JEFFERSON SLOUGH EURASIAN WATERMILFOIL
2020 MONITORONG REPORT

Jefferson County, Montana

Prepared for:

JEFFERSON COUNTY COMMISSIONERS
JEFFERSON RIVER WATERSHED COUNCIL
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1. INTRODUCTION

Eurasian watermilfoil (*Myriophyllum spicatum* L; EWM) is an invasive aquatic plant that is currently listed as a priority 2A noxious weed in the State of Montana (Pokorny and Mangold 2020). Ecological and economic impacts of EWM infestations are well documented throughout the United States. EWM infestations can displace native aquatic vegetation, thereby altering fish and waterfowl habitat and reducing food availably. It can negatively impact water quality, reduce water flow through streams and ditches, and clog agricultural, industrial, and domestic water intakes. For these reasons, EWM control is considered a high priority in Montana, especially when an infestation is a highly likely to spread to other water bodies.

EWM was first detected in Montana in 1973, in Lake County (Montana Field Guide 2020) but was not recognized as having a large presence in the State until 2003. Since that time, EWM has been detected in Sanders, Flathead, Gallatin, Madison, Jefferson, Broadwater, Phillips, Valley, McCone, Garfield, and Richland counties (Parkinson et al. 2020), and EWM management has become higher priority across the State.

EWM was first detected in Jefferson Slough in 2011 during a systematic survey of the Upper Missouri River watershed. Containment of the Jefferson Slough EWM infestation was identified as a high priority by Jefferson County and the State of Montana, as it could serve as a potential source population that would enable EWM spread into the Jefferson River and other downstream waters such as the Missouri River.

Shortly after EWM was detected in Jefferson Slough, Jefferson County and the Montana Department of Natural Resources and Conservation (DNRC) began attempting to control this relatively small, isolated population with the general goal of reducing the potential for EWM to become established in waterways downstream of Jefferson Slough. The infestation was limited to approximately 20 acres in the lower 4.3 miles of the slough (Figure 1) and therefore was determined to be highly treatable (Confluence 2014a). Control efforts began with mechanical removal (i.e. hand pulling in 2012 and 2013). Volunteers from several different organizations participated in these hand-pulling events, and removed hundreds of pounds of EWM from the upper portion of Jefferson Slough. Despite this intense effort, hand pulling was deemed to largely ineffective (Duncan 2013).

In 2014, the Jefferson County Board of Commissioners developed the Jefferson Slough Eurasian Watermilfoil Management Plan (i.e. JSEWM Management Plan), which identified actions designed to reduce and eventually eradicate the EWM infestation within Jefferson Slough. The actions identified by the JSEWM Management Plan included the use of aquatic herbicides, irrigation structure modifications to better manage flows, sediment reduction measures in tributaries to Jefferson Slough, and channel modifications to improve sediment transport through infested areas. The JSEWM Management Plan established a goal to reduce the amount of EWM present in the slough by 95% within 5 years, while recognizing that this timeline might need to be extended if funding was not secured for all project phases under the proposed 5-year timeline.

Following the adoption of the JSEWM Management Plan, aquatic herbicide applications began in 2014, and funding was secured for a Phase 1 channel modification project. The intent of the Phase 1 modification was to: 1) create an environment where EWM could not establish and thrive, and 2) bury existing populations of EWM as a method of eradication. EWM prefers habitat with high amounts of fine sediment and slow-moving water, environmental characteristics that are common in Jefferson Slough. Modifications of the channel physical dimension were intended to increase water velocity, reduce the accumulation of fine sediment, and prevent EWM establishment. The Phase 1 channel modification project was completed in 2018, and involved constructing a new, 3440-foot channel alignment beginning several hundred feet above the upstream-most known point of EWM infestation, and extending downstream to the confluence with Sheep Gulch.

In July 2020, the entire reach of Jefferson Slough originally identified as infested with milfoil in 2013 was monitored for EWM presence and density. This was the first time that EWM monitoring had been conducted since the Phase 1 channel modification project was completed. The remainder of this report details the findings of those monitoring efforts. These results will be used to inform future EWM control treatments on Jefferson Slough, and to help determine whether the treatments used thus far may be effective in other EWM-infested areas in Montana and the region.

1.1 Detailed Project Description and Location

Jefferson Slough is located in Jefferson County, MT, east of the town of Whitehall, and just south of I-90. Jefferson Slough was once a side channel of the Jefferson River that now serves as an important water conveyance for agricultural water users. Water flowing into Jefferson Slough originates in Pipestone Creek, Whitetail Creek, and the Jefferson River, the latter of which first flows through Slaughterhouse Slough before being diverted into Jefferson Slough through a regulated headgate (Confluence 2014b). Below the town of Cardwell, MT Jefferson Slough flows into the Boulder River, which joins the Jefferson River just a few miles downstream.

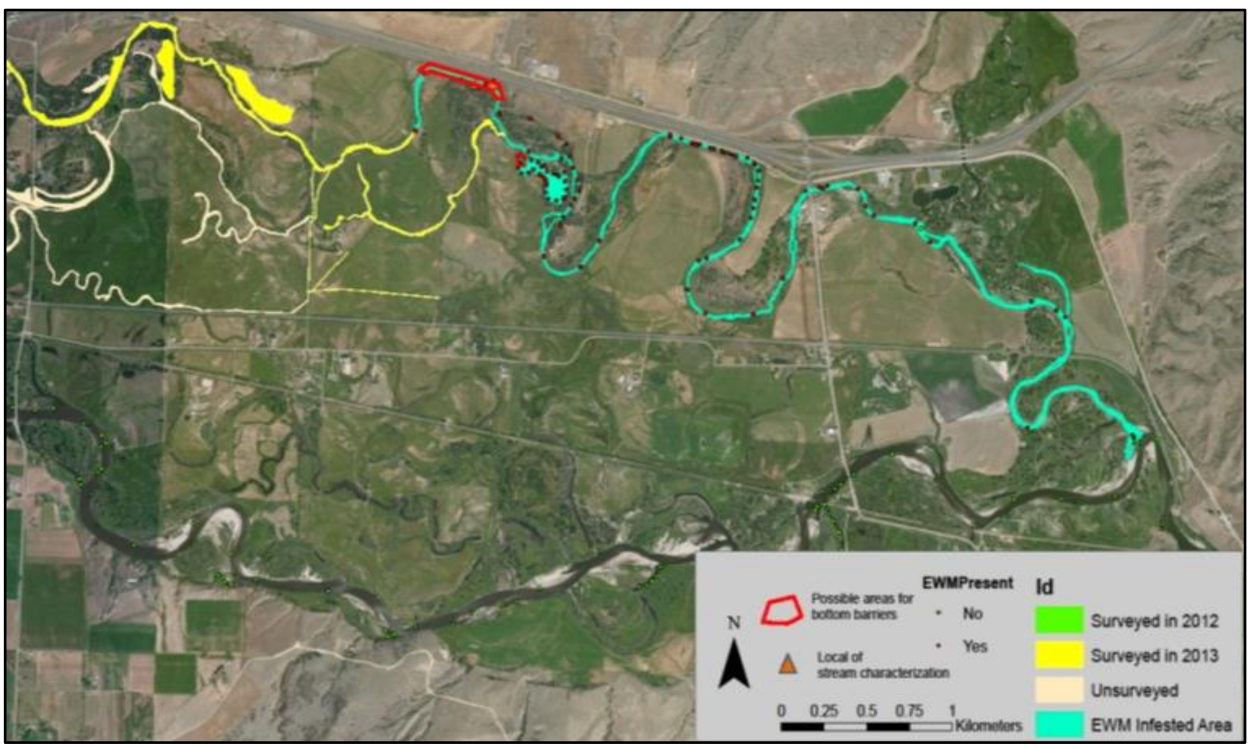

Figure 1. Results of EWM surveys conducted in Jefferson Slough in 2012 and 2013. Source: Craig McLane MT Fish, Wildlife and Parks.

2. METHODS

The first systematic survey of the EWM infestation in Jefferson Slough was conducted by Dr. John Madsen in August of 2013 and subsequent monitoring was conducted in both 2015 and 2016. The 2020 monitoring effort aimed to replicate previous monitoring efforts, but documentation of the precise monitoring locations was not recorded and the sampling methods used could not be replicated to provide a quantitative comparison of results. Thus, in 2020, a new set of methods and sample design were developed which should allow method replication for future EWM monitoring efforts.

2.1 Sample Design

Monitoring transects were systematically established every 200 feet beginning at Ed Simon's bridge and ending at the confluence with the Boulder River. The sample design established 122 potential transect locations along the lower 24,300 feet of Jefferson Slough (sample point locations shown in Figure 2).

A total of 95 transects were sampled for EWM presence and density. Twenty-seven transects were not sampled because the water in Jefferson Slough was either too deep or the sediment was too mucky to accurately collect samples in those locations. Four of these transects were located immediately below Simon's crossing, 17 between the end of the relocated reach and the Cardwell Bridge, and 6 were located below the Cardwell Bridge (Figure 2).

2.2 Aquatic Vegetation Sampling

Aquatic vegetation sampling occurred between July 20th and 22nd, when the average daily discharge ranged between 20.6 and 30.1 cubic feet per second. At each sampled transect, a measuring tape was stretched perpendicular across the channel to measure channel wetted width. If dense vegetation (e.g. cattails) prohibited access to the wetted edge, the wetted width was measured to the edge of the dense vegetation.

Once a transect was established, a metal rake was dragged across the transect along the bottom of the channel using a moderate amount of downward pressure. Only one swath was raked across each transect. Downward pressure was sufficient for the rake tines to penetrate soft sediment but rarely sufficient to capture much gravel in the tines. The rake was dragged across the transect until either the entire transect had been raked or the rake filled with vegetation. In the latter case, raking was paused so that the vegetation collected in the tines could be evaluated, and was then resumed at the same location until the entire transect was sampled. Whenever vegetation was assessed, the rake was lifted above the water's surface with the tines facing upward to minimize vegetation loss.

When the aquatic vegetation collected in the rake tines was inspected, species other than watermilfoil were removed. Three species of watermilfoil have been previously identified in Jefferson Slough: EWM, northern watermilfoil (*Myriophyllum sibiricum*), and a hybrid of the two (Duncan 2013). Since it can be difficult to differentiate between hybrids and either EWM or northern watermilfoil without genetic testing, all milfoil species that were collected were considered to be EWM.

2.3 EWM Abundance and Density

Presence / absence and density of EWM observed at each transect was assessed and recorded. EWM density was estimated using a semi-quantitative method that assigned a density class to each transect. Density classes were assigned as follows:

1 = a few plants in the rake
2 = rake is ½ full
3 = rake is full
4 = rake is overflowing
5 = multiple rakes full (number of rakes full were also recorded)

3.0 RESULTS

3.1 EWM Abundance

EWM was observed at 46.7% of the transects sampled, with the vast majority of patches observed below Mulligan's culvert. No EWM was observed above or within the Phase 1 channel modification. EWM was observed at 62% of the 92 transects sampled below the relocated channel.

3.2 EWM Density

The upstream-most extent where EWM was observed was approximately 940 feet downstream from the bottom of the of the Phase 1 channel modification reach, and 700 feet upstream of Tim Mulligan's culvert. The heaviest infestations were observed in a 0.5-mile section of channel which begins at the eastern edge of the Mulligan property boundary and ends where Jefferson Slough begins to run parallel to Irvine Lane and I-90. Ten of the sixteen (~62%) transects sampled in this section were assigned an EWM density class of 4 or 5 (overflowing rake or multiple rakes full). In the 39 transects sampled below the heavily infested section, EWM was assigned a density class of 4 or 5 at only three transects (7.7%), nine transects (23.1%) were assigned a density value of 3 (full rake), 11 transects (28.2%) were assigned a density value of 2 (1/2 full rake), 15 transects (38.5%) were assigned a value of 1 (just a few plants in the rake), and one transect (2.6%) did not have any EWM.

4.0 DISCUSSION

Management actions intended to control EWM in the lower 4.3 miles of Jefferson Slough have been effective in the upstream portions of this reach. The 2020 monitoring results indicated that herbicide applications coupled with the Phase 1 channel modification project have potentially eradicated the EWM infestations in the upper 0.8 miles of the infested reach, as no EWM was detected in this reach. An additional 0.5 miles below this reach contains very little EWM and the abundance is sufficiently low enough to conclude that the desired level of EWM control has been achieved within this channel segment. Prior to implementation of the JSEWM Management Plan, EWM infestations occupied 4.3 miles of the slough. Now, EWM exists only in the lower 3.5 miles of Jefferson Slough, with heavy infestations present the lower 3.0 miles. Based on the 2020 monitoring results, EWM has potentially been eradicated from 19% of the channel length and has been controlled in 30% of the channel length.

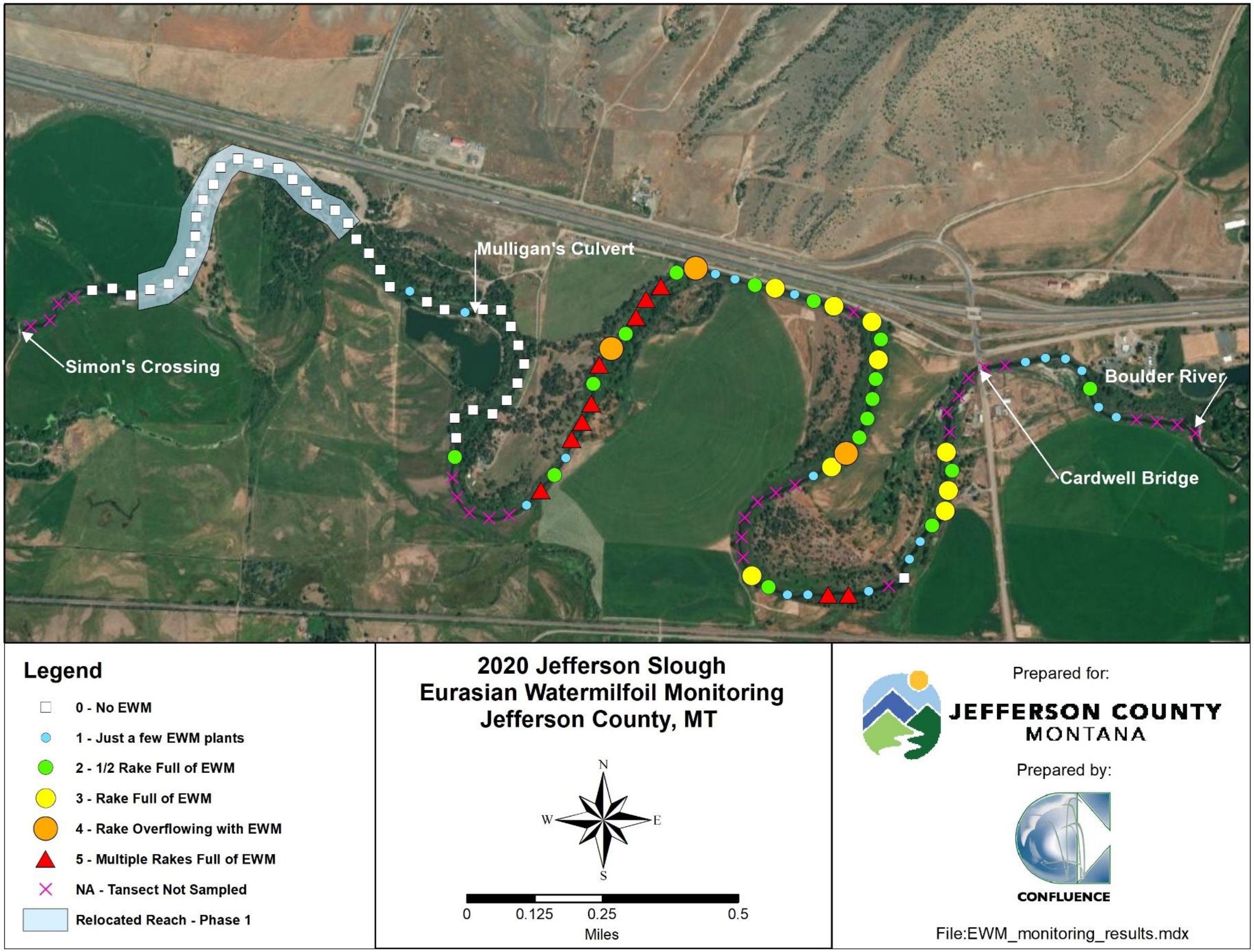

Figure 2. Results of 2020 EWM monitoring efforts in Jefferson Slough.

Despite the EWM control that has been achieved in the upstream end of Jefferson Slough, EWM abundance and density appears to have increased in the downstream portions of the infested reach. When visually comparing the 2020 EWM monitoring results to data collected in 2013 (Figure 3), EWM abundance appears to have increased in the middle segment of the Slough. EWM density may have also increased during this time period, but the evidence to support this statement on the whole is less clear, as it is based on a qualitative comparison of density data collected using different methods and displayed on a map (Figures 2 and 3). The 0.5-mile segment of Jefferson Slough that runs first parallel to Irvine Lane and I-90 and then turns south for approximately 0.2 miles, appears to have maintained consistent EWM abundance but experienced a decrease in EWM density. The lowest 1.6 miles appear to have experienced an increase in both EWM abundance and density. While quantitative data comparisons between 2013 and 2020 are not possible due to the use of different sampling methods, the 2020 monitoring results indicate that the use of herbicide alone in the lower 3.0 miles of Jefferson Slough has been less effective at achieving EWM control than the combination of herbicide and channel modification used further upstream. Although EWM control has thus far been achieved in the upper 0.8 miles of Jefferson Slough, results of the 2020 monitoring event indicate the goal of reducing EWM by 95% within 5 years of initiating the JSEWM Management Plan has not been met. Adaptive management strategies may be necessary to achieve an acceptable level of EWM control.

One adaptive management strategy would be to increase the herbicide applications from one to two per year, to account for different herbicide responses between EWM and EWM/northern watermilfoil hybrids. Guastello and Thum (2016) conducted a greenhouse experiment on EWM and EWM/northern watermilfoil hybrids (WM hybrids) collected from Jefferson Slough in 2015 to examine differences in herbicide response. They also sampled and collected EWM and WM hybrids before and after herbicide application in the Slough in 2016. They did not observe differences in mortality or herbicide tolerance between the EWM and WM hybrids in either the greenhouse experiment or their field studies. Instead they observed that the WM hybrid species rebounded more quickly following herbicide application. These observations make a case for potentially treating WM hybrids more frequently than pure EWM strains to achieve better control. While the 2020 monitoring effort did not attempt to identify EWM versus WM hybrids, both are known to exist in the Jefferson Slough monitoring reach. One certain conclusion that can be made from comparing the 2013 and 2020 data is that the segment found to have the highest density of EWM in 2020 (Figure 2) did not exhibit high densities of EWM in 2013 (Figure 3). In 2016, Guastello and Thum observed that the majority of the watermilfoil in this same segment was a WM hybrid. If the plants observed in this segment in 2020 are WM hybrids, this observation would corroborate their findings that WM hybrids potentially have a higher regrowth potential following herbicide application. If hybridization is responsible for the high density of watermilfoil observed in the segment of Jefferson Slough located upstream of Irvine Lane, then more frequent herbicide applications might be required to achieve control.

Additional channel modification projects should also be considered as an adaptive management strategy. For instance, the average slope of the segment of Jefferson Slough most heavily infested with EWM is less than 0.05%, therefore this channel segment conveys water very slowly and is prone to fine sediment accumulation (Confluence 2014b). The physical characteristics of this channel segment produce many suitable EWM habitat areas, and as such, it continues to support a relatively high density of EWM. This reach would be an excellent candidate for channel modification, as the physical characteristics of this reach could be altered to increase flow velocities and sediment transport capabilities. The upper 0.8 miles of the EWM infestation mapped in 2013 exhibited a similar slope of 0.05% prior to implementation of the

Phase 1 channel modification project. The modified channel, completed in 2018, is narrower and deeper than the original channel, and slope is now 0.07%. This segment now has higher flow velocities and transports sediment more effectively. Given that no EWM was observed in the modified channel segment in 2020, there is a high likelihood that EWM control could be achieved in other portions of Jefferson Slough by modifying the channel to similar physical characteristics.

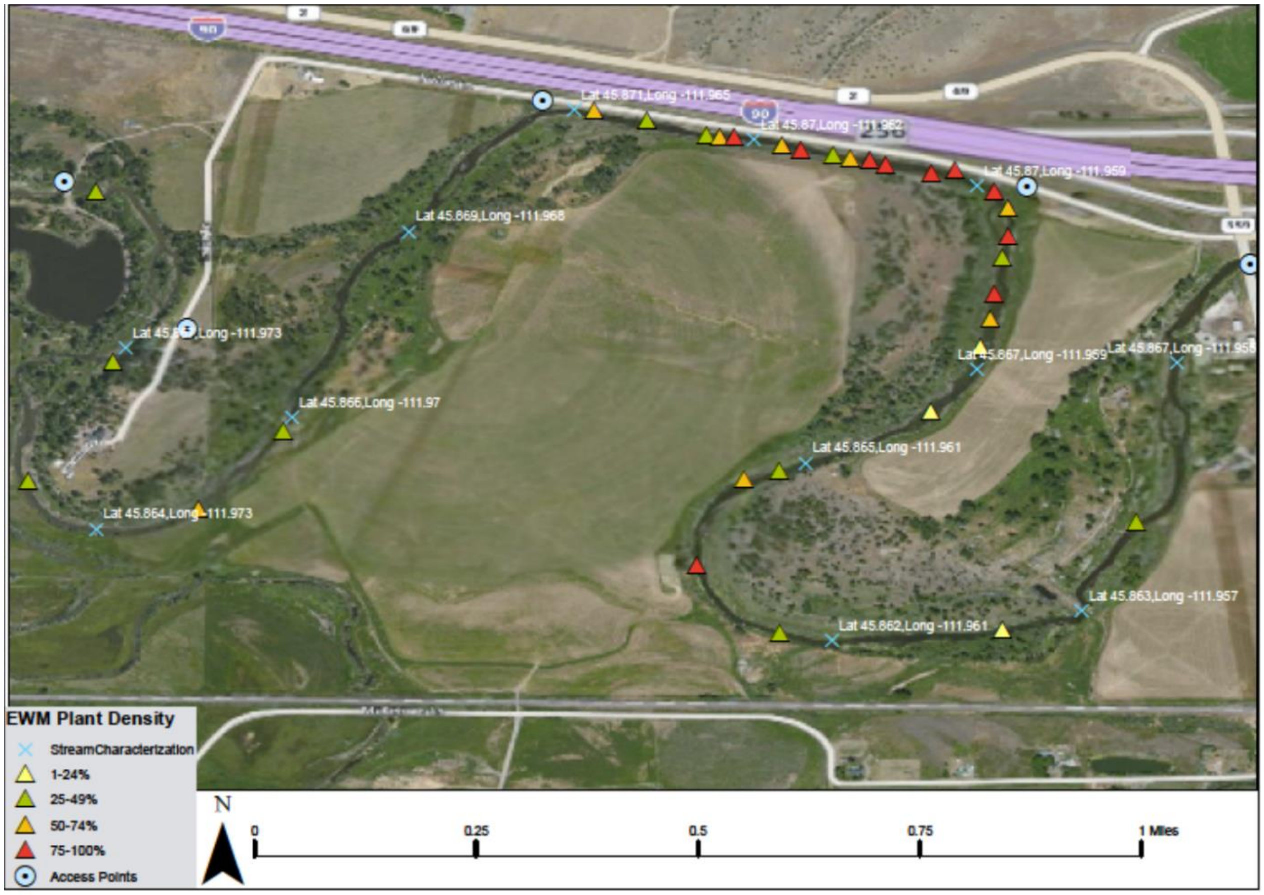

Figure 3. Results of 2013 EWM monitoring efforts. Figure credit: Craig McLane MT Fish Wildlife and Parks.

5.0 REFERENCES

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Appendix A

Eurasian Watermilfoil Monitoring Transect Locations

2020 Jefferson Slough Eurasian Water Milfoil Monitoring
Jefferson County, Montana

Tsect_No	Latitude	Longitude	Segment	Density	Notes
1	45.866799	-111.945979	Below realigned channel	NA	Too Deep
2	45.867011	-111.946691	Below realigned channel	NA	Too Deep
3	45.867067	-111.947472	Below realigned channel	NA	Too Deep
4	45.867114	-111.948253	Below realigned channel	NA	Too Deep
5	45.867166	-111.949030	Below realigned channel	1	Sampled
6	45.867415	-111.949709	Below realigned channel	1	Sampled
7	45.867894	-111.950060	Below realigned channel	2	Sampled
8	45.868373	-111.950393	Below realigned channel	1	Sampled
9	45.868681	-111.951042	Below realigned channel	1	Sampled
10	45.868681	-111.951800	Below realigned channel	1	Sampled
11	45.868556	-111.952564	Below realigned channel	1	Sampled
12	45.868445	-111.953329	Below realigned channel	NA	Too Deep
13	45.868371	-111.954105	Below realigned channel	NA	Too Deep
14	45.868085	-111.954699	Below realigned channel	NA	Too Deep
15	45.867603	-111.955060	Below realigned channel	NA	Too Deep
16	45.867154	-111.955501	Below realigned channel	NA	Too Deep
17	45.866633	-111.955378	Below realigned channel	NA	Too Deep
18	45.866089	-111.955468	Below realigned channel	3	Sampled
19	45.865599	-111.955223	Below realigned channel	2	Sampled
20	45.865069	-111.955344	Below realigned channel	3	Sampled
21	45.864530	-111.955443	Below realigned channel	3	Sampled
22	45.864118	-111.955919	Below realigned channel	2	Sampled
23	45.863678	-111.956363	Below realigned channel	1	Sampled
24	45.863206	-111.956755	Below realigned channel	1	Sampled
25	45.862703	-111.956923	Below realigned channel	0	Sampled
26	45.862482	-111.957518	Below realigned channel	NA	Too Deep - irrigation return
27	45.862313	-111.958262	Below realigned channel	1	Sampled
28	45.862200	-111.959028	Below realigned channel	5	Sampled
29	45.862187	-111.959802	Below realigned channel	5	Sampled
30	45.862166	-111.960586	Below realigned channel	1	Sampled
31	45.862149	-111.961356	Below realigned channel	1	Sampled
32	45.862342	-111.962089	Below realigned channel	2	Sampled
33	45.862634	-111.962742	Below realigned channel	3	Sampled
34	45.863116	-111.963101	Below realigned channel	NA	Too Deep
35	45.863653	-111.963192	Below realigned channel	NA	Too Deep
36	45.864179	-111.963085	Below realigned channel	NA	Too Deep
37	45.864603	-111.962613	Below realigned channel	NA	Too Deep
38	45.864859	-111.961923	Below realigned channel	NA	Too Deep
39	45.865079	-111.961205	Below realigned channel	NA	Too Deep
40	45.865341	-111.960515	Below realigned channel	1	Sampled
41	45.865599	-111.959829	Below realigned channel	3	Sampled
42	45.865980	-111.959293	Below realigned channel	4	Sampled
43	45.866405	-111.958806	Below realigned channel	2	Sampled
44	45.866915	-111.958516	Below realigned channel	2	Sampled
45	45.867444	-111.958349	Below realigned channel	2	Sampled
46	45.867970	-111.958245	Below realigned channel	2	Sampled
47	45.868497	-111.958184	Below realigned channel	3	Sampled
48	45.869038	-111.958100	Below realigned channel	2	Sampled
49	45.869512	-111.958472	Below realigned channel	3	Sampled
50	45.869744	-111.959183	Below realigned channel	NA	skipped
51	45.869895	-111.959934	Below realigned channel	3	Sampled
52	45.870007	-111.960702	Below realigned channel	2	Sampled
53	45.870165	-111.961451	Below realigned channel	1	Sampled
54	45.870320	-111.962202	Below realigned channel	3	Sampled

55	45.870381	-111.962977	Below realigned channel	2	Sampled
56	45.870519	-111.963734	Below realigned channel	1	Sampled
57	45.870650	-111.964495	Below realigned channel	1	Sampled
58	45.870792	-111.965252	Below realigned channel	4	Sampled
59	45.870642	-111.965982	Below realigned channel	2	Sampled
60	45.870271	-111.966557	Below realigned channel	5	Sampled
61	45.869911	-111.967106	Below realigned channel	5	Sampled
62	45.869427	-111.967462	Below realigned channel	5	Sampled
63	45.868968	-111.967833	Below realigned channel	2	Sampled
64	45.868572	-111.968367	Below realigned channel	4	Sampled
65	45.868130	-111.968817	Below realigned channel	5	Sampled
66	45.867608	-111.969023	Below realigned channel	2	Sampled
67	45.867082	-111.969062	Below realigned channel	5	Sampled
68	45.866589	-111.969400	Below realigned channel	5	Sampled
69	45.866126	-111.969768	Below realigned channel	5	Sampled
70	45.865614	-111.969984	Below realigned channel	1	Sampled
71	45.865149	-111.970394	Below realigned channel	2	Sampled
72	45.864734	-111.970894	Below realigned channel	5	Sampled
73	45.864326	-111.971416	Below realigned channel	1	Sampled
74	45.864046	-111.972081	Below realigned channel	NA	Too Deep
75	45.863937	-111.972840	Below realigned channel	NA	Too Deep
76	45.864072	-111.973592	Below realigned channel	NA	Too Deep
77	45.864478	-111.974088	Below realigned channel	NA	Too Deep
78	45.865001	-111.974299	Below realigned channel	NA	Too Deep
79	45.865544	-111.974210	Below realigned channel	2	Sampled
80	45.866058	-111.974191	Below realigned channel	0	Sampled
81	45.866591	-111.974266	Below realigned channel	0	Sampled
82	45.866815	-111.973584	Below realigned channel	0	Sampled
83	45.866723	-111.972826	Below realigned channel	0	Sampled
84	45.867100	-111.972308	Below realigned channel	0	Sampled
85	45.867572	-111.971921	Below realigned channel	0	Sampled
86	45.868086	-111.971676	Below realigned channel	0	Sampled
87	45.868578	-111.971932	Below realigned channel	0	Sampled
88	45.869072	-111.972233	Below realigned channel	0	Sampled
89	45.869505	-111.972633	Below realigned channel	0	Sampled
90	45.869509	-111.973314	Below realigned channel	0	Sampled
91	45.869414	-111.974002	Below realigned channel	1	Sampled
92	45.869465	-111.974782	Below realigned channel	0	Sampled
93	45.869665	-111.975466	Below realigned channel	0	Sampled
94	45.869929	-111.976140	Below realigned channel	1	Sampled - First EWM detection
95	45.870036	-111.976898	Below realigned channel	0	Sampled
96	45.870484	-111.977298	Below realigned channel	0	Sampled
97	45.870911	-111.977737	Below realigned channel	0	Sampled
98	45.871273	-111.978243	Realigned channel	0	Sampled
99	45.871685	-111.978569	Realigned channel	0	Sampled
100	45.872030	-111.979083	Realigned channel	0	Sampled
101	45.872173	-111.979795	Realigned channel	0	Sampled
102	45.872512	-111.980208	Realigned channel	0	Sampled
103	45.872803	-111.980749	Realigned channel	0	Sampled
104	45.873092	-111.981309	Realigned channel	0	Sampled
105	45.873214	-111.982073	Realigned channel	0	Sampled
106	45.873315	-111.982844	Realigned channel	0	Sampled
107	45.873072	-111.983504	Realigned channel	0	Sampled
108	45.872614	-111.983764	Realigned channel	0	Sampled
109	45.872195	-111.984139	Realigned channel	0	Sampled

110	45.871738	-111.984375	Realigned channel	0	Sampled
110	45.871224	-111.984383	Realigned channel	0	Sampled
112	45.870764	-111.984545	Realigned channel	0	Sampled
113	45.870267	-111.984792	Realigned channel	0	Sampled
114	45.869932	-111.985357	Realigned channel	0	Sampled
115	45.869756	-111.986043	Realigned channel	0	Sampled
116	45.869588	-111.986766	Above realigned channel	0	Sampled
117	45.869755	-111.987492	Above realigned channel	0	Sampled
118	45.869694	-111.988258	Above realigned channel	0	Sampled
119	45.869469	-111.988954	Above realigned channel	NA	Unsampleable
120	45.869289	-111.989520	Above realigned channel	NA	Unsampleable
121	45.868844	-111.989833	Above realigned channel	NA	Unsampleable
122	45.868671	-111.990563	Above realigned channel	NA	Unsampleable