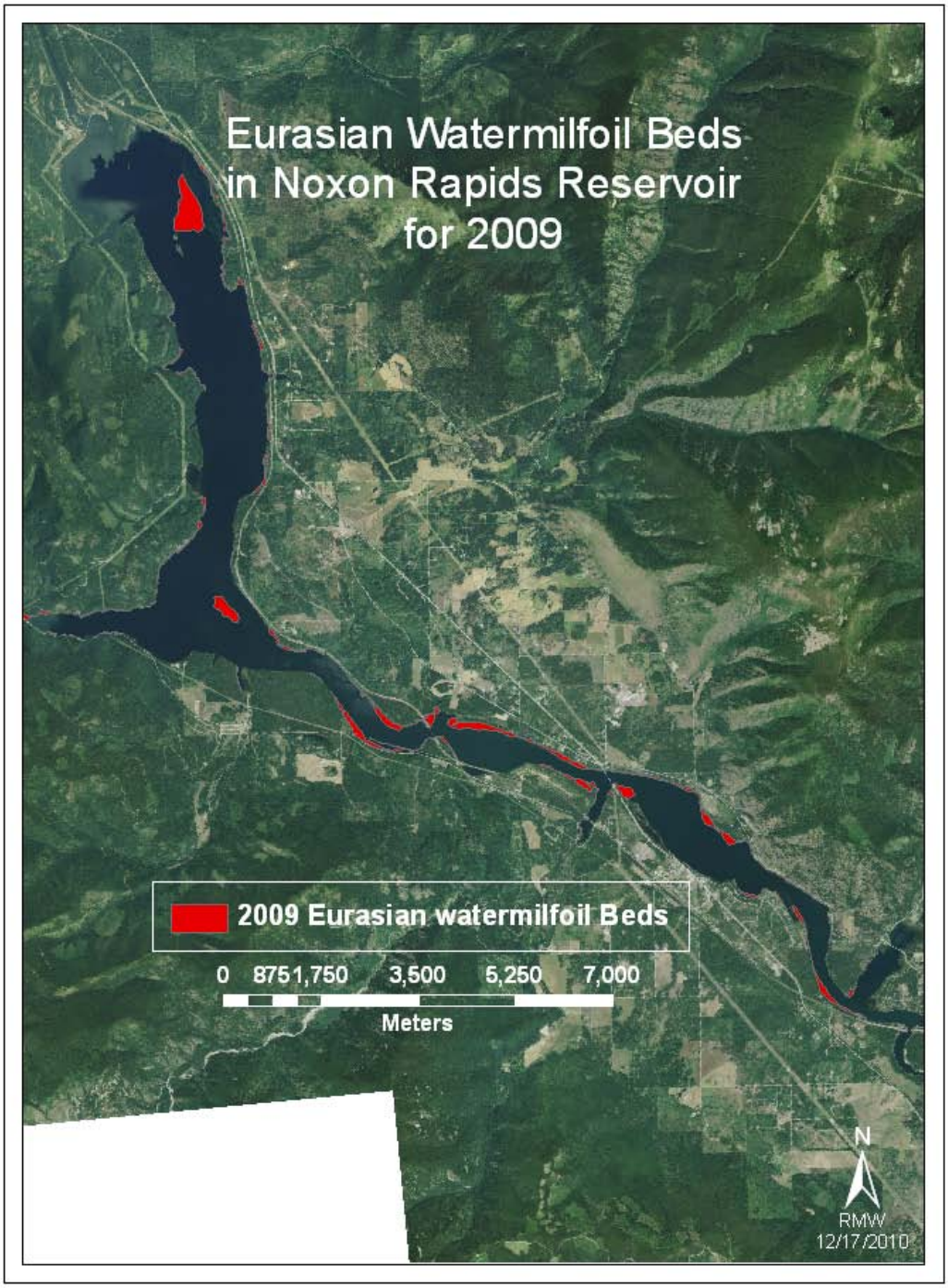

Figure 2. Eurasian watermilfoil beds in Noxon Rapids Reservoir near the dam as of 2009.

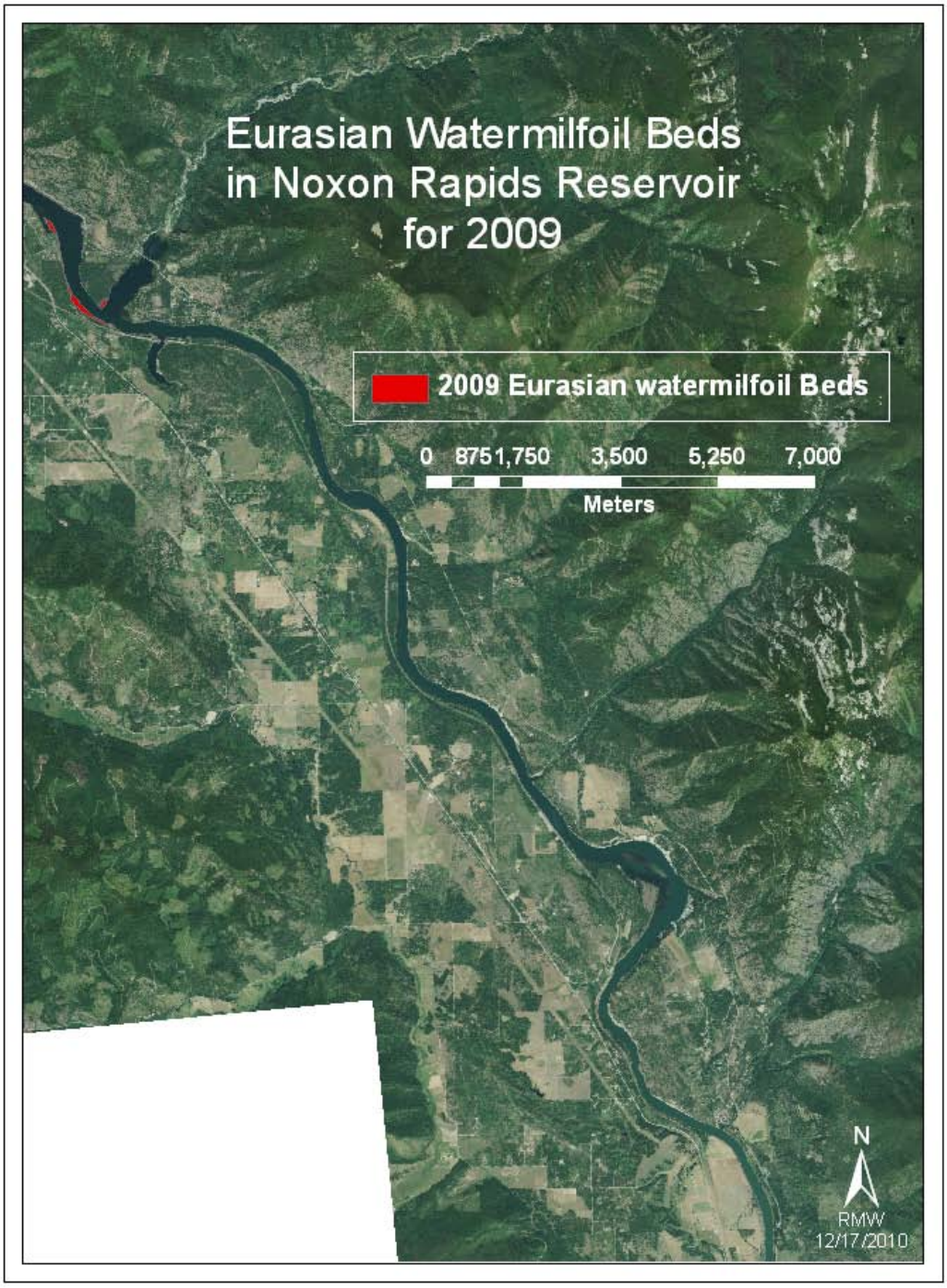

Figure 3. Eurasian watermilfoil beds in Noxon Rapids Reservoir near Finley Flats as of 2009.

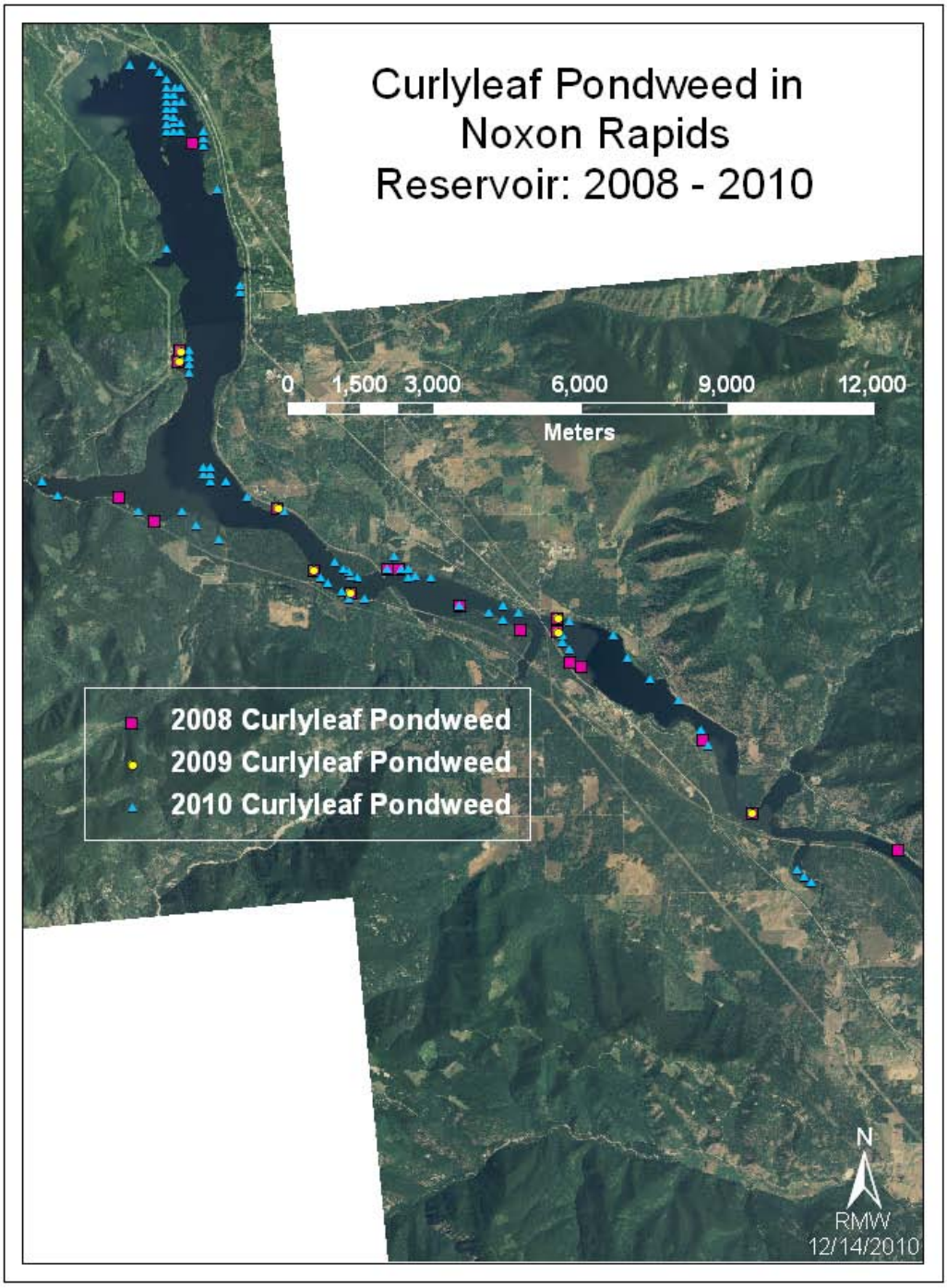

Figure 4. The locations of curlyleaf pondweed in Noxon Rapids Reservoir near the Noxon dam during littoral zone surveys conducted in 2008, 2009, and 2010.

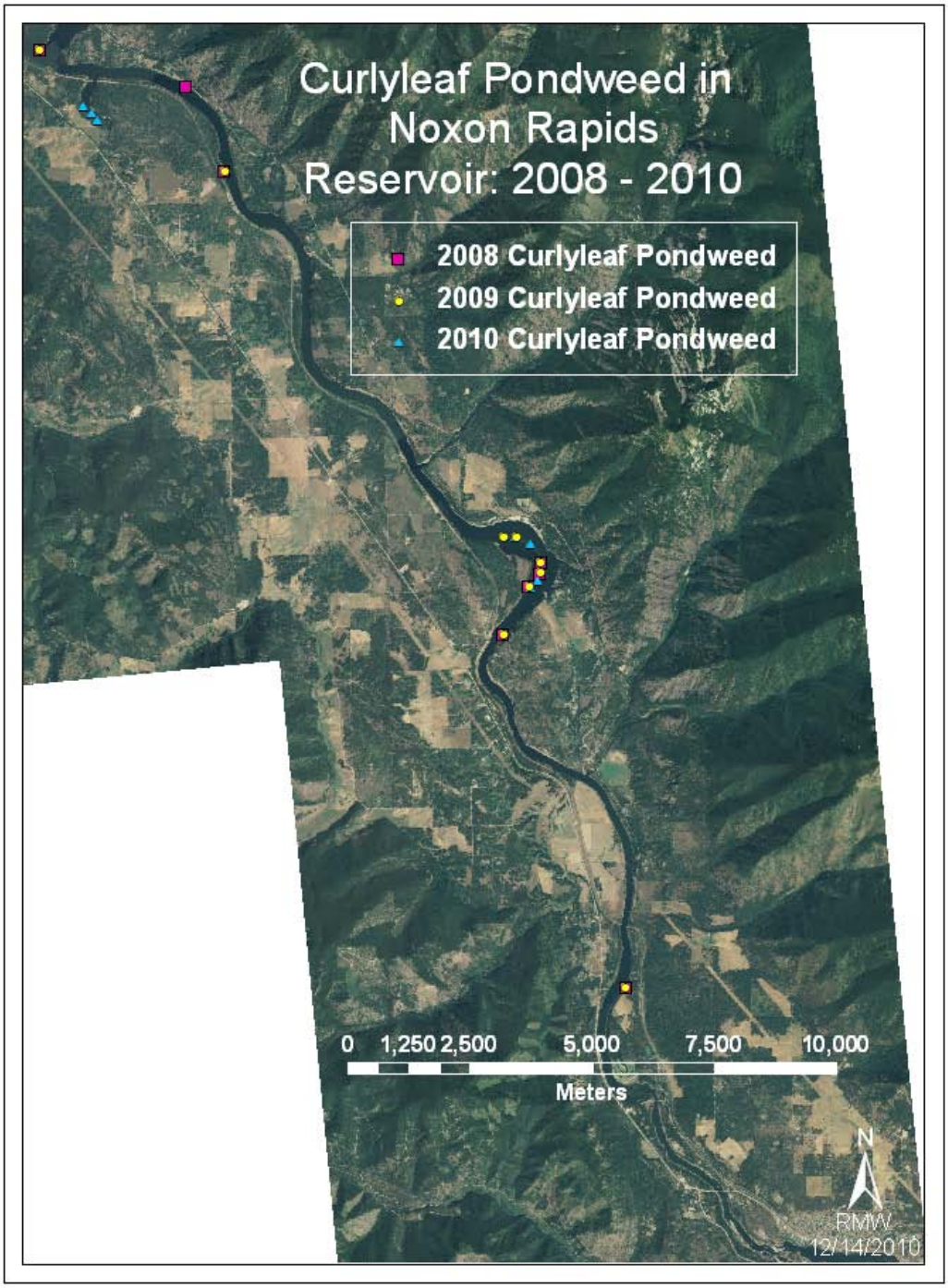

Figure 5. The locations of curlyleaf pondweed in Noxon Rapids Reservoir near Finley Flats during littoral zone surveys conducted in 2008, 2009, and 2010.

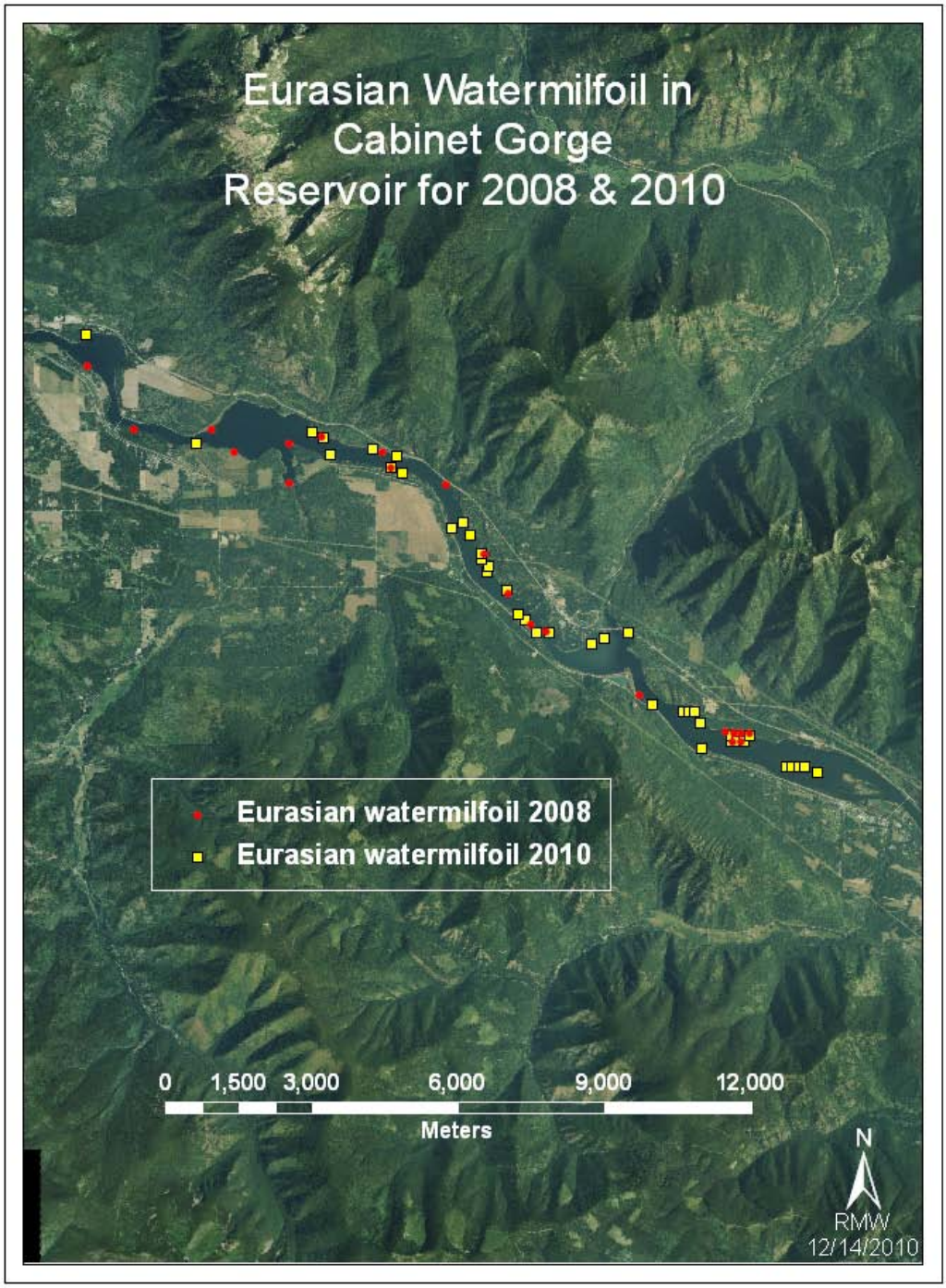

Figure 6. The locations of Eurasian watermilfoil in Cabinet Gorge Reservoir during littoral zone surveys conducted in 2008 and 2010.

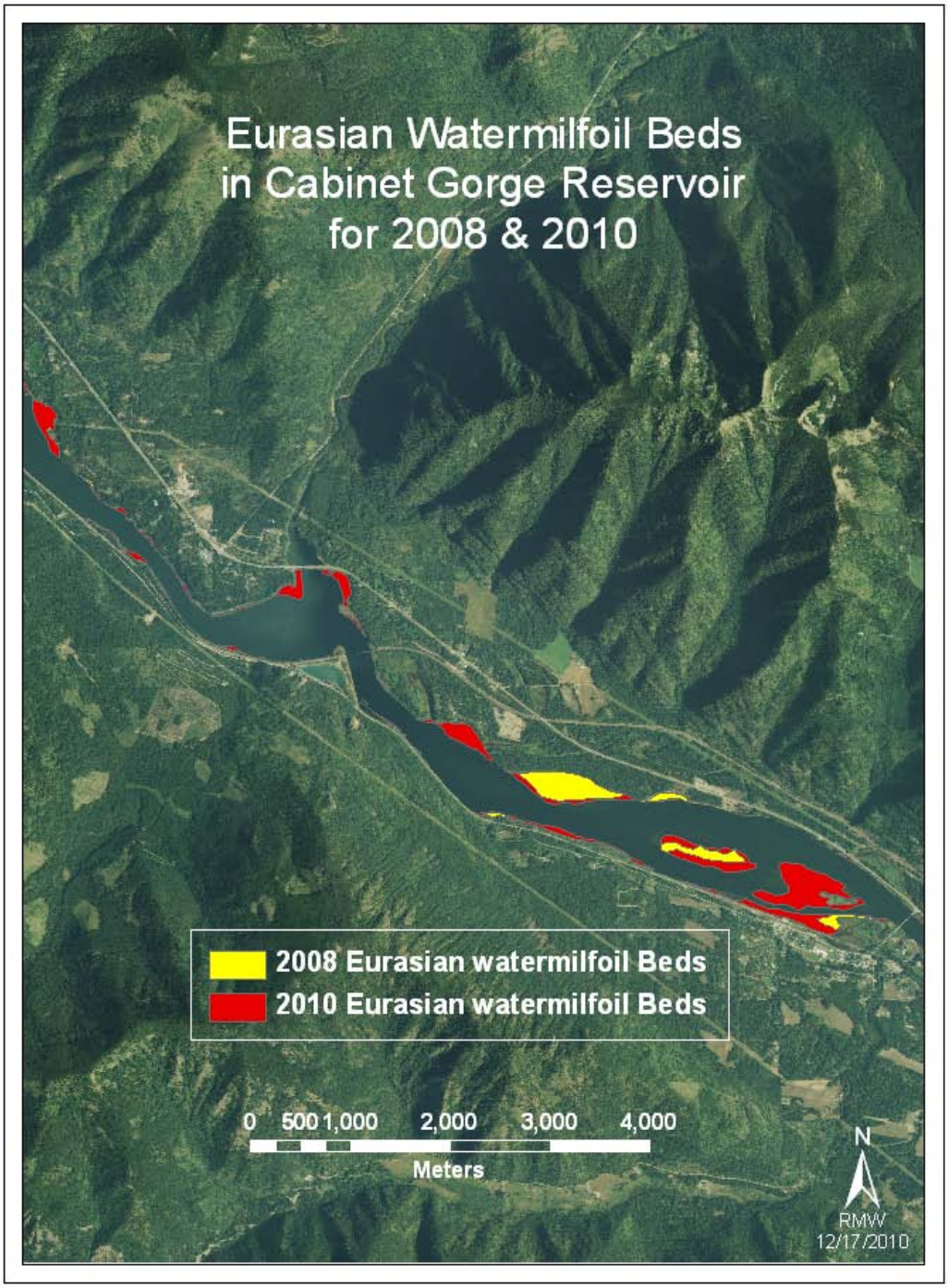

Figure 7. Eurasian watermilfoil beds in the upstream portion of Cabinet Gorge Reservoir for 2008 and 2010.

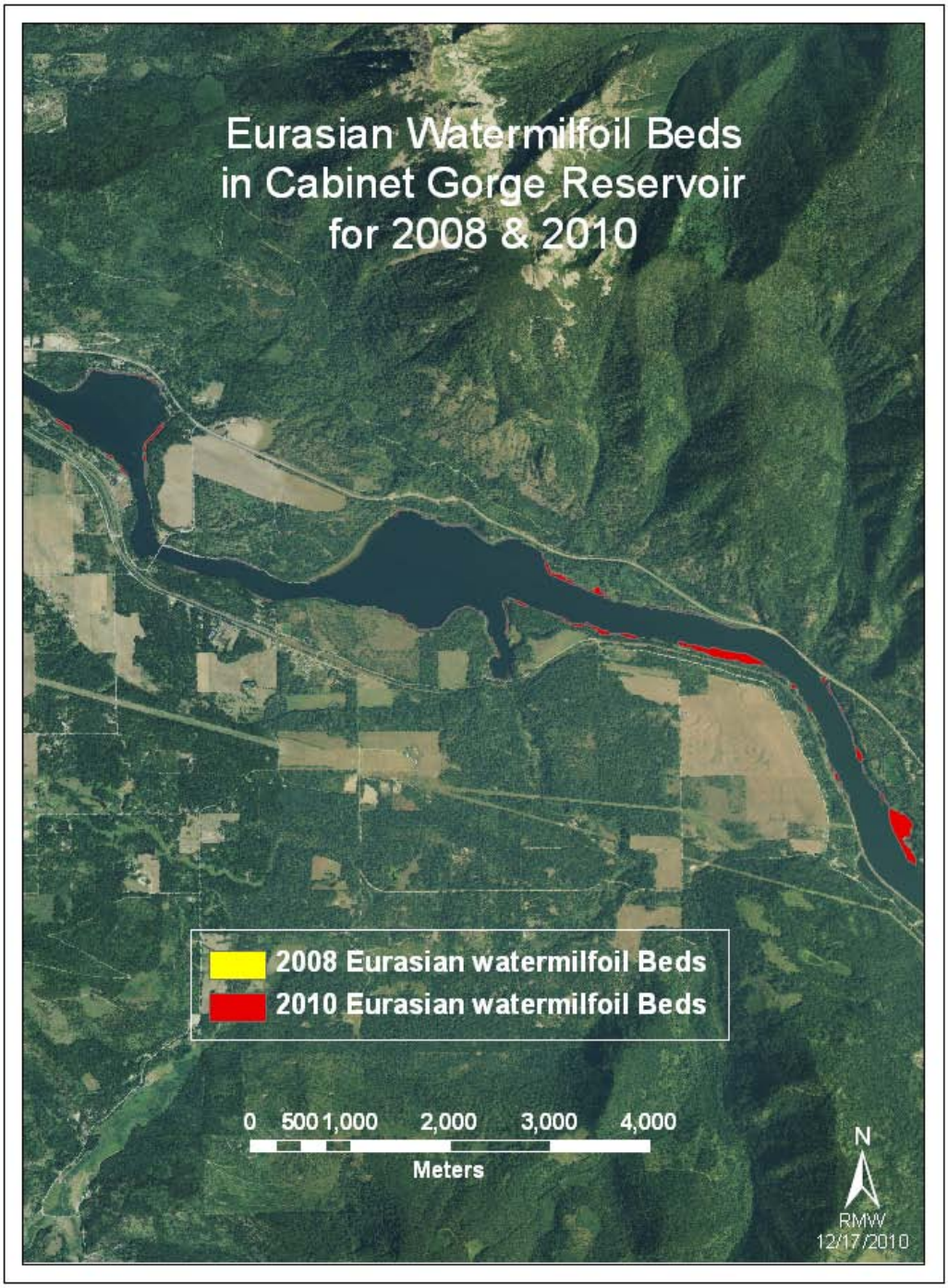

Figure 8. Eurasian watermilfoil beds in the downstream portion of Cabinet Gorge Reservoir for 2008 and 2010.

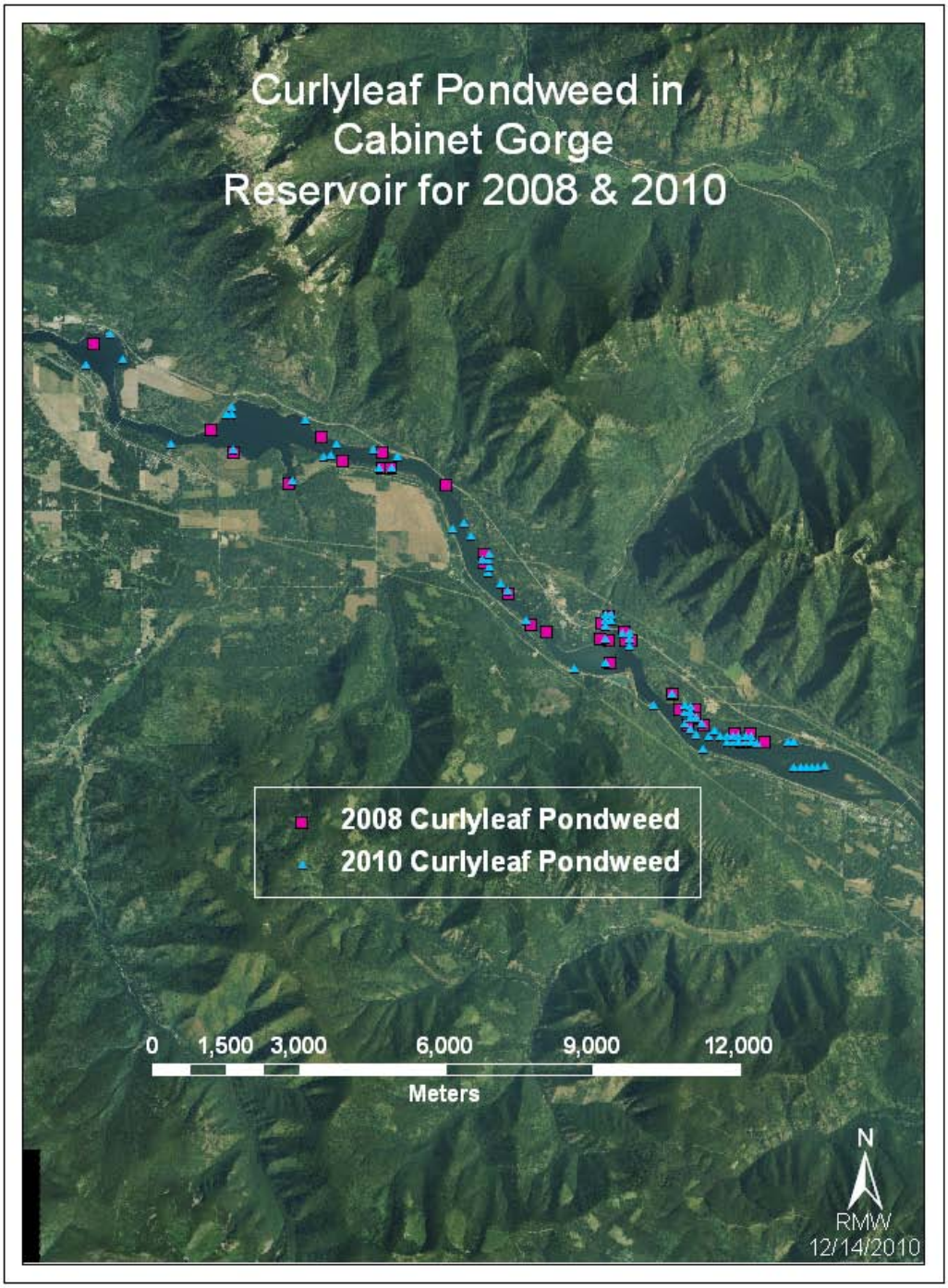

Figure 9. The locations of curlyleaf pondweed in Cabinet Gorge Reservoir during littoral zone surveys conducted in 2008 and 2010.