Upper Columbia River Basin Aquatic Invasive Species

2021 Early Detection and Monitoring Plan

June 2021

Contents

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Table 1. List of Acronyms

AIS	Aquatic invasive species	MCWD	Missoula County Weed District/AIS District
BOR	US Bureau of Reclamation	MISC	Montana Invasive Species Council
CLP	Curlyleaf pondweed	MDA	Montana Dept. of Agriculture
CRB	Columbia River Basin	MDT	Montana Dept. of Transportation
eDNA	Environmental DNA	SKC	Salish Kootenai College
EWM	Eurasian watermilfoil	Task Force	Sanders County Invasive Aquatic Plant Task Force
DNRC	Montana Dept. of Natural Resources & Conservation	WLI	Whitefish Lake Institute
FWP	Montana Dept. of Fish, Wildlife & Parks	UC^3	Upper Columbia Conservation Commission

1.0 Introduction

This report is a product of the Upper Columbia Conservation Commission (UC^3) Early Detection and Monitoring Committee. Montana Code Annotated 80-7-1026 requires UC^3 to monitor the condition of aquatic resources in the tributaries to the Columbia River and coordinate development of an annual monitoring plan. The purpose of this report is to inform future aquatic invasive species (AIS) early detection and monitoring conducted by UC^3 and project partners in the upper Columbia River Basin.

Contained in this report are partner sample locations for early detection monitoring efforts from 2020 to provide a framework to guide future prioritization of sampling efforts. The intended outcome of this report is to increase communication and coordination amongst project partners to optimize the effectiveness of early detection monitoring and to prioritize limited sampling resources.

2.0 Statewide History and Perspective of Aquatic Invasive Species Issue

In 2009, the Montana Legislature passed the Montana Aquatic Invasive Species Act with revisions in the 2011 legislative session for undertaking coordinated educational, prevention, detection and management activities to prevent, detect, control and manage aquatic invasive species.

Prior to 2016, Montana had been one of a few remaining states void of *Dreissenid* (zebra/quagga) mussels. However, calcium data suggests the Montana waters would be suitable to invasive mussels (Figure 1). In early November 2016, the Montana Department of Fish, Wildlife & Parks (FWP) reported that Tiber Reservoir, east of Shelby, Montana, tested positive for *Dreissenid* mussel veligers (larvae). FWP also reported a suspect veliger detection at Canyon Ferry near Helena.

Western states utilize standard operating procedures for watercraft inspections, decontamination, and monitoring through a coordination group called the Western Regional Panel on Aquatic Nuisance Species. They also have an agreed-upon process for classifying what language is used if *Dreissenid* mussels are detected in a waterbody (e.g. 'suspect' vs. 'positive'). See *Table 2* below for the definitions used by western states related to the language used relevant to invasive mussel monitoring and detections.

Table 2. Dreissenid Mussel Waterbody Classification Guidelines Adopted by the Western Regional Panel on Aquatic Nuisance Species

Term	Definition	De-Listing Criteria
Unsampled	Waterbody is not being sampled or monitored for invasive mussels	N/A
Undetected/Negative	Sampling/testing is on-going and no invasive mussels have been detected, or invasive mussels have not been detected within the timeframes for de-listing	N/A
Inconclusive (temporary status)	Waterbody has not met the minimum criteria for detection	1 year of negative testing (including at least one sample taken in the same month of subsequent year as the positive sample to account for seasonal env. variability)
Suspect	Waterbody has met the minimum criteria for detection (2 independent lab results from the same sample using scientifically accepted techniques, e.g., microscopy, PCR, gene sequencing, taxonomic identification).	3 years of negative testing to get to undetected/negative.
Positive	Multiple (2+) subsequent sampling events that meet the minimum criteria for detection	5 years of negative testing to get to undetected/negative.
Infested	A waterbody that has an established population of invasive mussels	Following a successful eradication or extirpation event including a minimum of 5 years post-event monitoring with negative results.

In late November 2016, Governor Bullock issued an executive order declaring a statewide natural resource emergency for Montana waterbodies. The executive order triggered the deployment of an Incident Command Team that worked quickly to identify and contain existing Dreissenid mussel populations and developed plans to prevent further introduction to other waterbodies. In January 2017, the governor disbanded the Incident Command Team and gave responsibility of the AIS effort to the Joint Montana Mussel Response Team, comprised of FWP and Montana Department of Natural Resources and Conservation (DNRC) staff, with support from the Montana Invasive Species Advisory Council (MISAC).

The Joint Montana Mussel Response Team developed an implementation strategy for the state of Montana with key sub-category recommendations, including: restrictions, closures, and decontamination; expansion of watercraft inspection stations; expansion of early detection monitoring; strengthening management and program frameworks; and development of a future rapid response plan for invasive species.

In 2017, the Montana Legislature passed House Bill (HB) 622 revising laws related to invasive species. Included in HB 622 was the creation of the Montana Invasive Species Council (MISC), formerly MISAC. MISC is a statewide partnership working to protect Montana's economy, natural resources, and public health through a coordinated approach to combat invasive species (aquatic and terrestrial). In addition, HB622 created the UC^3. MISC and UC^3 are administratively attached to DNRC. In 2017, the legislature also passed SB 363 that provided a funding mechanism for the Montana AIS Program.

The increased threat of *Dreissenid* mussels prompted local groups and agencies in or near the Upper Columbia River Basin in 2017 to implement enhanced local AIS programs to compliment efforts at the state

level. Included were the Blackfeet Nation, the Blackfoot Challenge, the Clearwater Resource Council, the Confederated Salish & Kootenai Tribes, Glacier National Park, Missoula County Weed/AIS District, Swan Valley Connections, the US Forest Service, US Fish & Wildlife Service Creston National Fish Hatchery, and the Whitefish Lake Institute.

3.0 Role of Upper Columbia Conservation Commission

The mission of the UC^3 is to protect the aquatic environment in Montana tributaries to the Columbia River from the threat of AIS in order to protect water resources, downstream interests, and the economic and ecological vitality of the region. UC^3 fosters close cooperation and coordination between international, federal, regional, state, tribal, and local water resource managers for the development and implementation of comprehensive Upper Columbia River Basin prevention and management measures to prevent the introduction and/or further establishment of AIS.

3.1 Members and Partners

The UC^3 includes 14 voting commission members who are appointed by and serve at the pleasure of the Governor for a designated term. They include a representative of each of the following:

1. Member at large
2. The Hydropower utility industry
3. Electric cooperatives located within the Columbia River Basin in Montana
4. Conservation districts
5. Private industry
6. Private landowners
7. The Confederated Salish and Kootenai Tribes
8. The Montana Invasive Species Council
9. A Conservation, Natural Resource or hunting/angling organization from the Upper/Middle Clark Fork River Basin
10. A Conservation, Natural Resource or hunting/angling organization from the Bitterroot River Basin
11. A Conservation, Natural Resource or hunting/angling organization from the Flathead River Basin
12. A Conservation, Natural Resource or hunting/angling organization from the Swan/Blackfoot River Basins
13. A Conservation, Natural Resource or hunting/angling organization from the Kootenai River Basin
14. A Conservation, Natural Resource or hunting/angling organization from the Lower Clark Fork River Basin

In addition, the speaker of the house and the president of the senate each appoint two nonvoting members to UC^3, one from each party.

The UC^3 seeks active input and participation from FWP, the DNRC AIS Grant program, the U.S. Forest Service, the National Park Service, the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture Natural Resources Conservation Service, the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, the Northwest Power and Conservation Council, the Province of British Columbia, and other appropriate entities as deemed necessary. Agency representatives actively participate in UC^3 meetings and projects and facilitate coordination and communication between the UC^3 and the representative's organization. In addition, ex-officio members may be recommended by consensus of the Commission. Ex-officio members could include additional representatives of state or federal entities, local government

organizations, tribal governments, Montana universities and private and for-profit organizations with an interest in the wellbeing of Montana pertaining to AIS.

4.0 Aquatic Invasive Species in the Upper Columbia River Basin

AIS include plants, animals, and pathogens that are non-native to an ecosystem. AIS are introduced accidentally or intentionally by human activity outside of their native range. AIS populations can reproduce quickly and spread rapidly because there are no natural predators or competitors to keep their populations in check. Just one organism, or in some cases a piece of a plant, is enough to start a new invasion. AIS can displace native species, clog waterways, impact irrigation and power systems, degrade ecosystems, threaten recreational fishing opportunities, and can cause wildlife and public health problems.

The UC[3] and the Montana Invasive Species Council (MISC) recognizes the AIS list compiled by FWP, DNRC, Montana Department of Agriculture (MDA), and the Montana Department of Transportation (MDT) in an interagency Memorandum of Understanding (see list in *table 3*).

Table 3. AIS of Highest Concern in Montana.

Species – common name	Species – scientific name	Where Listed/Regulated
American bullfrog	*Lithobates catesbeianus*	Interagency MOU/FWP Authority
Asian clam	*Corbicula fluminea*	Interagency MOU/FWP Authority
Bighead carp	*Hypophthalmichthys nobilis*	Interagency MOU/FWP Authority
Black carp	*Mylopharyngodon piceus*	Interagency MOU/FWP Authority
Brazilian waterweed	*Egeria densa*	Montana Noxious Weed List, Priority 3
Brittleleaf naiad	*Najas minor*	Interagency MOU/FWP Authority
Common water hyacinth	*Eichhornia crassipes*	Interagency MOU/FWP Authority
Chinese mysterysnail	*Cipangopaludina chinensi, Cipangopaludina chinensis malleata*	Interagency MOU/FWP Authority
Chytrid Fungus	*Batrachochytrium dendrobatidis*	Interagency MOU/FWP Authority
Curlyleaf pondweed	*Potamogeton crispus*	Montana Noxious Weed List, Priority 2B
Eurasian watermilfoil	*Myriophyllum spicatum*	Montana Noxious Weed List, Priority 2A
Fanwort	*Cabomba caroliniana*	Interagency MOU/FWP Authority
Faucet snail	*Bithynia tentaculata*	Interagency MOU/FWP Authority
Fishhook waterflea	*Cercopagis pengoi*	Interagency MOU/FWP Authority
Flowering rush	*Butomus umbellatus*	Montana Noxious Weed List, Priority 2A
Fragrant waterlily	*Nymphea odorata*	Interagency MOU/FWP Authority
Grass carp	*Ctenopharyngodon idella*	Interagency MOU/FWP Authority
Hydrilla	*Hydrilla verticillata*	Montana Noxious Weed List, Priority 3
New Zealand mudsnail	*Potamopyrgus antipodarum*	Interagency MOU/FWP Authority
Northern snakehead	*Channa argus*	Interagency MOU/FWP Authority
Parrot feather watermilfoil	*Myriophyllum aquaticum or M. brasiliense*	Montana Noxious Weed List, Priority 3
Proliferative Kidney Disease (PKX)	*Tetracapsuloides bryosalmonae*	Interagency MOU/FWP Authority
Quagga mussel	*Dreissena rostriformis bugensis*	Interagency MOU/FWP Authority
Red-rim melania	*Melanoides tuberculata*	Interagency MOU/FWP Authority
Red swamp crayfish	*Procambarus clarkia*	Interagency MOU/FWP Authority
Round goby	*Neogobius melanostomus*	

Species – common name	Species – scientific name	Where Listed/Regulated
Ruffe	*Gymnocephalus cernua*	Interagency MOU/FWP Authority
Rusty crayfish	*Orconectes rusticus*	Interagency MOU/FWP Authority
Silver carp	*Hypophthalmichthys molitrix*	Interagency MOU/FWP Authority
Spiny waterflea	*Bythotrephes longimanus*	Interagency MOU/FWP Authority
Starry Stonewort	*Nitellopsis obtuse*	Interagency MOU/FWP Authority
Tench	*Tinca tinca*	Interagency MOU/FWP Authority
Variable-leaf milfoil	*Myriophyllum heterophyllum*	Interagency MOU/FWP Authority
Virile crayfish	*Orconectes virilis*	Interagency MOU/FWP Authority
Viral hemorrhagic septicemia (VHS)	*Oncorhynchus 2 novirhabdovirus*	Interagency MOU/FWP Authority
Whirling disease	*Myxobolus cerebralis*	Interagency MOU/FWP Authority
Yellow floating heart	*Nymphoides peltata*	Interagency MOU/FWP Authority
Zander	*Sander lucioperca*	Interagency MOU/FWP Authority
Zebra mussel	*Dreissena polymorpha*	Interagency MOU/FWP Authority

Existing AIS species in the Upper Columbia River Basin include six aquatic plants; one mollusk, two pathogens and two amphibians (*see Table 4*). Non-native fish are not included in Tables 1 and 2 since they fall under different management guidelines by FWP. FWPs' Native Fish Management Plan seeks to: monitor the presence, distribution and abundance of Montana's native fish; maintain or enhance Montana's native fish populations and habitats; and encourage participation by the scientific community, agencies, and local communities to conserve and enhance native fish populations.

Table 4. AIS Known to be Present in the Upper Columbia River Basin.

AIS	Major River Drainage	Waterbody
American bullfrog (Lithobates catesbeianus)	Bitterroot	Bitterroot River
	Clark Fork	Clark Fork River
	Flathead	Flathead River
Curly-leaf Pondweed (*Potamogaton crispus*)	Bitterroot	Bitterroot River
	Clark Fork	Clark Fork River, including; - Confluence with Bitterroot - Cabinet Gorge Reservoir - Noxon Reservoir - Thompson Falls Reservoir
	Flathead	Flathead River (upper) Flathead River (lower), including; - Kicking Horse Reservoir - Ninepipe Reservoir - Pablo Reservoir Flathead Lake
Eurasian Watermilfoil (*Myriophyllum spicatum*)	Clark Fork	Clark Fork River (lower), including; - Noxon Reservoir - Cabinet Gorge Reservoir
	Flathead	Beaver Lake
Faucet Snail (*Bithynia tentaculata*)	Blackfoot	Upsata Lake Browns Lake
	Clark Fork	Georgetown Lake
	Flathead	Flathead River Flathead Lake Lost Loon Lake McWennegar Slough Smith Lake

AIS	Major River Drainage	Waterbody
Flowering Rush (*Butomus umbellatus*)	Clark Fork	Clark Fork River (lower), including; - Cabinet Gorge Reservoir - Noxon Reservoir - Thompson Falls Reservoir
	Flathead	Flathead River (upper) Flathead River (lower) Flathead Lake
Fragrant Waterlily (*Nymphaea odorata*)	Blackfoot	Blanchard Lake Browns Lake Lake Inez Rainy Lake Placid Lake Salmon Lake Seeley Lake Upsata Lake
	Bitterroot	1-3 private ponds
	Flathead	Beaver Lake Blanchard Lake Lake Mary Ronan
	Kootenai	Duck Lake Savage Lake
	Swan	Holland Lake*
New Zealand mudsnail (Potamopyrgus antipodarum)	Bitterroot	Private hatchery - Hamilton
Purple loosestrife (Lythrum salicaria)	Bitterroot	Bitterroot River
	Blackfoot	Clearwater River
	Flathead	Flathead River
	Kootenai	Kootenai River
Snapping Turtles (Chelydra Serpentina)	Bitterroot	Bitterroot River
	Clark Fork	Clark Fork River
	Flathead	Flathead River
Spiny water nymph	Clark Fork	Frenchtown Pond
Whirling Disease (*Myxobolus cerebralis*)	Bitterroot Blackfoot Clark Fork Kootenai	N/A
Yellowflag Iris (*Iris pseudacorus*)	Flathead	Whitefish Riverside Stormwater Pond* Whitefish River* Blanchard Lake Hwy 35 roadside ditch, mile marker 18
	Clark Fork	Clark Fork River including: -Cabinet Gorge Reservoir -Noxon Rapids Reservoir -Thompson Falls Reservoir Missoula irrigation canal
	Bitterroot	Bitterroot River Florence Irrigation Canal Miller Creek Pattee Creek
	Blackfoot	Salmon Lake* Clearwater River*

*Waterbodies either not listed for a species or not consistently reported by FWP and the Montana Natural Heritage Program.

4.1 Aquatic Invasive Species of Concern for the Upper Columbia River Basin

There are a number of AIS of highest concern for the Upper Columbia River Basin. *Table 5* (below) displays AIS that pose a higher risk potential to colonize and cause further environmental and economic impact to state waters. It is a prioritized watch list but does not include all AIS that have the potential to be transported to, or to colonize Montana waters.

Table 5 . AIS of Highest Concern for the Upper Columbia River Basin.

	Present in Montana	**Detected in Montana**	**Undetected in Montana**
Crustaceans			Spiny Waterflea Fishhook Waterflea Rusty Crayfish
Mollusks	Red-Rim Melania Faucet Snail*# New Zealand Mudsnail* Asian Clam	Quagga Mussel^ Zebra Mussel^	Chinese Mysterysnail
Parasites & Pathogens	Whirling Disease* Proliferative Kidney Disease (PKD)	IHN Virus	Asian Tapeworm Microsporidian Parasite VHS Virus
Plants	Eurasian Watermilfoil* Flowering Rush* Curly-leaf Pondweed* Fragrant Waterlily* Yellowflag Iris* Spiny water nymph		Hydrilla Brazilian Elodea Parrotfeather Milfoil Yellow Floating Heart

*Present in the Upper Columbia River Basin.
#Waterbodies either not listed for a species or not consistently reported by FWP and the Montana Natural Heritage Program.
^species unknown/undetermined (in the case of Zebra/Quagga detection, species analysis was inconclusive)

5.0 Importance of Aquatic Invasive Species Early Detection Monitoring

Once established, there are currently few, if any, methods to effectively control or eradicate AIS in natural waterbodies. Control methods require continued maintenance over time and often become cost prohibitive. Nationwide, there are very few AIS eradication success stories (especially *Dreissenid* mussels), and those that are successful are often due to unique environmental circumstances or special management options.

If AIS are detected during an early detection and monitoring program, managers have more options to implement rapid response strategies for control and containment efforts. Aggressive rapid response strategies can lead to effective containment in a waterbody and reduce the transport risk potential to other waters. The following AIS control effort case study examples in the Upper Columbia River Basin range in the time from onset of colonization to when control efforts began, along with the mitigation technique.

5.1 Management Case Studies

Case Study 1- Flowering Rush in Flathead Lake

Flowering Rush is the oldest known AIS in the Upper Columbia Basin, first collected in Montana along the north margin of Flathead Lake in 1962. From Flathead Lake, Flowering Rush has also spread 12 miles upstream of where the Flathead River enters the lake, and

165 miles downstream, into the Clark Fork River and all the way to Lake Pend Oreille in Idaho. Flowering Rush has affected more than 2,000 acres of Flathead Lake. It's estimated that it has the capability of invading 75 percent of Flathead's littoral zone, and as many as 12,000 of the lake's 124,000 surface acres, or nearly 10 percent of Flathead Lake's currently open waters. Flowering rush is established below the ten-foot drawdown zone to depths of twenty feet, but the extent is unknown.

Researchers from Salish Kootenai College (SKC) and The University of Montana have found that registered aquatic herbicides can suppress flowering rush top growth up to 90% through the growing season, and after five years of annual treatments the reproductive rhizome has been reduced up to 80%. They are also testing water column injections, where computer-controlled weighted hoses pulled behind a boat inject precise amounts of herbicides. Staffing availability, treatment costs, and the infestation magnitude have hindered control and eradication efforts, but SKC is currently working on implementing a control project leveraging state and federal funds.

Case Study 2- Curly-leaf Pondweed in Flathead Lake

The Flathead Basin Commission commissioned a report by Weed Management Services in 2015 to analyze Curly-leaf pondweed (CLP) in Flathead Lake and the Flathead River. A second draft of this report exists but it is unclear if a final report was published. Curly-leaf pondweed was first discovered in the Upper Columbia River Basin in Ninepipe Reservoir in 1974. Surveys conducted from 2010 to 2015 show only three sites as infested in Flathead Lake, including Lakeside, North Shore, and Bigfork Condominium Marinas. It is estimated that at least 5,000 acres in Flathead Lake are susceptible to colonization. In the Flathead River, Curly-leaf pondweed is scattered from the mouth of the river upstream 12 miles.

Methods used in Curly-leaf pondweed control efforts include diver dredge removal and herbicide application. Control effort results for Flathead Lake and the Flathead River from 2013-2015 are found in Table 6.

Table 6. Pounds of Curly-leaf Pondweed Removed from Flathead Lake and River.

Site	Year					
	2015		2014		2013	
	lbs FW* removed	% removed	lbs FW removed	% removed	lbs FW removed	% removed
Lakeside	297	90	486	90	95**	--
Bigfork	153	90	252	80	--	--
Flathead River	--	--	329	--	323	--
Fennon Slough	--	--	120	--	222	--

*FW=fresh weight of aquatic plants

** In 2013, CLP removal in Lakeside only occurred outside the break-wall due to lack of landowner permission.

Case Study 3- Eurasian Watermilfoil in Noxon and Cabinet Gorge Reservoirs

Eurasian watermilfoil (EWM) was discovered in Noxon Reservoir in 2007. Initial plant surveys revealed 247 acres of dense EWM in Noxon Reservoir and 117 acres of dense

EWM in Cabinet Gorge Reservoir. In response to this discovery, the Sanders County Aquatic Invasive Plants Task Force (Task Force) was formed in 2008. The Task Force is charged with managing aquatic invasive plants in Sanders County waterways.

Herbicide demonstrations to control EWM were conducted from 2009 to 2011. Based on these demonstrations, programs to control EWM were implemented in Noxon Reservoir (2010, 2012-2016) and Cabinet Gorge Reservoir (2014-15). As a result, dense EWM areas were reduced by 98% in Noxon Reservoir, and 77% in several Cabinet Gorge Reservoir sites through 2014. Throughout this time period, both reservoirs continued to support diverse communities of native plants. In 2015, extremely low run off and high temperatures began earlier than normal and continued through the summer. This situation created favorable growing conditions for EWM and led to the acreage of dense EWM in Noxon Reservoir climbing from 24 acres in the fall of 2014 to almost 150 acres in spring 2015. Herbicide treatment of EWM did not occur in either reservoir in 2017.

In 2017, a treatment plan was developed by the Task Force under guidance from a Scientific Advisory Panel for treatments in future years. This ~~an~~ analysis of treatment alternatives for EWM was conducted to examine the various options for managing EWM in Noxon and Cabinet Gorge reservoirs. The analysis examined different methods for treatment to reduce dense EWM coverage and prioritize treatment areas. Ultimately, chemical and mechanical methods were deemed most appropriate given the conditions in the reservoirs. Public or residential use sites (e.g., boat launches, docks, swimming areas) were given the highest priority for treatment with large, high density shallow areas with substantial boat traffic being given secondary priority. In 2018 and 2019 treatment in Noxon and Cabinet Gorge reservoirs was focused on these high priority areas. Treatment consisted of using endothall and diquat on 30.9 acres across the two reservoirs in 2018. In 2019, 75.4 acres were treated with endothall and diquat across the two reservoirs. In addition, 22.9 acres on Noxon Reservoir were treated on a trial basis with a new herbicide called ProcellaCOR. In 2020, 13.5 acres were treated with endothall + diquat combo, and a second-round trial of ProcellaCOR was used on 5.9 acres. The vegetation experienced delayed growth in 2020, so many plots had little to no EWM during pre-treatment surveys. During 6-week post-treatment monitoring, much of the vegetation in those previously-clear plots had grown up into the water column so it's anticipated that the acreage will be back up between 50 and 100 acres this year (2021).

In addition to treatment, genetic testing of milfoil plants has occurred on Noxon Reservoir. Results indicate that hybrid watermilfoil exists there. Little research has been conducted on these hybrid strains and how best to treat them, increasing the difficulty of managing invasive watermilfoil in these reservoirs. Other components of the EWM management program developed on Noxon and Cabinet Gorge reservoirs includes educational outreach to increase public awareness and teach plant identification, and assistance with the placement of bottom barriers at key public boat ramps and public and private docks. Funding to support the EWM management program on Noxon and Cabinet Gorge reservoirs has been provided by Avista through the Clark Fork Settlement Agreement and grants from DNRC and the U.S. Army Corps of Engineers.

<u>Case Study 4- Eurasian Watermilfoil in Beaver Lake</u>

After EWM was discovered at the Beaver Lake boat ramp in 2011 by DNRC staff, an ad-hoc committee comprised of interested parties formed to address the issue, including; the Flathead Basin Commission, Flathead County Weed District, MDA, DNRC, FWP, and the Whitefish Lake Institute (WLI).

The initial management effort included the placement of bottom barriers at the infestation site. The bottom barriers proved effective in eradicating the majority of the localized population near the boat ramp, however, smaller, scattered EWM populations near the boat ramp and along the western shoreline remained.

Since 2012, WLI has recommended an AIS Management Plan to the City of Whitefish that includes control/eradication suction dredging efforts for EWM at Beaver Lake. Whitefish has prioritized this effort due to the proximity of Beaver Lake to Whitefish Lake, including hydrologic connectivity. Suction dredge efforts to control EWM in Beaver Lake have been highly effective. Suction dredging involves a diver identification survey of single plants or plant communities and then suction dredging the plants from the roots to prevent fragmentation. WLI also deploys and maintains a sediment curtain owned by the Flathead Lakers near the lake outlet to Beaver Creek to prevent downstream drift of any plant fragments. WLI will recommend that suction dredging continue in Beaver Lake indefinitely.

Table 7. Beaver Lake EWM Removal Summary by Suction Dredging Summary.

Year	EWM Removed (FW/lbs)*	Number of Plants
2012	23.5	No data available
2013	5	No data available
2014	<1	No data available
2015	<1	15
2016	<0.25	5
2017	<0.25	2
2018	0	0
2019	No weight data available	Several hundred individual plants
2020	3	Unknown

*FW=fresh weight

In June 2019, EWM plants were again found near the boat ramp by a FWP survey crew. FWP and WLI partnered in a suction dredge operation to remove plants and bottom barriers were placed over the impacted area. It appears that some plants are at depths that will require a dive team to mitigate. In 2020, additional EWM plants were hand removed by FWP divers and bottom barriers were deployed near the boat ramp.

Although some EWM remains present in Beaver Lake, the potential for Beaver Lake EWM population to be the parent source for other waterbodies is substantially reduced due to the control effort.

6.0 Early Detection Monitoring (2020)

Figures 2 and 3 display AIS early detection monitoring locations in the Upper Columbia River Basin by sample type in 2020. Partners have used plankton tows (microscopy analysis) as the primary early

detection tool and it is the standard recognized by FWP. Increasingly, partners have collected environmental DNA (eDNA) samples. Other early detection and monitoring tools include the deployment of artificial substrates and ocular surveys around boat ramps and other prioritized shoreline areas. Citizen scientist volunteers are often the eyes in the field for their local lake.

An example of an existing AIS-related citizen scientist program in the Upper Columbia River Basin is the Northwest Montana Lakes Network (NMLN). The UC^3 was able to secure a federal Bureau of Reclamation (BOR) grant in 2018 to develop the Upper Columbia Lakes Network (UCLN) to expand citizen science AIS monitoring throughout the Upper Columbia Basin. The contract to develop and initiate the UCLN was awarded to the Whitefish Lake Institute through a competitive process. The BOR funds have now been expended, but the UC^3 is committed to continuance and expansion of the UCLN to additional interested parties utilizing existing operating funds; additional funding options are currently being explored. See Section 10 for sampling and other recommendations related to AIS monitoring in the Upper Columbia River Basin.

7.0 Sample Collection and Equipment Decontamination Protocols

Sample collection protocols often vary by partner due to funding availability, staffing levels, and environmental conditions. Project partners should use the FWP AIS Management Program Field Sampling and Laboratory Standard Operating Procedures (2019), or the Western Regional Panel on Aquatic Nuisance Species Sampling and Monitoring Protocol (2018) as a starting point for their specific program needs. eDNA monitoring procedures should follow lab-specific protocols. University of Montana Conservation Genetics Laboratory (MCGL) can provide protocols for invasive mussel eDNA sample collection. The reports cover sample collection and equipment decontamination protocols. Partners should communicate with their receiving analytical laboratory for any special instructions, including sample preservation. FWP has also developed an AIS sampling data application (app) that is available to partners to encourage consistent and timely data collection. FWP is developing a training program for partners interested in AIS survey and sampling efforts. The training reviews AIS survey and sample collection protocols for invasive mussels, weeds, clams, snails and crayfish. The UC^3 is planning to coordinate the development of AIS monitoring training videos for the various types of monitoring by organizations and citizen scientists that could be utilized statewide as a training tool and/or annual refresher for volunteers.

Dreissenid mussel habitat suitability is based on many factors, including calcium, pH, alkalinity, and temperature. Western jurisdictions often use calcium data as a predictor of potential mussel invasion, including the state of Montana (*Figure 1*). The majority of lakes within the Upper Columbia Basin fall within the tolerance threshold for invasive mussel habitation if calcium is analyzed independently. Although there is much variability in calcium concentrations between lakes, it is evident that the overall risk-based habitat suitability is high.

Determining lakes that are most suitable for zebra/quagga mussels will be especially important in making management decisions unique to each lake, especially if an infestation occurs. Alkalinity concentrations for all lakes in the NMLN area meet the minimum requirement of 18 mg/L for zebra/quagga mussel habitation (Northwest Northwest Montana Lakes Network 2018 Annual Report). Calcium data will be collected in the 2021 season and incorporated in a future iteration of the Upper Columbia Basin AIS Early Detection & Monitoring Plan. In addition to water chemistry, it is important to also consider watercraft traffic patterns and use of each waterbody (e.g. more out-of-watershed boat use would suggest a higher AIS introduction risk).

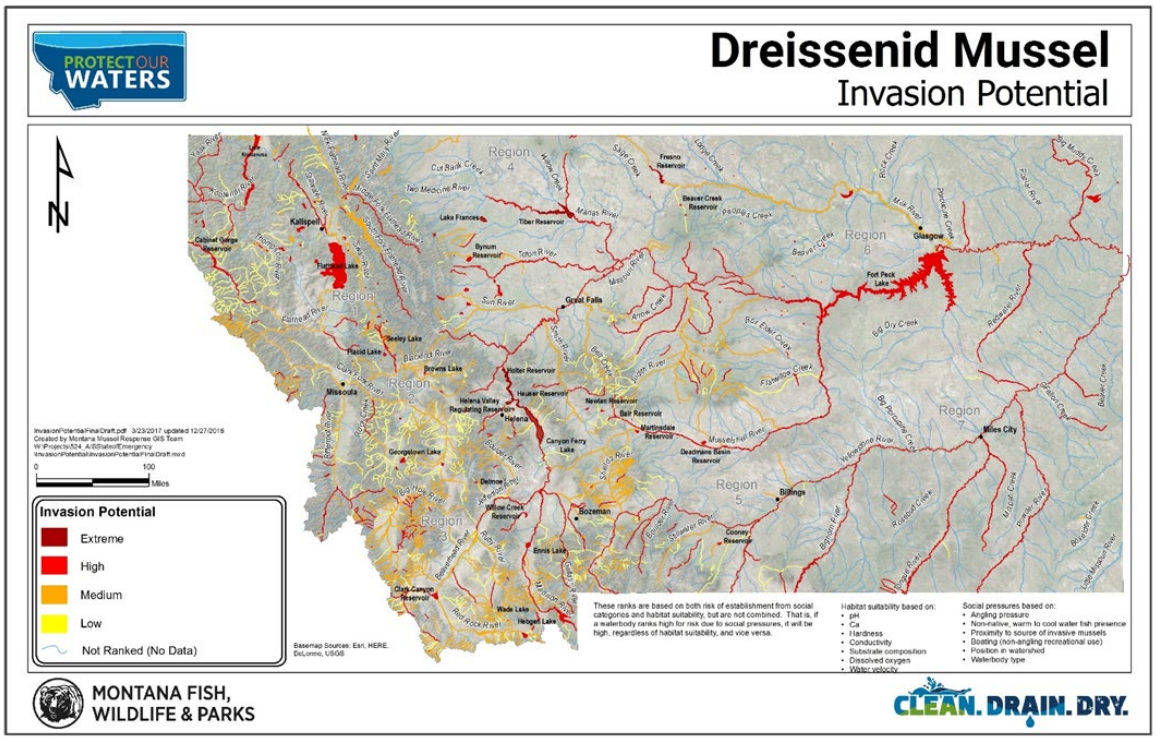

Figure 1 (above). Dreissenid Mussel Invasion Potential Map (Montana FWP).

In April 2018, a six-person panel of AIS *e*DNA experts were assembled by MISC to evaluate the use of eDNA for Dreissenid mussel early detection and provide input and guidance to managers regarding its use in Montana. Key findings from that panel discussion are found in Appendix I.

While the *figures 3 and 4* (below) display AIS early detection monitoring locations in the Upper Columbia River Basin by sample type in 2020, it is anticipated that the sampling trend (locations, organizations, type of monitoring) will be similar for the 2021 season based on indications from FWP and other partners. An AIS Monitoring Workshop for the Upper Columbia Basin was held in February 2021.

FWP	Region	Sampling Interval	Year Sampling Interval	Year Last Sampled	Next Sampling Year	Sampling Year	Water (Orange waters are ones that have more than one partner sampling)	Lake/River	LLID_Text	Sec	Risk	Max Score	Social Rank	Habitat Rank
FWP	3	Annual	1	2020	2021	2021	East Gallatin River	River	1113345458915		2	2	2	0
WLI	1	Annual	1	2020	2021	2021	Echo Lake	Lake	1140423481273		3	4	2	4
FWP	1	Annual	1	2020	2021	2021	Echo Lake	Lake	1140423481273		3	4	2	4
FWP	3	Every 1-2 Y	1	2020	2021	2021	Elk Lake	Lake	1116126446822		2	4	2	4
FWP	5	Every 2-3 Y	2	2020	2022	2022	Emerald Lake (SW of Roscoe near W. Rosebud)	Lake	1096942452564		1	1	0	1
FWP	3	Annual	1	2020	2021	2021	Ennis Lake	Lake	1116830454306		3	3	3	3
FWP	6	Annual	1	2020	2021	2021	Ester Lake (SW of Malta - Phillips Co)	Lake	1082582480985		2	4	1	4
FWP	4	Annual	1	2020	2021	2021	Eureka Reservoir	Lake	1123145478813		3	4	2	4
WLI	1	Every 1-2 Y	1	2020	2021	2021	Fish Lake (Near Dickey Lake off 93)	Lake	1147230486754		1	1	0	1
FLBS	1	Annual	1	2020	2021	2021	Fish Lake (Near Dickey Lake off 93)	Lake	1147230486754		1	1	0	1
FWP	1	Annual	1	2020	2021	2021	Flathead Lake	Lake	1140996479165		4	4	3	4
WLI	1	Annual	1	2020	2021	2021	Flathead Lake	Lake	1140996479165		4	4	3	4
FWP	1	Annual	1	2020	2021	2021	Flathead Lake	Lake	1140996479165		4	4	3	4
FWP	1	Annual	1	2020	2021	2021	Flathead River (above Dam)	River	1147748473651	2	2	2	2	2
FWP	1	Annual	1	2020	2021	2021	Flathead River (below dam)	River	1147748473651	1	2	2	2	2
FWP	6	Annual	1	2020	2021	2021	Flynn Pond (Near Chinook)	Lake	1091560486227		2	4	1	4
FWP	6	2 yrs	2	2020	2022	2022	Forsman Reservoir (Langen) (N of Glasgow)	Lake	1067155485962		2	3	1	3
USACE	6	Annual	1	2020	2021	2021	Fort Peck Dredge Cuts	Lake	1064493480359		3	2	2	2
FWP	4	Annual	1	2020	2021	2021	Fort Peck Lake	Lake	1068985477252		4	4	3	4
FWP	4	Annual	1	2020	2021	2021	Fort Peck Lake	Lake	1068985477252		4	4	3	4
FWP	6	Annual	1	2020	2021	2021	Missouri River)	River	1064191480488	5	3	4	0	4
BN	6	Annual	1	2020	2021	2021	Fort Peck Trout Pond	Lake	1064407480553		3	4	0	4

Figure 2 (above). Example of 2021 AIS Monitoring coordination in Montana (FWP)

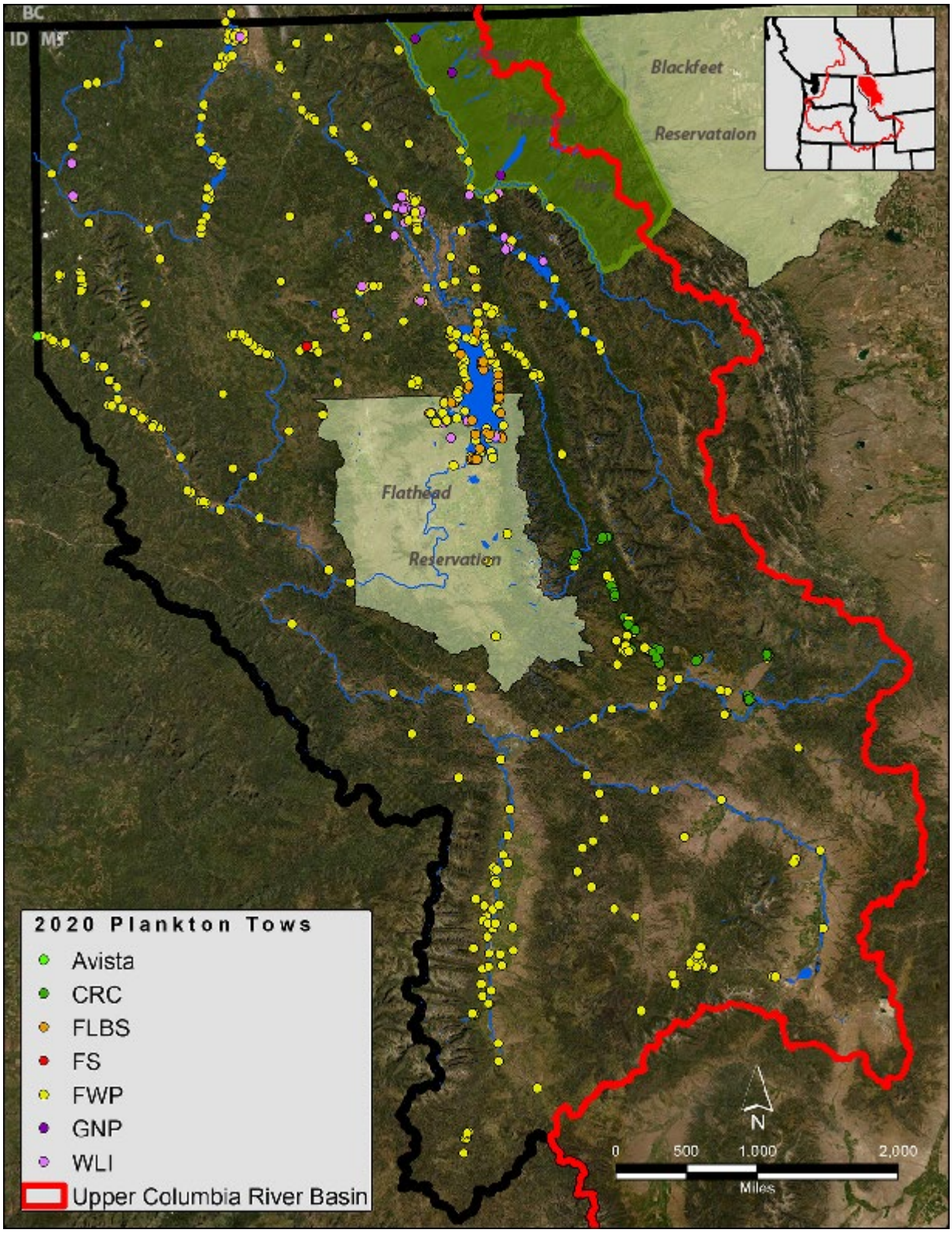

Figure 3. 2020 Upper Columbia River Basin invasive mussel plankton tow monitoring locations (courtesy Phil Matson, The University of Montana, Flathead Lake Biological Station).

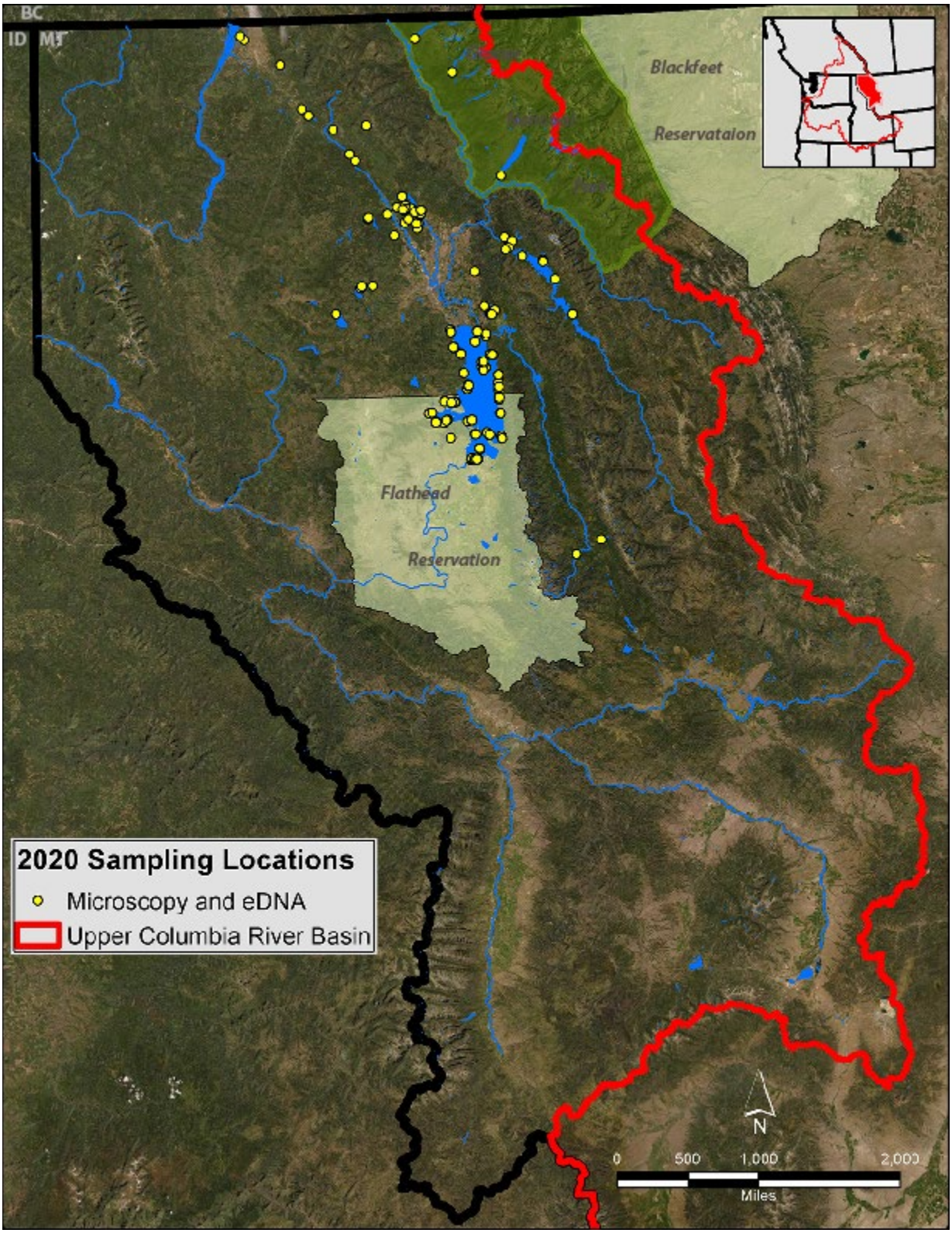

Figure 4. 2020 Upper Columbia River Basin invasive mussel eDNA monitoring locations (courtesy Phil Matson, The University of Montana, Flathead Lake Biological Station).

8.0 Analytical Laboratories

Project partners in the Upper Columbia River Basin have used the FWP AIS laboratory in Helena for microscopy veliger detection. The lab processes early detection samples free of charge.

Other laboratories that provide microscopy Dreissenid veliger early detection analysis include:

- EcoAnalysts Labs, Moscow, Idaho
- US Bureau of Reclamation Technical Services Center, Denver, Colorado

For eDNA samples, project partners have used the University of Montana Conservation Genetics Laboratory (MCGL) for analysis. The AIS assay list at MCGL includes; two *Dreissenid* genus specific, two zebra species specific, one quagga species specific, *Dreissenid* versus native mollusks KASP assay (not quantitative), Eurasian watermilfoil vs native milfoil KASP assay (not quantitative), curly leaf pondweed, New Zealand mudsnail, brook trout, bull trout, rainbow trout and northern pike.

Other *e*DNA labs can provide this service or serve as independent verifiers. A partial list includes:

- US Bureau of Reclamation Technical Services Center, Denver, Colorado
- US Geological Survey Laboratory- LaCrosse, Wisconsin
- US Forest Service Laboratory – Missoula, Montana
- Murdock Laboratory, University of Montana Genomics Core Facility- Missoula, Montana
- Pisces Molecular Lab- Boulder, Colorado
- Portland State University- Portland, Oregon

9.0 Recommendations

An objective of this report is to identify AIS early detection and monitoring data needs in the Upper Columbia River Basin. Figures 3 and 4 of this report provide a spatial representation of early detection and monitoring efforts from 2020 and a basis to inform a discussion between project partners to fill data gaps where needed. Recommendations identified by the UC^3 Early Detection and Monitoring Committee include:

1) Comment on FWP Field Sampling and Laboratory Standard Operating Procedures
   The UC^3 Early Detection and Monitoring Committee should review and provide comments and recommendations to any updates to the FWP field sampling and laboratory standard operating procedures where warranted.
   STATUS: Committee to provide comments and suggestions as needed and/or when changes are made.

2) Annual Early Detection and Monitoring Coordination Meeting and Training
   The UC^3 should coordinate on an annual basis, in mid-winter, an annual early detection and monitoring coordination meeting with project partners. The purpose of this meeting would be to review the previous year's sampling efforts and results and identify areas in need of sampling (or increased frequency/intensity of sampling sampling). The annual coordination meeting should be followed by several FWP led trainings around the basin in early spring to provide consistency in sample collection amongst partners.
   STATUS: Such a meeting was conducted remotely in 2021 due to the covid-related challenges with meeting in person. Hopefully these efforts will return to in-person meetings later in 2021 or early 2022.

3) Database Expansion & Use of Data Application

UC^3 recommends continued refinement and development of the FWP AIS database. In 2017, FWP developed an AIS and water quality monitoring application (app) to facilitate accurate and consistent data collection amongst participating groups. In 2020, many but not all partners used the app for data entry. The app allows approved users to collect and submit AIS survey information, water quality parameters and other observations related to AIS early detection monitoring. The information is downloaded, verified, and posted to the FWP GIS and Montana Heritage Program websites. Sample analysis results are also posted along with the sample collection locations. After a processing time, partners and the public will be able to view their sample collection data and the results from any veliger early detection samples that were collected and submitted in conjunction with the app.

STATUS: Most of the monitoring partners in the basin are utilizing the FWP data app. Glacier National Park is currently exploring options for adoption.

4) *e*DNA Sampling Protocols Refinement

The eDNA Science Panel (Appendix I) provided a discussion of sampling protocols. Although the techniques on the actual field sample collection are well-developed, uncertainty remains regarding detection probabilities, how many samples should be collected, where they should be collected, and at what time of year they are best collected. Some of these same questions remain around veliger sampling as well, however efforts should be made to improve our knowledge of the effectiveness of the eDNA approach for early detection and monitoring. Efforts should be made to address discrepancies between methodologies and communicated widely to partners (engaged in monitoring) in the future.

STATUS: These efforts will continue in 2021.

5) Continue to support the establishment and growth of the Upper Columbia Lakes Network (UCLN)

The Upper Columbia Lakes Network (UCLN), a new initiative funded by the Bureau of Reclamation (BOR), came about to support UC^3's AIS early detection effort. The UCLN provides an opportunity to engage lake groups and citizens in long-term water quality stewardship. Several lake monitoring groups exist in northwest Montana but the UCLN program aims to increase consistency in protocols, incorporate new partner groups, add to the volunteer base, and allow more high priority lakes that are not currently sampled to be monitored. The UCLN identifies interested groups within the region, provides equipment, and offers training for AIS monitoring and decontamination protocols. The new UCLN website, ucln.net, serves as a central clearing house for protocols and AIS resources and will highlight and track monitoring efforts throughout the basin. Results from 2020 efforts can be found in Section 10. All monitoring results in the basin should be reported to FWP as well.

STATUS: The UC^3 is committed to ensuring the continuance and ideally, expansion of the UCLN throughout the Upper Columbia Basin. Operating funds have been committed and additional (federal grant) funds have been proposed/applied for in 2021.

6) Track Veliger Survivability in Ballast Water Studies

UC^3 had previously recommended a veliger ballast water survival study as it is currently unknown how long a veliger can survive in varying water quantity and temperature environments. The Bureau of Reclamation is currently implementing such a veliger ballast

water survival study and the results should be available after its completion in 2020. Results from this type of study could inform risk potential and quarantine periods.
STATUS: While the BOR study continues, two other studies have been completed that shed light on this issue. One is a M.S. Thesis from the University of Minnesota (Doll 2018) and the other is a study by the Utah Division of Wildlife Resources (N. Owens, Powerpoint presentation of results). The Owens study documented high rates of passage and survival of both veligers and small adults (<10mm) through common ballast pumps. Doll (2018) documented >95% mortality of veligers in residual ballast water after 48hrs at 20C. Both studies concluded recreational boats do pose a veliger transportation risk and Doll (2018) identified ballast tanks and inboard/outboard motors as having the greatest number of veligers compared to other boat areas such as livewells and splashwells which had few. We continue to await the publication of the BOR findings on this subject.

7) Develop virtual/video training options for partners and citizen scientists.
A video component for AIS training could be valuable in terms of getting new organizations, citizens scientists and other volunteers engaged without requiring extensive travel or planning in-person training events mid-season. A segmented video could be targeted to different audiences (e.g. plankton tow monitoring partners vs citizen scientists or shoreline homeowners looking for something lower tech). This could also serve as a great annual refresher for existing groups/individuals and provide continuity in the event of an unforeseen issue that would prevent in person training/travel (such as the global pandemic).
STATUS: The UC^3 has committed funds and is currently developing an RFP to solicit contractors to bid on a project to produce professional high-quality AIS monitoring training videos. The video will be made in the basin but provided as a free resource to any interested group/individual statewide. The UC^3 will coordinate with FWP and other monitoring partners on the planning and production of the video. Links can be provided on the UC^3, FWP, invasivespecies.mt.gov and UCLN websites.

10.0 Emerging Programs, Science, and Technology for Early Detection Monitoring

As new techniques or strategies emerge in early detection monitoring, each should be evaluated by UC^3 to determine their applicability and efficacy in the Upper Columbia River Basin. Those that offer cost-effective improvements in the overall effectiveness should be considered for deployment in the basin.

As an example, researchers from FLBS are working on a mobile digital PCR (polymerase chain reaction machine) “DNA Tracker.” The tracker is designed to analyze and test water samples in near real-time for evidence of environmental DNA (*e*DNA) for the target organism as compared to an existing template.

The tracker can detect invasive mussel *e*DNA extracted from early detection and monitoring samples collected from plankton net tows. Additionally, the unit can detect mussel *e*DNA from boats during the inspection process, providing empirical validation of a boat’s status. In 2018, testing on Lake Mead found the unit capable of detecting “free” *e*DNA without the need for reagents to induce cell lysis.

Whereas this technology could provide a powerful tool in early detection monitoring, field protocols and other issues related to *e*DNA need to be vetted by project partners.

10. 1 Northwest Montana Lakes Network (NMLN) Upper Columbia Lakes Monitoring Network Contract Update - 2020

- **Clearwater Resource Council (CRC) AIS Program** - http://crcmt.org/aquatic-invasive-species
    - Purpose: to prevent the introduction of AIS, especially Dreissenid mussels, in the Clearwater Chain-of-Lakes and greater Clearwater and Blackfoot Watersheds.
    - Initiated in 2010 as citizen grass-roots effort with deployment of artificial substrate traps in 4 major lakes. Formally launched by CRC in 2011.
    - Recruit and train volunteer Citizen Scientists to conduct monitoring. Modify scientific protocols to enable Citizen Scientists to collect quality samples with ease and confidence. Provide lake-specific kits to prevent cross-contamination.
    - Annually collect 200+/- veliger tow samples on the 6 major lakes in the Clearwater Chain-of-Lakes.
    - As funding permits, CRC aims to:
        - Support similar efforts on three lakes in Powell County and two lakes in Missoula County in the Flathead Watershed, collecting an additional 130 samples
        - Synoptic monitoring on an additional 8-10 lakes
        - Aquatic plant identification and mapping
        - Submit samples for eDNA testing
        - Conduct outreach and education programs in the local area
    -
- **Northwest Montana Lakes Network-** https://nmln.info/
    - Partnership with FWP and WLI since 2010
    - Purpose: Long-term water quality monitoring and AIS early detection sampling. Trains citizen scientists and supplies equipment for long term water quality data collection and sharing. Includes an annual in-depth water quality monitoring sampling visit by WLI scientist.
    - 41 lakes (not open to additional lakes), 50 sites in 4 counties with 50+ volunteers
    - Provided volunteers plankton tow nets, Secchi disks and water monitor.
    - Held 2 trainings with FWP in 2019, as of 2020 12 new volunteers from 8 partner groups, 16 samples from 10 lakes, 5 more kits to give out.
    - Data Collection Goals:
        - Establish lake trend data over time
        - Help determine the trophic status of lakes
        - Implement early AIS detection and prevention

- **Upper Columbia Lakes Network-** https://ucln.net/
    - Goal: Aims to increase consistency in protocols, incorporate new partner groups, add to the volunteer base, and implement monitoring on additional high priority lakes that are not currently monitored.

- Strategy: Identifies interested groups within the region, provides equipment and offers training for AIS monitoring and decontamination protocols.
- Supports UC^3's AIS early detection efforts and all data goes into the FWP database.
- Engages lake groups and citizens in AIS early detection sampling and identification.
- Provides equipment and training for AIS monitoring and decontamination protocols.
- Citizen scientists monitor for invasive species with plankton tow nets and visual inspection.
- Different from NMLM in that additional lakes may be added to UCLN (but cannot with NMLM because of FWP restrictions).
- Volunteers are trained to sample multiple times throughout the year targeting late summer to early fall.
  2020: Provided volunteers plankton tow nets, Secchi disks and water monitor. Held 2 trainings with FLBS & FWP in 2019, as of 2020 12 new volunteers from 8 partner groups, 16 samples from 10 lakes.. Individual trainings have been conducted since COVID restrictions were instated.
- Discussion:
  - Annual costs: Supplies, shipping, coordinator, travel, training
  - Creation of training video (for use statewide)
    - Implemented one-on-one trainings for volunteers during COVID but this is not sustainable in the future. Would like to create trainings videos with FWP staff to train volunteers on monitoring and use as a refresher year after year.
    - What are partners in the basin/state doing to reach the general public: are there materials out there, is a video needed, what would be good to create to get more boots on the ground, etc.?

11.0 Literature Cited

Doll, A. (2018). *Occurrence and Survival of Zebra Mussel (Dreissena polymorpha) Veliger Larvae in Residual Water Transported by Recreational Watercraft*. MS Thesis, University of Minnesota.

Montana Fish, Wildlife & Parks (2019). Aquatic Invasive Species Management Program- Field Sampling and Laboratory Standard Operating Procedures. Helena, Montana.

Northwest Montana Lakes Volunteer Monitoring Network Annual Report (2018).

Western Regional Panel on Aquatic Nuisance Species (2020). Dreissenid Mussels Sampling and Monitoring Protocol. Livingston, Montana.

12.0 Supporting Documents

Montana Fish, Wildlife & Parks (2019). FWP AIS Management Program Field Sampling and Laboratory Standard Operating Procedures.

Montana Natural Heritage Program (2020). Invasive Species Field Guide.

University of Montana, Flathead Lake Biological Station (2019). Field Protocol for Collecting Dreissenid Veligers and eDNA via Horizontal Plankton Tow

APPENDIX I: eDNA Panel Recommendations

Montana Invasive Species Council

Key Findings eDNA Science Advisory Panel: A discussion on eDNA technology use in invasive species management

A six-person panel of aquatic invasive species, monitoring and eDNA experts was assembled in April 2018 by the Montana Invasive Species Council (MISC) to evaluate the use of environmental DNA (eDNA) for dreissenid mussel early detection and provide input and guidance to managers regarding its use in Montana.

Key Challenges and Recommendations by Panelists

Challenges

- Lack of standardized protocols
    - Field collection
    - Lab analysis
    - Communication of results (between researchers/labs and managers)
    - Management response
- Balance of risk and uncertainty
    - Understand the costs of false negatives or false positives to assess risk tolerance
    - Perspective on terms false negatives and false positives
- Detection threshold of eDNA for false negatives is not known and varies with sampling/analysis methods
- A limited number of labs are conducting eDNA analysis for early detection of dreissenids and use different protocols
- No coordinated dreissenid eDNA group to help address gaps and encourage communication
- Few published peer reviewed studies for dreissenid eDNA
- Communicating what a “positive” eDNA sample means

Recommendations

- Develop, refine, and agree upon method/standards with adaptive capacity
    - Decontamination protocols (utilize existing US Fish and Wildlife Service for Asian carp effort)
    - Field collection
    - Lab analysis including Quality Assurance/Quality Control standardization
    - Data reporting requirements and standards
- Develop consistent language (for both within lab and out)
- Develop a communication plan between managers and lab
    - Approach eDNA results as a link in a chain of evidence
    - Clearly define the steps to be taken following a detection. An eDNA detection could result in further sampling or directly lead to a management action, depending on these pre-defined steps
- Coordinate across western partners and cross-border partners via the suggested avenues

APPENDIX II: UC^3 Early Detection & Monitoring Committee

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Glacier National Park

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Montana Fish, Wildlife & Parks

Katie Finley-Squeque, Aquatic Invasive Species Coordinator
Confederated Salish & Kootenai Tribes

Joann Wallenburn, Aquatics Director (retired)
Clearwater Resource Council
Missoula AIS District Board Member (Chair)

Tom Woolf, Aquatic Invasive Species Bureau Chief
Montana Fish, Wildlife & Parks

Kate Wilson, Commission Administrator
Montana Dept. of Natural Resources & Conservation

Cassidy Bender, Commission Coordinator
Montana Dept. of Natural Resources & Conservation