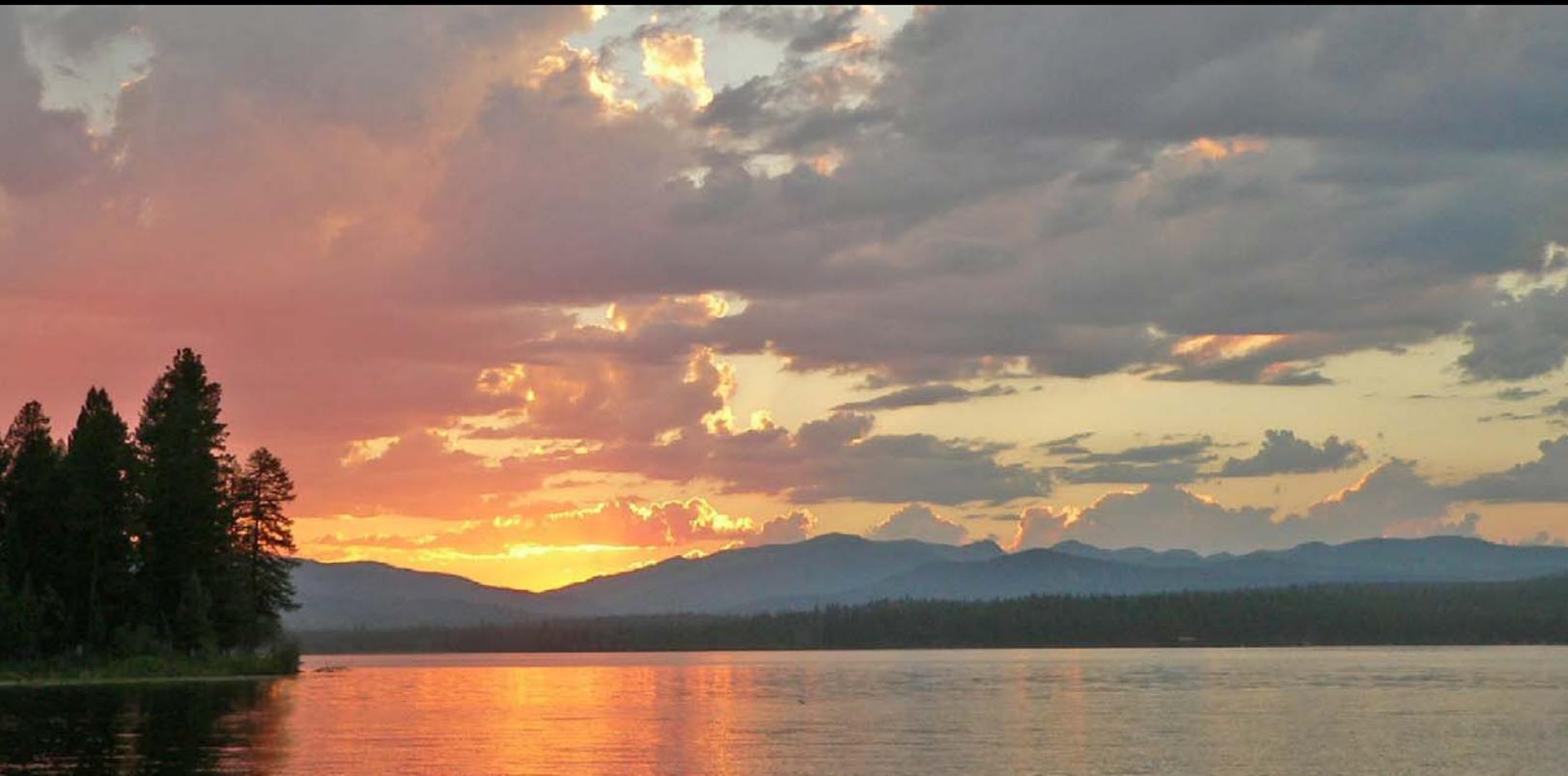




Littoral Survey of Noxon and Cabinet Gorge Reservoirs

Sanders County, MT - 2017



Sanders County
Aquatic Invasive Plants Task Force
Reservoir-Wide Monitoring

Nov. 20, 2017

Prepared for:

Board of County Commissioners
Aquatic Invasive Plant Task Force
Sanders County, Montana
Attention: Kim Bergstrom
Task Force Facilitator
1111 Main Street
Thompson Falls, MT 59873

Submitted by:

Water & Environmental Technologies
480 East Park Street
Butte, MT 59701
406.782.5220

Table of Contents

Preface:	1
Introduction:.....	2
Methods:	2
Existing Data Review:	2
Geospatial Database Creation:.....	2
Point Intercept Surveys:.....	3
Results and Discussion:	4
Noxon Reservoir:	4
Cabinet Gorge Reservoir:	5
Conclusion and Recommendations:.....	6
Noxon Reservoir:	6
Cabinet Gorge Reservoir:	7
Future Surveys:	7
References:.....	8

Tables:

Table 1. Percent frequency of aquatic plant species in Noxon Reservoir in 2017

Table 2. Dense beds of Eurasian watermilfoil identified in Noxon Reservoir in 2017

Table 3. Percent frequency of aquatic plant species in Cabinet Gorge Reservoir in 2017

Table 4. Dense beds of Eurasian watermilfoil identified in Cabinet Gorge Reservoir in 2017

Figures:

Figure 1. Proposed Survey Points (Pre-survey) on Noxon Reservoir

Figure 2. Proposed Survey Points (Pre-survey) on Cabinet Gorge Reservoir

Figure 3. Rake Toss Points on Noxon Reservoir in 2017

Figures 4-7. Rake Toss Points with Eurasian watermilfoil on Noxon Reservoir in 2017

Figures 8-11. Bed Delineation of Invasive Species on Noxon Reservoir in 2017

Figure 12. Rake Toss Points on Cabinet Gorge Reservoir in 2017

Figures 13 & 14. Rake Toss Points with Eurasian watermilfoil on Cabinet Gorge Reservoir in 2017

Figures 15 & 16. Bed Delineation of Invasive Species on Cabinet Gorge Reservoir in 2017

Preface:

This report presents data collected by Water and Environmental Technologies, Butte Montana, in 2017 on Noxon and Cabinet Gorge reservoirs. Funding was provided by Sanders County, Montana through the Aquatic Invasive Plants Task Force. All surveys were conducted by Jay Slocum and John Babcock.

For more information please contact Jay Slocum at jslocum@waterenvtech.com, or visit our website at www.waterenvtech.com.



Photo 1 & 2: Double-sided thatch rake used to collect vegetation samples and quantify plant density.

Littoral Survey of Noxon and Cabinet Gorge Reservoirs, Sanders County, MT – 2017
Sanders County Aquatic Invasive Plants Task Force

Jay Slocum – Senior Wildlife Biologist
Water and Environmental Technologies – Butte, MT

Introduction:

Eurasian watermilfoil (EWM) (*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 (Turnage et al. 2014). By systematically surveying infested reservoirs, the locations and intensities of infestations will become evident. This information will give reservoir managers baseline information to focus management options and facilitate suitable control methods.

The 2017 Alternatives Analysis (DeBruyckere et al. 2017) and the 2017 Adaptive Management Plan (Getsinger et al. 2017) provide recommendations for ongoing vegetation monitoring methods and adaptive management alternatives. These documents, along with input from Sanders County Aquatic Invasive Plants Task Force Facilitator Kim Bergstrom, helped Water and Environmental Technologies (WET) personnel revise the survey methodology implemented during the 2017 reservoir-wide surveys of Noxon and Cabinet Gorge reservoirs. Changes to the survey methodology increased the overall efficiency and scope to include prioritized areas, such as boat launches and well-established EWM infestation areas.

Methods:

Existing Data Review:

The littoral surveys conducted in 2013 on Noxon and Cabinet Gorge reservoirs (Turnage et al. 2014) provided the foundation for the reservoir-wide survey methodology for point intercept assessments. A WET Geographic Information Systems (GIS) Specialist reviewed the existing geospatial data to determine whether data quality objectives were being met and used efficiently. Two recommendations were identified: 1) sample data post-2013 was collected in sample-point-clusters in some areas, which resulted in a biased collection pattern and increased frequency of certain plant species; and 2) some sampling locations were located outside the littoral zone (deeper than 40-feet). The sample point clusters and intercept sample points located outside the littoral zone were determined to be unnecessary and were excluded from the 2017 reservoir-wide surveys of Noxon and Cabinet Gorge reservoirs.

Geospatial Database Creation:

During the 2017 review of the existing geospatial data it was determined that creating a GIS driven database to promote field data collection consistency would be helpful to meet data quality objectives. This database ensures that future surveys will be methodically conducted using pre-defined point intercept attributes, point intercept grid pattern schemas, and bed delineation attributes. This GIS geodatabase was created with input from the AIS Task Force and Avista.

The geodatabase consists of the following:

- Reservoir-wide - grid pattern schemas:
 - 150-meter grid pattern – Noxon Reservoir,
 - 125-meter grid pattern – Cabinet Gorge Reservoir, and
 - 50-meter grid pattern – Noxon and Cabinet Gorge Reservoirs.
- 2017 Pre-Defined Point Intercept Sampling Locations – Derived from the 2013 Turnage and Madsen sampling patterns with sample point clusters and intercept sample points located outside the littoral zone removed.
- Invasive Species Bed Delineation Polygons.
- Survey Point Intercept Data Results.

The point intercept grid patterns schemas of 150 meters on Noxon reservoir and 125 meters on Cabinet Gorge reservoir were maintained as requested by the AIS Task Force. The 50-meter grid pattern was developed due to recommendations made in the 2017 Adaptive Management Plan (Getsinger et al. 2017) for site-specific sampling when aquatic invasive species are encountered.

Point Intercept Surveys:

Point intercept surveys were conducted on September 11 through September 15, 2017 to assess the aquatic plant community in the Noxon and Cabinet Gorge reservoirs littoral zones (0-40 ft) and quantify the level of infestation of EWM. To be consistent with previous survey efforts, the existing 150-meter grid pattern was used for the Noxon survey (**Figure 1**) and the existing 125-meter grid pattern was used for the Cabinet Gorge survey (**Figure 2**). As previously mentioned, sample clusters and intercept points located in water deeper than 40-feet were not sampled. Point intercept survey methods were similar to those utilized during past Noxon and Cabinet Gorge reservoir-wide surveys. Pre-survey data analysis showed there was 346 proposed point intercept survey sites on Noxon reservoir and 297 proposed sites on Cabinet Gorge reservoir (**Figures 1 & 2**).

EWM, curlyleaf pondweed, and flowering rush beds were delineated with the relative density of each invasive species quantified. Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage (**Photos 1 & 2**). Larger significant beds containing non-target species were also delineated for future reference and possible analysis. At sites indicating the presence of EWM additional point intercept surveys using a finer resolution 50-meter grid pattern were conducted. This fine-resolution data was used to construct bed delineations and help quantify invasive species density in the mapped area. Due to low flows, dense surface vegetation, and reservoir water drawdowns for infrastructure maintenance, many bed areas near shorelines and shallow areas were inaccessible. These areas were surveyed in calm water conditions that allowed for point intercept data collection along the bed edges augmented by ocular estimations of the extent and density of the bed. These methods did not assess invasive species in areas that contained less than 20% density, thus the actual areas inhabited by invasive species is greater than the delineated bed areas.

Surveys and bed delineations were conducted using Global Positioning System (GPS) and mobile ArcGIS technology to navigate and collect field data. Data collection accuracy was sub-foot depending on satellite reception, however, this accuracy was diminished by the length and width of the boat. For efficiency purposes, survey data was typically collected from the bow of the boat and electronically recorded near the stern. WET personnel deployed mobile GIS software and GPS enabled data collection devices for in-field geographic and attribute data collection. At each survey point, a weighted thatch rake was deployed twice to determine the presence of plant species. The rake was consistently tossed 15 feet horizontally from the boat, allowed to settle on the reservoir bottom, then slowly retrieved. Spatial data was recorded using a Trimble Geo XH 2008 Series Geo Explorer Geographic Information Data Collector and a Humminbird Helix 5 CHIRP Sonar/GPS G2 Combo was used to navigate and track boat routes. ArcPad software allowed for in-field geographic and attribute data collection. Data was recorded in databases using specific drop-down pick-lists designed for this project.

The existing GIS bed mapping data was digitized from past survey efforts (before 2017) and was considered a rough estimate of infested areas derived from data analysis and interpolation. One of the objectives of the 2017 survey effort was to create and maintain a geospatial database that contained a comprehensive and quantifiable record of the invasive plants beds for both reservoirs. To populate this newly created geospatial database, invasive species beds that contained any quantifiable densities were mapped. This included dense EWM beds and areas that did not meet the 50% density criteria but did contain quantifiable densities of invasive species. These low-density beds were typically found in previously treated or mapped areas.

Results and Discussion:

Noxon Reservoir:

Noxon reservoir had an aquatic plant community richness of 17 species (**Table 1**). The non-native species EWM, curlyleaf pondweed, and flowering rush were found at 32.6, 14.7, and 4.0% of surveyed points within the littoral zone, respectively. Observed curlyleaf pondweed frequency is likely lower than actual frequency because the survey was conducted during its dormancy period. The most common native species observed were coontail (*Ceratophyllum demersum*) 39.1%, elodia (*Elodea canadensis*) 20.0%, leafy pondweed (*Potamogeton foliosus*) 7.9%, northern watermilfoil (*Myriophyllum sibiricum*) 6.7% and sago pondweed (*Potamogeton pectinatus*) 6.7% (**Table 1**).

Researchers have identified a hybrid Eurasian/northern watermilfoil in these reservoirs and are assessing its impacts on northern watermilfoil populations and distribution. Distinguishing between native northern watermilfoil and the invasive EWM is difficult and time intensive due to the presence of hybrids. These hybrid watermilfoils have morphological characteristics of both the native and invasive species and tend to exhibit growth and density characteristics more closely related to the EWM. For the purposes of this survey, hybrid watermilfoil was not quantified, rather, it was classified as an invasive species and a hybrid notation was noted in the survey comment section.

There are 1,942 acres of littoral habitat in Noxon reservoir which covers approximately 25% of the water body's surface area (Wersal et al. 2010). Sampling occurred at 430 points throughout the reservoir (**Figures 3-7**). Approximately 214 acres within 36 delineated areas were classified as “dense EWM beds” during the 2017 reservoir-wide assessment (**Table 2, Figures 8-11**). In 2008, the initial estimate of dense EWM was 247 acres, with 323 acres in 2009 (Wersal et al. 2010), 96.6 acres in 2013 (Turnage et al. 2014), 19.7 acres in 2014, 90.8 acres in 2015, and 97 acres in 2016 (Hanson 2016). The 214 acres delineated in 2017 and classified as “dense beds” contained greater than 50% EWM plant density. This accounts for approximately 11.0% and 2.7% of the littoral and total reservoir acreages, respectively. This has decreased by 33.7% from the highest acreage reported, 323 acres in 2009. This represents a decrease of 13.3% in EWM bed acreage from the initial 2008 estimate. Surveys conducted in 2017 delineated invasive species beds that contained observable densities of invasive plant species and remapped previously delineated beds. According to the 2016 Littoral Survey Report, any dense beds of EWM that were not mapped in previous surveys, were mapped. The 2017 remapping effort probably accounts for some of the increase in acreage covered by invasive species from the 2016 survey due to the natural spread of untreated bed areas.

Overall approximately 440 acres of vegetative beds consisting of 67 unique areas were mapped during the 2017 survey on Noxon reservoir. Thirty-six (36) delineated areas consisting of approximately 214 acres, or 48.6% of the mapped beds, were classified as dense EWM beds (**Figures 8-11**). Twenty-eight (28) delineated areas consisting of approximately 137 acres, or 31.1% of the mapped beds, were classified as invasive species beds with less than 50% densities (**Figures 8-11**). These beds consisted of either EWM, curlyleaf pondweed, or flowering rush with some areas containing multiple invasive species. Three (3) delineated areas consisting of approximately 89 acres, or 20.2% of the mapped beds, were classified as dense non-target species beds (**Figures 8-11**). These non-target species beds were mapped to document areas that may be impacting recreational use.

Cabinet Gorge Reservoir:

Cabinet Gorge reservoir had an aquatic plant community richness of 16 species (**Table 3**). The non-native species EWM, curlyleaf pondweed, and flowering rush were found at 29.0, 7.0 and 0.3 percent of surveyed points within the littoral zone, respectively. Observed curlyleaf pondweed frequency is likely lower than actual frequency because the survey was conducted during its dormancy period. The most common native species observed were coontail 39.3%, elodea 30.1%, Richardson's pondweed (*Potamogeton richardsonii*) 6.8%, leafy pondweed 6.5%, and whitestem pondweed (*Potamogeton praelongus*) 5.4% (**Table 3**). For the purposes of this survey, hybrid watermilfoil was not quantified, rather, it was classified as an invasive species and a hybrid notation was noted in the survey comment section.

There are 1,121 acres of littoral habitat in Cabinet Gorge reservoir covering 38% of the water body's surface area (Wersal et al. 2010). Sampling occurred at 369 points throughout the reservoir (**Figures 12-14**). Approximately one hundred eighty-two (182) acres within 20 delineated areas were classified as “dense EWM beds” during the 2017 reservoir-wide assessment (**Table 4, Figures 15 & 16**). In 2008, the initial estimate of dense EWM was 78 acres, with 328 acres in

2010 (Wersal et al. 2010), 205 acres in 2013 (Turnage et al. 2014), 205 acres in 2015, and 209 acres in 2016 (Hanson 2016). The 182 acres delineated in 2017 and classified as “dense beds” contained greater than 50% EWM plant density. This accounts for approximately 16.2% and 6.1% of the littoral and total reservoir acreage respectively. This has decreased by 44.5% from the highest acreage reported, 328 acres in 2010. This represents an increase of 133% in EWM bed acreage from the initial 2008 estimate. The water level was low during the 2017 survey, thus exposing some of the littoral habitat that had been mapped in 2016. Dense beds were delineated at a finer scale in 2017, which decreased some dense bed acreage from what was mapped in 2016. These factors probably account for some of the decline in acreage covered by invasive species from the 2016 survey. No widespread EWM control efforts have been implemented on Cabinet Gorge reservoir, though portions of the reservoir were treated in 2014 and 2015.

Overall approximately 266 acres of vegetative beds consisting of 44 unique areas were mapped during the 2017 survey on Cabinet Gorge reservoir. Twenty (20) delineated areas consisting of approximately 182 acres, or 68.4% of the mapped beds, were classified as dense EWM beds (**Figures 15 & 16**). Nineteen (19) delineated areas consisting of approximately 70 acres, or 26.3% of the mapped beds, were classified as invasive species beds with less than 50% densities (**Figures 15 & 16**). These beds consisted of either EWM or curlyleaf pondweed with some areas containing both invasive species. Four (4) delineated areas consisting of approximately 10 acres, or 3.7% of the mapped beds, were classified as dense non-target species beds (**Figures 15 & 16**). These non-target species beds were mapped to document areas that may be impacting recreational use. One delineated area (CAB-6) consisting of approximately 4 acres, or 1.5% of the mapped beds, was classified as an area likely to contain dense EWM when inundated (**Figure 16**).

Conclusion and Recommendations:

Noxon Reservoir:

EWM occurs throughout the entire length of the reservoir but tends to be abundant in the downstream reaches (**Figures 4-7 & 8-11**). Approximately 64 acres of dense EWM beds are located within one-mile of Trout Creek, 43.7 acres of dense beds occur within one-mile of Vermillion Bay and 31.5 acres of dense beds occur within one-mile of North Shore. Of the eight recreation areas assessed, these three recreational access points contain the largest acreages of dense EWM on Noxon reservoir. Targeting these sites for possible future control would increase treatment efficiency, provide treatment in high use/recreation areas, and influence shorelines owned by private stakeholders.

Of the 430 points sampled reservoir-wide, 358 points or 83.2% were surveyed at depths ranging from 1-25 feet. Of the 358 points sampled in the upper littoral zone, 286 points or 66.5% contained vegetation samples. Sixty-three (63) points or 14.6% were surveyed at depths ranging from 25-40 feet. Of the 63 points sampled in the lower littoral zone, 2 points or 3.1% contained vegetation samples. Nine (9) points or 2.1% were located at depths greater than 40 feet. These points were confirmed by sonar depth readings and should be removed from future surveys.

Cabinet Gorge Reservoir:

EWM occurs throughout the entire length of the reservoir but tends to be abundant in the upstream reaches (**Figure 13-16**). Approximately 128 acres of dense EWM beds are located within one-mile of Noxon Park, 17.0 acres of dense beds occur within one-mile of Bull River and 3.1 acres of dense beds occur within one-mile of Heron. Of the four recreation areas assessed, these three recreational access points contain the largest acreages of dense EWM on Cabinet Gorge reservoir. These sites should be considered high priority areas.

Of the 369 points sampled reservoir-wide, 326 points or 88.3% were surveyed at depths ranging from 1-25 feet. Of the 326 points sampled in the upper littoral zone, 224 points or 68.7% contained vegetation samples. Thirty-four (34) points or 9.2% were surveyed at depths ranging from 25-40 feet. Of the 34 points sampled in the lower littoral zone, 1 point or 2.9% contained vegetation samples. Nine (9) points or 2.4% were located at depths greater than 40 feet. These points were confirmed by sonar depth readings and should be removed from future surveys.

Future Surveys:

Ongoing monitoring efforts should continue utilizing the database provided. By refining the 2017 Pre-Defined Point Intercept Sampling Locations and incorporating the 2017 survey results, future surveys can be conducted more efficiently and effectively. Referencing the predefined reservoir-wide grid pattern schemas will also help maintain survey methodology consistency. The grid pattern schemas identify survey locations that should be included into ongoing reservoir-wide monitoring which are currently lacking. Future surveys should duplicate and repopulate the Invasive Species Bed Delineation Polygons and Survey Point Intercept Data feature classes provided. This will allow for unbiased records of each future monitoring event to be contained in one centralized database for easy reference and analysis. This monitoring database should be coupled with a treatment and control database in the future. By merging the monitoring and treatment results into one data system, resource managers will be able to make informed invasive species control decisions.

References:

- DeBruyckere, L., and T. Pennington. 2017. Analysis of Treatment Alternatives for Invasive Watermilfoil in Noxon Rapids and Cabinet Gorge Reservoirs, Sanders County, Montana, Creative Resource Strategies, Salem, OR.
- Getsinger, K.D., J.D. Madsen, G. Turnage, and J. Badger. 2017. Invasive aquatic plant control for Noxon and Cabinet Gorge reservoirs, Montana: An adaptive management plan. A report prepared for the Sanders County Aquatic Invasive Plants Task Force. Geosystems Research Institute Report #5074.
- Hanson, E. 2016. Noxon and Cabinet Gorge Reservoirs Littoral Survey 2016, Sanders County, Montana. Hanson Environmental, Missoula, MT.
- Turnage, G. and J. D. Madsen. 2014. Littoral Survey of Noxon and Cabinet Gorge Reservoirs, Montana, 2013. GRI Report #5061, Geosystems Research Institute, Mississippi State University. January 2014.
- Wersal, R.M., J.D. Madsen, & J.C. Cheshier. 2010. Aquatic plant monitoring in Noxon Rapids Reservoir and Cabinet Gorge Reservoir for 2010. Geosystems Research Institute Report# 5042.

Tables:

Table 1. Percent frequency of aquatic plant species in Noxon Reservoir in 2017.

Table 2. Dense beds of Eurasian watermilfoil identified in Noxon Reservoir in 2017.

Table 3. Percent frequency of aquatic plant species in Cabinet Gorge Reservoir in 2017.

Table 4. Dense beds of Eurasian watermilfoil identified in Cabinet Gorge Reservoir in 2017.

Table 1. Percent frequency of aquatic plant species in Noxon Reservoir in 2017.

Scientific Name	Common Name	Percent Occurrence
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	32.6%
<i>Potamogeton crispus</i>	curly leaf pondweed	14.7%
<i>Butomus umbellatus</i>	flowering rush	4.0%
<i>Ceratophyllum demersum</i>	coontail	39.1%
<i>Chara spp.</i>	chara	5.1%
<i>Elodea canadensis</i>	elodea	20.0%
<i>Heteranthera dubia</i>	water stargrass	2.3%
<i>Myriophyllum sibiricum</i>	northern watermilfoil	6.7%
<i>Najas flexilis</i>	slender naiad	0.5%
<i>Ranunculus aquatilis</i>	white waterbuttercup	2.8%
<i>Potamogeton foliosus</i>	leafy pondweed	7.9%
<i>Potamogeton illinoensis</i>	Illinois pondweed	1.9%
<i>Potamogeton pectinatus</i>	sago pondweed	6.7%
<i>Potamogeton praelongus</i>	whitestem pondweed	1.2%
<i>Potamogeton richardsonii</i>	Richardson's pondweed	5.8%
<i>Sagittaria cuneata</i>	arum-leaf arrowhead	0.2%
<i>Vallisneria americana</i>	water celery	0.2%

Table 2. Dense Beds of Eurasian watermilfoil identified in Noxon Reservoir in 2017.

Plot Identifier	Density* and Survey Comments	Acres
NOX-3/37/59	EWM-3	0.19
NOX-3/37/59	EWM-4	0.42
NOX-4	EWM-2.5	13.57
NOX-4-1	EWM-4	7.4
NOX-5-1	EWM-3.5	21.97
NOX-5-2	EWM-3	0.04
NOX-5-3	EWM-3	0.02
NOX-5-4	EWM-3, FR-1	0.1
NOX-5-5	Ocular Estimation, EWM-3 (Shallow)	19.69
NOX-6	EWM-2.5	13.57
NOX-7	EWM-3	2.75
NOX-9	EWM-4, CLPW- 1	3.44
NOX-10	EWM-2.5 along bank w/ coontail at depth, bed weakens heading west	13.06
NOX-11	EWM-3	10.25
NOX-12	EWM-3	16.83
NOX-24	EWM-3	3.81
NOX-29/58	EWM=3, CLWP present in western portion of bed	7.48
NOX-30	EWM-3	3.56
NOX-31-2	EWM-4	0.15
NOX-31-3	EWM-3	0.06
NOX-31-5	EWM-4	0.1
NOX-43/44	EWM-4	31.71
NOX-48-1	EWM-4	0.42
NOX-50	EWM-2.5 CLPW-1	22.48
NOX-52-1	EWM-3, CLPW-1	0.71
NOX-54	EWM-4	2.46
NOX-56	EWM-4	2.32
NOX-57	EWM-3, coontail also predominant	6.8
NOX-64	EWM-3, very small 20'x20'	0.01
NOX-65	EWM-3, small linear 5' off bank	0.01
NOX-66	EWM-2.75	2.51
NOX-67	EWM-4	0.56
NOX-68	EWM-3	0.57
NOX-73	EWM-3	0.42
NOX-74	EWM-3	1.21
NOX-77	EWM-4	3.94
TOTAL		214.6

*Density is measured on a 1-5 scale, with 5 being 100% dense.

Table 3. Percent frequency of aquatic plant species in Cabinet Gorge Reservoir in 2017.

Scientific Name	Common Name	Percent Occurrence
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	29.0%
<i>Potamogeton crispus</i>	curly leaf pondweed	7.0%
<i>Butomus umbellatus</i>	flowering rush	0.3%
<i>Ceratophyllum demersum</i>	coontail	39.3%
<i>Chara spp.</i>	chara	3.8%
<i>Elodea canadensis</i>	elodea	30.1%
<i>Heteranthera dubia</i>	water stargrass	0.5%
<i>Myriophyllum sibiricum</i>	northern watermilfoil	2.4%
<i>Najas flexilis</i>	slender naiad	0.3%
<i>Ranunculus aquatilis</i>	white waterbuttercup	0.8%
<i>Potamogeton foliosus</i>	leafy pondweed	6.5%
<i>Potamogeton friesii</i>	flatstem pondweed	3.0%
<i>Potamogeton illinoensis</i>	Illinois pondweed	2.2%
<i>Potamogeton pectinatus</i>	sago pondweed	4.6%
<i>Potamogeton praelongus</i>	whitestem pondweed	5.4%
<i>Potamogeton richardsonii</i>	Richardson's pondweed	6.8%

Table 4. Dense Beds of Eurasian watermilfoil indentified in Cabinet Gorge Reservoir in 2017.

Plot Identifier	Density* and Survey Comments	Acres
CAB-1-1	EWM-3, FR-1	16.28
CAB-1-3	EWM-4.5	35.67
CAB-1-6	EWM-3	6.77
CAB-2	EWM-4	65.11
CAB-3	EWM-3	11.16
CAB-4	EWM-3	10.82
CAB-5-1	EWM-4	0.3
CAB-5-1	EWM-2.75, CLPW-1	9.09
CAB-6-1	EWM-3	5.39
CAB-8	EWM-3, coontail also predominant	3.38
CAB-9-1	EWM-3	6.73
CAB-13	EWM-3	0.61
CAB-14	EWM-3	1.87
CAB-16	EWM-4	3.73
CAB-21	EWM-3	2.24
CAB-22	EWM-2.5	0.15
CAB-24	EWM-2.5	1.85
CAB-28	EWM-3	0.31
CAB-29-1	EWM-3	0.39
CAB-30	EWM-3	0.26
TOTAL		182.1

*Density is measured on a 1-5 scale, with 5 being 100% dense.

Figures:

Figure 1. Proposed Survey Points (Pre-survey) on Noxon Reservoir.

Figure 2. Proposed Survey Points (Pre-survey) on Cabinet Gorge Reservoir.

Figure 3. Rake Toss Points on Noxon Reservoir in 2017.

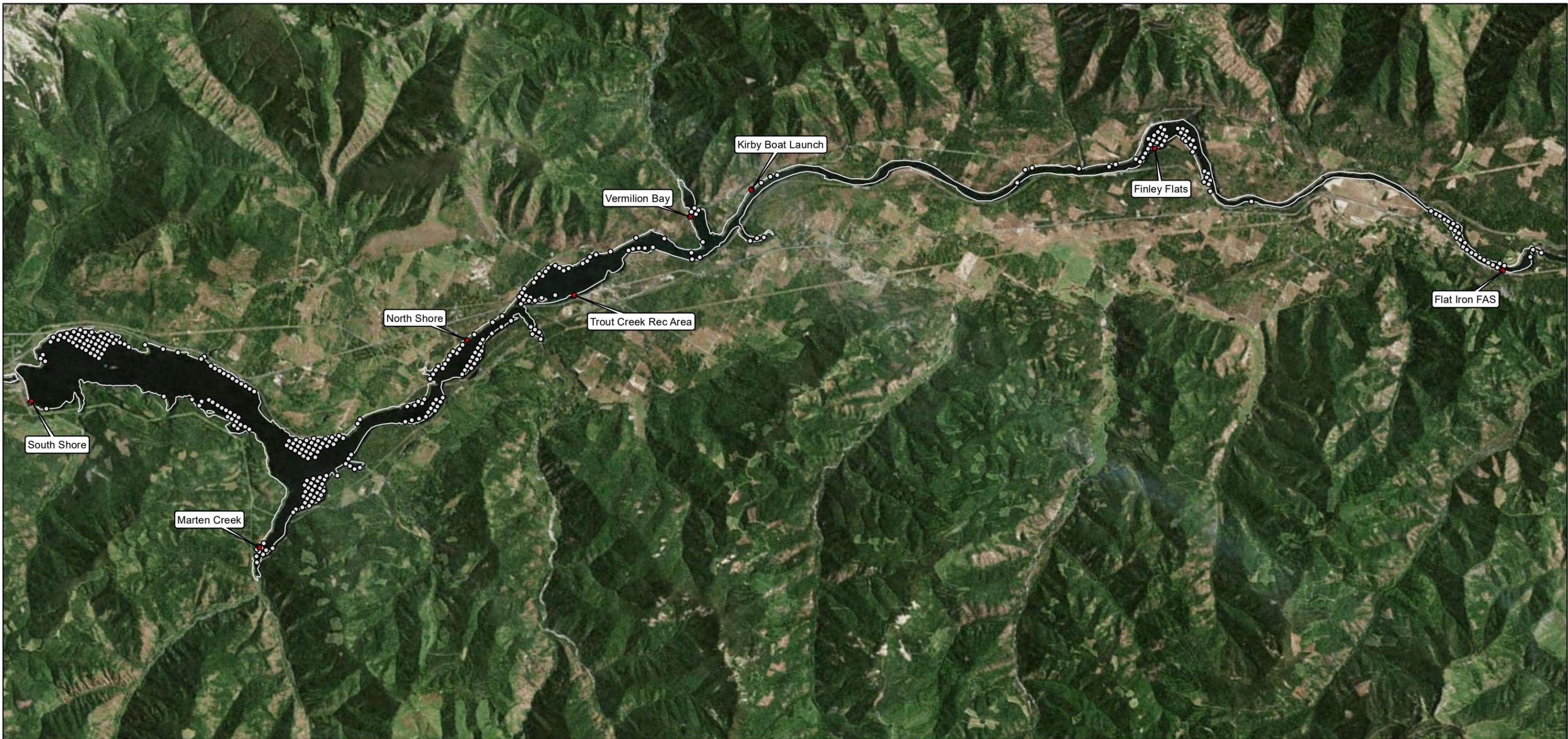
Figures 4-7. Rake Toss Points with Eurasian watermilfoil on Noxon Reservoir in 2017.

Figures 8-11. Bed Delineation of Invasive Species on Noxon Reservoir in 2017.

Figure 12. Rake Toss Points on Cabinet Gorge Reservoir in 2017.

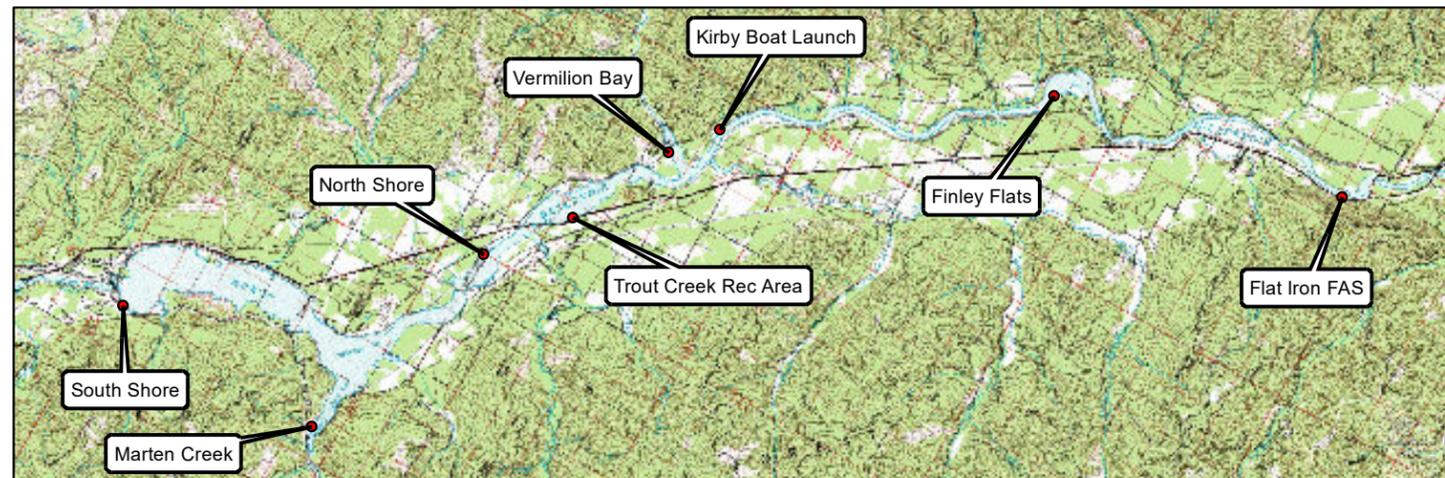
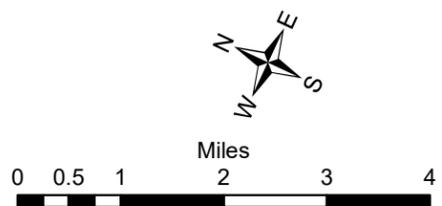
Figures 13 & 14. Rake Toss Points with Eurasian watermilfoil on Cabinet Gorge Reservoir in 2017.

Figures 15 & 16. Bed Delineation of Invasive Species on Cabinet Gorge Reservoir in 2017.



Legend

- Access Points
- Proposed Survey Points (Pre-survey) = 346 sites
- ▭ Noxon Rapids Reservoir



**Proposed Survey Points (Pre-survey) = 346 sites
Littoral Zone Survey on Noxon Reservoir**

**Aerial Site Map - 2017 AIS Survey
Sanders County**

Job#: SandersM01

Date: 12/7/2017

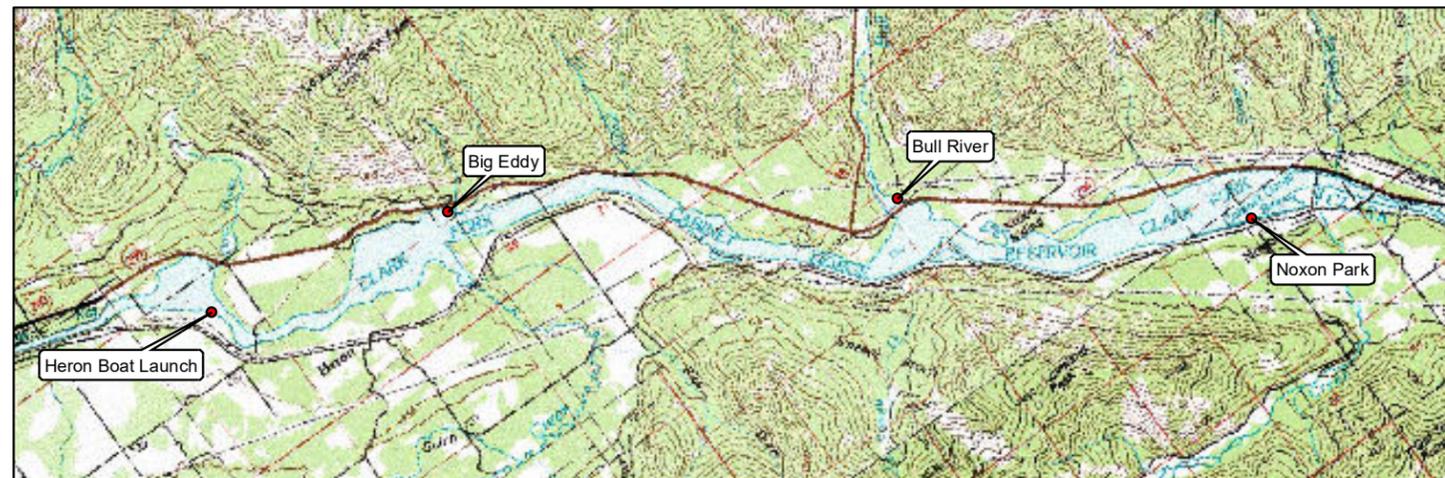
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_1_NOX_Proposed_Survey_Points.mxd, Author:

FIGURE 1



Legend

- Access Points
- Proposed Survey Points (Pre-survey) = 297 sites
- ▭ Cabinet Gorge Reservoir



**Proposed Survey Points (Pre-survey) = 297 sites
Littoral Zone Survey on Cabinet Gorge Reservoir**

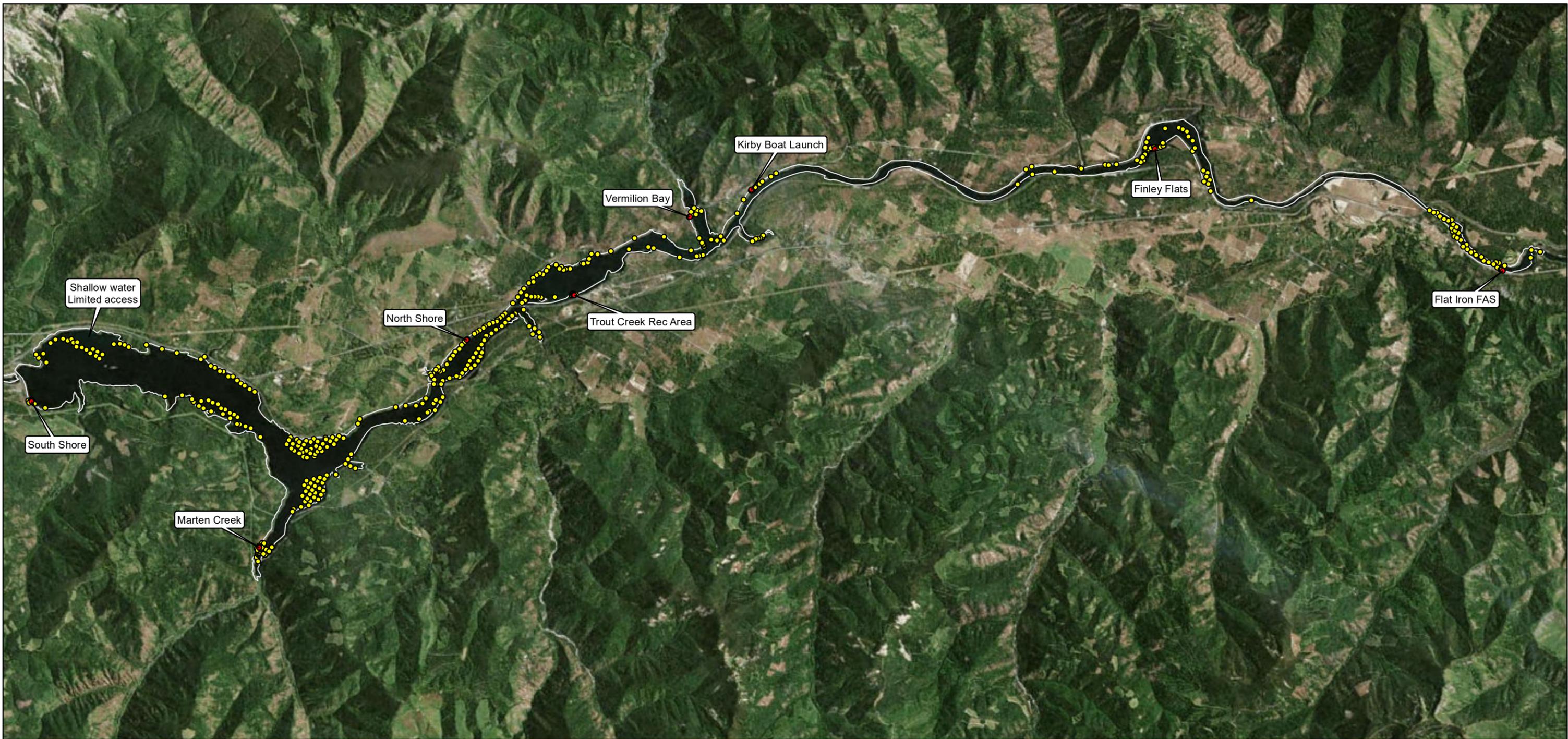
**Aerial Site Map - 2017 AIS Survey
Sanders County**

Job#: SandersM01

Date: 12/7/2017

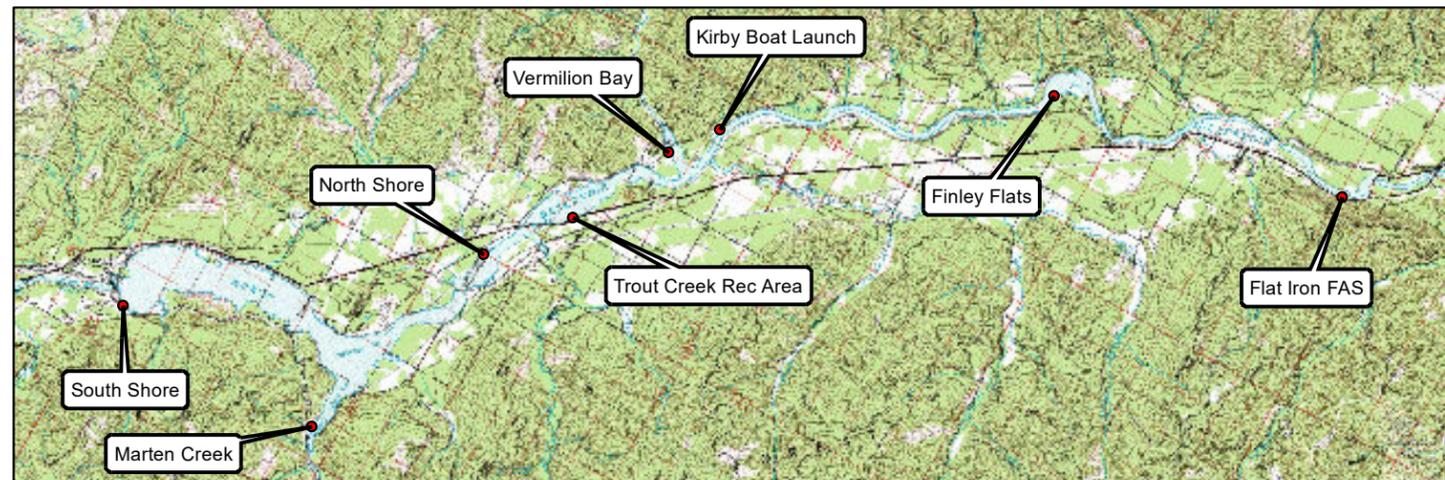
FIGURE 2

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_11_CAB_Proposed_Survey_Points.mxd, Author:



Legend

- Access Points
- Rake Toss Points = 430 sites
- Noxon Rapids Reservoir



**Rake Toss Points = 430 sites
Littoral Zone Survey on Noxon Reservoir**

**Aerial Site Map - 2017 AIS Survey
Sanders County**

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_2_NOX_Rack_Toss_Points.mxd, Author: jslocum

FIGURE 3

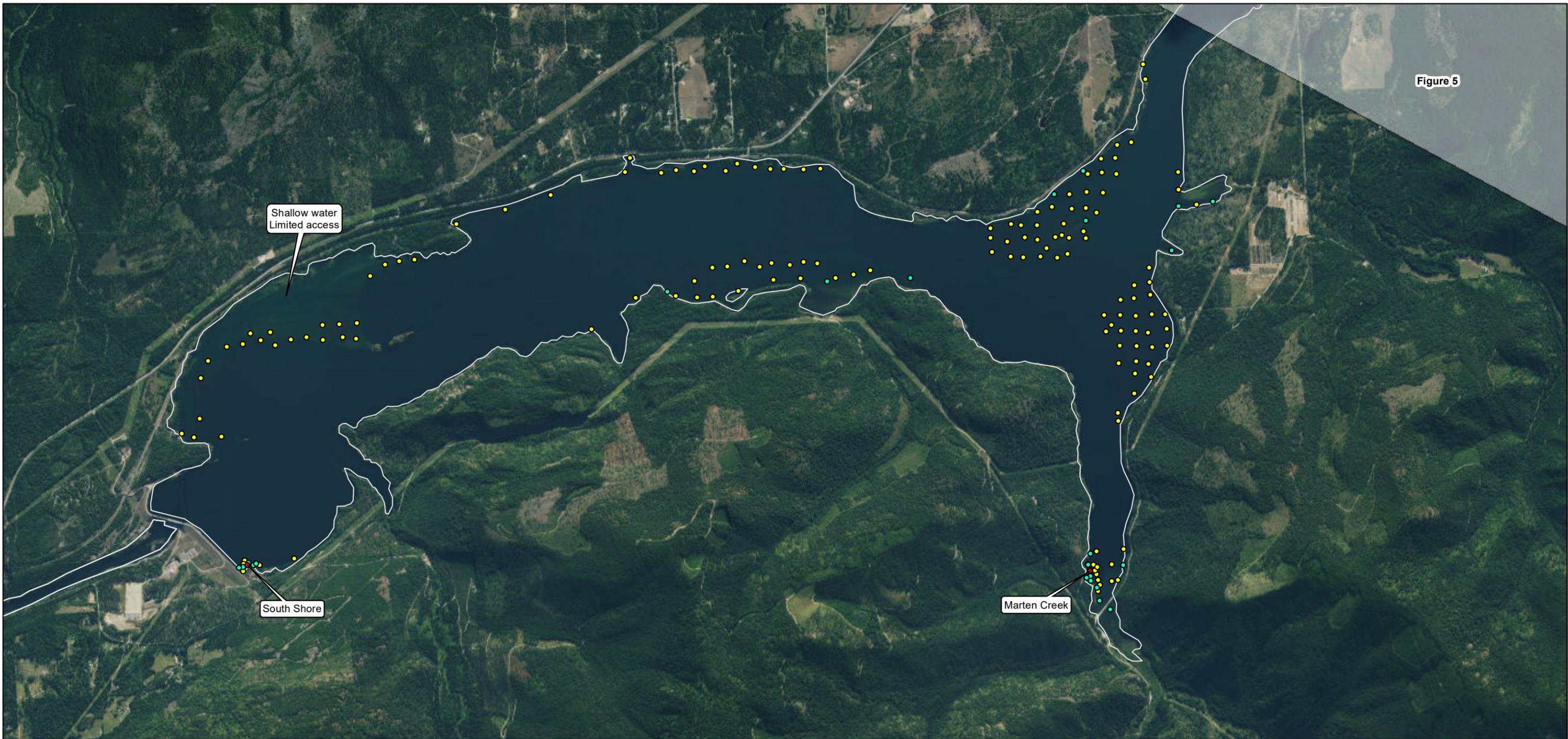
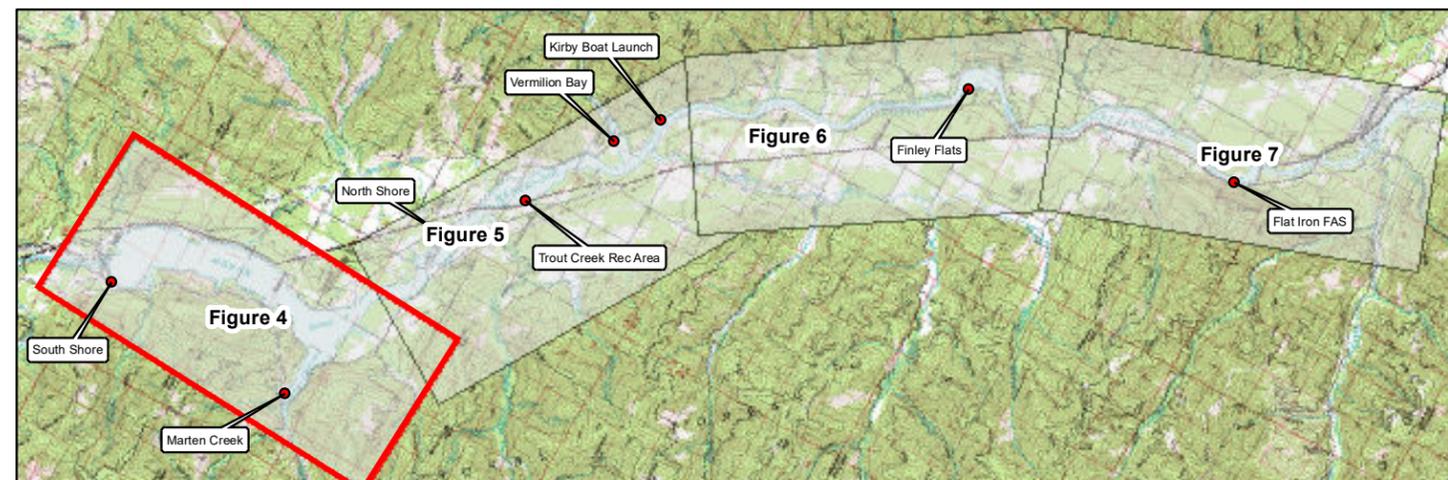
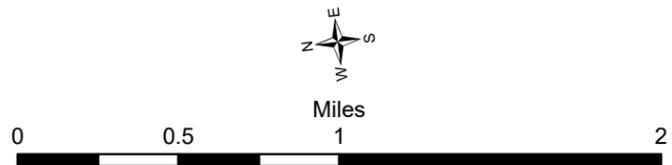


Figure 5

Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 140 sites
- Rake Toss Points = 430 sites
- Noxon Rapids Reservoir
- Index Map



**Rake Toss Points with Eurasian watermilfoil
Littoral Zone Survey on Noxon Reservoir**

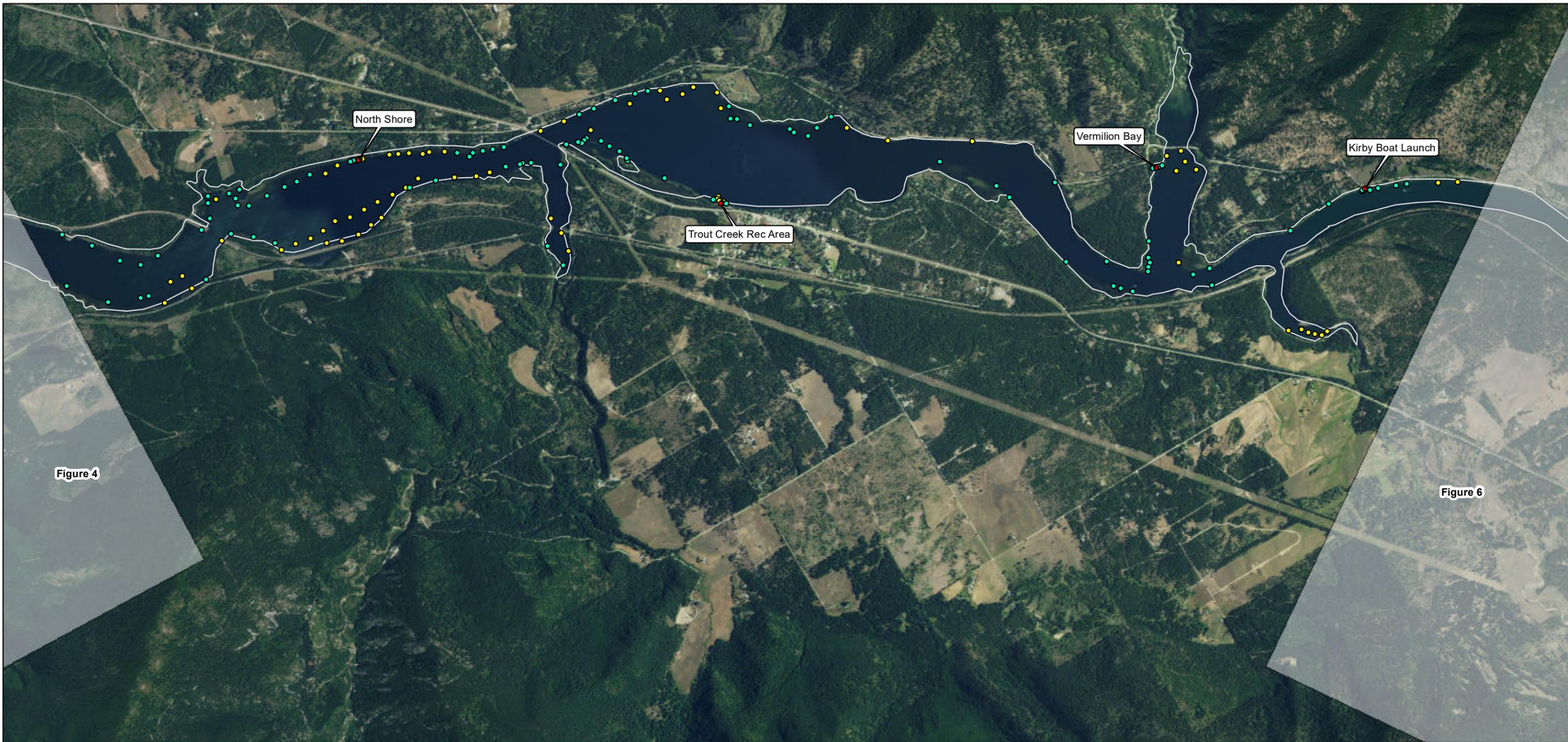
*Aerial Site Map - 2017 AIS Survey
Sanders County*

Job#: SandersM01

Date: 12/7/2017

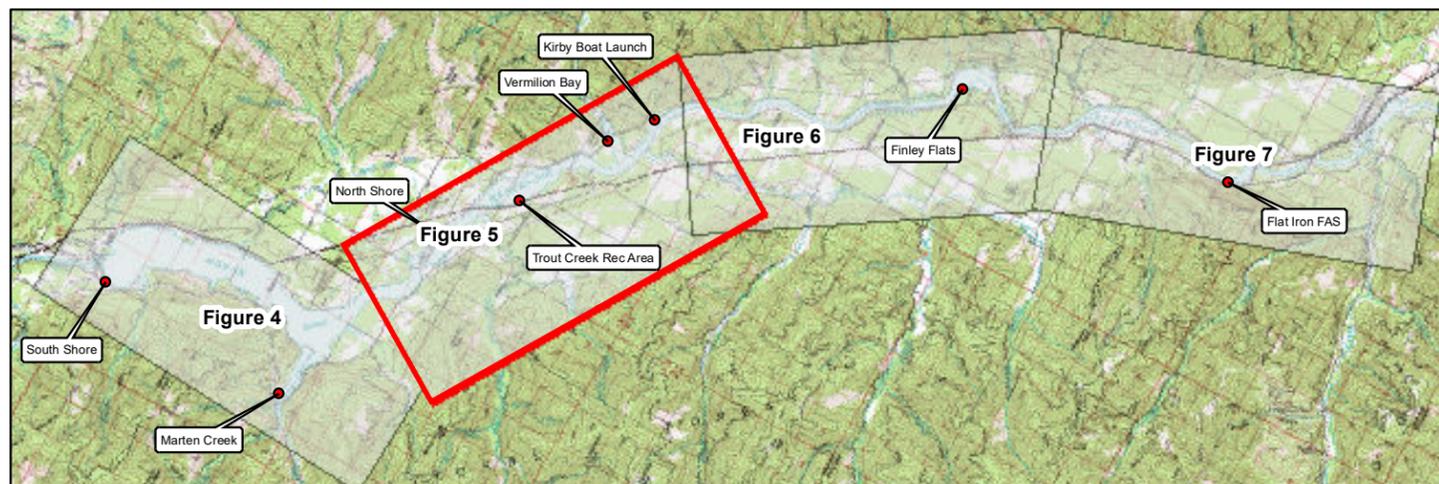
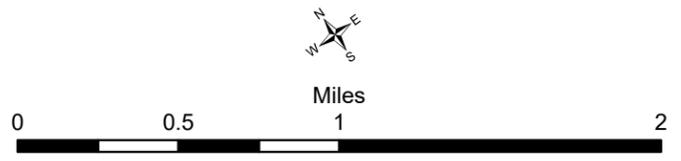
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_3_NOX_RT_Lower.mxd, Author: jslocum

FIGURE 4



Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 140 sites
- Rake Toss Points = 430 sites
- Noxon Rapids Reservoir
- Index Map





Rake Toss Points with Eurasian watermilfoil Littoral Zone Survey on Noxon Reservoir

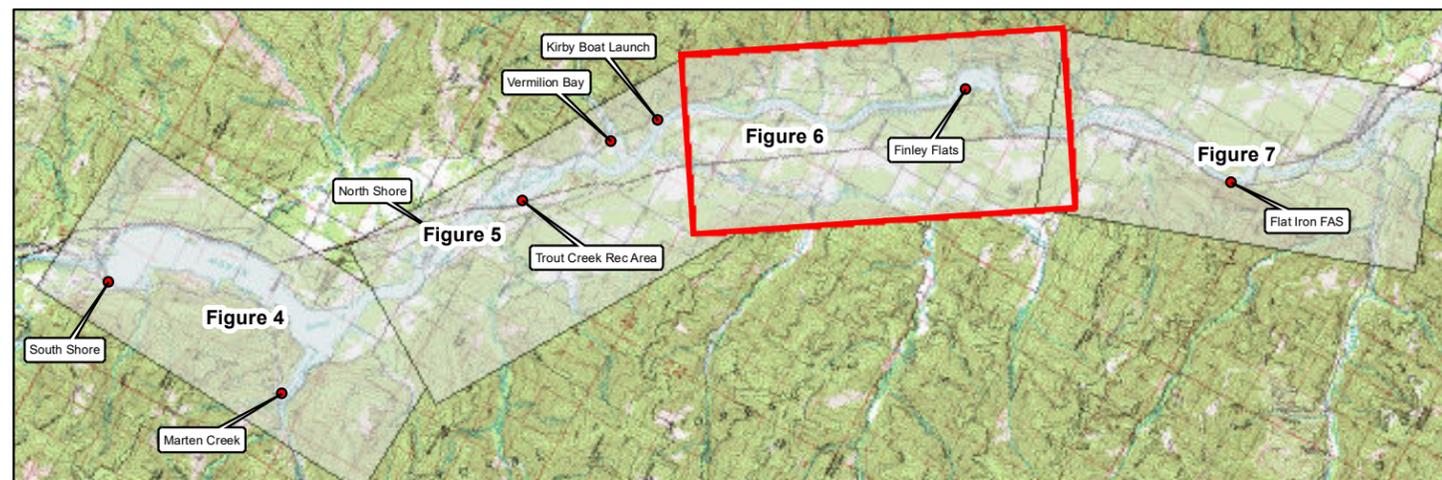
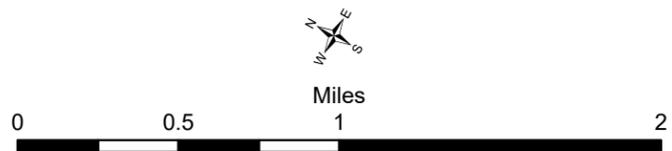
Aerial Site Map - 2017 AIS Survey Sanders County

Job#: SandersM01	FIGURE 5
Date: 12/7/2017	
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_4_NOX_RT_Lower.mxd, Author: jslocum	



Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 140 sites
- Rake Toss Points = 430 sites
- Noxon Rapids Reservoir
- Index Map



Rake Toss Points with Eurasian watermilfoil Littoral Zone Survey on Noxon Reservoir

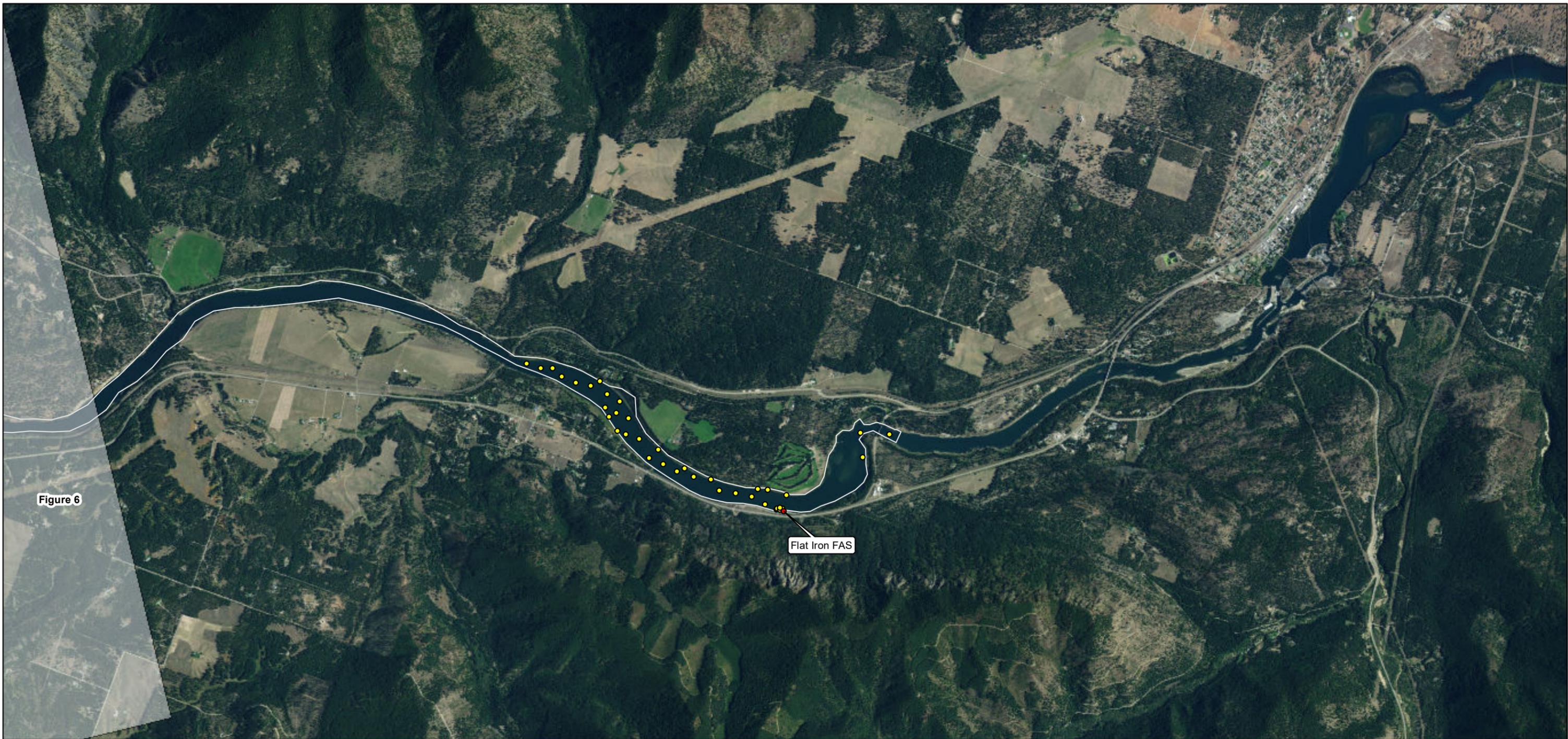
Aerial Site Map - 2017 AIS Survey Sanders County

Job#: SandersM01

Date: 12/7/2017

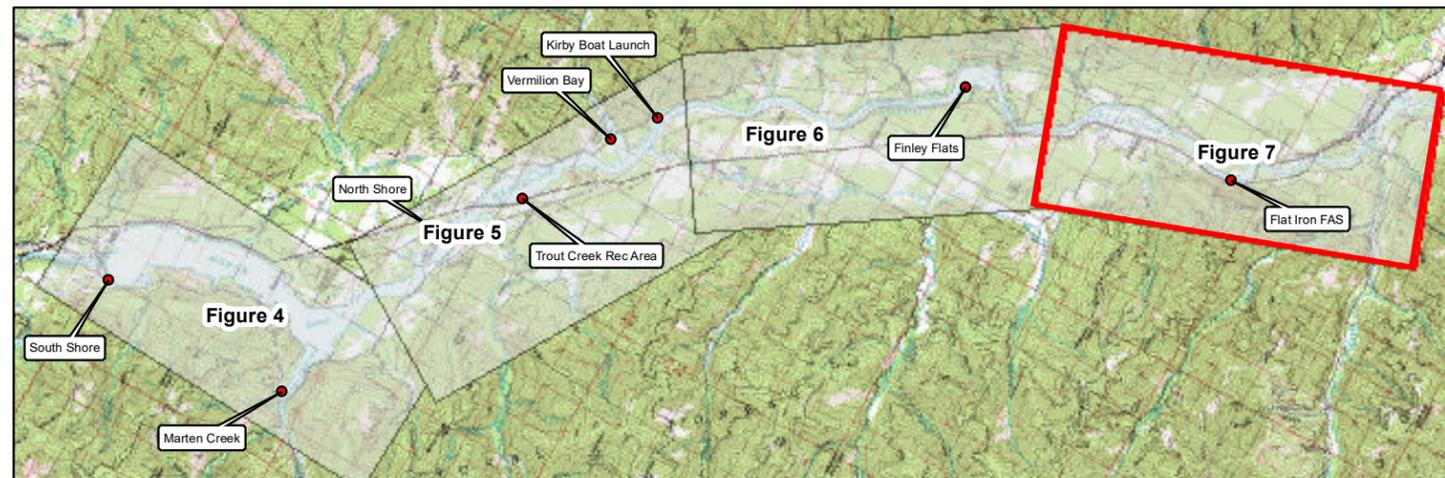
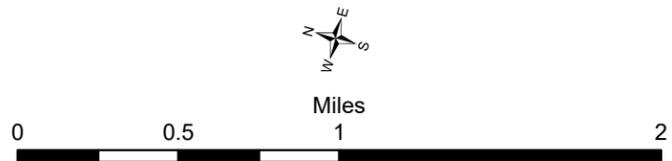
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_5_NOX_RT_Lower.mxd, Author: jslocum

FIGURE 6



Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 140 sites
- Rake Toss Points = 430 sites
- Noxon Rapids Reservoir
- Index Map



**Rake Toss Points with Eurasian watermilfoil
Littoral Zone Survey on Noxon Reservoir**

*Aerial Site Map - 2017 AIS Survey
Sanders County*

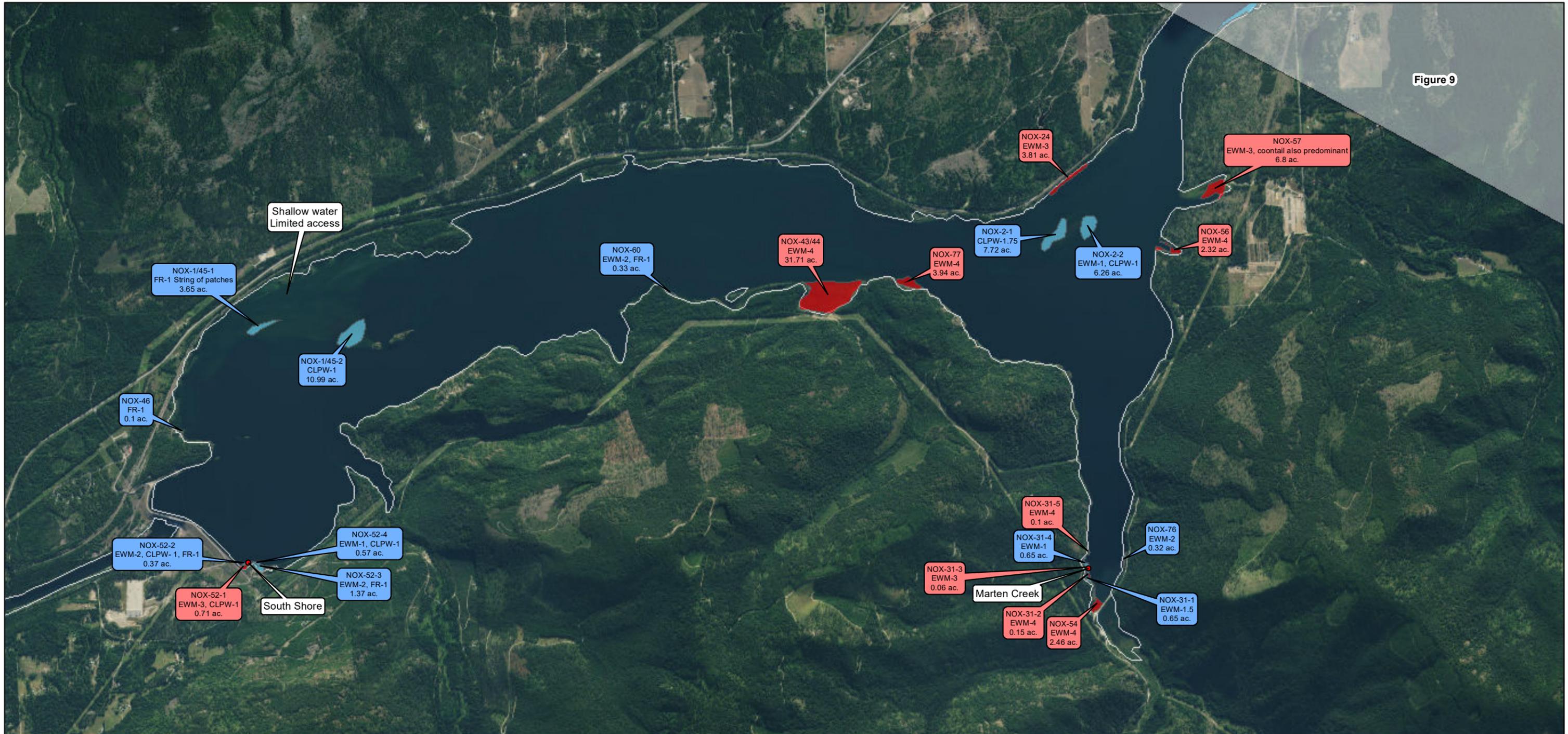
Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_6_NOX_RT_Lower.mxd, Author: jslocum

FIGURE 7

Figure 9



Legend

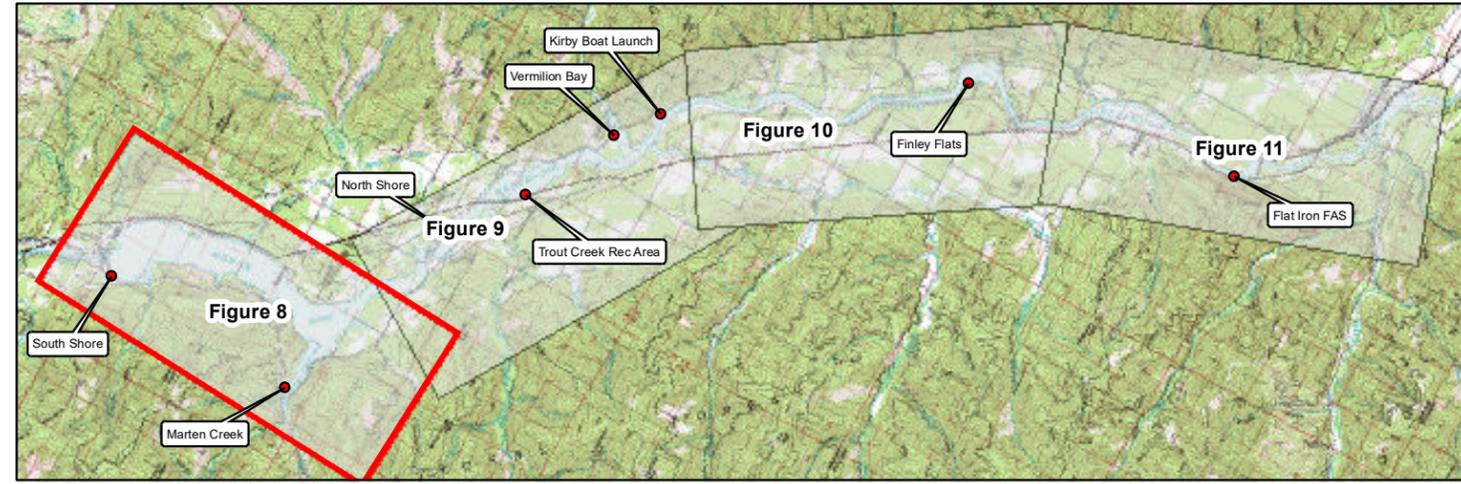
- Access Points
- Dense Eurasian watermilfoil beds = 36 sites
- Low density or non-target sp. beds = 31 sites
- Noxon Rapids Reservoir
- Index Map

Note:
 EWM = Eurasian watermilfoil
 CLPW = curlyleaf pondweed
 FR = flowering rush

Bed ID - Dense EWM
 Survey Comments and Bed Density
 Delineated Area

Bed ID - Low density beds
 Survey Comments and Bed Density
 Delineated Area

Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.



Bed Delineations of Invasive Species Littoral Zone Survey on Noxon Reservoir

Aerial Site Map - 2017 AIS Survey Sanders County

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_7_NOX_Beds.mxd, Author: jslocum

FIGURE 8

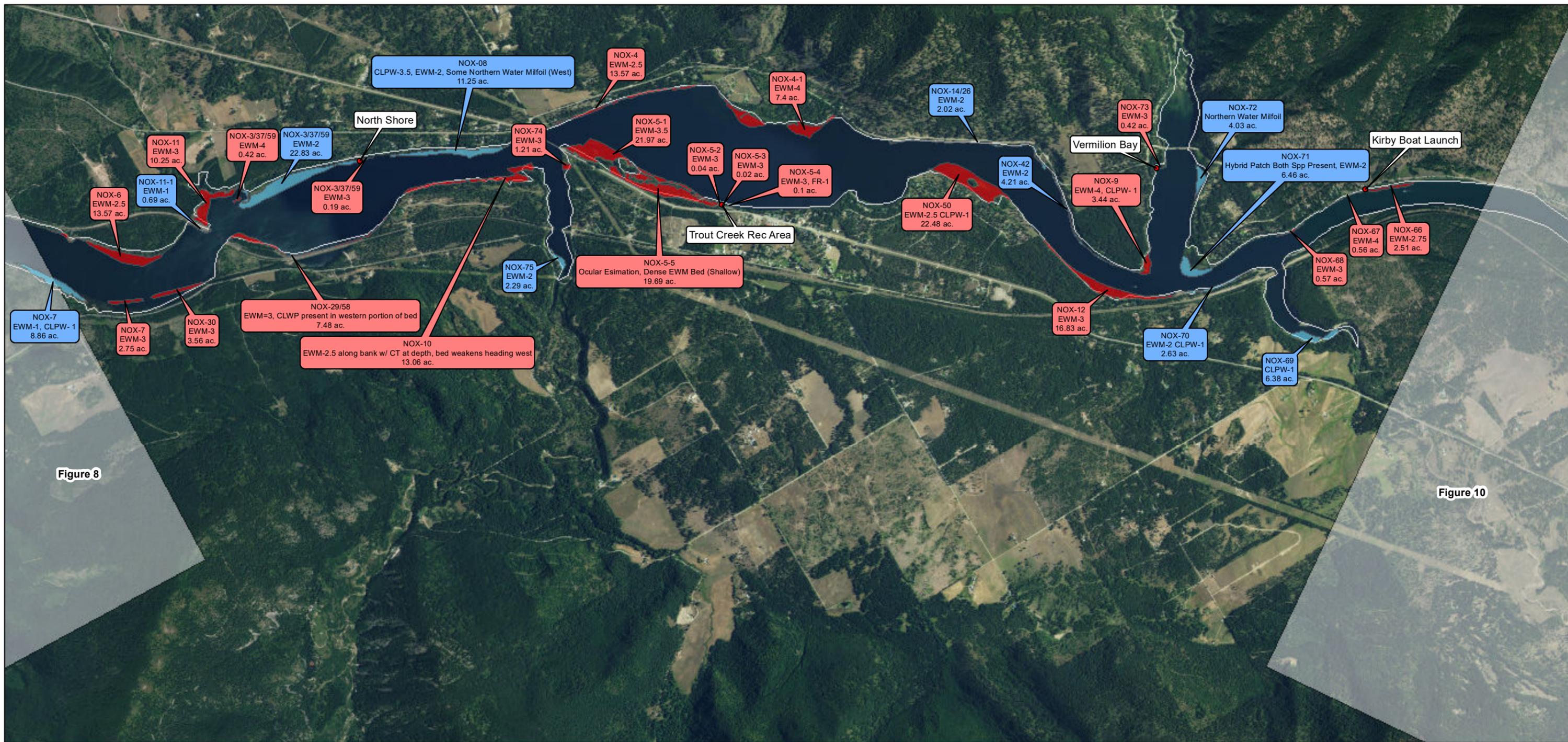


Figure 8

Figure 10

Legend

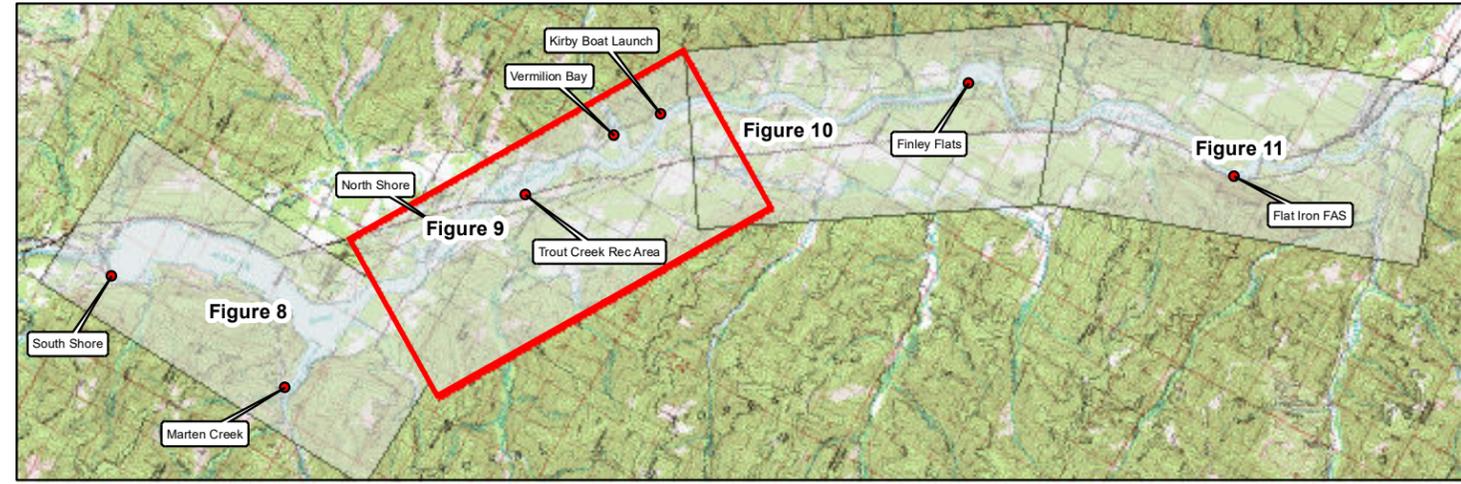
- Access Points
- Dense Eurasian watermilfoil beds = 36 sites
- Low density or non-target sp. beds = 31 sites
- Noxon Rapids Reservoir
- Index Map

Note:
 EWM = Eurasian watermilfoil
 CLPW = curlyleaf pondweed
 FR = flowering rush

Bed ID - Dense EWM
 Survey Comments and Bed Density
 Delineated Area

Bed ID - Low density beds
 Survey Comments and Bed Density
 Delineated Area

Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.



**Bed Delineations of Invasive Species
 Littoral Zone Survey on Noxon Reservoir**

**Aerial Site Map - 2017 AIS Survey
 Sanders County**

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_8_NOX_Beds.mxd, Author: jslocum

FIGURE 9

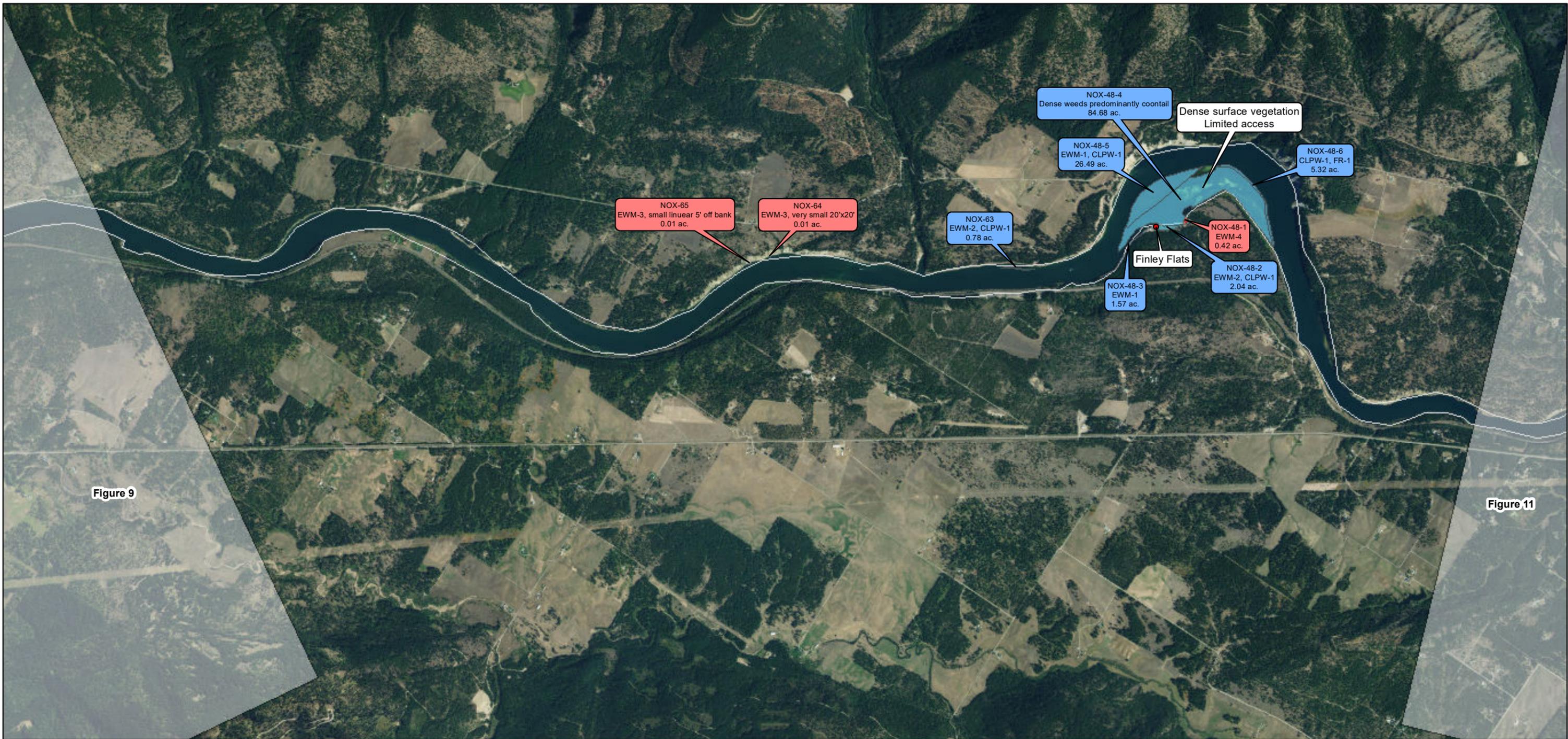


Figure 9

Figure 11

Legend

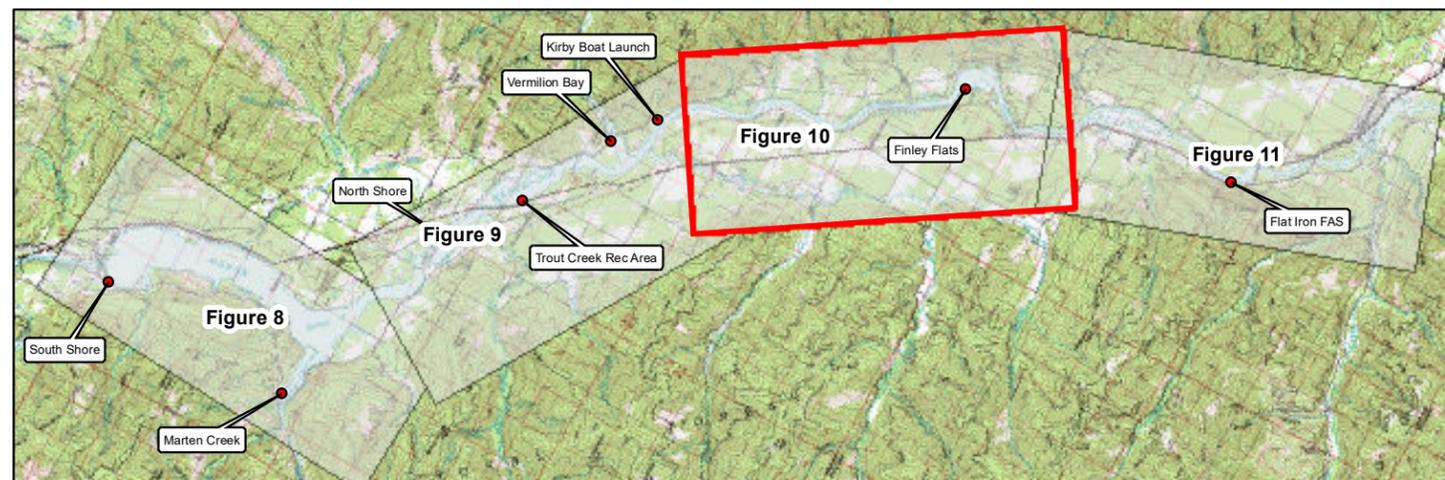
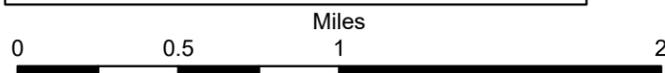
- Access Points
- Dense Eurasian watermilfoil beds = 36 sites
- Low density or non-target sp. beds = 31 sites
- Noxon Rapids Reservoir
- Index Map

Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.

Note:
EWM = Eurasian watermilfoil
CLPW = curlyleaf pondweed
FR = flowering rush

Bed ID - Dense EWM
Survey Comments and Bed Density
Delineated Area

Bed ID - Low density beds
Survey Comments and Bed Density
Delineated Area



**Bed Delineations of Invasive Species
Littoral Zone Survey on Noxon Reservoir**

**Aerial Site Map - 2017 AIS Survey
Sanders County**

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_9_NOX_RT_Lower.mxd, Author: jslocum

FIGURE 10



Figure 10

Legend

- Access Points
- Dense Eurasian watermilfoil beds = 36 sites
- Low density or non-target sp. beds = 31 sites
- Noxon Rapids Reservoir
- Index Map

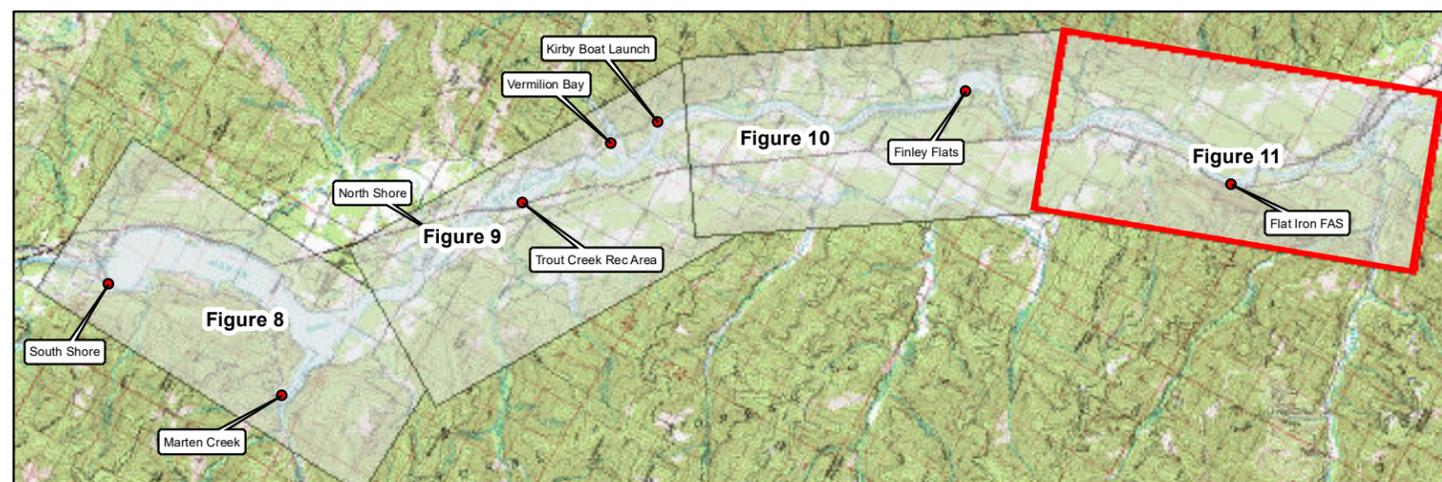
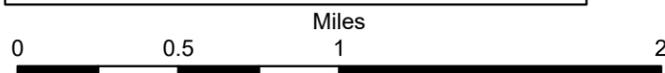
Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.

Note:

EWM = Eurasian watermilfoil
 CLPW = curlyleaf pondweed
 FR = flowering rush

Bed ID - Dense EWM
 Survey Comments and Bed Density
 Delineated Area

Bed ID - Low density beds
 Survey Comments and Bed Density
 Delineated Area



**Bed Delineations of Invasive Species
 Littoral Zone Survey on Noxon Reservoir**

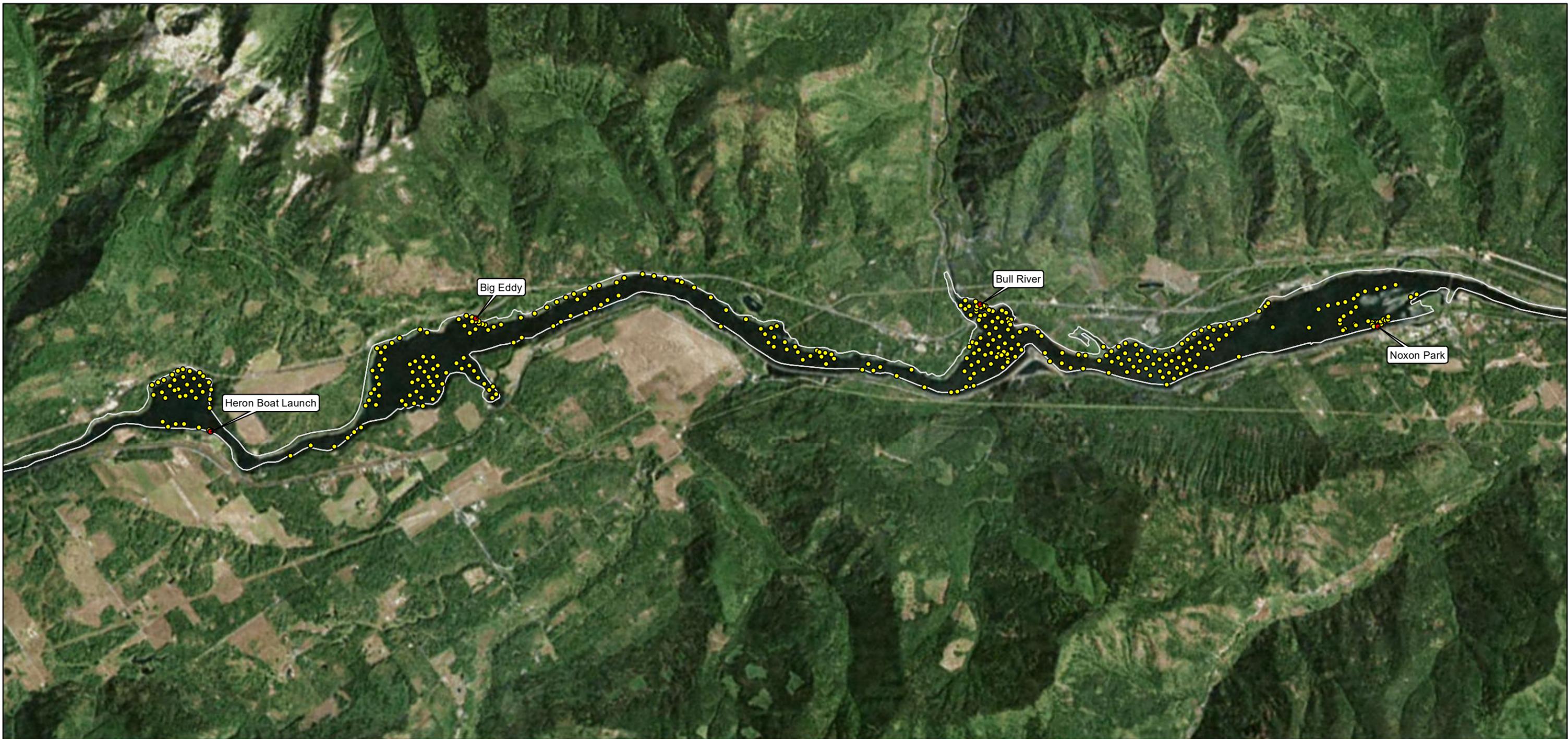
**Aerial Site Map - 2017 AIS Survey
 Sanders County**

Job#: SandersM01

Date: 12/7/2017

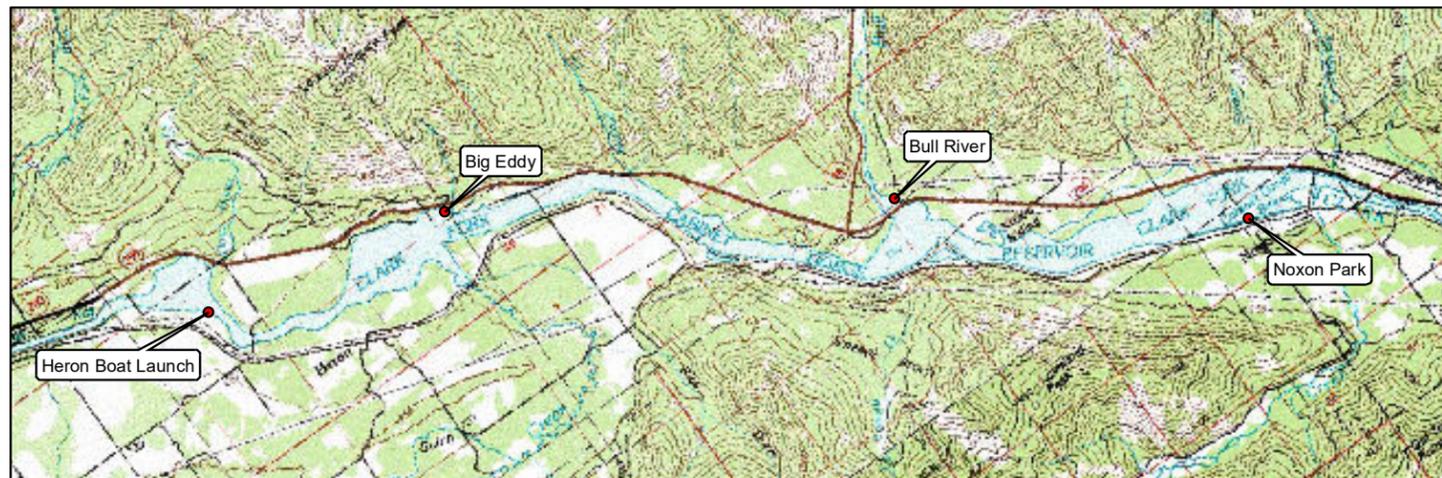
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_10_NOX_Beds.mxd, Author: jslocum

FIGURE 11



Legend

- Access Points
- Rake Toss Points = 369 sites
- Cabinet Gorge Reservoir



Rake Toss Points = 369 sites
Littoral Zone Survey on Cabinet Gorge Reservoir

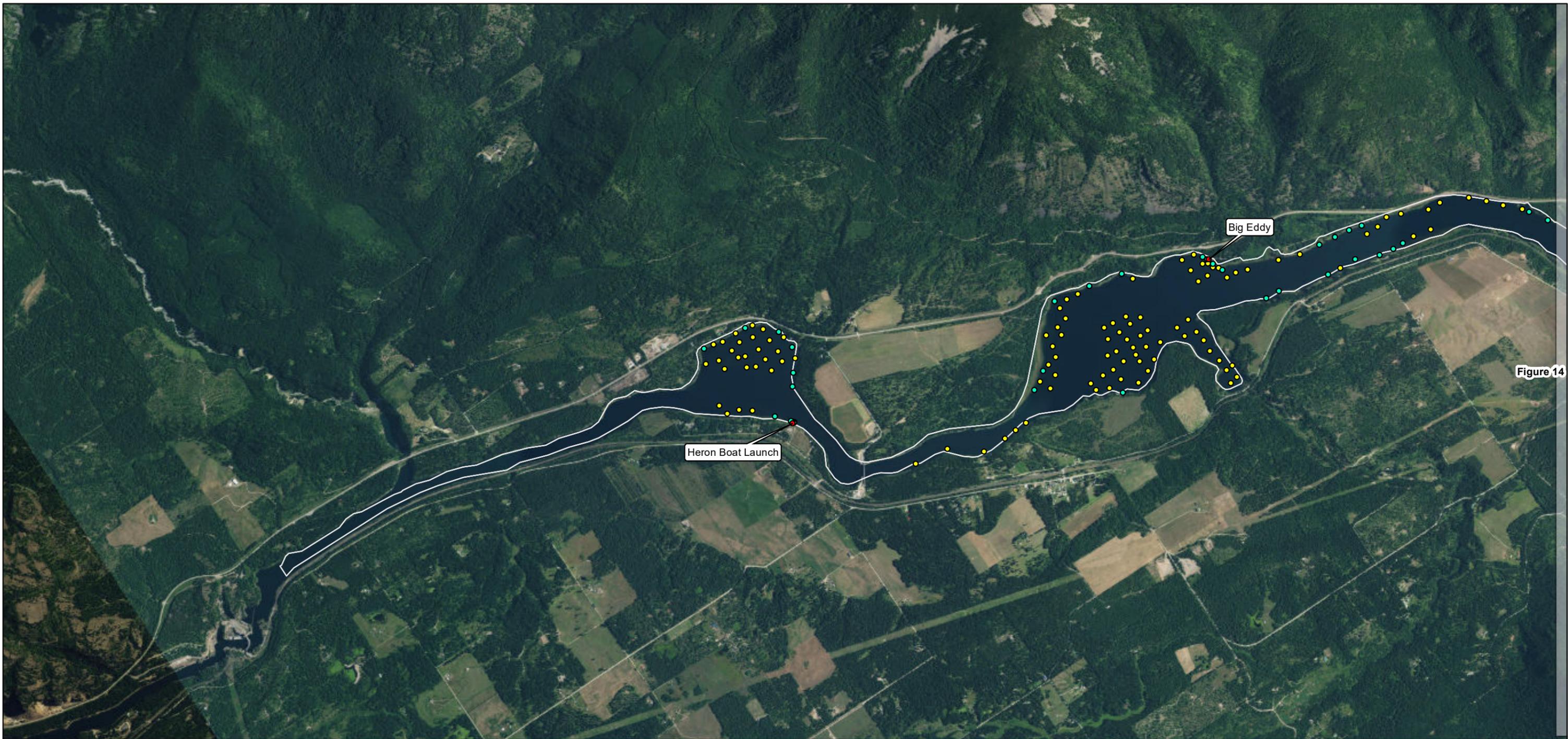
Aerial Site Map - 2017 AIS Survey
Sanders County

Job#: SandersM01

Date: 12/7/2017

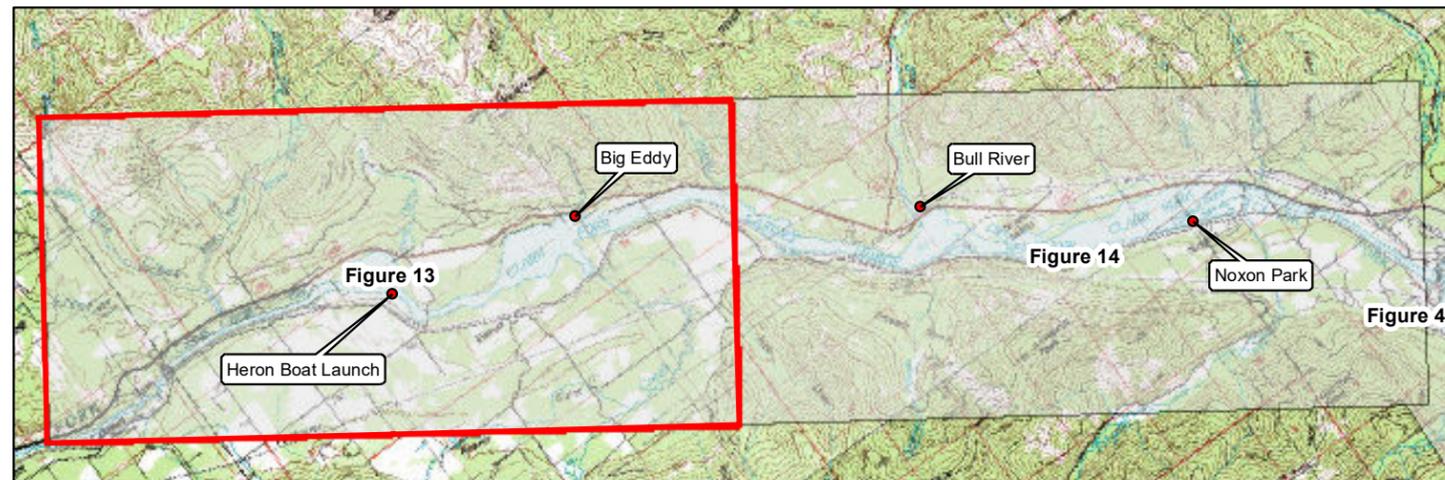
FIGURE 12

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_12_Cab_Rack_Toss_Points1.mxd, Author: jsloum



Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 107 sites
- Rake Toss Points = 369 sites
- ▭ Cabinet Gorge Reservoir
- ▭ Index Map



**Rake Toss Points with Eurasian watermilfoil
Littoral Zone Survey on Cabinet Gorge Reservoir**

**Aerial Site Map - 2017 AIS Survey
Sanders County**

Job#: SandersM01	FIGURE 13
Date: 12/7/2017	
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_13_RT_Lower.mxd, Author: jslcum	

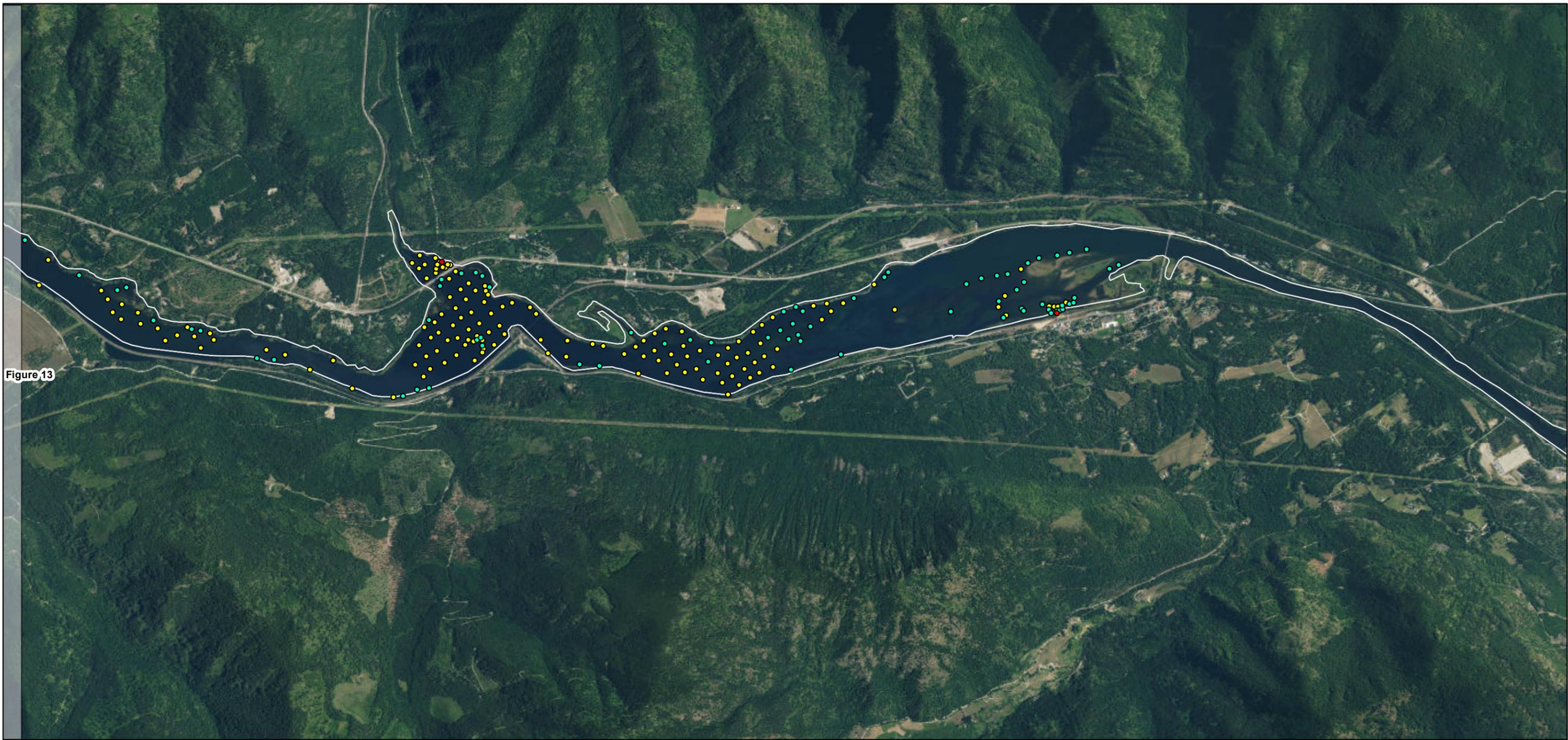
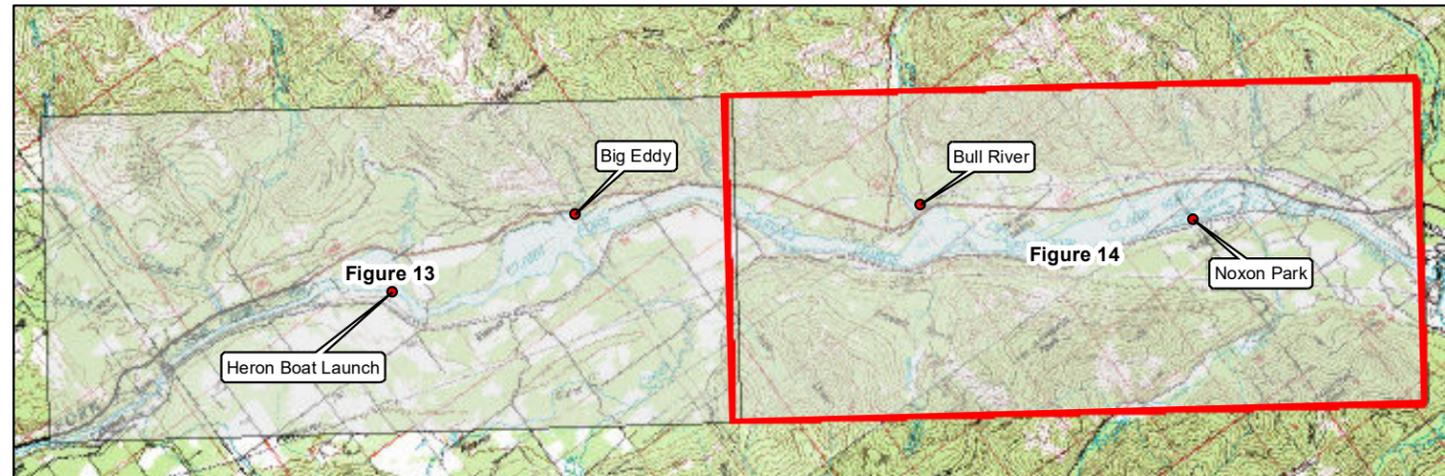
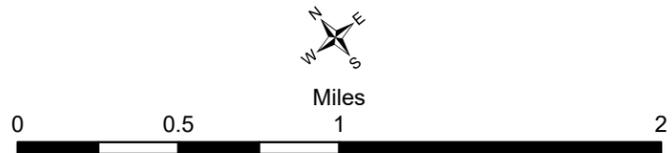


Figure 13

Legend

- Access Points
- Rake Toss Points with Eurasian watermilfoil = 107 sites
- Rake Toss Points = 369 sites
- Cabinet Gorge Reservoir
- Index Map



Rake Toss Points with Eurasian watermilfoil Littoral Zone Survey on Cabinet Gorge Reservoir

Aerial Site Map - 2017 AIS Survey Sanders County

Job#: SandersM01	FIGURE 14
Date: 12/7/2017	
Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_14_RT_UpperCAB.mxd, Author: jslocum	

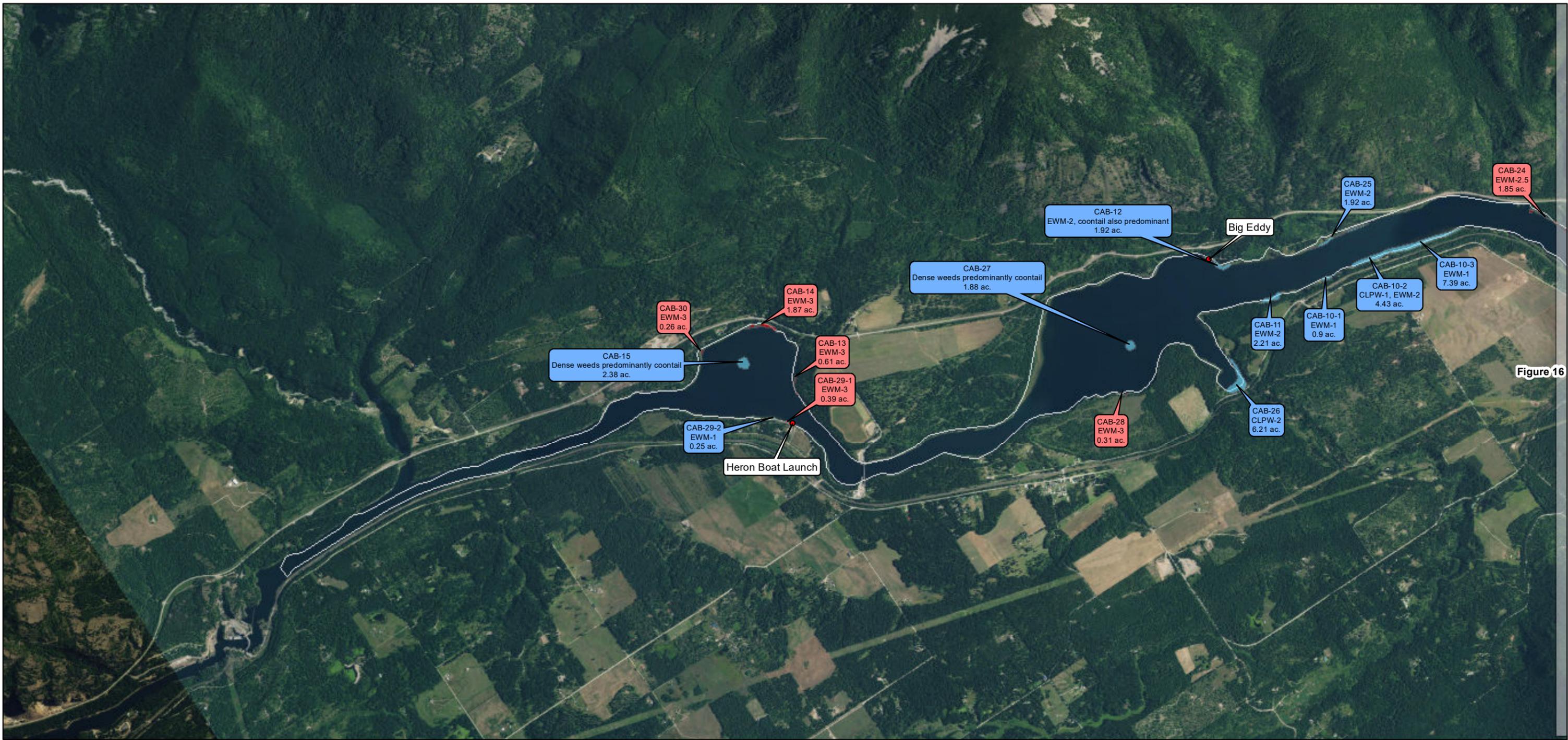


Figure 16

Legend

- Access Points
- Dense Eurasian watermilfoil beds = 20 sites
- Low density or non-target sp. beds = 24 sites
- Cabinet Gorge Reservoir
- Index Map

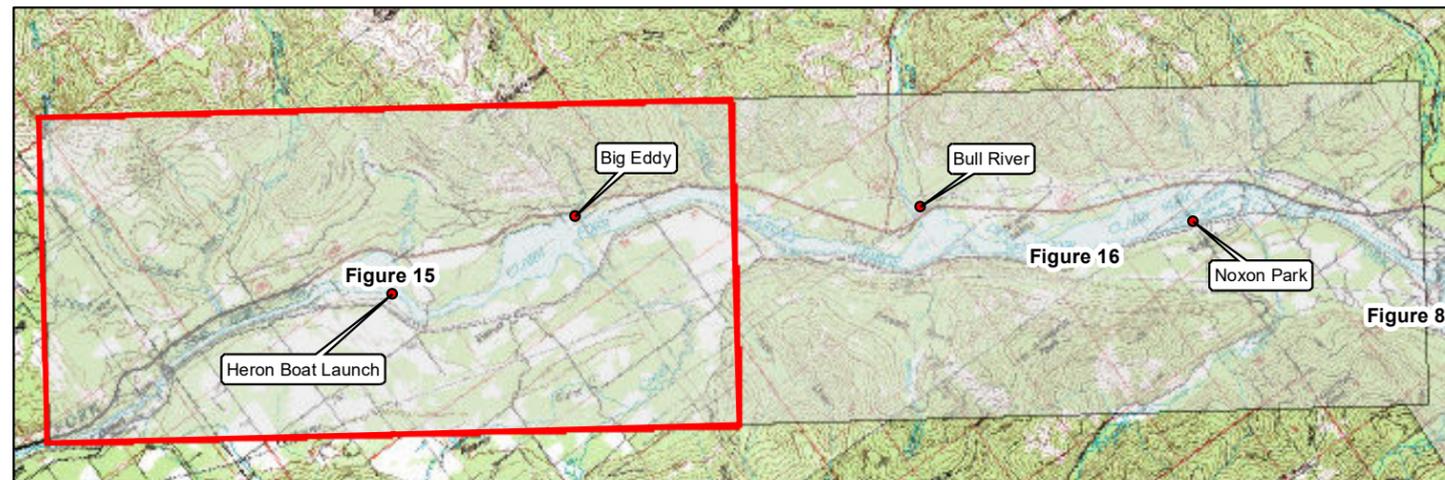
Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.

Note:

EWM = Eurasian watermilfoil
 CLPW = curlyleaf pondweed
 FR = flowering rush

Bed ID - Dense EWM
 Survey Comments and Bed Density
 Delineated Area

Bed ID - Low density beds
 Survey Comments and Bed Density
 Delineated Area



**Bed Delineations of Invasive Species
 Littoral Zone Survey on Cabinet Gorge Reservoir**

**Aerial Site Map - 2017 AIS Survey
 Sanders County**

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_15_Beds_Lower.mxd, Author: jilocum

FIGURE 15

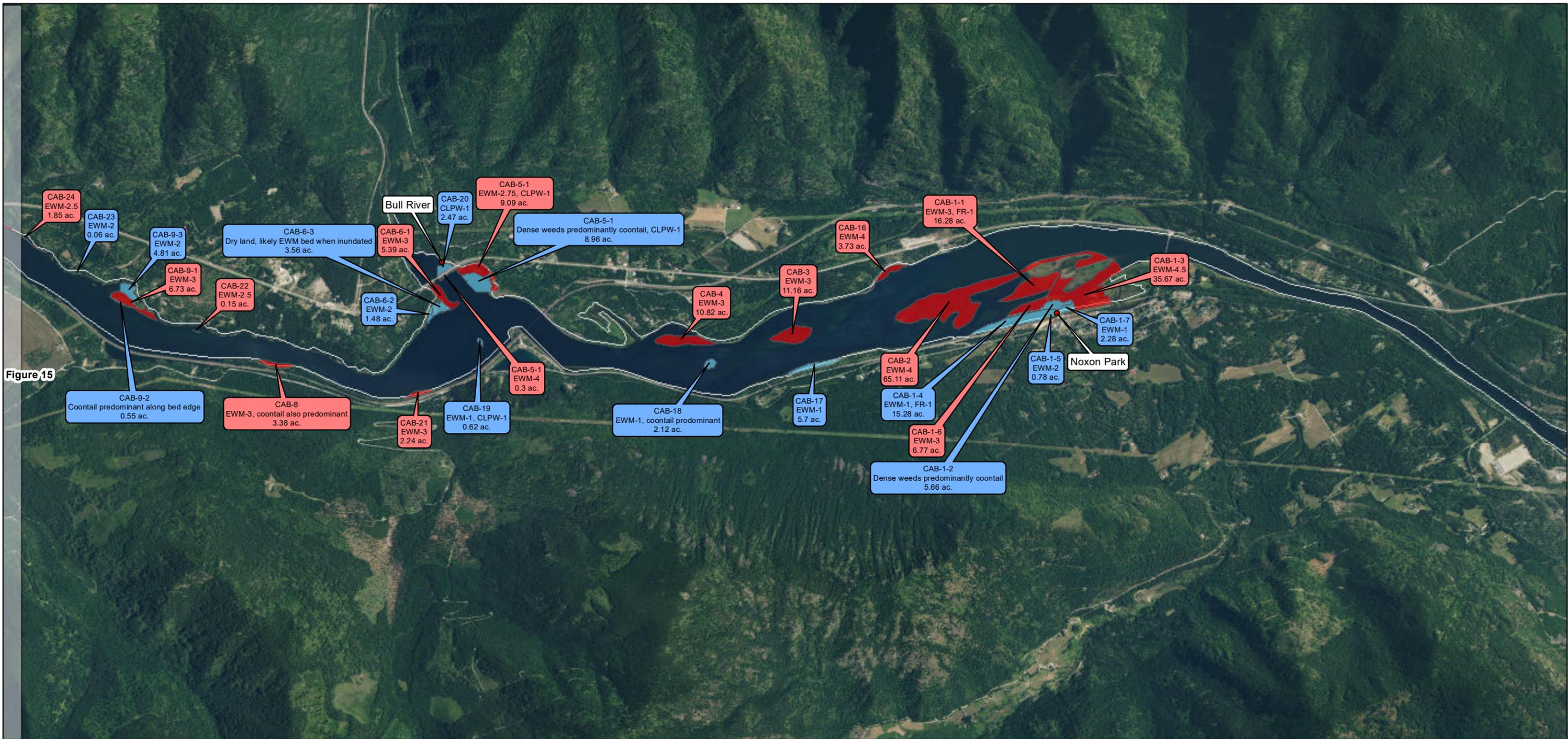


Figure 15

Legend

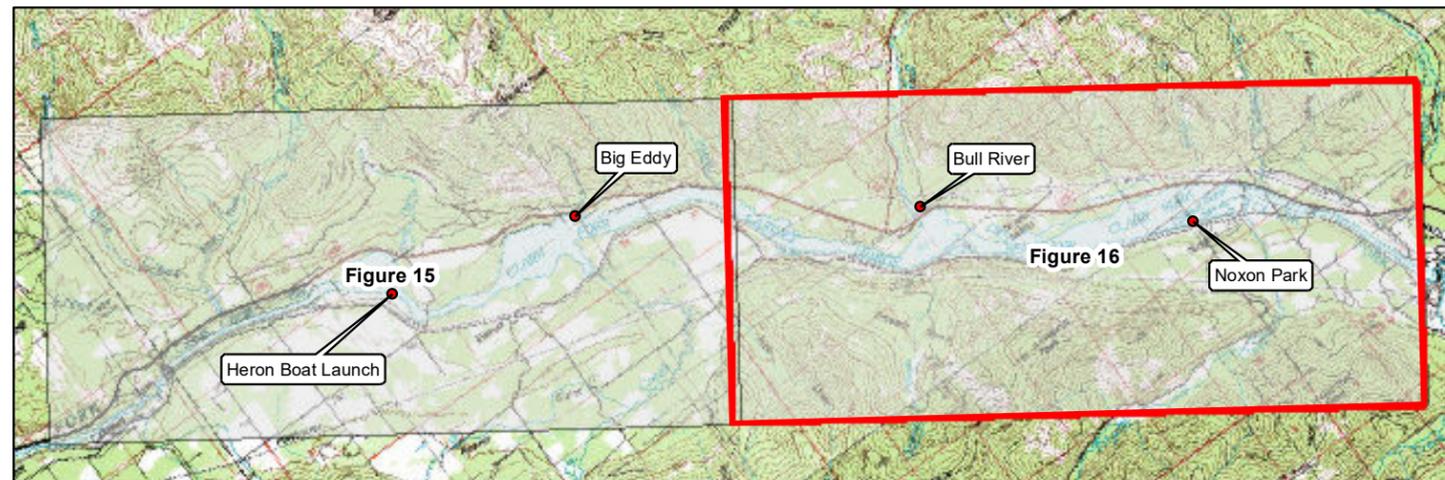
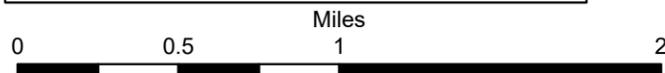
- Access Points
- Dense Eurasian watermilfoil beds = 20 sites
- Low density or non-target sp. beds = 24 sites
- Cabinet Gorge Reservoir
- Index Map

Density was quantified by recording the amount of invasive species vegetation covering the sampling implement during each thatch rake toss using a scale from 1-5, with 5 representing 100% coverage.

Note:
 EWM = Eurasian watermilfoil
 CLPW = curlyleaf pondweed
 FR = flowering rush

Bed ID - Dense EWM
 Survey Comments and Bed Density
 Delineated Area

Bed ID - Low density beds
 Survey Comments and Bed Density
 Delineated Area



**Bed Delineations of Invasive Species
 Littoral Zone Survey on Cabinet Gorge Reservoir**

**Aerial Site Map - 2017 AIS Survey
 Sanders County**

Job#: SandersM01

Date: 12/7/2017

Path: M:\AIS - Aquatic Vegetation Monitoring - Sanders County\Figure_16_Beds_Upper.mxd, Author: jilocum

FIGURE 16