A native mussel with a cluster of attached zebra mussels found on Beconia Beach on the south basin of Lake Winnipeg. Photo credit: C. Parks, Province of Manitoba.

# Dreissenid Mussel Rapid Response in the Columbia River Basin: Recommended Practices to Facilitate Endangered Species Act Section 7 Compliance

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# LIST OF ACRONYMS

| | |
|---|---|
| AIS | Aquatic Invasive Species |
| ARPA | Archaeological Resources Protection Act |
| BMPs | Best Management Practices |
| CRB | Columbia River Basin |
| DPS | Distinct Population Segments |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| ESU | Evolutionarily Significant Unit |
| HDPE | High Density Polyethylene |
| KCl | Potassium Chloride (Potash) |
| MAC | Multi-agency Coordination |
| NAGPRA | Native American Graves Protection and Repatriation Act of 1990 |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NMFS | National Marine Fisheries Service |
| PBF | Physical and Biological Features |
| PCB | Polychlorinated biphenyl |
| PCE | Primary Constituent Element |
| PSMFC | Pacific States Marine Fisheries Commission |
| QA/QC | Quality Assurance/Quality Control |
| SDS | Safety Data Sheet |
| SPCC | Spill Prevention, Control, and Countermeasures Plan |
| USFWS | United States Fish and Wildlife Service |
| WRP | Western Regional Panel on Aquatic Nuisance Species |

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# CHAPTER 1. INTRODUCTION AND BACKGROUND

This document is intended to be a living document, reviewed and updated at least annually, and on an as-needed basis, to ensure the CRB states and Treaty Tribes have access to the latest information to inform a dreissenid response in the CRB.

## Background

Since their introduction to the Great Lakes region of North America in the 1980s, invasive dreissenid mussels (zebra mussels [*Dreissena polymorpha*] and quagga mussels [*Dreissena rostriformis bugensis*]) have expanded their distribution in North America. From 2012–2017, the states of Washington, Oregon, Idaho, and Montana intercepted a total of 313 dreissenid-fouled watercraft that originated from throughout North America (http://psmfc.maps.arcgis.com/apps/webappviewer/index.html?id=aa6a6527a26a44ddbff097b99241462e). In 2016, invasive mussel larvae were discovered in Tiber and Canyon Ferry Reservoirs in Montana—this was the first documented detection of dreissenids near the perimeter of the Columbia River Basin (CRB). The westward expansion of dreissenids has been aided by unintentional pathways, including transport of watercraft, and precipitates the need for contingency plans and other planning efforts to facilitate rapid response (Bossenbroek et al. 2007). Rapid response includes actions that natural resource managers must be prepared to take in the event of a dreissenid introduction.

*The Columbia River Basin Interagency Invasive Species Response Plan: Dreissenid Species* (a.k.a. CRB Plan) was developed in September 2008 (and updated in 2011, 2014, and 2017) to facilitate the coordination of a rapid, effective, and efficient interagency response to delineate, contain, and when feasible, eradicate dreissenids if introduced to CRB waters. The scope of the CRB Plan incorporates waters in the CRB, including the states of Washington, Oregon, Idaho, and Montana, and reservation and ceded lands of Columbia River Treaty Tribes. The plan highlights the coordination and management structure of a response, the responsibilities and roles of entities involved, notification lists and procedures, and a scientific review and compilation of information associated with different types of control options. The CRB Plan has been tested since its inception via a series of exercises and workshops in the CRB states, and has been updated at regular intervals as new information has become available.

Section 7(a)(1) of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531-1544, 87 Stat. 884) directs all Federal agencies to use their existing authorities to carry out programs to conserve threatened and endangered species. Section 7(a)(2) of the ESA directs all Federal agencies to ensure, in consultation with the U.S. Fish & Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), that their actions do not jeopardize listed species, or destroy or adversely modify critical habitat. Critical habitat is defined in section 3 of the ESA as: (1) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) Specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

Although ESA sections 7(a)–(d) continue to apply to agency responses to acts of God, disasters, casualties, national defense, or security emergencies, etc., the regulations implementing these sections (described below) provide for expedited procedures to accommodate the need for Federal agencies to respond promptly to emergency circumstances.

In 2017, the USFWS contracted with Pacific States Marine Fisheries Commission (PSMFC) to develop this manual to inform, expedite, and facilitate Section 7 consultations to include response actions that will minimize impacts of invasive mussel

## Triggering an Endangered Species Act Consultation

Section 7 (a)(2) of the ESA requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any federally listed threatened or endangered species, or to result in the destruction or adverse modification of designated critical habitat.

When a Federal agency determines that its action "may affect" a listed species and/or designated critical habitat, the agency is required to consult with the USFWS and/or the National Marine Fisheries Service (NMFS) to ensure the above standards are met.

Even if a non-federal jurisdiction is leading a rapid response operation, an associated federal action may trigger a need for compliance with Section 7 of the ESA, such as:

- Actions on federal land
- Actions that require a federal permit
- Actions that require a federal license
- Actions using federal funds
- Actions implemented by federal agency employees

control and eradication attempts on listed species and their designated critical habitats. The effort to produce this manual is intended to improve coordination, collaboration, and preparedness among the many entities that would be engaged in invasive mussel rapid response actions in the CRB.

Emergency consultation is an expedited consultation process that considers listed species concerns while allowing an action agency to respond to an emergency situation. Chapter 2 of this manual provides more information on the emergency consultation process.

## Purpose of this Manual

This manual is intended to be used in conjunction with the CRB Plan and any associated rapid response plans (e.g., state plans) to implement an immediate and effective response to an introduction of dreissenid mussels in the CRB. This manual describes: the core elements of the emergency consultation process; the proposed action; and listed species and critical habitats occurring within the U.S. portion of the CRB. This manual also describes best management practices that can be used to avoid or minimize adverse impacts to listed species and critical habitat, and steps involved in post-emergency consultation.

The purpose of this manual is to:

- Delineate a suite of most-likely rapid response eradication actions for a potential introduction of dreissenids within CRB states;

- Provide an assessment of the potential for those actions to affect ESA-listed species and critical habitats; and

- Present best management practices (BMPs) that can avoid, reduce, or eliminate adverse effects of the rapid response actions on listed species and/or critical habitat. The BMPs are recommendations that action agencies can use to reduce their effects to listed species and their habitats after engaging emergency consultation procedures with USFWS.

## Scope and Intent of this Manual

Information in this manual is intended to facilitate emergency consultation procedures for Federal actions associated with an introduction of dreissenids in the U.S. portion of the CRB. This manual is not meant to be a comprehensive guide for dreissenid mussel response in the CRB; the CRB plan serves that function. The information in this manual could help inform the listed species/critical habitat portion of a National Environmental Policy Act (NEPA) analysis. Emergency response activities not statutorily exempt from NEPA may require the development of a brief Environmental Assessment that describes the need, alternatives, environmental impacts of proposed actions and alternatives, and the list of agencies and persons consulted. Similarly, information contained in this manual could help State and other non-Federal agencies comply with the ESA (e.g., Section 6 or Section 10). However, this manual does not

### State Response Actions and Section 6 of the ESA

In general, State response actions involving emergency circumstances and take of listed species are likely to have a Federal nexus that will facilitate take coverage under the emergency consultation provision of the implementing regulations for section 7 of the ESA. Take is defined under the ESA to include: kill, harm, harass, capture, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in such conduct. In addition, Section 6 of the ESA allows for the take of listed species by a state agency when it is either:

(a) an action carried out by the state agency (or its designated agent) that is signatory to a current and valid Section 6 cooperative agreement with the Service; is carried out for conservation purposes consistent with the cooperative agreement, a species' specific recovery plan, and the ESA; and is not reasonably anticipated to result in death, disabling, out-of-state removal, introduction outside of native range, or captivity exceeding 45 days of any federally-endangered species. See Appendix A for the underlying regulatory provision from 50 CFR § 17.21(c)(5).

(b) in accordance with a Section 10 permit issued by the Service.

The Service has determined that rapid response to eradicate an incipient introduction of zebra or quagga mussels into the Columbia Basin would fall under the "conservation purposes" criterion in (a).

directly address NEPA or ESA compliance for non-federal actions, which are addressed, to some degree, in the CRB plan (Heimowitz and Phillips 2008). This manual discusses a subset of the treatment options listed in the CRB plan, focusing on the treatments most likely to be used in open water-systems. If a treatment is not included in this manual, the action agency can obtain species-specific best-management practices for ESA listed species via the emergency consultation process.

The focus of this manual is ESA listed species under the jurisdiction of the U.S. Fish and Wildlife Service. Guidance on protecting non-listed species (i.e. state listed sensitive species) is not included as part of this manual.

## **Quagga and Zebra Mussels** (*Dreissenid spp*).

This manual focuses on members of the genus *Dreissena*, including zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*). Although there are differences in the biology of these two species, they share many similar life history traits and cause similar adverse environmental and economic impacts. Both species have European origins and were introduced to the United States in the 1980s via ballast water discharge in the Great Lakes region. Both zebra and quagga mussels can attach to a broad range of surfaces, including pilings, pipes, rock, cement, steel, rope, crayfish, other bivalves, aquatic plants, and each other, forming dense colonies. Both zebra and quagga mussels reproduce with external fertilization; eggs and sperm are released into the water column, with larvae (veligers) emerging within three to five days from fertilized eggs (Benson et al. 2018). Reproduction is triggered by water temperature, and in some locations, reproduction can occur continually throughout the year (Benson et al. 2018).

## Environmental Effects

The environmental impacts of zebra and quagga mussels to lakes and rivers is profound. Both species compete effectively with many native species and may completely replace native mussels, causing dramatic alterations of the native food chain (Hogan et al. 2007). The introduction of zebra and quagga mussels into the CRB, which drains 258,500 square miles in seven western states and Canada, has the potential to threaten native species, particularly salmon and trout and essential fish habitat (Pacific Fishery Management Council 2014), as well as cultural, industrial, agricultural, recreational, navigation, and subsistence use of waters.

Once established, dreissenid mussels can dramatically alter the ecology of a water body and associated fish and wildlife populations. As filter feeders, they selectively remove phytoplankton and other particles from the water column, shifting production from the pelagic to the benthic portion (Sousa et al. 2009). In Lake Michigan, dreissenid invasions have caused significant phytoplankton community structure shifts, including dominance in cyanobacteria (deStasio et al. 2014). In Lake Simcoe, Ontario, Canada, there were significant and sustained declines in phytoplankton biovolumes and chlorophyll *a* during the 12 years following invasion by dreissenids (Baranowska et al. 2013).

Dreissenids have accelerated the decline of freshwater bivalves, nearly extirpating native unionids 25 years after invasive mussels were introduced to the Great Lakes region (Burlakova et al. 2014). By attaching themselves to the surfaces of other bivalves, dreissenid mussels can starve freshwater mussels and drive indigenous populations to local extinction (Montgomery and Wells 2010). Dreissenid mussels can also affect dissolved oxygen through respiration, and dissolved calcium carbonate concentrations through shell building (Strayer 2009). The filtering capabilities of dreissenids increase water transparency, decrease chlorophyll concentrations, and increase the amount of pseudofeces (Claxton et al. 1998). Increases in pseudofeces reduce oxygen levels, which makes water pH more acidic and toxic (Snyder et al. 1997). Increased water clarity increases light penetration and causes growth in aquatic plants (Zhu et al. 2006). Dreissenids also bioaccumulate pollutants, which can be passed up the food chain, increasing wildlife exposure to organic pollutants (Snyder et al. 1997). Polychlorinated biphenyl (PCB) concentrations in mussel tissue are correlated to sediment PCB levels, indicating mussels may provide an entry point for PCBs into nearshore benthic food webs (Macksasitorn et al. 2015).

## Economic Effects

The economic costs associated with dreissenids are significant. The economic impact of zebra and quagga mussels to the hydropower systems on the Columbia and Snake Rivers is of particular concern. If introduced into the CRB, dreissenid mussels could affect all submerged components and conduits of this system, including fish passage facilities, navigation locks, raw water distribution systems for turbine cooling, fire suppression, irrigation, trash racks, diffuser gratings, and drains.

The following studies are examples of documented and estimated costs of a dreissenid introduction:

- The infestation of zebra mussels in the Great Lakes has cost the power industry $3.1 billion between 1993–1999, including a total economic impact of more than $5 billion (WRP 2009). The power generation industry in the Great Lakes expends $1.2 million annually per power plant to monitor and control zebra mussels, and $1.7 million annually to research better zebra mussel control methods. Water treatment plants pay $480,000–$540,000 annually to control zebra mussels, and municipal water treatment facilities pay $353,000 annually to control zebra mussels (Colautti et al. 2006).

- In the Lower Colorado River, the Hoover dam has incurred, or planned, costs totaling $10,231,208 for construction, supplies, services, and operations and maintenance to address dreissenid mussel infestations since invasive mussels were first discovered in 2007 (Bureau of Reclamation 2016).

- Annual welfare losses (i.e., costs or loss of benefits) of a dreissenid invasion in the CRB is estimated at $64 million, although that estimate did not include losses related to fish and wildlife resources (Warziniack et al. 2011).

- The direct economic impacts (impacts to dams, removal from boat launches, direct impacts to fishing) of invasive mussels to the State of Washington is estimated to be $43,112,000. Total economic activity at risk is 500 lost jobs and $27.8 million in labor income (Community Attributes, Inc. 2017).

- Idaho estimated an infestation of zebra mussels would cost the state $94,474,000 to hydropower facilities, other dams, drinking water systems, golf courses, boat facilities and maintenance, hatcheries and aquaculture industries, loss of angler days, and irrigation (Idaho Aquatic Nuisance Species Task Force 2009).

- A recent economic study commissioned by the Montana Invasive Species Council (Nelson 2019) estimated that if dreissenid mussels were to colonize all water bodies in Montana, the potential economic damages would total between $72.4 to $121.9 million in mitigation costs, $23.9 to $112.1 million in lost revenue, and $288.5 to $497.4 million in property value losses. Excluding property value losses, the top three stakeholder industries facing the largest potential economic impacts from dreissenid mussel invasion were tourism, hydropower, and irrigation, accounting for 60 to 75 percent of the total potential damages statewide (Nelson 2019).

## Cultural Effects

Maintaining biocultural diversity and cultural resilience depends on continued access to culturally salient native biota (Pfeiffer and Ortiz 2007). Community members face challenges retaining, or reviving, their ancestral traditions when invasive species diminish cultural access (Pfeiffer and Voeks 2008). When invasive species displace culturally important native species, cultural storyscapes (i.e., the place-based intergenerational narrative maintained by a native society, which incorporates both tangible and intangible traditions) are affected by altering the character of sacred, or ritual sites, and displacing, or diminishing the growth of ethnobiologically important native species in ancestral gathering sites (Pfeiffer and Voeks 2008).

Invasive species also have indirect effects on culture, such as affecting human health and well-being through the use of toxic chemicals to mitigate biological invasions (Mackenzie 2003).

Culturally important native aquatic species have been displaced or reduced through the introduction of non-native species for recreational fishing, negatively impacting indigenous groups reliant on wild harvest of these species (Pfeiffer and Voeks 2008). Escaped farmed Atlantic salmon (*Salmo salar*) threaten wild salmonids in the Pacific Northwest, where native salmon are of significant cultural and spiritual importance to tribes (Pfeiffer and Voeks 2008). Invasive European green crab (*Carcinus maenas*) are displacing native marine and freshwater mussels, impacting tribes that harvest these native species for ornamental and ceremonial ware (Pfeiffer and Voeks 2008).

The most significant effects of invasive species have been introduced diseases that have produced catastrophic reductions in population and associated social breakdown in the Americas (Mitchell 2003) to cultural disorientation in Australia (Carey and Roberts 2002).

Invasive species create changes in narratives and lexicons, causing native peoples to designate invasive species based on their place, or culture, of origin (Pfeiffer and Voeks 2008). Some invasive species that displace culturally important native species either serve to facilitate, or impoverish, culture (Pfeiffer and Voeks 2008).

Cultural attachment to, and acceptance of, invasive species can perpetuate invasive species spread and introduction (Pfeiffer and Voeks 2008).

## The Consequences of No Action

This manual has been prepared to facilitate a rapid response to an introduction of dreissenids in the CRB because the anticipated consequences of taking no, or delayed, action would include long-lasting, significant, and detrimental economic, environmental, and social effects that would change ecosystem function and processes throughout the CRB and affect the quality of life for people who live in the Basin. Because of these well-documented consequences, this manual has been prepared assuming that a federal agency would be engaged in a prompt response to an introduction of dreissenids in the CRB. However, there are many factors influencing whether or not attempts to eradicate dreissenids in any CRB water body will be successful (especially if dreissenids become established in large river systems, or large water bodies). In addition, the potential impacts of response actions to listed species and critical habitats are never fully known prior to control actions. It is entirely possible that well-intentioned response tactics (particularly those with known non-target effects, such as aqueous biocides) would simultaneously fail to stop the spread of a dreissenid mussel invasion while potentially degrading the condition of imperiled fish and wildlife and their habitats. Therefore, at the time of an actual response, it is prudent to weigh the short-term and long-term economic and environmental costs of eradication attempts with the likely long-term costs of managing circumstances involving established populations of dreissenids.

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# CHAPTER 2. THE EMERGENCY CONSULTATION PROCESS

## Process Overview

The implementing regulations for Section 7 of the ESA at 50 CFR 402.05 provide for consultation to be conducted in an expedited manner under emergency circumstances. The regulations state that such provisions apply "…to situations involving acts of God, disasters, casualties, national defense or security emergencies, etc." The Endangered Species Consultation Handbook (USFWS and NMFS 1998) further clarifies emergency circumstances include "…response activities that must be taken to prevent imminent loss of human life or property." The USFWS considers an incipient dreissenid outbreak in the CRB to meet the regulatory definition of an emergency situation given the clear and significant threat to property if invasive mussels become established. **During any emergency situation, the first priority is protecting human safety and health. Where listed species and critical habitats are involved, the USFWS and NMFS also place a priority on providing recommendations/technical assistance to Federal response agencies for avoiding and minimizing any adverse effects to listed species and critical habitats likely to be caused by response efforts without impeding the protection of human health and safety.**

In emergency situations, consultation does not occur on the emergency; rather, consultation is conducted on the agency response to the emergency, and consultation is handled in an expedited manner. If a formal consultation is required, it is initiated as soon as practicable after the emergency is under control.

Typically, when an emergency situation occurs, the Federal action agency contacts:

- The USFWS Regional Ecological Services Office (either Region 1 or 6 for the CRB) by telephone if an emergency event is determined to be in proximity to listed species or critical habitat and warrants Section 7 consultation. See Appendix B for a list of the FWS Ecological Services Section 7 contacts for the CRB States.

- National Oceanic and Atmospheric Administration Fisheries staff in the West Coast office by email if an emergency event may occur in locations where ESA-listed species exist and to determine the potential effects on those species and/or designated critical habitat. The contact should occur as quickly as possible following the onset of the emergency.

Detailed guidance on emergency consultation procedures is provided on pages 8-1 through 8-6 of the Endangered Species Consultation Handbook (USFWS and NMFS 1998) and excerpted below.

## PROCEDURES FOR HANDLING EMERGENCY CONSULTATIONS

**(A) Initial Contact by the Action Agency**

The initial stages of emergency consultations usually are done by telephone or facsimile, followed as soon as possible (within 48 hours if possible) by written correspondence from the Services. This provides the Services with an accurate record of the telephone contact. This record also provides the requesting agency with a formal document reminding them of the commitments made during the initial step in emergency consultation (Figure 8-1). During this initial contact, or soon thereafter, the Services' role is to offer recommendations to minimize the effects of the emergency response action on listed species or their critical habitat (the informal consultation phase). DO NOT stand in the way of the response efforts.

If this initial review indicates the action may result in **jeopardy** or **adverse modification**, and no means of reducing or avoiding this effect are apparent, the agency should be so advised, and the Services' conclusions documented.

Project leaders should establish procedures (e.g., a calling tree) within their offices outlining who can be called to handle the emergency consultation. Once these procedures have been established, they should be provided to all Federal agencies in that operating area responsible for handling emergency situations (e.g., Coast Guard, Environmental Protection Agency, and Federal Emergency Management Agency) and any other Federal agencies with responsibilities in the operating area.

The FWS Field Office conducting the consultation should notify the FWS Assistant Regional Director responsible for endangered species and/or the ecosystem at risk, following timeframes established by FWS Regional guidance. The notification should be in memo form, following the format outlined in Exhibit 8-1. Early telephone notification may be required. For NMFS, the Regional Director should notify the Director, Office of Protected Resources.

**(B) Initiating Formal Consultation**

As soon as practicable after the emergency is under control, the action agency initiates formal consultation with the Services if listed species or critical habitat have been adversely affected. Although formal consultation occurs after the response to the emergency, procedurally it is treated like any other formal consultation. However, the action agency has to provide additional information to initiate a formal consultation following an emergency:

- a description of the emergency;
- a justification for the expedited consultation; and
- an evaluation of the response to and the impacts of the emergency on affected species and their habitats, including documentation of how the Services' recommendations were implemented, and the results of implementation in minimizing take.

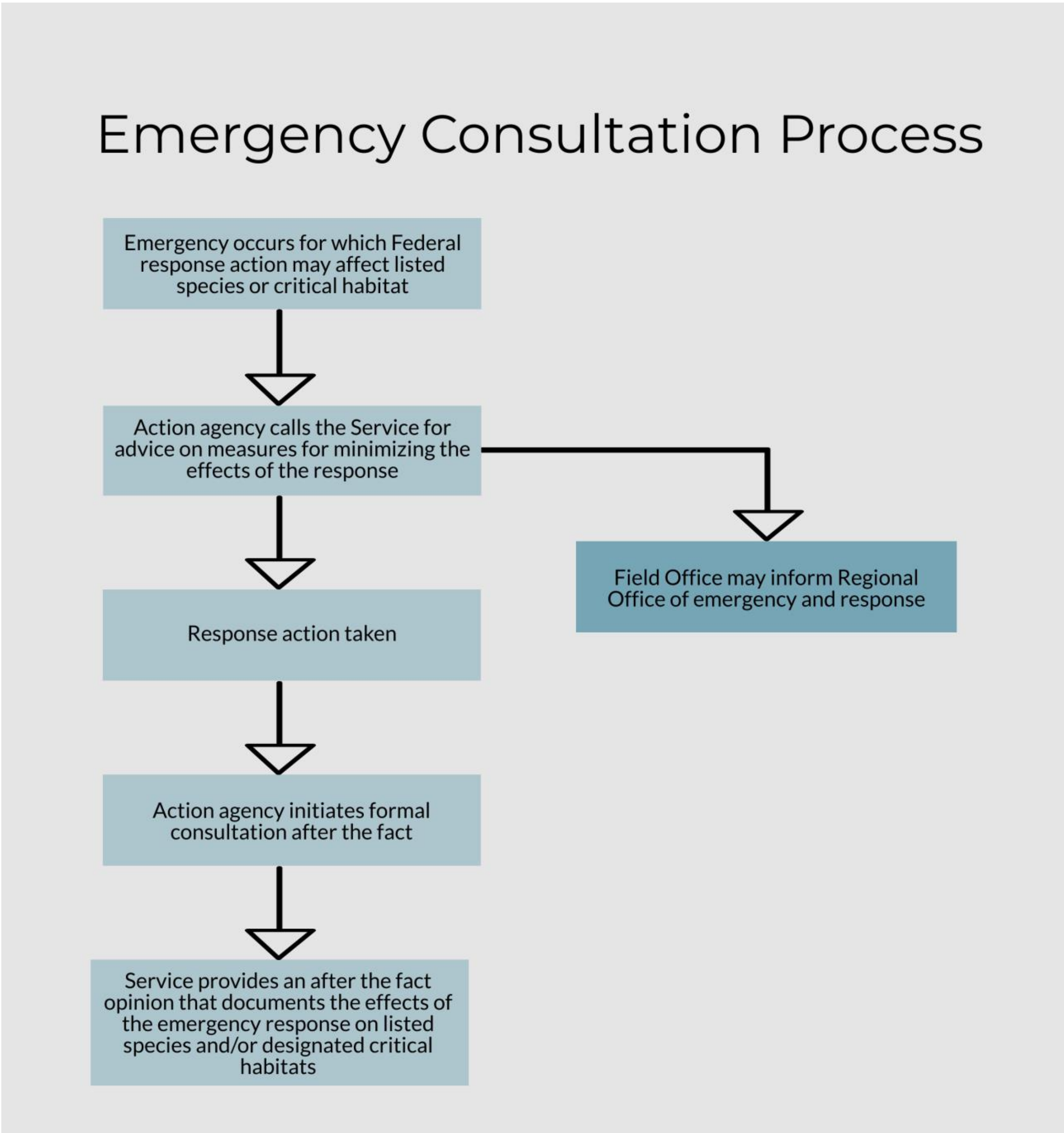


Figure 1. Emergency Consultation Process (excerpted from Figure 8-1 of the USFWS Endangered Species Consultation Handbook 1998).

**(C) Emergency Biological Opinion**

After concluding formal consultation on an emergency, the Services issue an emergency biological opinion. The "effects of the action" section, documents the recommendations provided by the Services to the action agency and the results of agency implementation of the recommendations on listed species. The timeframe, format and contents are the same as for formal consultation (see Chapter 4 of the ESA Consultation Handbook (USFWS and NMFS 1998)). A sample of standardized language for an emergency consultation document can be found in Appendix B in the ESA Consultation Handbook. The standardized statements for formal consultation have been modified to reflect that this is, in most cases, an after-the-fact consultation.

Documenting **jeopardy** and **adverse modification** biological opinions is particularly important to tracking the effect on species and habitat conditions. For FWS, emergency biological opinions with the conclusion of "not likely to jeopardize" the species or "not likely to result in destruction or **adverse modification** of critical habitat" are completed at the Field Office level. However, if the conclusion is likely **jeopardy** or **adverse modification**, the consultation is elevated to the Regional Office. Such a finding may not have a reasonable and prudent alternative available, unless some further action can restore or enhance the species to a level below the **jeopardy** threshold. For NMFS, emergency opinions are signed in Washington by the Director, Office of Protected Resources, except where a specific Region has been delegated signature authority (i.e., Northwest and Southwest Regions have been delegated signature authority for anadromous fish).

**(D) Incidental Take Statement**

If incidental take is anticipated during the emergency response, the Services can advise the action agency during the informal consultation phase of ways to minimize take. In some circumstances, the actual or estimated take occurring from the agency's emergency response actions can be determined, and should be documented in the biological opinion for future inclusion in the species' environmental baseline. The incidental take statement in an emergency consultation does not include reasonable and prudent measures or terms and conditions to minimize take, unless the agency has an ongoing action related to the emergency. Rather, an emergency consultation incidental take statement documents the recommendations given to minimize take during informal consultation, the success of the agency in carrying out these recommendations, and the ultimate effects on the species of concern through take.

**(E) Conservation Recommendations**
Emergency consultations may contain conservation recommendations to help protect listed species and their habitats in future emergency situations or initiate beneficial actions to conserve the species.

Note: While the timing of "emergencies" is unpredictable, the types of emergencies that may affect listed species or critical habitat can be determined in advance. Emergency response actions are routinely practiced by responsible Federal agencies. Advance coordination with responsible Federal agencies is encouraged so that endangered species components can be incorporated into the emergency response where appropriate.

**Conferences**

Section 7(a)(4) of the ESA requires Federal agencies to confer with the USFWS and NMFS (the Services), as appropriate, in cases where the agency, or the Services, have determined that a proposed or ongoing Federal action is likely to jeopardize the continued existence of species proposed to be listed under Section 4 of the ESA, or result in the destruction or adverse modification of critical habitat proposed to be designated for such species; see Chapter 6 (pp. 6-1 through 6-10) of the Services' Consultation Handbook (USFWS and NMFS 1998).

The Services encourage Federal agencies to conference on actions that may affect a proposed species, or proposed critical habitat. In such cases, conference concurrence determinations, or conference opinions, can be adopted as formal concurrences or biological opinions, respectively, after a proposed species is listed, or the critical habitat is designated. This approach can avoid disruption of project implementation due to the need to initiate and complete formal consultation at the time of listing or designation. It also facilitates, or promotes, action agency consideration of the conservation needs of proposed species and the recovery function of proposed critical habitat. Emergency consultation procedures can be adapted to accommodate the conference process if necessary.

## Exhibit 8-1. FWS Emergency consultation notification memorandum to the Regional Office (optional).

(date)

Memorandum

To: Assistant Regional Director, Region __(number)___

From: Field Supervisor, ____(name of Field Office)____

Subject: Emergency Consultation on ____(name of Federal action)___.

This office has completed an informal emergency consultation. The following information summarizes the location of the emergency, nature of the emergency, listed species and critical habitat(s) involved, and how those species and habitats are likely to be affected by the emergency.

Date of Contact: Time:

Contact(s) Name:

Agency:

Contact(s) Title:

Nature of the Emergency:

Species/Critical Habitats in the Area:

Anticipated Effects:

Recommendations Given the Contact:

## Alignment with Regional and State Plans

The use of emergency consultation procedures aligns with the CRB Plan. Use of emergency consultation procedures is consistent with the Department of the Interior's objectives to use efficient and effective processes that provide for a timely and rapid response to dreissenid introductions. Also, the states in the CRB (Washington, Oregon, Idaho, Montana, Wyoming, Nevada and Utah) have state-specific Aquatic Nuisance Species Management Plans approved by the Aquatic Nuisance Species Task Force (https://www.anstaskforce.gov/stateplans.php). In addition, Washington (DeBruyckere et al. 2014), Oregon (Draheim et al. updated 2017), Idaho (Idaho Department of Agriculture updated 2015) and Montana (Montana Fish, Wildlife, and Parks 2018) have specific dreissenid mussel rapid response plans that align with state AIS plans. The use of emergency consultation procedures aligns with these state plans.

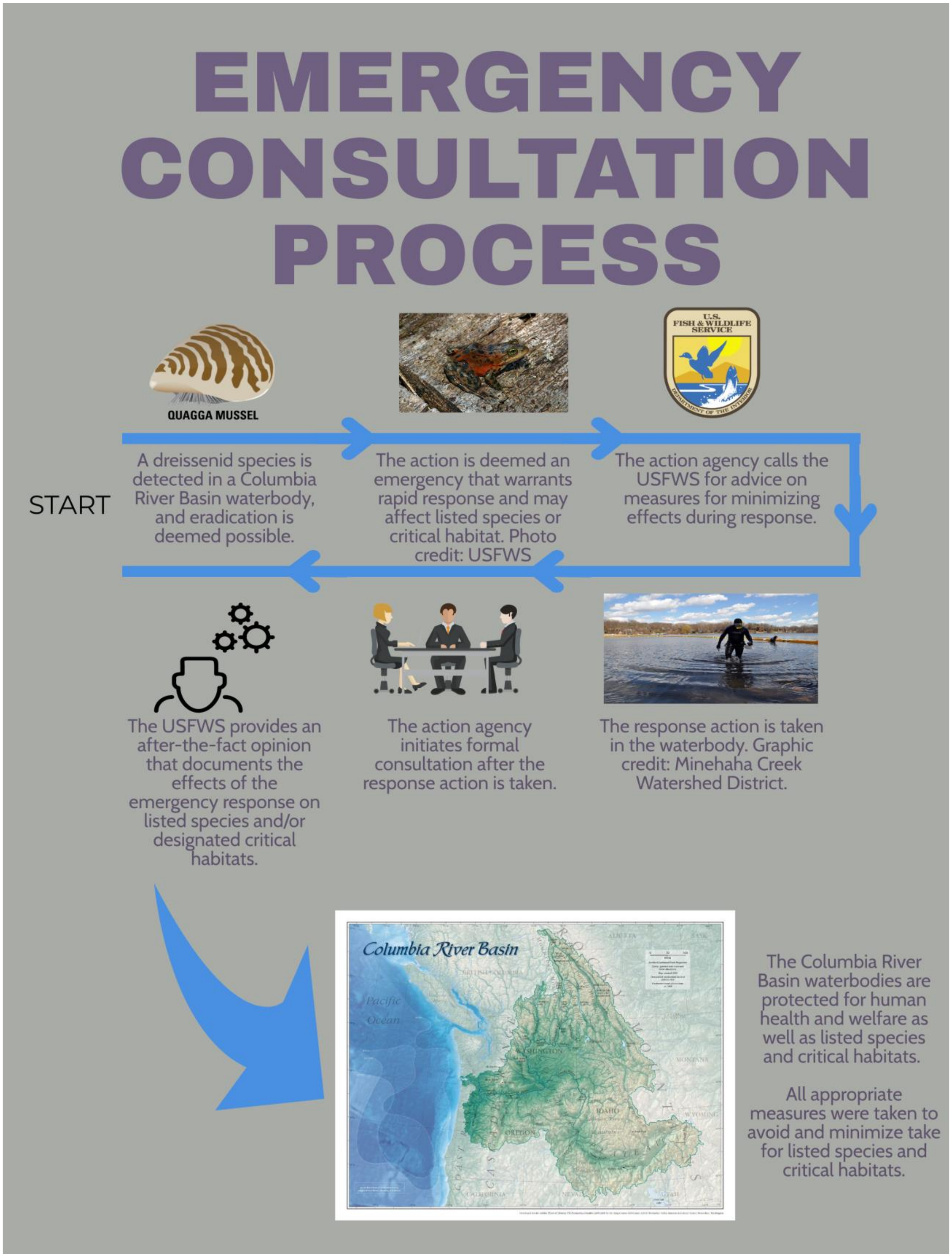


Figure 2. Emergency consultation process for an introduction of dreissenids in the Columbia River Basin. Graphic credit: Creative Resource Strategies, LLC.

## Chapter Two References

DeBruyckere, L.A., W. Brown, and B. Tweit. 2014. Washington Dreissenid Mussel Rapid Response Plan. 63pp.

Draheim, R., R. Boatner, G. Dolphin, and L. DeBruyckere. 2017. Oregon Rapid Response Plan. 93pp.

Idaho Department of Agriculture. 2015. Idaho Rapid Response Plan for Early Detection of Dreissenid Mussels. 5pp.

Montana Fish, Wildlife & Parks. 2018. The State of Montana's Dreissenid Mussel Rapid Response Guidelines.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook – Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.

# CHAPTER 3. RESPONSE ACTIONS

A detection of dreissenids in a CRB water body in the United States would likely result in a rapid response action, with a Federal nexus (e.g., Federal funding), in the states of Washington, Oregon, Idaho, and/or Montana via implementation of the CRB plan, and therefore likely trigger the emergency consultation process (Chapter 2).

Any water body in the CRB could be a potential location for the proposed action, from free-flowing rivers and streams, to hydropower reservoirs, to isolated water bodies. Access to any water body is dependent on the road network to each water body, and the amount of development and access sites available. Areas close to public use access sites, such as boat launches and marinas, are the most likely locations where both dreissenid detections and response actions would occur as a result of dreissenid introduction through watercraft, or water-based, recreation activities.

Specific tasks associated with each response action may include detection area isolation, sample collection, site monitoring, site preparation, fish and wildlife salvage, mussel treatment, equipment decontamination, site restoration activities associated with the control action (if necessary), and implementation of conservation and minimization measures and best management practices to avoid and minimize adverse environmental effects.

This chapter describes the types of most likely treatments and activities that would occur in response to a detection of dreissenids in an open water system. The CRB plan outlines many different control options, including treatments that may not be appropriate, or feasible, for response in open-water systems (see Section D-1 of the CRB plan).

## Defining the Affected Area

The potentially affected area (or action area as described in the ESA section 7 regulations) for any hypothetical rapid response action would include all areas affected directly or indirectly by the response, and not merely the immediate area involved in the response (e.g., upstream, downstream, hatcheries, infrastructure, etc.). Therefore, for the broad purposes of this manual, it could include any water body in the CRB, including all access sites into and out of the water body, staging areas, and other infrastructure adjacent to the water body, areas downstream of the site (if applicable), and any other areas affected by implementation of the response action.

## Description of Possible Response Actions

Appendix D of the CRB Plan (Heimowitz and Phillips 2008) describes, in detail, the numerous methods available to control invasive dreissenids in a variety of situations, including hydropower facilities, closed water systems, and open water bodies. Appendix D of the CRB plan summarizes the latest science associated with treatment types and efficacy for physical, biological, and chemical controls. Any rapid response action could include detection, isolation of the treatment area, fish and wildlife salvage, eradication tactics, and riparian restoration.

## Treatment Steps

The following steps are applicable to all treatments and align with the *Columbia River Basin Interagency Invasive Species Response Plan* (Heimowitz and Phillips 2008).

1. Receive report or lab analysis of a **positive identification** of dreissenids and **make initial notifications** per Section IV-A, Appendix C of the *Columbia River Basin Interagency Invasive Species Response Plan*. Initiate USFWS emergency consultation and/or NMFS consultation.

2. **Activate appropriate organizational elements** of the CRB Interagency Response Plan per Section IV-A of the *Columbia River Basin Interagency Invasive Species Response Plan.*

3. **Verify the reported introduction** per the mutually agreed upon methods and protocols established by the western states.[1]

4. **Determine the extent of the colonization** per Section IV-A, Appendix B of the *Columbia River Basin Interagency Invasive Species Response Plan.*

5. **Establish an external communications system** per Section III, Section IV, and Appendix B of the *Columbia River Basin Interagency Invasive Species Response Plan.*

6. **Obtain and organize resources** needed for a control action per Section IV-A of the *Columbia River Basin Interagency Invasive Species Response Plan.*

[1] https://www.buildingconsensusinthewest.org/monitoring

7. **Prevent further spread via quarantine and pathway management** per Section IV-A, Appendix B of the *Columbia River Basin Interagency Invasive Species Response Plan.*

8. **Initiate available/relevant control actions** per Section IV-A, Appendices B and D of the *Columbia River Basin Interagency Invasive Species Response Plan.* Ensure conservation measures and best management practices are implemented to avoid and minimize any detrimental effects to native fish and wildlife and their habitats.

9. **Initiate post-response consultation requirements** with appropriate agencies per direction from those agencies (USFWS, NMFS, etc.).

## Rapid Response Project Activities

This section lists the main steps for most rapid response actions, and identifies each step and associated activities. The purpose of this section is to outline the possible activities that could occur for a typical rapid response action that would need to be considered for inclusion in an Emergency Consultation for that action.

## 1. Site Mobilization

Equipment expected to be used in any control effort: vehicles, boats, trailers, generators, small fuel and oil containers for small engines, pumps, hose material, silt curtains, portable water tanks, other barrier material, and treatment chemicals.

Site mobilization includes access and vegetation and wildlife considerations. Best management practices for each are included in Chapter 5 in this document.

## 2. Area Isolation

The areas adjacent to public access site(s) where the detection of dreissenids is confirmed will be immediately closed to boat traffic, and any contaminated watercraft, including derelict vessels, will be removed. Isolation reduces the potential that dreissenid veligers or juveniles could escape the treatment area, which is important when the invasion is detected early and eradication is most likely. A barrier must significantly limit or eliminate water transfer from the treatment area to the main water body. Complete elimination of connectivity for the duration of treatment is preferred.

- Establish mandatory decontamination procedures for all existing watercraft.

- Collect samples inside and outside of the contaminated area for immediate analysis.

- Determine the feasibility of using silt curtains or barriers to close the bay or marina to open water.

Isolation of a portion of the water body is intended to eliminate water transfer from the treatment area to the main water body and prevent the transfer of aquatic life from the main water body into the treatment area. Two methods commonly used to create this isolation are silt curtains and bladder dams.

- Impervious silt curtains (Figure 3) would be deployed via boat (e.g., commercial silt curtain or HDPE material anchored in place), then secured to shore on the other end, or the boat can deploy the curtain in a circular fashion around the perimeter of a treatment area. Silt curtains can be up to 30.5 m in length, with a skirt of the same depth. Curtains can be fastened together to extend as far as necessary, whereas the skirts have a bottom chain for weight, and can be anchored to the substrate with sand bags.

The skirt is lowered, and sandbag anchors placed once the curtain has been appropriately stretched. This includes dropping the weighted skirt by untying or cutting, binding, and attaching and lowering sandbags into place.

Removal steps occur in the reverse order.

- Inflatable bladder dams [e.g., PLUG (Portable Lightweight Ubiquitous Gasket) and Tiger (PVC-coated fabric) dams, high density polyethylene (HDPE) liner material] would be deployed by humans on foot.

Inflatable bladder dams (Figure 4) can be positioned across the substrate and pumped with water to effectively block connectivity. This isolation method may be depth-limited.

Figure 3. Example of a deployed turbidity curtain.

Methods for bladder dam deployment may include:

- Bladder dams are unrolled and waded into place on foot, and the bladders are then filled via water pumped into the bladder.

- Any pump intake would be required to draw as specified by NMFS (2001) to protect juvenile fishes 20–30 mm.

Removal steps occur in the reverse order. If water is used from the water body being treated, the bladder water would receive treatment before being discharged.

Figure 4. Example of a deployed inflatable bladder dam. Source: hydrologicalsolutions.com.

Methods that could be used to isolate a portion of the water body, in addition to silt curtains and inflatable bladder dams, may include geotextile fabric filled with an appropriate material as well as a combination of sandbags, polyvinyl chloride (PVC)-coated fabric, and blocks.

**Water tracer dyes**

To evaluate the effectiveness of containment barriers (regardless of type) after installation but prior to treatment, tracer dyes may be used. Water tracing introduces xenobiotic substances[2] into waters and are a potential source of water contamination (Behrens et al. 2001). The selection of a tracer depends on the receiving system, cost, ease of analysis, toxicity, ambient background concentrations, and the degree to which the tracer behaves conservatively (Runkel 2015). Fluorescent dyes used as water tracers should be readily soluble in water, conservative, stable through time, measurable at large dilutions, simply and easily detectable, low in toxicity, readily available and inexpensive, and not deteriorate upon contact with water as well as pose no significant health or environmental threats (Field et al. 1995).

[2] Xenobiotic substances are synthetic chemicals generally not naturally produced.

## 3. Rescue/Salvage

In cases in which listed aquatic species are present, attempts should be made to rescue/salvage listed species (that would not naturally move away from the action area). The guidelines and protocols identified in NMFS (2000) and Reynolds (1996) for electrofishing would be implemented during listed fish salvage. For all other listed species, such as mollusks, all attempts would be made to rescue/salvage any listed species and retain them offsite, or move them into another portion of the water body where it has been determined they will not be affected by the action.

Fish salvage methods may include:

- Boat or backpack electrofishing gear calibrated to the specific onsite water conditions (i.e., conductivity).

- At least one team of three people would wade, or operate a boat throughout the treatment area, netting fish and placing them in containers of fresh water with air supply until no fish are captured for a period of 5–10 minutes. Number of teams and total collection effort would depend on size of the treatment area.

- Fish would be transferred to a separate holding tank with uncontaminated water calibrated to the ambient treatment area water temperature with oxygen supply.

- A clean water flush calibrated to the ambient treatment area temperature would completely replace the tank volume prior to fish release outside of the treatment area.

- A separate crew with sanitary equipment would conduct the fish transfer via nets and smaller containers adjacent to the treatment area.

- All equipment used during salvage would be treated onsite using the same methods as equipment sterilization (discussed below).

# 4. Response Method Options

A suite of chemical and non-chemical options exists for controlling invasive mussels in the CRB; some treatments are appropriate solely for hydropower facilities and water delivery systems, in which fish are not present and the water can be treated before being released into a sewage system. Other treatments, which may have lower toxicity to fish and living organisms, are more appropriate for open water situations. Although the CRB plan outlines numerous potential control options, many treatments may not be appropriate, or feasible, for response in open-water systems (see Section D-1 of the CRB plan (Heimowitz and Phillips 2008). The scope of this manual includes the treatment options most likely to be used in open-water systems. For example, oxidizing biocides (i.e., chlorine, bromine, hydrogen peroxide, ozone, and potassium permanganate) and non-oxidizing compounds (proprietary molluscicides; i.e. Clam-Trol, Bulab, and Bayluscide) are listed as chemical treatment options in the CRB plan. Although these treatments may be effective at controlling invasive dreissenid mussels, they are highly toxic to other aquatic species, including fishes, and are not included in this manual as likely treatment options in open-water situations (see Chapter 1 – Scope and Intent).

The most likely treatment options that would be implemented for any water body in the four CRB states would include both chemical and physical treatments:

### A. Chemical Methods

The use of chemicals requires knowledge of permitting, labeling, and chemical-specific application regulations (BOR 2015).

1. **Muriate of Potash**—used as a biocide; requires a Section 18 Pesticide Emergency Exemption from the US Environmental Protection Agency (USEPA).
2. **EarthTec QZ™**—used as a biocide; (only in water bodies with non-salmonid/trout species).
3. **Zequanox®**—the only EPA-registered biocide for mussels.
4. **Rhodomine dye**—used to evaluate water flow and containment effectiveness (not used as a biocide).

### B. Mechanical and Other Methods

1. **Intense Ultraviolet-B and Ultraviolet-C Radiation**
2. **Water level management**
3. **Physical removal**

4. **Benthic mats**

Combinations of treatments may be used, and retreatments may be necessary. Treatment areas would be isolated up to 45 days during treatment to maximize dreissenid mussel exposure time, incorporate variables, such as temperature variations (which affects efficacy of potash), and provide for re-treatment, if needed. The 45-day isolation period would incorporate two full treatments if a second treatment was necessary to achieve 100% mortality.

## Bioassays

Several bioassays could be employed to determine the effectiveness of each treatment.

If adult dreissenid mussels are present in a water body, mussel mortality could be assessed via in-situ cage bioassays (Lund et al. 2017). Source bioassay specimens from the waterbody where proposed treatment(s) will occur. If possible, four cages of ~50–100 mussels per cage could be placed within the treatment area. Cages could be constructed of plastic canvas mesh sheets (1–2 mm openings), anchored to the lake bottom. If the water body is stratified (having distinct epilimnion, metalimnion, and hypolimnion), additional bioassays representative of the different layers may be appropriate. Live, gaping, and dead mussels could be recorded daily until all mussels are dead or until no additional mussels die over three consecutive days.

### A. Chemical Methods

### A1. Chemical Method – Muriate of Potash

In basin locations in which ESA-listed salmonids and their critical habitat exist, the most likely product to be used, based on least toxicity to aquatic life as well as cost, is potash.

Potash is a common plant fertilizer which is largely comprised of potassium salts. Forms used to treat dreissenids include potassium chloride (KCl), potassium hydroxide (KOH), and potassium sulfide ($K_2SO_4$).

Potassium fertilizers used in agriculture have been shown to precipitate salts when applied in large quantities and/or through time, which can cause salinity problems in spoils (Magen 1996). There is either a paucity of information on the effects of potassium applied directly to water, or the only actual outcome is increased nutrient loading.

Irrigation systems cause compound leaching over time and allow precipitates to accumulate in soils (Burt and Isbell 2005).

### *Toxicity*

Potassium ions interfere with the respiration of dreissenids at the gill surface (Fisher et al. 1991, Aquatic Sciences Inc. 1997). Acute lethal effects of potash on juvenile brook trout (*Salvelinus fontinalis*) and juvenile Chinook salmon (*Oncorhynchus tshawytscha*) are not expected at concentrations used to control dreissenids (Densmore et al. 2018). In fact, exposure concentrations of eight times greater than the dose of KCl used as a molluscide (800 mg/L) in a static system during a 96-hour period resulted in no mortality, and no behavioral, histological, or gross morphological effects on fish of either species (Densmore et al. 2018). Significant mortality among sensitive aquatic invertebrates, such as water fleas (Daphniidae), is not unexpected (Densmore et al. 2018). Other invertebrates, such as crayfish (*Procambarus* spp.), demonstrate some degree of sensitivity to KCl (Densmore et al. 2018). For example, crayfish exposed to KCl at higher concentrations (e.g., 800 mg/L–1,600 mg/L) for at least 24 hours experienced immobilization, but half were able to fully recover in fresh water within 24 hours (Densmore et al. 2018). Further analysis is needed to fully realize the threats to crayfish and other invertebrate species from KCl.

Liquid potash was successfully used, with 100% effectiveness, to eradicate zebra mussels from the Millbrook Quarry in Virginia, USA (Fernald and Watson 2014).

### *Potash Application*

Potash consists primarily of potassium chloride (KCl). Potash is not a registered pesticide in the United States and requires a Section 18 Pesticide Emergency Exemption from the U.S. Environmental Protection Agency (USEPA) to allow its use in the four CRB states.

Target application rates are 95–115 mg/L (KCl), ≤ 10 mg/L (KOH), and 160–640 mg/L ($K_2SO_4$). Applications may be made at the surface, mid-depth, or deep waters to ensure appropriate mixing and to maintain the desired concentration throughout the treatment area. Potash can be applied up to 21 days after mixing to achieve desired effectiveness.

Equipment includes High Density Polyethylene storage tanks with spill containment to protect against spills and ensure a constant supply of stock solution. A stock solution of about 12% potassium is mixed by a chemical supplier and delivered to the site on an as required basis where it is transferred to the storage tanks and kept in solution by an electric tank mixer. The quantity of metric tons of KCl required to treat the site is estimated in advance based on the size of the contained portion of the water body.

Water-based operations use a work boat outfitted with a specially designed diffuser assembly. Stock solution from the shore-based storage tanks continuously feed the diffuser through a floating 3.8 cm (1.5 in.) diameter supply line and shore-based centrifugal pump transfer system. Proper diffusion of potassium is a critical element of the treatment method.

Treatment proceeds on a systematic basis by separating the cordoned off areas into segments or treatment zones delineated by water depth. The work platform-based retractable diffuser assembly consists of perforated vertical flexible hoses having capped and weighted ends attached to the horizontal section. This allows for an enlarged mixing zone to be achieved while the flexible hose reduces damage due to submerged obstacles. An echo sounder is used to monitor water depth and the depth of the submerged diffuser assembly to maintain an optimum height above the bottom of the water body. This system also reduces the risk of entangling the diffuser assembly on bottom features.

To ensure the potassium diffusion system is operating efficiently and is attaining target potassium concentrations throughout the treatment zone, potassium spot monitoring is completed during each charge operation. This provides personnel with information on how quickly and how well the potassium is dispersing through the treatment zone. This information can be used to modify the treatment protocol, either by increasing or decreasing the dosing rate to achieve target concentrations. Following the “charge” activities, a final sampling exercise is conducted throughout each cordoned off area to characterize potassium concentrations at various depth profiles. Monitoring points at each enclosed area are spaced depending on the width of the enclosed area at each transect location. Sites are monitored along each transect to ensure feasible and maximum monitoring coverage of the treated transect area. Duplicate samples are collected and analyzed for every tenth sample for quality assurance and quality assurance/quality control (QA/QC) purposes.

To determine the potassium concentrations, water samples are obtained by two different methods. Surface grabs are conducted where water depths are less than 2 m and are collected at least 0.15 m below the surface. A peristaltic pump, or Kemmerer bottle, is used to collect samples from each thermocline present in the sectioned off area and at depths greater than 2 m. Samples are analyzed with a concentration meter, in combination with a potassium probe. Sample identification, location, depth, date, GPS coordinates for each monitoring point, and other pertinent information is recorded in a field logbook and on reporting log sheets. The field instruments are calibrated prior to use every day with standards of known value. Monitoring is conducted daily throughout a 12-hour shift.

## A2. Chemical Method – EarthTec QZ™

EarthTec QZ™ is a copper-based algaecide/bactericide (a formulation of copper sulfate pentahydrate) labeled to control zebra and quagga mussels. EarthTec QZ™ is registered in all 50 states as an algaecide/bactericide and in Montana and Washington as a molluscide. EarthTec QZ™ is documented as achieving 100% mortality of mussels when exposed to the product for 96 hours (Watters et al. 2013). The product can be spread on the surface of a water body or pumped into a water body, and disperses rapidly.

EarthTec QZ™ is a liquid formulation that is miscible in water and has ionic diffusion properties that cause it to readily disperse throughout the water column. The product's active ingredient is delivered in the cupric ion form—a biologically active form of copper (Watters et al. 2013). EarthTec QZ™ does not have any degradation byproducts, and no adjuvants or surfactants are used in the application.

### *Toxicity*

Lethal dose and exposure time of zebra mussels to EarthTecQZ™ had been identified under laboratory conditions (Watters et al. 2013, Claudi et al. 2014).

The cupric ion ($Cu_{2+}$) form of copper is considered the most toxic form of copper to aquatic life because it is the most bioavailable (Eisler 2000, Solomon 2009). In addition, the cupric ion form of copper is more lethal in soft water compared to hard waters rich in cations because cations reduce its bioavailability (Pagenkopf 1983, Paquin et al. 2002). The toxicity of copper to fish and other aquatic life depends on its bioavailability, which is strongly dependent on pH, the presence of dissolved organic carbon (DOC), and water chemistry, such as the presence of calcium ions.

- Juvenile rainbow trout (*Oncorhynchus mykiss*) were exposed to either hard water or soft water spiked with copper for 30 days (Taylor et al. 2000). Fish in the hard-water, high dose (60 µg/L) treatment groups showed an increased sensitivity to copper.

- The mean 96-hour $LC_{50}$ (with 95% confidence limits) for copper exposure in alevin, swim-up, parr and smolt steelhead (*Salmo gairdneri*) is 28 (27–30), 17 (15–19), 18 (15–22), and 29 (>20) µg/L of copper, respectively (Chen and Lin 2001). The mean 96-hour $LC_{50}$ for copper exposure in alevin, swim-up, parr, and smolt Chinook salmon (*Oncorhynchus tshawytscha*) is 26 (24–33), 19 (18–21), 38 (35–44), and 26 (23–35) µg/L of copper, respectively. The experiments were done by adding copper as copper sulfate.

- Aquatic snails (*Biomphalaria glabrata*) had a 24-hour and 48-hour $LC_{50}$ (with 95% confidence intervals) of 1.868 (1.196–3.068) and 0.477 (0.297–0.706) mg/L Cu, respectively (de Oliveira-Filho et al. 2004).

- 1-day-old freshwater snail eggs (*Lymnaea luteda*) were exposed to copper at concentrations from 1 to 320 µg/L of copper for 14 days at 21 °C in a semi-static embryo toxicity test (Khangarot and Das 2010). Embryos exposed to copper at 100 to 320 µg/L died within 168 hours. At lower doses from 3.2–10 µg/L, significant delays in hatching and increased mortality were noted.

### *EarthTec QZ™ Application*

Application methods vary depending on the scale of project. It is applied at a rate of up to 2 mg/L, not to exceed 0.1 mg/L total copper. Concentrations may be held constant up to 30 days (depending on dose) to achieve effective treatment for all dreissenid life stages. EarthTec QZ™ copper is highly water soluble and does not precipitate. The product remains suspended until uptake by bacteria and algae occurs (Master Label for EarthTec QZ™, EPA Reg. No. 64962-1). Dispersion into the water body quickly reduces concentrations to below effective levels outside of the isolated treatment area.

EarthTec QZ™ is applied near the water surface and allowed to disperse, or is delivered via hose and pump to the depths, sites, and surfaces of the area of infestation. When applying to large areas, it is dispensed along a route with gaps no greater than 200 feet. Generally, when fish are present, no more than one-half of the body of water is treated at a time, starting near one shore and moving outward in bands to allow fish to move away. When treating half of a body of water, the second half must not be treated within 14 days from the last treatment. For effective control of adult and juvenile mussels, it is applied at the recommended rate of 2–16 parts per million (i.e., 2–16 gallons of EarthTec QZ™ per million gallons of water) to yield a rate of 0.120–0.960 mg/L (ppm) metallic copper. A total of at least four days is required for mortality of dreissenids to occur. Colder water temperatures may require longer exposures and doses closer to the high end of the allowable range. Within the half of the water body being treated, repeat applications may be needed to maintain lethal concentrations of copper for a sufficient time period. The second half of the water body is not treated within 14 days of the last treatment of the first half. Effective control can also be achieved by longer exposures (e.g., 5–30 days) at lower doses (1–5 parts per million EarthTec QZ™, to yield a rate of 0.06–0.30 mg/L (ppm) metallic copper.) When reapplying, a concentration of 1.0 mg/L (ppm) metallic copper in the treated water is not exceeded.

## A3. Chemical Method – Zequanox®

Zequanox® is a biopesticide consisting of the dead bacterial cells of *Pseudomonas fluorescens* strain CL145 A that, when ingested by zebra and quagga mussels, destroy the digestive lining (https://marronebioinnovations.com/molluscicide/zequanox/). All treatments are undertaken by state-licensed applicators. Prior to beginning chemical treatment, the area to be treated is sealed off using non-permeable geotextile membranes, creating a contained open water body.

Zequanox® is maintained at a rate of 100 mg/L for up to eight hours; treatments are often repeated, although the label recommends no more than four Zequanox® applications annually.

*Toxicity*

Zequanox® is a potential tool for controlling dreissenids in shallow water habitats in lakes without significant long-term effects on water quality (Whitledge et al. 2014). However, this biopesticide does cause temporary, but substantial, reductions in dissolved oxygen because of the barriers that prevent well-oxygenated water from circulating into treatment zones (Whitledge et al. 2014).

Exposure to Zequanox® caused no mortality to blue mussels (*Mytilus edulis*) or any of six native North American unionid clam species (*Pyganodon grandis*, *Lasmigona compressa*, *Strophitus undulatus*, *Lampsilis radiata*, *Pyganodon cataracta*, and *Elliptio complanata*) (Bureau of Reclamation 2011). Exposure of duck mussel (*Anodonta* spp.), non-biting midge (*Chironomus plumosus*), and white-clawed crayfish (*Austropotamobius pallipes*) to Zequanox® in a 72-hour static renewal toxicity test at concentrations of 100–750mg active ingredient/liter resulted in $LC_{50}$ values for *Anodonta*: $\geq$500mg active ingredient/liter, *C. plumosus*: 1075mg active ingredient/liter, and *A. pallipes*: $\geq$750mg active ingredient/liter, demonstrating that Zequanox ® does not negatively affect these species at concentrations required for greater than 80% zebra mussel mortality (i.e., 150mg active ingredient/liter) (Meehan et al. 2014).

Nicholson (2018) conducted a replicated aquatic mesocosm experiment using open-water applications of Zequanox® (100 mg/L of the active ingredient) to determine the responses of primary producers, zooplankton, and macroinvertebrates to Zequanox® exposure in a complex aquatic environment. Short-term increases occurred in phytoplankton and periphyton biomass (250–350% of controls), abundance of large cladoceran grazers (700% of controls), and insect emergence (490% of controls). Large declines initially occurred among small cladoceran zooplankton (88–94% reductions in *Chydorus sphaericus*, *Ceriodaphnia lacustris*, and *Scapheloberis mucronata*), but abundances generally rebounded within three weeks. Declines also occurred in amphipods (*Hyalella azteca* - mean abundance 77% less than controls) and gastropods (*Viviparus georgianus* - survival 73 ±16%), which did not recover during the experiment. Short-term impacts to water quality included a decrease in dissolved oxygen (minimum 1.2 mg/L), despite aeration of the mesocosms.

### *Zequanox® Application*

Products are mixed in tanks and injected at the water surface. Following treatment, monitoring occurs every 1–2 days for 14 days post-treatment. Monitoring consists of collecting surface water samples at various locations inside the treatment area. Samples are submitted for analysis by mass spectroscopy, with results reported within 1–2 days. Portable meters are used to inform bump applications in the field.

During the Zequanox® application, concentrations are estimated using turbidity measurements, on the first and last day of treatment application. Monitoring of concentrations is of limited utility because the active agent in Zequanox® is degraded within 24 hours after it is added to water (Molloy et al. 2013).

## A4. Chemical Method – Rhodomine Dye

There are water tracers that are carcinogenic, genotoxic, or ectoxic[3]. Fluorescent dyes that demonstrate no effect on genotoxicity or ecotoxicity are classified as safe for use in water tracing (Behrens et al. 2001). Rhodamine dyes (aminoxanthenes) are used as hydrologic tracers in surface water systems (Runkel 2015). Rhodamine dyes are synthesized by reacting 3-dialkylaminophenols with phthalic anhydride (Ismael et al. 2013). Rhodamine WT is water soluble, highly detectable, and fluorescent in a part of the spectrum not common to materials commonly found in water, harmless in low concentrations, and reasonably stable in aquatic environments (USGS 1986). Domenico and Schwartz (1990) described rhodamine WT as a conservative, ideal tracer because it does not react with other ions or the geologic medium to any appreciable extent.

### *Toxicity*

Molinari and Rochat (1978) concluded there is relatively low ecotoxicological risk from rhodamine WT. Smart (1984) concluded rhodamine WT is a severe irritant to the eye and moderately irritating to the skin. Nestmann and Kowbel (1979) documented rhodamine WT was mutagenic in the *Salmonella typhum*/mammalian microsome Ames test.

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[3] Carcinogenic substances have the potential to cause cancer. Genotoxic substances have the potential to damage genetic information within a cell, causing mutations, which may lead to cancer. Ectoxic substances have the potential to place biological, chemical, or physical stressors on an ecosystem.

Douglas et al. (1983) concluded rhodamine WT does not represent a major genotoxic hazard because it was weak in vitro mutagenicity using very high dye concentrations.

In aquatic ecosystems, larval stages of shellfish and algae are most sensitive to fluorescent dyes (Smart 1984). However, Rhodamine WT does not affect development nor cause mortality in shellfish eggs and larvae after 48 hours exposure, and dye concentrations as high as 1 mg/l can be tolerated for two days without damage to aquatic organisms (Smart 1984). Fairy shrimp, *Thamnocephalus platyurus*, had a toxicity of $EC_{50}$ 24 hours: 1,698 mg/L-1. A total of 48-hour exposures at 24° C of 11,000 Pacific oyster (*Crassostrea gigas*) eggs per liter and 6,000 12-day-old larvae per liter, in sea water with concentrations of rhodamine WT ranging from 1 µg/l to 10 mg/l, resulted in development of the eggs to normal straight-hinge larvae and no abnormalities in the larvae development (Parker 1973). Coho salmon (*Oncorhynchus kisutch*) and Donaldson rainbow trout (*Oncorhynchus* mykiss) held for 17.5 hours in a tankfull of sea water with a dye concentration of 10 mg/l at 22°C showed no mortalities or respiratory problems (Parker 1973). A concentration of 375 mg/l, and extended time of an additional 3.2 hours resulted in no mortalities or abnormalities (Parker 1973). The fish remained healthy in dye-free water when last checked one month after the test. J.S. Worttley and T.C. Atkinson (reported as personal commun., 1975, in Smart and Laidlaw 1977) exposed a number of freshwater and brackish water invertebrates, including water flea (*Daphnia magna*), shrimp (*Gammarus zadllachl*), log louse (*Asellus aquaticus*), may fly (*Cloeon dipterum*), and pea mussel (*Visidium spp.*), to water containing up to 2,000,000 µg/L of rhodamine WT for periods of up to 1 week. No significant differences in mortality between the test and control animals were observed.

Dye concentrations for water tracing purposes are low enough to exert almost no toxic impacts on water fauna, including fairy shrimp, water fleas (*Daphnia magna*), horned planorbis snail (*Planorbis corneus*), and guppy fish (*Poecilla reticulata*) (Rowinski and Chrzanowski 2011).

The lethal dose of rhodamine WT in rats is 25,000 mg kg-1 (Field et al. 1995). The oral lethal dose for humans is estimated to be 25,000 mg kg -1 d-1, which would require an adult to ingest 875,000 mg l-1 of rhodamine WT for a dose of 25,000 mg kg-1 d-1 to be achieved (Field et al. 1995). Field et al. (1995) tested the possible ecotoxicity effects of 12 water tracer dyes, including rhodamine WT, on human health. They concluded rhodamine WT has no skin absorption, has limited oral uptake, has inadequate data on carcinogenicity, and poses little concern for both oncogenic and mutagenic effects as well as little concern for chronic toxicity, including liver and kidney effects.

Ecological toxicity structure-activity relationship (SAR) concerns for rhodamine WT are as follows:

Fish (96 hours LC50) > 320 mg 1-1a
Cladocera (48 hours LC50) 170 mg l-1a
Green algae (96 hours EC50) 20 mg l -1
The high $LC_{50}$ demonstrated for aquatic organisms indicate unlikely serious effects on groundwater fauna from 1-2 mg 1-1 dye concentrations in the water (Field et al. 1995).

When used at recommended dosages, rhodamine WT does not constitute an environmental hazard associated with manmade nitrosamines in the environment (Steinheimer and Johnson 1986). However, it should be noted that Field et al. (1995) emphasized their focus on acute toxicity relative to lethal doses, noting that other toxicological effects, such as developmental toxicity, were not calculated.

*Rhodamine WT Application and Best Management Practices* (from Field et al. 1995)
The maximum recommended concentration of rhodamine WT is 2 mg 1-1. Individuals using tracers should be experienced or well trained in their use, and tracer concentrations should not exceed 1–2 mg 1-1 persisting for a period in excess of 24 hours in groundwater at the point of groundwater withdrawal, or discharge. Such concentrations are well below toxicity levels and allows for easy recognition by the naked eye.

## B1. Mechanical and Other Methods – Intense Ultraviolet-B and Ultraviolet-C Radiation

Ultraviolet (UV) radiation is an effective method for controlling zebra mussels in all life stages, although veligers are more sensitive than adults. Complete veliger mortality can be obtained within four hours of exposure to UV-B radiation, and adult mortalities can also be obtained if constant radiation is applied. UV radiation can be harmful to other aquatic species, and its effectiveness may be decreased by turbidity and high suspended solids loads (Wright et al. 1997). Doses as low as 26.2 $mJ/cm^2$ and 79.6 $mJ/cm^2$ can decrease survival of pre-settlement stage larvae by nearly 50% and 80%, respectively, within four days of exposure (Stewart-Malone et al. 2015).

The use of UV light to control larval dreissenids in industrial cooling water systems is well documented (Pucherelli and Claudi 2017). To reduce environmental effects, lower costs, and avoid the need for discharge permitting, UV light irradiation can be used to prevent or limit mussel colonization in industrial facilities, and can be used in water bodies in combination with treatments targeted at adult dreissenids. Site-specific characteristics, such as the ability of the water to transmit UV light, suspended solids, and flow conditions, affect the efficacy of this treatment (Pucherelli and Claudi 2017). This technique requires continuous UV light application for up to 120 hours, and is considered only partially effective in killing larval dreissenids.

The UV light is applied using watercraft and submerged UV light panels, which are raised and lowered in the water column to target larval dreissenids.

## B2. Mechanical and Other Methods – Water Level Management

Sudden water-level drawdowns during several winter conditions can temporarily reduce dreissenids in impounded river sections, although this type of control is considered a method to temporarily reduce large numbers of adults (Leuven et al. 2014).[4] Freezing air temperatures are highly lethal to zebra mussels within a matter of hours (Grazio and Montz 2002). Water drawdowns occur when managers decrease the maximum depth in a body of water that has adequate water level control structures (Grazio and Montz 2002). Winter water drawdowns were used to treat Lake Zumbro, Minnesota, and Edinboro Lake, Pennsylvania, in 2000 and 2001. Although complete mortality of invasive mussels was observed in drawdown areas (1.5-meter drawdowns), mussels successfully overwintered in waters deeper than the maximum drawdown depth (Grazio and Montz 2002). A drawdown of Ed Zorinsky Reservoir (Zorinsky Lake), Nebraska, in the winter of 2010 resulted in the eradication of zebra mussels within the lake, and the lake was refilled and re-opened for recreation in 2012 (Hargrave and Jensen 2012). Zebra mussel veligers were detected in May 2016, however, adult mussels have not been observed. Total elimination of dreissenids with this management technique is unlikely, and the potential costs and benefits before attempting fall/winter lake drawdowns for zebra mussel control should be evaluated on a site-by-site basis.

## B3. Mechanical and Other Methods – Physical Removal

Information in this section is from Culver et al. (2013).

Removal, either by hand or another mechanical method, can potentially eradicate dreissenid mussels when 1) the structure from which mussels are being removed lends itself to this technique, and 2) when mussels are concentrated within specific areas of a water body or on particular infrastructure within it. Mussel populations can successfully be eradicated using this strategy only if 1) no additional larval or juvenile/adult mussels are entering the water body from infested waters (aqueduct or reservoir) and/or boat traffic, and 2) if enough mussels are removed to reach the point where the population can no longer sustain itself. Achieving the latter can be difficult, due to the mussels' ability to inhabit inaccessible places, limiting removal efforts and increasing chances

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[4] In a study in the Netherlands, the overall density of dreissenids decreased, but six months after the water level was increased, the mussel density slightly increased. Within 18 months, the mussel density had recovered to pre-drawdown levels.

that individuals will survive. Where there are many inaccessible areas, a combination of tactics will likely be most effective.

Even when eradication is not possible, this strategy offers an effective method for controlling the population when applied appropriately, and when used in combination with other control tactics. Likewise, if the infested area is large (>20,000 square feet),[1] a combination of oxygen deprivation using tarps and manual/mechanical removal may be useful.

The steps to be taken in manual removal include organizing divers, training divers, determining the distribution of mussels, conducting pre-implementation surveys, preparing the target site, manually removing the mussels using hand-held tools, collecting the mussels, disposing of the mussels, decontaminating persons and gear, and evaluating tactic success. For more information on the specific steps associated with manual and mechanical removal of aquatic invasive species, California Sea Grant has developed an information sheet (2013) for educational purposes (https://caseagrant.ucsd.edu/sites/default/files/3%20Manual%20Mechanical%20Individual_121418.pdf)

## B4. Mechanical and Other Methods – Benthic Mats

Benthic mats are large, dark tarps anchored to the bottom of a water body to control invasive mussels by restricting water flow, oxygen and food from the mussels beneath the mats, and blocking light to prevent photosynthesis from producing oxygen beneath the mats.[5]

[5] https://invasivemusselcollaborative.net/management/

## 5. Summary of Application Rates and Contact Time for Dreissenid Treatment Methods

The *Columbia River Basin Interagency Invasive Species Response Plan: Zebra Mussels and Other Dreissenids* (Heimowitz and Phillips 2008) documents the chemical methods available for dreissenid control, including the ones documented in Table 1. Appendix D in the CRB Plan identifies the treatment, target age, efficiency, contact time/concentration, and comments relative to effects on the environment and other species. Information from that appendix is summarized here for the treatments included in this manual.

Table 1. Summary of application rates and contact time for dreissenid chemical treatments.

| Treatment Method | Target Dreissenid Life Stage | Efficiency | Application Rate | Contact Time |
|---|---|---|---|---|
| **Potash (KCl)** | Juveniles and adults | Prevent larval settlement (50%) 95–100% mortality | 95–115 mg/L | 21 days |
| **Potash ($KH_2PO_4$)** | Juveniles and adults | 100% | 160–640 mg/L | 21 days |
| **Potash (KOH)** | Juveniles and adults | 95–100% mortality | $\leq$ 10 mg/L | 21 days |
| **EarthTec QZ™** | Juveniles and adults | 100% | 0.5–2 mg/L, not to exceed 0.1 mg/L total copper (Master Label for Earthtec™, EPA Reg. No. 64962-1) | 30 days |
| **Zequanox®** | Juveniles and adults | 70–100% | 150 mg/L (Zequanox Label – Open Water Systems[6]) | 1–2 weeks |
| **UV-B Radiation** | Juveniles and adults | 50–80% | 10–100 $mJ/cm^2$ | 5 days |

[6] https://marronebio.com/download/zequanox-label/

## Project Timeline

Rapid response actions are implemented immediately upon detection of dreissenids in a given area. Physical activity onsite occurs until the severity of the invasion is determined through initial treatment and extended treatment area isolation. Additional treatments may be required for 100% effectiveness. Isolation barriers remain in place until monitoring suggests 100% mussel mortality has occurred and water chemistry is acceptable for barrier removal.

It is likely that mussel detection and treatment would occur during warmer months of the year, when both mussel growth and activity is greatest (estimated April through September) and when water temperatures are conductive to the most likely chemical treatments. However, discussions should occur with State and Federal natural resource agencies to adhere to in-water work timing windows (see Best Management Practices). Restoration occurs only after the final treatment in the case of a site requiring riparian access. Plant restoration, if necessary, would likely occur during October–March.

## Chapter Three References

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# CHAPTER 4. LISTED SPECIES AND CRITICAL HABITAT IN THE FOUR CRB STATES

The purpose of this chapter is to provide information about the listed species and their critical habitats that are known to occur in Washington, Oregon, Idaho, and Montana (the four states that protect the majority of the Columbia River Basin). The intent is to provide easy access to key life history vulnerabilities associated with those species and critical habitat, with the likely effects of an action on species, and additional species-specific best management practices to inform any proposed action to control (or eradicate) dreissenids.

The information in this chapter was obtained from the U.S. Fish and Wildlife Service Environmental Conservation Online System (ECOS), and was supported by each state's heritage database system. This information is accurate as of the date of publication of this manual, and may change in the future. The material in this chapter does not substitute for the need to communicate with the local U.S. Fish and Wildlife Service Ecological Services Program to confirm the accuracy of this information as well as any new information and updates made since the development of this document.

The four CRB states have a total of 70 federally listed species and 2 proposed listed species (Table 2). A detailed list of federally listed species by state, including a hyperlink to the ECOS profile, a link to the distribution map, and links to information about critical habitat and critical habitat maps (if appropriate) is provided in Table 3.

Table 2. Number of federally listed threatened and endangered species by CRB state.

| | Oregon | Washington | Idaho | Montana |
|---|---|---|---|---|
| **Mammals** | 2T, 1E | 4T, 3E | 3T, 1E | 3T, 1E |
| **Birds** | 5T, 1E | 5T, 1E | 1T | 3T, 2E |
| **Amphibians** | 1T | 1T | 0 | 0 |
| **Fish** | 13T, 2E | 13T, 1E | 1T, 1E | 2E |
| **Invertebrates** | 2T, 3E | 1T, 1E | 1T, 3E | 0 |
| **Plants** | 8T, 11E | 8T, 4E | 5T, 0E | 3T, 0E |
| **TOTALS** | **31T, 18E** | **32T, 10E** | **11T, 5E** | **9T, 5E** |

Table 3. Listed threatened (T), endangered (E), and experimental population (XN) species and critical habitat (CH) in the CRB states. Species highlighted in orange were included in this analysis; species with no highlight were excluded from this analysis because dreissenids would not be found in their habitat, or the species would not be directly or indirectly affected by rapid response actions for dreissenids. Note: This table also includes NOAA trust species (green highlight). NOAA trust species are not included in this analysis because at the time of this publication, another process was underway involving federal agencies and actions associated with listed NOAA fisheries.

| | ECOS Profile | Oregon | Washington | Idaho | Montana |
|---|---|---|---|---|---|
| **MAMMALS** | | | | | |
| Black-footed ferret (*Mustela nigripes*) | Link | | | | E, XN |
| Canada lynx (*Lynx canadensis*) CH Map (2014), 5-year review (2017) | Link | T | T | T | T |
| Columbian white-tailed deer (*Odocoileus virginianus leucurus*)[7] | Link | T | T | | |
| Gray wolf (*Canis lupus*)[8] | Link | E[9] | E[10] | | |
| Grizzly bear (*Ursus arctos horribilis*) CH (1976) | Link | | T | T | T |
| Mazama pocket gopher (*Thomomys azama pugetensis, glacialis, tumuli, and yelmensis*) CH (2014): Olympia CH Map, Roy Prairie CH Map, Tenino CH Map, Yelm CH Map | Link | | T | | |
| Northern Idaho ground squirrel (*Urocitellus endemicus*) | Link | | | T | |
| Northern long-eared bat (*Myotis septentrionalis*) | Link | | | | T |
| Columbia Basin Pygmy rabbit (*Brachylagus idahoensis*) (Columbia Basin DPS) | Link | | E | | |
| Southern Selkirk Mountains woodland caribou (*Rangifer tarandus caribou*) CH Map, CH (2012) | Link | | E | E | |
| **BIRDS** | | | | | |
| Marbled murrelet (*Brachyramphus marmoratus*)[11] CH Map, CH (2016) | Link | T | T | | |
| Northern spotted owl (*Strix occidentalis caurina*) CH Map, CH (2012) | Link | T | T | | |
| Piping plover (*Charadrius melodus*) CH Map, CH (2002) | Link | | | | T |
| Red knot (*Calidris canutus rufa*) | Link | | | | T |
| Short-tailed albatross (*Phoebastria albatrus*) | Link | E | E | | |
| Streaked horned lark (*Eremophila alpestris strigata*) CH Map, CH (2013) | Link | T | T | | |

[7] Columbia River population.

[8] Conterminous USA, lower 48 states, except where otherwise designated).

[9] Endangered in the western 2/3 of Oregon as defined by a boundary line that extends south from the Washington border along Hwy 395 to Burns Junction, and continues south on Hwy 95 to the Nevada border. Wolves east of that line are not federally listed.

[10] Endangered in the western 2/3 of Washington, west of Hwy 97, State Route 17 and US 395. WDFW has primary management authority to the east of that line. Wolves that inhabit tribal lands east of highways 97, 17, and 395 are managed by those tribal entities.

[11] Washington, Oregon, and California population.

| | ECOS Profile | Oregon | Washington | Idaho | Montana |
|---|---|---|---|---|---|
| Western snowy plover (*Charadrius alexandrines nivosus*)[12] CH Map, CH[13, 14] (2012) | Link | T | T | | |
| Whooping crane (*Grus americana*) | Link | | | | E, XN |
| Yellow-billed cuckoo (*Coccyzus americanus*)[15] , Proposed critical habitat - CH Map, CH (2014) | Link | T | T | T | T |
| **AMPHIBIANS** | | | | | |
| Oregon spotted frog (*Rana pretiosa*) CH Map, CH (2016) | Link | T | T | | |
| **FISH** | | | | | |
| Bull trout (*Salvelinus confluentus*)[16] CH Map, CH (2010) | Link | T, XN | T | T | T |
| Chinook salmon (*Oncorhynchus tshawytscha*) CH (2000) | | | | | |
| Upper Columbia spring-run ESU | | | E | | |
| Snake River spring/summer run ESU | | T | T | | |
| Snake River fall-run ESU | Link | T | T | | |
| Puget Sound ESU | | | T | | |
| Lower Columbia River ESU | | T | T | | |
| Upper Willamette River ESU | | T | | | |
| Chum salmon (*Oncorhynchus keta*) CH (2000) | | | | | |
| Hood Canal summer-run ESU | Link | | T | | |
| Columbia River ESU | | T | | | |
| Coho Salmon (*Oncorhynchus kisutch*) CH (2000) | | | | | |
| Oregon Coast ESU | Link | T | | | |
| Lower Columbia River ESU | | | T | | |
| Sockeye salmon (*Oncorhynchus nerka*) | | | | | |
| Snake River ESU [CH (1993)] | Link | E | | | |
| Ozette Lake ESU [CH (2000)] | | | T | | |
| Steelhead (*Oncorhynchus mykiss*) CH (2005) | | | | | |
| Upper Columbia River DPS | | | T | | |
| Upper Willamette River DPS | Link | | T | | |
| Middle Columbia River DPS | | T | | | |
| Lower Columbia River DPS | | T | T | | |

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[12] Pacific coast population.

[13] Critical habitat was designated in 2005 for 32 areas along the coasts of California, Oregon, and Washington. A recovery plan was finalized in September 2007. On December 17, 2010, the USFWS, along with other federal agencies and the State of Oregon, signed off on a statewide Habitat Conservation Plan. On June 19, 2012, a final rule of critical habitat was published for the coasts of California, Oregon, and Washington.

[14] Ibid.

[15] Western population.

[16] Conterminous USA, lower 48 states.

| | ECOS Profile | Oregon | Washington | Idaho | Montana |
|---|---|---|---|---|---|
| Snake River Basin DPS<br>Puget Sound DPS | | T | T<br>T | | |
| Kootenai River white sturgeon (*Acipenser transmontanus*) CH Map, CH (2008) | Link | | | E | E |
| Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) | Link | T | | | |
| Pallid sturgeon (*Scaphirhynchus albus*) | Link | | | | E |
| **INVERTEBRATES** | | | | | |
| Banbury Springs limpet (*Lanx* spp.) | Link | | | E | |
| Bliss Rapids snail (*Taylorconcha serpenticola*) | Link | | | T | |
| Bruneau hot springsnail (*Pyrgulopsis bruneauensis*) | Link | | | E | |
| Snake River physa snail (*Physa natricina*) | Link | | | E | |
| Fender's blue butterfly (*Icaricia icarioides fender*) CH Map, CH (2006) | Link | E | | | |
| Taylor's checkerspot butterfly (*Euphydryas editha taylori*) CH Map, CH (2013) | Link | E | E | | |
| Oregon silverspot butterfly (*Zpeyeria zerene hippolyta*) CH Map, CH (1980) | Link | T, XN | T | | |
| Vernal pool fairy shrimp (*Branchinecta lynchi*) CH Map, CH (2011) | Link | T | | | |
| Vernal pool tadpole shrimp (*Lepidurus packardi*) | Link | E | | | |
| **PLANTS** | | | | | |
| Applegate's milk-vetch (*Astragalus applegatei*) | Link | E | | | |
| Bradshaw's desert parsley (*Lomatium bradshawii*) | Link | E | E | | |
| Cook's lomatium (*Lomatium cookii*) CH Map, CH (2010) | Link | E | | | |
| Gentner's fritillary (*Fritillaria gentneri*) | Link | E | | | |
| Golden paintbrush (*Castilleja levisecta*) | Link | T | T | | |
| Greene's tuctoria (*Tuctoria greenei*) | Link | E | | | |
| Howell's spectacular thelypody (*Thelypodium howellii* spp. *spectabilis*) | Link | T | | | |
| Kincaid's lupine (*Lupinus sulphureus spp. kincaidii*) CH Map, CH (2006) | Link | T | T | | |
| Large-flowered woolly meadowfoam (*Limnanthes pumila spp. grandiflora*) CH Map, CH (2010) | Link | E | | | |
| MacFarlane's four o'clock (*Mirabilis macfarlaneil*) | Link | T | | T | |
| Malheur wire-lettuce (*Stephanomeria malheurensis*) CH Map, CH (1982) | Link | E | | | |
| Marsh sandwort (*Arenaria paludicola*) | Link | | E | | |
| McDonald's rockcress (*Arabis macdonaldiana*) | Link | E | | | |
| Nelson's checker-mallow (*Sidalcea nelsoniana*) | Link | T | T | | |
| Rough popcornflower (*Plagiobothrys hirtus*) | Link | E | | | |
| Showy stickweed (*Hackelia venusta*) | Link | | E | | |
| Slender Orcutt grass (*Orcuttia tenuis*) CH Map, CH (2006) | Link | T | | | |
| Slickspot peppergrass (*Lepidium papilliferum*) CH Map, CH (2014) | Link | | | T | |
| Spalding's catchfly (*Silene spaldingii*) | Link | T | T | T | T |
| Umtanum desert buckwheat (*Eriogonum codium*) CH Map, CH (2013) | Link | | T | | |
| Ute Ladies'-tresses (*Spiranthes diluvialis*) | Link | | T | T | T |

| | ECOS Profile | Oregon | Washington | Idaho | Montana |
|---|---|---|---|---|---|
| Water howellia (*Howellia aquatilis*) | Link | T | T | T | T |
| Wenatchee Mountains checker-mallow (*Sidalcea oregana var. calva*) CH Map, CH (2001) | Link | | E | | |
| Western lily (*Lilium occidentale*) | Link | E | | | |
| White bluffs bladderpod (*Physaria douglasii spp. tuplashensis*) CH Map, CH (2013) | Link | | T | | |
| Willamette daisy (*Erigeron decumbens var. decumbens*) CH Map, CH (2006) | Link | E | | | |
| PROPOSED SPECIES | | | | | |
| North American wolverine (*Gulo gulo luscus*) | | | | | P |
| Western glacier stonefly (*Zapada glacier*) (Glacier NP, Grand Teton NP, Absaroka/Beartooth Wilderness) | | | | | P |
| Meltwater lednian stonefly (*Lednia tumana*) | | | | | P |

**Endangered** (E)—Any species that is in danger of extinction throughout all or a significant portion of its range.

**Threatened** (T)—Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

**Proposed** (P)—Any species of that is proposed in the Federal Register to be listed under section 4 of the Act.

**Non-essential experimental population** (XN)—A population of a listed species reintroduced into a specific area that receives more flexible management under the Act.

**Critical Habitat/Proposed Critical Habitat** (CH, PCH)—The specific areas (i) within the geographic area occupied by a species, at the time it is listed, on which are found those physical or biological features (I) essential to conserve the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by the species at the time it is listed upon determination that such areas are essential to conserve the species.

## Species Excluded from Further Analysis

The list of species in Table 3 was reviewed to determine if any could be eliminated from consideration because of known species distribution or its critical habitat (Appendix D). Because the habitat of the listed or proposed species is habitat in which dreissenids would not be found, or which would potentially be directly or indirectly affected by rapid response actions for dreissenids, these species are excluded from further analysis. However, it should be noted that if site preparation or staging areas are established in terrestrial habitats including shoreline or riparian habitats, some species could be impacted and may warrant consideration when planning staging areas for rapid response. The following species were excluded from further analysis:

### MAMMALS

Black-footed ferret (*Mustela nigripes*)
Canada lynx (*Lynx canadensis*)
Gray wolf (*Canis lupus*)[17]
Grizzly bear (*Ursus arctos horribilis*)
Mazama pocket gopher (*Thomomys azama pugetensis, glacialis, tumuli*, and *yelmensis*)
Northern Idaho ground squirrel (*Urocitellus endemicus*)
Northern long-eared bat (*Myotis septentrionalis*)
Columbia Basin Pygmy rabbit (*Brachylagus idahoensis*) (Columbia Basin DPS)
Southern Selkirk Mountains woodland caribou (*Rangifer tarandus caribou*)
North American wolverine (*Gulo gulo luscus*)

### BIRDS

Marbled murrelet (*Brachyramphus marmoratus*)[18]
Northern spotted owl (*Strix occidentalis caurina*)
Short-tailed albatross (*Phoebastria albatrus*)
Whooping crane (*Grus americana*)
Streaked horned lark (*Eremophila alpestris strigata*)

### INVERTEBRATES

Bruneau hot springsnail (*Pyrgulopsis bruneauensis*)
Fender's blue butterfly (*Icaricia icarioides fender*)
Taylor's checkerspot butterfly (*Euphydryas editha taylori*)
Oregon silverspot butterfly (*Zpeyeria zerene hippolyta*)
Vernal pool fairy shrimp (*Branchinecta lynchi*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

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[17] Conterminous USA, lower 48 states, except where otherwise designated)
[18] Washington, Oregon, and California population

PLANTS

Applegate's milk-vetch (*Astragalus applegatei*)
Cook's lomatium (*Lomatium cookii*)
Gentner's fritillary (*Fritillaria gentneri*)
Golden paintbrush (*Castilleja levisecta*)
Greene's tuctoria (*Tuctoria greenei*)
Howell's spectacular thelypody (*Thelypodium howellii* spp. *spectabilis*)
Kincaid's lupine (*Lupinus sulphureus* spp. *kincaidii*)
Large-flowered woolly meadowfoam (*Limnanthes pumila spp. grandiflora*)
MacFarlane's four o'clock (*Mirabilis macfarlaneil*)
Malheur wire-lettuce (*Stephanomeria malheurensis*)
Marsh sandwort (*Arenaria paludicola*)
McDonald's rockcress (*Arabis macdonaldiana*)
Rough popcornflower (*Plagiobothrys hirtus*)
Showy stickweed (*Hackelia venusta*)
Slender Orcutt grass (*Orcuttia tenuis*)
Slickspot peppergrass (*Lepidium papilliferum*)
Spalding's catchfly (*Silene spaldingii*)
Umtanum desert buckwheat (*Eriogonum codium*)
Wenatchee Mountains checker-mallow (*Sidalcea oregana var. calva*)
Western lily (*Lilium occidentale*)
White bluffs bladderpod (*Physaria douglasii* spp. *tuplashensis*)

## Potential Effects of Chemical Methods on Listed Species and Critical Habitats Associated with CRB Water Bodies

Table 4 (below) compiles information for each listed species and associated designated critical habitat(s) known to occur in the CRB. The table briefly summarizes key species life history attributes and vulnerabilities, the potential effects of an action on key life stages and critical habitats, and species-specific BMPs that can reduce detrimental effects. If no documented vulnerabilities are listed, it is unknown what, if any, impacts may occur to any life stages and critical habitats. Appendix E of this document includes important information about the threatened and endangered species in the CRB whose life history needs are met by CRB water bodies, and their associated critical habitats where designated.

Table 4. Potential estimated effects of chemical treatments on important life history needs and critical habitat (https://ecos.fws.gov) for listed species whose life history needs are partially, or entirely, met by CRB water bodies. This table also includes species-specific best management practices to avoid or lessen impacts from chemical treatment activities. The chemical methods considered below do not reflect the entirety of chemical method options, but are limited in scope to include the chemical methods most likely to be used in an open-water dreissenid rapid response scenario within the CRB.

**Ungulates**

**Toxicity of potash to ungulates:** There is no published information on the effects of potash on any life stage of ungulates, or this particular ungulate species.

**Toxicity of EarthTec QZ™ to ungulates:** There is no published information on the effects of EarthTec QZ™ on ungulates, however, sheep can be particularly sensitive to products containing copper sulfate, possible due to inefficient copper excretion (Oruc et al. 2009). The toxic doses of copper sulfate for cattle are 200–880 mg/kg. Sheep are ten times more sensitive; they have a toxic dose of 20–110 mg/kg of copper sulfate (Thompson 2007).

**Toxicity of Zequanox® to ungulates:** There is no published information on the effects of Zequanox® on any life stage of ungulates, or this particular ungulate species.

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Columbian white-tailed deer (*Odocoileus virginianus leucurus*) | Riparian access development could fragment habitat. Restoration activities could introduce invasive species and cause fragmentation of habitats. | Columbian white-tailed deer are not found in CRB water bodies; they are found in riparian areas associated with the Lower Columbia River. Thus, no life stage of this species would be present in a water body where application of any of the proposed chemical treatments would occur. It is unlikely any potash treatment would occur within the Columbia River system unless the area was capable of being cordoned off prior to treatment (this would avoid/lessen any indirect impacts to ungulates). | No critical habitat designated. | Any activities in riparian areas within the geographic scope of this species should be minimized to avoid fragmenting riparian habitat, or introducing invasive species.<br>Use existing access roads and entries.<br>Avoid introducing invasive species (see BMPs section of manual).<br>Avoid fragmentation of habitat via restoration activities. |

**Birds**

**Toxicity of potash to birds:** There is no published information on the potential negative effects of potash on least terns, piping plovers, red knots, western snowy plovers, yellow-billed cuckoos, or other avian species. Potassium chloride (KCl) is used as a supplement (0.2 and 0.4% KCl) in diet or drinking water of poultry to reduce the effects of high environmental temperature by maintaining the water/electrolyte balance (Dai et al. 2009).

**Toxicity of EarthTec QZ™ to birds: L**imited information is available on the toxicity of copper sulfate to wild birds (Eisler 1998). A flock of captive 3-week-old Canada geese (*Branta canadensis*) used a pond treated with copper sulfate; Ten of the geese died nine hours after ingestion of roughly 600 mg/kg copper sulfate (Henderson and Winterfield 1995). Although copper is known to be moderately toxic to birds (Boone et al. 2012), copper sulfate poses less of a threat to birds than to other animals - The lowest lethal dose (LDLo) for this material in pigeons and ducks is 1,000 mg/kg and 600 mg/kg, respectively (TOXNET 1975-1986). The oral $LD_{50}$ for Bordeaux mixture in young mallards is 2,000 mg/kg (Tucker and Crabtree 1970). The toxicity of copper to aquatic life depends on its bioavailability, which is strongly dependent on pH, the presence of dissolved organic carbon (DOC), and water chemistry, such as the presence of calcium ions (http://npic.orst.edu/factsheets/archive/cuso4tech.html).

**Toxicity of Zequanox® to birds:** Zequanox has a "practically non-toxic" designation for birds. No mortality was observed after feeding mallards a 2,000 mg/kg dose of live P. fluorescens strain CL145A (Bureau of Reclamation 2011). The no observable effect limit (NOEL) was set at >2,000 mg/kg and classified Zequanox® as "practically non-toxic to mallard."

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Least tern (*Sterna antillarum*) | Anthropogenic disturbance is a key factor affecting least terns at breeding colonies and foraging locations (Burton and Terrill 2012).<br>Terns mid-May through August on river sandbars.<br>Increased turbidity may negatively affect least tern foraging success (USFWS 1990). | Potash—Interior least terns forage on small fish. Numerous studies have demonstrated acute toxicity to fish from muriate of potash, however, mortality occurred at dosages that far exceed dosages that would be used to control dreissenids (e.g., bluegill, *Lepomis macrochirus*), 96 hours @ $LC_{50}$ @ 2,010 mg/L (Mosaic 2004). It is unlikely that an application of muriate of potash would affect the food of interior least terns. Anthropogenic disturbance associated with a potash application could affect least tern nesting and foraging success.<br>EarthTec QZ™—Interior least terns forage on small fish. EarthTec QZ™ is toxic to fish and other aquatic life (Master Label for EarthTec™, EPA Reg. No. 64962-1). Waters treated with this product may be hazardous to other aquatic organisms (Master Label for EarthTec QZ™, EPA Reg. No. 64962-1). It is estimated that EarthTec QZ™ could affect the foraging success of least terns if the product were applied in water bodies in which least terns feed.<br>Zequanox®—Zequanox® would likely not affect least terns. | No critical habitat designated. | Survey action site in advance to determine presence.<br>Avoid disturbance activities during nesting season, if possible.<br>Minimize turbidity in the water column during control action, especially in sites near least tern nests, and in locations where least terns forage. |
| Piping plover (*Charadrius melodus*) | Disturbance to nesting plovers.<br>Introduction of beachgrass.<br>Invertebrate prey mortality. | Potash—Piping plovers consume invertebrates. Potash has the potential to affect the prey base of shorebirds in small, shallow water areas where potash is applied. Examples of ecotoxicity of muriate of potash on invertebrates is 48 hours @ $EC_{50}$ @ 337–825 mg/L (*Daphnia magna*), and 96 hours @ $LC_{50}$ @ 940 mg (*Physa heterostropha*) (Mosaic 2004). However, given the mobility of the bird, it is not expected that an action in a shallow portion of a CRB water body would affect the ability of the bird to feed in and around untreated areas of that same water body, and adjacent water bodies. Any effects on prey species (invertebrates) are expected to be minimal long-term because benthic communities typically recolonize quickly after disturbance (McCauley et al. 1977, Albright and Borithilette 1982, Romberg et al. 1995, Wilson and Romberg 1996).<br>EarthTec QZ™—Piping plovers consume invertebrates. EarthTec QZ™ has the potential to affect the prey base of shorebirds in small, shallow water areas where it is applied.<br>Zequanox®—Piping plovers consume invertebrates. Zequanox® has the potential to affect the prey base of shorebirds in small, shallow water areas where it is applied. | Critical habitat in the Columbia River Basin is in Montana in Unit MT-2 (The Missouri River flowing through the Assiniboine and Sioux Tribes of Fort Peck reservation lands, state land, and private land) and Unit MT-3 (Fort Peck Reservoir – 77,370 acres within the Charles M. Russell National Wildlife Refuge). There is no other critical habitat for piping plovers in the CRB.<br>The Missouri River and Fort Peck Reservoir are susceptible to the introduction and establishment of dreissenids (Creative Resource Strategies, LLC 2017), and critical habitat for piping plovers can be affected by reductions in their prey base caused by all three potential chemicals—potash, EarthTec QZ™, and Zequanox®. | Survey action site in advance to determine presence from early May-late August.<br>Avoid disturbance activities during nesting season, if possible.<br>Avoid activities that result in introduction of non-native vegetation.<br>Assess impact of action on invertebrate food availability. |

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Red knot<br>(*Calidris canutus rufa*) | Disturbance to migratory birds.<br>Introduction of invasive species.<br>Invertebrate prey mortality.<br>Red knots are rare from May through October in Montana wetlands. At other times of the year, they are found in marine coastal environments in North America including Washington and Oregon. | Potash—Potash has the potential to affect the prey base of shorebirds in small, shallow water areas where potash is applied.<br>EarthTec QZ™—EarthTec QZ™ has the potential to affect the prey base of shorebirds in small, shallow water areas where it is applied.<br>Zequanox®—Red knots consume invertebrates. Zequanox® has the potential to affect the prey base of shorebirds in small, shallow water areas where it is applied.<br>However, given the mobility of the bird, it is not expected that an action in a shallow portion of a CRB water body, using any potash, EarthTec QZ™, or Zequanox®, would affect the ability of the bird to feed in and around untreated areas of that same, and adjacent water bodies. Red knots are migratory; they are rarely observed in Montana wetlands. | No critical habitat designated. | Survey for presence May–October.<br>Assess impact of action on invertebrate food availability. |
| Yellow-billed cuckoo<br>(*Coccyzus americanus*) | Degradation of riparian habitat. | The primary diet of yellow-billed cuckoos is caterpillars, which would not be affected by an action involving potash, EarthTec QZ™, or Zequanox®. It is unlikely that chemical treatments would occur in rivers and streams and in broad floodplains. If a treatment were to occur in a large river system, it would likely occur in a small area that could be cordoned off for treatment.<br>Construction equipment and treatment crews could disturb nests during breeding season, if emergency action occurs in breeding habitat during breeding/fledging seasons. | Critical habitat includes riparian habitat along low-gradient (surface slope less than 3 percent) rivers and streams, and in open riverine valleys that provide wide floodplain conditions (greater than 325 ft (100 m). Rivers and streams of lower gradient and more open valleys with a broad floodplain are essential physical or biological features for this species (Federal Register 79(158)).<br>Riparian habitats would likely not be affected by any chemical treatment, particularly if BMPs are followed that avoid disturbance to these areas. | Avoid activities that result in loss or degradation of riparian habitat.<br>Avoid introducing invasive species (see BMPs section of manual).<br>Avoid disturbance activities during breeding and nesting season, if possible. |

### Amphibians

**Toxicity of potash to amphibians:** Pollution is the 2nd major threat to amphibian populations (IUCN 2008). Agricultural chemicals are a potential cause of amphibian declines (Relyea and Mills 2001), and malformed amphibians have been reported to occur in agricultural areas where pesticides and fertilizers are applied extensively (Ouellet et al. 1997, Taylor et al. 2005). Agricultural pesticides can affect amphibian growth, development, reproduction, and behavior (Carey and Bryant 1995). There is no published information on the potential negative effects of potash on amphibian populations, however, introduction of potash into a water body would alter the water chemistry, and in shallow portions sectioned off with barriers, would raise the water temperature, albeit temporarily (note: Potash itself would not alter the water temperature, but barricading a portion of the water body could increase the water temperature in the barricaded portion because of lack of mixing with deeper, colder water in the water body).

**Toxicity of EarthTec QZ™ to amphibians:** Larval ambystomatids were highly sensitive to Cu with 50% mortality at 18.7, 35.3, and 47.9 ppb for three species. Cu also caused reduced growth rates in *A. talpoideium* (Savannah River Ecological Laboratory 2016).

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|---|---|---|---|---|
| Concentrations of copper sulfate were found to be toxic to amphibians at or below those recommended for plant control – 0.31 mg/L was lethal to northern leopard frog tadpoles (Landé and Guttman 1973); Fort and Stover (1997) documented susceptibility to copper with increased age in African clawed frogs (*Xenopus* laevis) - $LC_{50}$ values of 1.32 mg/L for embryos, and 0.20 mg/L for 12-16 day-old tadpoles. Growth of African clawed frogs was reduced at concentrations as low as 0.048 mg/L, and completely inhibited at 1.3 mg/L in embryos (Fort and Stover 1997). Distal hind limb aplasia, which is a sensitive indicator of copper toxicosis, occurred in 8.5% of larvae exposed to 0.05 mg/L copper (Fort and Stover 1997).<br><br>**Toxicity of Zequanox® to amphibians:** There is no published information on the toxicity of Zequanox® to amphibians at any key life stage. | | | | |
| **Species** | **Vulnerabilities** | **Potential Effects on Key Life Stages** | **Potential Effects on Critical Habitats** | **Species-specific BMPs** |
| Oregon spotted frog (*Rana pretiosa*) | Disturbance, including ground disturbance (e.g., road grading) during breeding and larval development.<br><br>Alterations to existing habitats, including loss of connectivity, disturbance to riparian vegetation, sedimentation, vegetation clearing in and adjacent to breeding ponds and streams, fluctuating water levels, and temperature changes.<br><br>The Oregon Spotted Frog is a wetland/marsh specialist that prefers floodplain wetlands, side channels, and sloughs associated with permanent waterbodies. Habitats have good solar exposure with low to moderate amounts of cover by emergent vegetation (25–50%; Watson et al. 2003), and silty, rather than gravelly substrate. Habitat requirements are divided into three life-seasons: breeding (oviposition) and early larval habitat, active summer habitat, and overwintering habitat.<br><br>Dispersal/connective habitat is required to link the three main habitat types during late spring and fall:<br><br>Breeding and early larval habitat: • areas that experience shallow inundation (3° C in March/April (Environment Canada 2014); and • contain indigenous aquatic vegetation (e.g., rushes, sedges, grasses, pondweeds, buttercups) or moderate amounts of Reed Canarygrass (*Phalaris* spp.).<br><br>Active Season (summer) habitat: • wetlands that are >40 cm deep (Watson et al. 2003, Environment Canada 2014); and • contain moderately dense, structurally diverse submergent, emergent, and floating vegetation (Licht 1969, 1986a,b; McAllister and Leonard 1997, Popescu 2012).<br><br>Over-winter habitat: • springs, seeps, or low-flow channels that do not freeze in the winter and have more stable levels of dissolved oxygen than other areas (Pearl and Hayes 2004); or • in deeper water, beaver dams or areas of dense submerged vegetation (Hayes et al. 2001, Watson et al. 2003, Chelgren et al. 2006, Govindarajulu 2008, Pearson 2010, COSEWIC 2011).<br><br>Dispersal/connective habitat: • any aquatic habitat that connects the three main habitat types during late spring and fall. | Oregon spotted frog habitat is closely correlated with the type of habitat a dreissenid action would occur in (i.e., shallow water along a wetland edge).<br><br>Potash—It is estimated that the addition of potash to a water body occupied by Oregon spotted frog could potentially affect the growth, development, reproduction, and behavior of individuals.<br><br>EarthTec QZ™—It is estimated that the application of EarthTec QZ™ to a water body occupied by Oregon spotted frog would be toxic to various life stages of this species. EarthTec QZ™ could affect breeding, larval, and adult stages of Oregon spotted frogs.<br><br>Zequanox® - There is no published information on the toxicity of Zequanox® to amphibians during key life stages. | 65,038 acres and 20.3 river miles in Whatcom, Skagit, Thurston, Skamania, and Klickitat counties in Washington, and Wasco, Deschutes, Klamath, Lane, and Jackson counties in Oregon.<br><br>See Vulnerabilities in this section for a description of breeding and early larval habitat, active season, over-winter habitat, and dispersal-connective habitat.<br><br>Potash—Barricades used during a potash application could result in elevated water temperatures in areas barricaded for treatment, which could affect breeding and early larval habitat, active season habitat, and over-winter habitat.<br><br>EarthTec QZ™—EarthTec QZ™ could affect submerged, emergent, and floating vegetation important to breeding and early larval habitats, active season habitats, and over-winter habitats.<br><br>Zequanox® - There is no published information on the toxicity of Zequanox® to critical habitat for amphibians. | Reduce and minimize the amount of disturbance or activities occurring in and around critical habitat.<br><br>Avoid construction activities during the frog's active season (November to mid-August).<br><br>Minimize the footprint of the action.<br><br>Reduce ground disturbance to facilitate revegetation.<br><br>Restore disturbed sites using a combination of strategies, such as natural regeneration, seeding with a native grass mix and short-lived cover crop, planting native vegetation, and using weed-free materials to reduce the need for weed management, such as hand-pulling weeds.<br><br>Salvage species prior to action. |

## Fish

**Toxicity of potash to fish:** Based upon the acute toxicity testing of KCl using both juvenile brook trout and juvenile Chinook salmon, acute lethal effects of potash on these salmonids at these life stages are not expected at concentrations commonly used to control invasive dreissenid mussels (100 mg/L) (Densmore et al. 2018). Exposure concentrations of as much as 800 mg/L KCl, eight times greater than the dose of KCl used as a molluscicide, were applied to these fish in static systems for 96 hours; there was no evidence of mortality attributable to KCl exposure among either species (Densmore et al. 2018). Behavioral or gross morphological effects on these fish from KCl-based molluscicide applications at levels up to 800 mg/L were also not indicated (Densmore et al. 2018). Several listed fish species forage on invertebrates, particularly during juvenile life stages. The ecotoxicity of muriate of potash on invertebrates is 48 hours @ $EC_{50}$ @ 337–825 mg/L (*Daphnia magna*), and 96 hours @ $LC_{50}$ @ 940 mg (*Physa heterostropha*) (Mosaic 2004). Daphniid exposure trials – $LC_{50}$ @ 196 mg/L for 48 hours; significant mortality of sensitive aquatic invertebrates is not expected at the KCl concentrations used to control dreissenids (Densmore et al. 2018). Crayfish exposure trials resulted in mortality and temporary paralysis at concentrations of 800 and 1,600 mg/L for at least 24 hours (Densmore et al. 2018). Other ecotoxicology studies: *Lepomis macrochirus* – $LC_{50}$ – 2010 mg/L (Mosaic 2014). Substantial differences exist in the accuracy of models to predict organism survival to introduced toxins, such as potassium, calcium, and magnesium (Pillard et al. 2000).

**Toxicity of EarthTec QZ™ to fish:** Copper is one of the most toxic heavy metals to fish (Nowak and Duda 1996). According to the label for this product, "this pesticide is toxic to fish and aquatic invertebrates. Waters treated with this product may be hazardous to aquatic organisms. Treatment of aquatic weeds and algae can result in oxygen loss from decomposition of dead algae and weeds. This oxygen loss can cause fish and invertebrate suffocation." The proposed low and high application rates well above the range of salmonid and prey $LC_{50}$ (96 hour), and the $LC_{50}$ (96 hour) for pond snails falls at the lowest proposed application rate (TOXNET 1975–1986). Direct bioassay of rainbow trout (assumed adult) subject to EarthTec QZ™ resulted in a NOEC of 0.240 mg/L copper, and $LC_{50}$ of 0.294 mg/L copper (https://www.icais.org/pdf/2017presentations/Monday/PM/1B/230_Hammond.pdf) which are both above the proposed high copper application of 0.1 mg/L. Fish kills have been reported after copper sulfate applications for algae control in ponds and lakes, however, oxygen depletion and dead organisms clogging the gills have been cited as the cause of fish deaths, resulting from massive and sudden plant death and decomposition in the water body (Bartsch 1954, Hanson and Stefan 1984, Masser et al. 2006). Copper can either temporarily, or permanently, disrupt olfaction in fish (Solomon 2009), possibly interfering with their ability to locate food, predators, and spawning streams (Chapman 1978, Jaensson and Olsen 2010). It is unknown if there are any bioaccumulation effects of EarthTec QZ™.

Fish eggs are more resistant than young fish fry to the toxic effects of copper sulfate (Gangstad 1986).

- Juvenile rainbow trout (*Oncorhynchus mykiss*) were exposed to either hard water, or soft water, spiked with copper for 30 days (Taylor et al. 2000). Fish in the hard-water, high dose (60 µg/L) treatment groups showed an increased sensitivity to copper.
- The mean 96-hour $LC_{50}$ (with 95% confidence limits) for copper exposure in alevin, swim-up, parr and smolt steelhead (*Salmo gairdneri*) are 28 (27–30), 17 (15–19), 18 (15–22), and 29 (>20) µg/L of copper respectively (Chen and Lin 2001). The mean 96-hour $LC_{50}$ for copper exposure in alevin, swim-up, parr and smolt Chinook salmon (*Oncorhynchus tshawytscha*) are 26 (24–33), 19 (18–21), 38 (35–44), and 26 (23–35) µg/L of copper respectively. The experiments were done by adding copper as $CuCl_2$.
- The 48-hour $LC_{50}$ for fathead minnow (*Pimephales promelas*) is 19.2 $\pm$ 3.1 (mean $\pm$ SD) mcg/L Cu (Mastin and Rodgers 2000).

**Toxicity of Zequanox® to fish:** No mortality from Zequanox® has been observed in fathead minnows (*Pimephales promelas*), young-of-the-year brown trout (*Salmo trutta*), and juvenile bluegill sunfish (*Lepomis macrochirus*) (Bureau of Reclamation 2011). Fish trials conducted with dead bacteria have indicated that applications of killed cells were harmless to fish, yet were still highly lethal to Dreissena spp. mussels (Bureau of Reclamation 2011). Temporary, but substantial, reductions in dissolved oxygen were observed in treatment locations during the morning following Zequanox® treatment in two trials, likely due to the presence of the barriers that prevented well-oxygenated water from circulating into treatment zones from adjacent areas in the lake (Whitledge et al. 2015).

A 2018 study evaluated the effects of Zequanox® on juvenile lake sturgeon (*Acipenser fulvescens*) and lake trout (*Salvelinus namaycush*) (Luoma et al. 2018). No acute mortality was observed in either species; however, significant latent mortality was observed in lake trout that were exposed to the highest dose of Zequanox®. Statistically significant but biologically minimal differences were observed in the weight (range 20.17 to 21.49 g) of surviving lake sturgeon at the termination of the 33 d post-exposure observation period. Survival was not impacted in the lake trout 100 mg/L treated group for the first 3 weeks; however, impacts were readily detectable 4 weeks (28 d) after Zequanox® exposure. Poor food consumption, emaciation, and abdominal hemorrhaging were observed about 3 to 4 weeks after exposure in some of the lake trout exposed to 100 mg/L A.I. of Zequanox®.

Cold water, cool water, and warm water fish were tested for exposure-related effects to *Pseudomonas fluorescens*, Strain CL145A. (Luoma et al. 2015). Analyses of test animal condition factors and survival revealed that a 24-hour continuous dose of SDP affected all species. Calculated concentrations of SDP that would be lethal to 50 percent of the test animals ($LC_{50}$) for the cold water species were 19.2 and 104.6 mg/L for rainbow and brook trout, respectively. The $LC_{50}$ for the cool water species were 185.4, 176.9 and 8.9 mg/L for yellow perch, walleye, and lake sturgeon, respectively. The $LC_{50}$ for the warm water species were 173.6, 139.4, and 63.1 for the largemouth bass, smallmouth bass, and channel catfish, respectively.

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Bull trout<br>(*Salvelinus confluentus*) | Threats to any of the nine Primary Constituent Elements[19]:<br>1. Springs, seeps, groundwater sources, and subsurface water connectivity<br>2. Migration habitats<br>3. Food base<br>4. Complex aquatic environments<br>5. Water temperature<br>6. Spawning and rearing habitat<br>7. A natural hydrograph<br>8. Sufficient water quality and quantity<br>9. Sufficient low levels of occurrence of non-native predatory fish, or competing fish species | Disturbance to any water body can increase sedimentation and suspended solids, which can be detrimental to fish, resulting in lethal effects, sublethal effects that alter the physiology of the fish, and behavioral effects that change the activity of the fish and could contribute to mortality through time (Newcombe and MacDonald 1991). Increased turbidity can cause behavioral changes to fish, including stress, reduced feeding, impacts to growth rates, interference with cues necessary in homing and migration, and death (Lloyd 1987). Bull trout are highly susceptible to sediment inputs (USFWS 1998, Bash et al. 2001).<br>Young bull trout less than 200mm in length forage on invertebrates.<br>Potash—Adult bull trout in the vicinity of the action area would have sufficient ability to avoid the area; any long-term effects on prey species are expected to be minimal because benthic communities typically recolonize quickly after disturbance (McCauley et al. 1977, Albright and Borithilette 1982, Romberg et al. 1995, Wilson and Romberg 1996). However, there may be short-term effects on invertebrate species, which may affect the foraging ability of juvenile bull trout.<br>EarthTec QZ™—All life history stages of bull trout area expected to be negatively affected by the addition of EarthTec QZ™ to a water body.<br>Zequanox®—Bull trout are expected to be negatively affected by Zequanox® based on the sensitivity of rainbow and brook trout to this chemical. | Potash—Of the nine PCEs, potash could potentially affect the migration habitats, water temperature, and spawning and rearing habitat of bull trout by altering the water chemistry during critical life stages/use of shallow portions of CRB water bodies.<br>EarthTec QZ™—Of the nine PCEs, EarthTec QZ™ would detrimentally affect migration habitats, food base, complex aquatic environments, and spawning and rearing habitat.<br>Zequanox—None of the nine PCEs would likely be affected by Zequanox®. | Salvage or move fish out of contained treatment sites.<br>Implement BMPs to avoid introducing invasive species (see BMPs section of manual).<br>Minimize disturbance at the shoreline and in benthic portions of the water body to minimize turbidity.<br>Prior to an action in an area with a known bull trout population or critical habitat, determine total suspended solid concentrations, and gather information on the size, shape, and composition of sediment.<br>Consider timing of treatment to prevent barriers for seasonal migrations. |

[19] Primary constituent elements are physical and biological features that are essential to the conservation of the species. These include, but are not limited to: space for individual and population growth and for normal behavior; food, water, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, or rearing of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Kootenai River white sturgeon (*Acipenser transmontanus*) | Spawning and rearing habitat are the key limiting factors for Kootenai River White Sturgeon. Spawning and incubation occur from mid-May to August (Duke et al. 1999, Kootenai Tribe of Idaho 2005). Recruitment failure is caused by egg or larval suffocation, predation, and/or other mortality factors associated with early life stages (Anders 1991, Anders and Richards 1996, Duke et al. 1999, USFWS 1999, Paragamian et al. 2001, Anders 2002). Low turbidity increases predation (Kootenai Tribe of Idaho 2005). | Potash—Based on recent studies with salmonids (Densmore et al. 2018), the introduction of potash to Kootenai River white sturgeon habitat, at the levels sufficient to cause dreissenid mortality, would likely not affect this species.<br>EarthTec QZ™—All stages of white sturgeon are expected to be negatively affected by the addition of EarthTec QZ™ to a water body from direct application of the product. There is an expected reduction in oxygen in areas isolated by barriers after the product has been applied.<br>Zequanox®—Zequanox® applications (in small areas - less than 1 acre) are not likely to have long-term water quality impacts, such as ammonia toxicity (Meehan et al. 2014; Whitledge et al. 2015). However, the impacts of largescale, open-water applications of Zequanox® on water quality remain largely unknown (Luoma et al. 2018). The $LC_{50}$ for lake sturgeon was 8.9mg/L (Luomo et al. 2015). | Kootenai River white sturgeon critical habitat includes 18.3 river miles of the Kootenai River. Critical habitat is designated in the braided reach, which begins at river mile 159.7, below the confluence with the Moyie River, and extends downstream within the Kootenai River, into the meander reach, to river mile 141.4 below Shortys Island.<br>Spawning habitats (cobble and gravel substrates) and rearing habitats are key components of critical habitat. Disruption to spawning and rearing habitats could occur during potash applications. | Salvage or move fish out of contained treatment sites.<br>Consider timing of treatment (if possible) to prevent exposure to sensitive life stages including eggs and larvae.<br>Consider timing of treatment to prevent barriers for seasonal migrations. |
| Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) | Major impacts to habitat and abundance include: 1) reduction and alteration of stream discharge; 2) alteration of stream channels and morphology; 3) degradation of water quality; 4) reduction of lake levels and concentrated chemical components in natural lakes; and 5) introductions of non-native fish species (Coffin and Cowan 1995). LCT spawn in cold, flowing streams. | Potash—Based on recent studies with salmonids (Densmore et al. 2018), the introduction of potash to LCT, at the levels sufficient to cause dreissenid mortality, would likely not affect adults.<br>Degradation of water quality and chemical composition of lake water are two key impacts that affect habitat and species abundance of Lahontan cutthroat trout (Coffin and Cowan 1995); therefore, introduction of potash to LCT habitat/water bodies could temporarily affect this species.<br>EarthTec QZ™—All stages of Lahontan cutthroat trout are expected to be negatively affected by the addition of EarthTec QZ™ to a water body from direct application of the copper-based product as well as an expected reduction in oxygen after the product has been applied.<br>Zequanox®—Zequanox® could temporarily reduce the dissolved oxygen in the treatment area of the water body, thus it has the potential to affect this species. | No critical habitat designated. | Salvage or move fish out of treatment sites.<br>Consider timing of treatment (if possible) to prevent exposure to sensitive life stages including eggs and larvae.<br>Consider timing of treatment to prevent barriers for seasonal migrations. |

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Shortnose sucker (*Chasmistes brevirostris*) | Life history information from USFWS (1993): Shortnose suckers have complex life histories that include stream/river, lake, marsh, and shoreline habitats. They spawn during the spring over gravel substrates in habitats less than 4.3 ft (1.3 m) deep in tributary streams and rivers. | Adults generally occupy deep water habitats, and could move to other habitats within a larger water body during a chemical application.<br>Potash—Based on recent studies with salmonids (Densmore et al. 2018), the introduction of potash to LCT, at the levels sufficient to cause dreissenid mortality, would likely not affect adults. Juveniles would use locations where a potash application would likely occur, i.e., shallow water areas. The invertebrate prey base would likely be affected by a potash application, which could affect the survivability of larval and juvenile suckers. Any long-term effects on prey species are expected to be minimal because benthic communities typically recolonize quickly after disturbance (McCauley et al. 1977, Albright and Borithilette 1982, Romberg et al. 1995, Wilson and Romberg 1996).<br>EarthTec QZ™—All stages of Shortnose Sucker are expected to be negatively affected by the addition of EarthTec QZ™ to a water body from direct application of the copper-based product as well as an expected reduction in oxygen after the product has been applied.<br>Zequanox®—It is unknown what effect Zequanox® may have on sucker populations as no specific studies have been conducted. Zequanox® could temporarily reduce the dissolved oxygen in the treatment area of the water body, thus it has the potential to affect this species. | About 136 miles of streams and 123,590 acres of lakes and reservoirs for shortnose sucker in Klamath and Lake Counties in Oregon have been designated critical habitat.<br>Potash would likely have no effects on critical habitat.<br>Both EarthTec QZ™ and Zequanox® would likely affect oxygen levels in critical habitat. | Salvage or move fish out of treatment sites.<br>Consider timing of treatment to prevent barriers for seasonally migrating fishes. |

### Aquatic invertebrates

**Toxicity of potash to mollusks**: Freshwater mollusks are particularly sensitive to environmental change, which has made them the most threatened fauna in North America (Johnson et al. 2013, Williams et al. 2008). Naturally high potassium concentrations decreased the diversity of mussel populations in the Missouri River Basin (Imlay 1973). Any river or stream with a potassium concentration of equal to or greater than 7 mg/L lacked mussels whereas mussels could be found in rivers with concentrations of less than 4 mg/L (Imlay 1973). Toxicity studies using two bivalves (Alabama Rainbow (*Villosa nebulosa*) and Orangenacre Mucket (*Hamiota perovalis*)), and two gastropods (Round Rocksnail (*Leptoxis ampla*), and Pebblesnail (*Somatogyrus* spp.)) concluded that native mussels may be more sensitive to potassium than zebra mussels (48-h $LC_{50}$ value for 24,000µg/L for juvenile Southern Rainbow (*Villosa vibex*) mussels—the authors suggested potassium should not be used as a molluscicide (Gibson et al. 2018). Alabama Rainbow had an $EC_{50}$ value of 15,966 µg/L (95% CI = 12,450–20,476µg/L), whereas Orangenacre Mucket had an $EC_{50}$ value of 11,938µg/L (95% CI = 10,089–14,134 µg/L). An $EC_{50}$ value could not be calculated for Round Rocksnail, however it is expected to be much more sensitive than most other species tested (Gibson et al. 2018). At 100µg/L, 50% of the test organisms were classified as dead at the end of the trial but only a third of the test organisms died at the highest concentration (1000µg/L), thus the $EC_{50}$ value for Round Rocksnail was more than 1000 µg/L. Partial kills (≤33%) were observed at all five concentrations. The pebblesnails had an $EC_{50}$ value of 7285 µg/L (95% CI = 5739–9245µg/L), which is lower than either mussel species tested in the study (Gibson et al. 2018).

Significant mortality among sensitive aquatic invertebrates, such as daphniids, is not unexpected (Densmore et al. 2018). Other invertebrates, such as crayfish, demonstrate some degree of sensitivity to KCl (Densmore et al. 2018). Crayfish exposed to KCl at higher concentrations (e.g., 800 mg/L–1,600 mg/L) for at least 24 hours experienced immobilization, but half were able to fully recover in fresh water within 24 hours (Densmore et al. 2018).

**Toxicity of EarthTec QZ™ to invertebrates and mollusks:** EarthTec QZ™ is toxic to invertebrates. The 48-hour $LC_{50}$ for the non-biting midge (*Chironomus tentans*) is 1,136.5 ± 138.6 (mean ± SD) µg/L Cu (Mastin and Rodgers 2000). Reported 48-hour $LC_{50}$ concentrations for *Daphnia magna* include 0.00115 mmol CuSO4/L85 and 18.9 ± 2.3 (mean ± SD) µg/L Cu (Mastin and Rodgers 2000). The $LC_{50}$ for *Daphnia pulex* was relatively constant at 24, 48, and 72 hours. Reported values were 21–31 µg/L, 20–31 µg/L, and 20–29 µg/L, respectively (Ingersoll and Winner 1982). The 24- and 48-hour EC50(with 95% confidence intervals) for *Daphnia similis* was 0.035 (0.030–0.042) and 0.032 (0.026–0.039) mg/L Cu, respectively (de Oliveira-Filho et al. 2004).

Copper disrupts surface epithelia function and peroxidase enzymes in mollusks (USEPA 2009). Aquatic snails (*Biomphalaria glabrata*) had a 24-hour and 48-hour $LC_{50}$ (with 95% confidence intervals) of 1.868 (1.196–3.068) and 0.477 (0.297–0.706) mg/L Cu, respectively (de Oliveira-Filho et al. 2004). 1-day-old freshwater snail eggs (*Lymnaea luteda*) were exposed to copper at concentrations from 1 to 320 µg/L of copper for 14 days at 21 °C in a semi-static embryo toxicity test (Khangarot and Das 2010). Embryos exposed to copper at 100 to 320 µg/L died within 168 hours. At lower doses from 3.2–10 µg/L, significant delays in hatching and increased mortality were noted.

**Toxicity of Zequanox® to mollusks/mussels/invertebrates:** Exposure to Zequanox® caused no mortality to blue mussels (*Mytilus edulis*) or any of six native North American unionid clam species (*Pyganodon grandis, Lasmigona compressa, Strophitus undulatus, Lampsilis radiata, Pyganodon cataracta*, and *Elliptio complanata*) (Bureau of Reclamation 2011). Exposure of duck mussel (*Anodonta* spp.), non-biting midge (*Chironomus plumosus*), and white-clawed crayfish (*Austropotamobius pallipes*) to Zequanox® in a 72-hour static renewal toxicity test at concentrations of 100–750mg active ingredient/liter resulted in $LC_{50}$ values for Anodonta: ≥500mg active ingredient/liter, C. plumosus: 1075mg active ingredient/liter, and A. pallipes: ≥750mg active ingredient/liter, demonstrating that Zequanox® does not negatively affect these species at concentrations required for greater than 80% zebra mussel mortality (i.e., 150mg active ingredient/liter) (Meehan et al. 2014).

Nicholson (2018) conducted a replicated aquatic mesocosm experiment using open-water applications of Zequanox® (100 mg/L of the active ingredient) to determine the responses of primary producers, zooplankton, and macroinvertebrates to Zequanox® exposure in a complex aquatic environment. Short-term increases occurred in phytoplankton and periphyton biomass (250–350% of controls), abundance of large cladoceran grazers (700% of controls), and insect emergence (490% of controls). Large declines initially occurred among small cladoceran zooplankton (88–94% reductions in *Chydorus sphaericus*, *Ceriodaphnia lacustris*, and *Scapheloberis mucronata*), but abundances generally rebounded within three weeks. Declines also occurred in amphipods *Hyalella azteca* (mean abundance 77% less than controls) and gastropods *Viviparus georgianus* (survival 73 ±16%), which did not recover during the experiment. Short-term impacts to water quality included a decrease in dissolved oxygen (minimum 1.2 mg/L), despite aeration of the mesocosms.

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Banbury Springs limpet (*Lanx* spp.) | Potash is lethal to mollusks. EarthTech QZ™ is toxic to mollusks and invertebrates. | Potash—At the concentrations used to cause 100% mortality to dreissenids, potash would likely cause 100% mortality to mollusks, which demonstrate higher sensitivities to potash than dreissenids (Gibson et al. 2018).<br>EarthTech QZ™—At the concentrations used to cause 100% mortality to dreissenids, EarthTech QZ™ would likely cause a range of effects, from significant delays in hatching to mortality (de Oliveira-Filho et al. 2004).<br>Zequanox®—AT the concentrations used to cause 100% mortality to dreissenids, Zequanox® would likely have a negative effect, including mortality, on gastropods, either through direct toxicity, or indirect effects (Nicholson 2018). | No critical habitat designated. | Salvage prior to action. |
| Bliss Rapids snail (*Taylorconcha serpenticola*) | Potash is lethal to mollusks. EarthTech QZ™ is toxic to mollusks and invertebrates. | Potash—At the concentrations used to cause 100% mortality to dreissenids, potash would likely cause 100% mortality to mollusks, which demonstrate higher sensitivities to potash than dreissenids (Gibson et al. 2018).<br>EarthTech QZ™—At the concentrations used to cause 100% mortality to dreissenids, EarthTech QZ™ would likely cause a range of effects, from significant delays in hatching to mortality (de Oliveira-Filho et al. 2004).<br>Zequanox®—AT the concentrations used to cause 100% mortality to dreissenids, Zequanox® would likely have a negative effect, including mortality, on gastropods, either through direct toxicity, or indirect effects (Nicholson 2018). | No critical habitat designated. | Species would need to be collected and removed from any treatment sites prior to treatment. |

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| Snake River physa snail (*Physa natricina*) | Potash is lethal to mollusks. EarthTech QZ™ is toxic to mollusks and invertebrates. | Potash—At the concentrations used to cause 100% mortality to dreissenids, potash would likely cause 100% mortality to mollusks, which demonstrate higher sensitivities to potash than dreissenids (Gibson et al. 2018).<br>EarthTech QZ™—At the concentrations used to cause 100% mortality to dreissenids, EarthTech QZ™ would likely cause a range of effects, from significant delays in hatching to mortality (de Oliveira-Filho et al. 2004).<br>Zequanox®—AT the concentrations used to cause 100% mortality to dreissenids, Zequanox® would likely have a negative effect, including mortality, on gastropods, either through direct toxicity, or indirect effects (Nicholson 2018). | No critical habitat designated. | Species would need to be collected and removed from any treatment sites prior to treatment. |

**Plants**

**Toxicity of potash to plants:** Potassium plays a critical role in plant growth and metabolism, and contributes to the survival of plants under abiotic or biotic stress (Wang et al. 2013). Potassium can often be deficient in the environment (Truong 2017). At the concentrations used to kill dreissenids, potash would not negatively affect these plant species because of the demonstrated role that potassium plays in plant growth and metabolism (Wang et al. 2013).

**Toxicity of EarthTec QZ™ to plants:** One of the limiting factors in the use of copper compounds is their serious potential for phytotoxicity, or poisonous activity in plants (USEPA 1986). Copper sulfate can kill plants by disrupting photosynthesis. 200 ppm of copper was found in grass five months after it was sprayed with copper sulfate to control liver fluke (TOXNET 1975–1986). Blue-green algae in some copper sulfate-treated Minnesota lakes appeared to become increasingly resistant to the algaecide after 26 years of use (Pimental 1971).

**Toxicity of Zequanox® to plants:** Phytotoxicity (degree of toxic effects to plants) of microbial suspensions of Zequanox® were tested on some of the most common aquatic and non-aquatic weed species, including common water plantain (*Alisma plantago-aquatica*), small-flower umbrella sedge (*Cyperus difformis*), nightshade, bindweed, mallow, and curly dock (*Rumex crispis*; MBI 2009). Suspensions at 100 and 200 mg/L were prepared in distilled water and sprayed on the plant species. No phytotoxic symptoms were observed at either test concentration in any of the tested plants.

| Species | Vulnerabilities | Potential Effects on Key Life Stages | Potential Effects on Critical Habitats | Species-specific BMPs |
|---|---|---|---|---|
| Bradshaw’s desert parsley (*Lomatium bradshawii*) | Saturated, or flooded prairies adjacent to creeks and small rivers in the Willamette Valley are a habitat type that is declining because of agriculture and development.<br>Restoration activities could introduce invasive species and cause fragmentation of habitats | The majority of Bradshaw's lomatium populations occur on seasonally saturated or flooded prairies, adjacent to creeks and small rivers in the southern Willamette Valley. Any chemical application would not occur in this specific habitat type, but could occur along a small river adjacent to this habitat type. Disturbance to the site and damage to any existing plants as a result of equipment use and access to the water body could detrimentally affect individual plants. | No critical habitat designated. | The presence of this species should be assessed prior to any actions along creeks and small rivers in the southern Willamette Valley to determine the potential to affect this species as a result of any disturbance activities associated an action as well as take action to minimize impacts. |
| Nelson’s checker-mallow (*Sidalcea nelsoniana*) | Nelson's checker-mallow most frequently occurs in Oregon ash (*Fraxinus latifolia*) swales and meadows with wet depressions, or along streams. The species also grows in wetlands within remnant prairie grasslands. Some populations occur along roadsides at stream crossings where non-native plants, such as reed canarygrass (*Phalaris arundinacea*), | Any chemical application would not occur in the habitat type for Nelson’s checker-mallow, however, an application could occur in streams adjacent to this habitat type. Disturbance to the site and damage to any existing plants as a result of | No critical habitat designated. | The presence of this species should be assessed prior to any actions along streams/stream crossings to determine the potential to affect this species as a result of any disturbance activities associated an action as well as take action to minimize impacts. |

| | | | | |
|---|---|---|---|---|
| | blackberry (*Rubus* spp.), and Queen Anne's lace (*Daucus carota*), are also present. Nelson's checkermallow primarily occurs in open areas with little or no shade and will not tolerate encroachment of woody species.<br>Restoration activities could introduce invasive species and cause fragmentation of habitats. | equipment use and access to the water body could detrimentally affect individual plants. | | |
| Ute Ladies'-tresses (*Spiranthes diluvialis*) | The orchid occurs along riparian edges, gravel bars, old oxbows, high flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers. It also is found in wetland and seepy areas near freshwater lakes or springs.<br>Restoration activities could introduce invasive species and cause fragmentation of habitats | Any chemical application would not occur in the habitat type for Ute Ladies'-tresses, however, an application could occur in an adjacent freshwater lake, perennial stream, oxbow, or river. Disturbance to the site and damage to any existing plants as a result of equipment use and access to the water body could detrimentally affect individual plants. | No critical habitat designated. | The presence of this species should be assessed prior to any actions in these water bodies/wetlands to determine the potential to affect this species as a result of any disturbance activities associated an action as well as take action to minimize impacts. The BLM and USFWS have developed avoidance and minimization measures for Ute ladies'-tresses in Appendix 14 of Proposed Richfield RMP/Final EIS (Bureau of Land Management 2008). |
| Water howellia (*Howellia aquatilis*) | This species is restricted to small, vernal, freshwater wetlands, glacial pothole ponds, or former river oxbows that have an annual cycle of filling with water over the fall, winter and early spring, followed by drying during the summer months (USFWS ECOS database). These habitats are generally small [< 2.47 ac] and shallow [< 3.3 ft]. Water howellia was found in shallow water or around the edges of deep ponds.<br>Restoration activities could introduce invasive species and cause fragmentation of habitats. | Chemical application, disturbance to the site and damage to any existing plants as a result of equipment use and access to the water body could detrimentally affect individual plants. | No critical habitat designated. | The presence of this species should be assessed prior to any actions in these water bodies/wetlands to determine the potential to affect this species as a result of any disturbance activities associated an action as well as take action to minimize impacts. |
| Willamette daisy (*Erigeron decumbens* var. *decumbens*) | Willamette daisy populations are known mainly from bottomland habitats, but one population is found in an upland prairie remnant.<br>Restoration activities could introduce invasive species and cause fragmentation of habitats. | None of the proposed three chemicals (potash, EarthTec QZ™, Zequanox®) would negatively affect Willamette daisy at the concentrations used to kill dreissenids. Disturbance to the site and damage to any existing plants as a result of equipment use and access to the water body could detrimentally affect individual plants. | Critical habitat for the Willamette daisy is located in Polk, Benton, Yamhill, Lane, Marion, Linn, and Douglas Counties in Oregon as well as Lewis County in Washington. Critical habitat includes wet prairies, which is not suitable habitat for dreissenids. | The presence of this species should be assessed prior to any actions in these water bodies/wetlands to determine the potential to affect this species as a result of any disturbance activities associated an action as well as take action to minimize impacts. |

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## Effects of Non-Chemical Methods on Listed Species and Critical Habitats of Species Associated with CRB Water Bodies

Table 5 (below) summarizes information for each listed species and associated designated critical habitat(s) known to occur in the CRB. The table compiles key species life history attributes and vulnerabilities, the potential effects of an action on key life stages and critical habitats, and species-specific BMPs that can reduce those detrimental effects. Very few studies have been conducted on the effects of non-chemical treatments on species and critical habitats in the CRB, or in other locations (Table 5). Appendix E of this document includes important information about threatened and endangered species in the CRB whose life history needs are met by CRB water bodies, and their associated critical habitats where designated.

Table 5. Potential estimated effects of non-chemical treatments on listed species and critical habitats of species associated with CRB water bodies. This table also includes species-specific BMPs to avoid or lessen impacts from non-chemical treatment activities. The non-chemical methods considered below do not reflect the entirety of options, but are limited in scope to include the non-chemical methods most likely to be used in an open-water rapid response scenario within the CRB.

| **Intense Ultraviolet-B and Ultraviolet-C Radiation**<br><br>Increases in ambient levels of UV-B radiation have significantly contributed to amphibian population declines (Blaustein and Wake 1995). Researchers have found that UV-B radiation can kill amphibians directly, cause sublethal effects, such as slowed growth rates and immune dysfunction, and work synergistically with contaminants, pathogens, and climate change (Kiesecker and Blaustein 1995, Long et al. 1995, Anzalone et al. 1998, Blaustein et al. 1998, Belden and Blaustein 2002, Blaustein et al. 2003). | | |
|---|---|---|
| **Species** | **Potential Effects on Key Life Stages and Critical Habitats** | **Species-specific BMPs** |
| Oregon spotted frog (*Rana pretiosa*) | Embryo mortality and/or deformities, reducing larval survival, and affecting swimming activity.<br><br>Based on the effects of UV-B light on other amphibian species, Oregon spotted frogs and their critical habitat would likely be negatively affected by the use of UV-B light, causing embryo mortality and/or deformities, reducing larval survival, and affecting swimming activity. | Capture and remove Oregon spotted frogs (all life stages present) prior to use of this control.<br><br>Any activities in riparian areas within the geographic scope of this species should be minimized to avoid fragmenting riparian habitat, or introducing invasive species.<br><br>Use existing access roads and entries.<br><br>Implement BMPs to avoid introducing invasive species (see BMPs section of manual).<br><br>Avoid fragmentation of habitat via restoration activities. |

| Species | Potential Effects on Key Life Stages and Critical Habitats | Species-specific BMPs |
| --- | --- | --- |
| Other frog and toad species | Western Toad (*Bufo boreas*)—Exposure to UV-B increases embryo mortality, causes developmental abnormalities, and hampers antipredator behavior. Exposure to high levels of UV-B increases susceptibility of embryos to infection by a parasitic fungus *Saprolignia ferix* (Worrest and Kimeldorf 1976, Blaustein et al. 1994, Kats et al. 2000, Kiesecker and Blaustein 1995, Kiesecker et al. 2001).<br>Common Toad (*Bufo bufo*)—Exposure to UV-B increases embryo mortality and reduces larval survival (Lizana and Pedraza 1998, Häkkinen et al. 2010).<br>Common Froglet (*Crinia signifera*)—Exposure to UV-B increases embryo mortality (Broomhall et al. 2000).<br>Common Tree Frog (*Hyla arborea*)—Exposure to UV-B causes skin darkening (Langhelle et al. 1999).<br>California treefrog (*Hyla cadaverina*)—Exposure to UV-B increases embryo mortality (Anzalone et al. 1998).<br>Gray Treefrog (*Hyla chrysoscelis*)—Exposure to UV-B causes embryonic deformities (Starnes et al. 2000).<br>Gray Treefrog (*Hyla versicolor*)—Exposure to UV-B causes skin darkening and decreased swimming activity. Exposure to UV-B and carbaryl decreases swimming activity of larvae (Zaga et al. 1998).<br>Green and Golden Bell Frog (*Litoria aurea*)—Adult and larval frogs show behavioral avoidance of high levels of UV-B (van de Mortel and Buttemer 1998).<br>Peron's Tree Frog (*Litoria peronii*)—Adult and larval frogs show behavioral avoidance of high levels of UV-B (van de Mortel and Buttemer 1998). | Capture and remove all life stages of frogs and toads prior to use of this control.<br>Any activities in riparian areas within the geographic scope of this species should be minimized to avoid fragmenting riparian habitat, or introducing invasive species.<br>Use existing access roads and entries.<br>Avoid introducing invasive species.<br>Avoid fragmentation of habitat via restoration activities. |

| Species | Potential Effects on Key Life Stages and Critical Habitats | Species-specific BMPs |
|---|---|---|
| | Verreaux's Tree Frog (*Litoria verreauxii*)—Exposure to UV-B increases embryo mortality (Broomhall et al. 2000).<br><br>Pacific Treefrog (*Pseudacris regilla*)—Exposure to UV-B causes developmental and physiological abnormalities and reduces larval survival. Exposure to UV-B in combination with high levels of nitrates reduces larval survival (Hays et al. 1996, Ovaska et al. 1997, Hatch and Blaustein 2003).<br><br>Western Chorus Frog (*Pseudacris triseriata*)—Exposure to UV-B causes embryonic deformaties (Starnes et al. 2000). | |

**Drawdowns/dewatering**

Winter drawdowns can decrease taxonomic richness of macrophytes and benthic invertebrates and shift assemblage composition to favor taxa with r-selected life history strategies and with functional traits resistant to direct and indirect drawdown effects (Carmignani and Roy 2017). Fish assemblages, though less directly affected by winter drawdowns (except where there is critically low dissolved oxygen), can be indirectly negatively affected via decreased food resources and changes in spawning habitat (Carmignani and Roy 2017).

Drawdowns modify abiotic conditions, cause sediment dessication and freezing, place stress on vegetative root structures (Siver et al. 1986), displace plants as a result of erosion of frozen sediment during spring refills (Beard 1973, Mattson et al. 2004), and stifle species growth by increasing acidity and cations to toxic concentrations (Peverly and Kopka 1991). Annual winter drawdowns can, through time, coarsen sediment texture and remove nutrients in the exposure zone, making these sites unsuitable for macrophyte colonization and growth, particularly in steep-sided basins (Hellsten 1997).

Other adverse impacts of drawdowns (New Hampshire Department of Environmental Services 2019) may include:

- Large amounts of aquatic plants and organisms that succumb to the drawdown begin to decay shortly after drawdown, but nutrient release to the water body may not occur until full-pond level is achieved. Nutrients released from decayed material will quickly be used by algae and cyanobacteria, leading to increased cell production. Shallow lakes have shown shifts from clear, plant-dominated conditions to turbid, algal dominated systems.
- Algal or cyanobacteria blooms may follow.
- Aquatic food web changes may result in shifts in plant and animal structure.
- Oxygen concentrations throughout the water column may be impacted.
- Changes in the bottom sediment may also occur. Softer sediments may become compacted, or frozen segments that are lighter than water could loosen and float around in large masses, or as floating islands in the water body, only to settle once again in a new location.
- Impacts to aquatic animal species can be significant. These impacts range from stranding animals to food chain modifications, or stressors associated with the drawdown. Fish, frogs, salamanders, turtles, aquatic insect larvae, mussels, and others can be affected by a drawdown. Agile and faster moving organisms may be able to move upstream or downstream to other unimpacted habitats, however, these fish may be confined to smaller, shallower areas where they become easy prey to consumers, or suffer from oxygen deprivation. Slower moving, more sedentary organisms have a greater risk to negative impacts. Freshwater mussels, snails, insects, and crayfish may not be able to find suitable habitat, and may succumb to the drawdown.

| Species | Potential Effects on Key Life Stages and Critical Habitats | Species-specific BMPs |
|---|---|---|
| Macroinvertebrates | Macroinvertebrates that are semivoltine (have more than one generation or brood/year), have long life cycles, have low to moderate mobility (e.g., clams and crawlers), or are fine-sediment burrowers) can be sensitive to drawdowns and dewatering (Carmignani and Roy 2017).<br><br>Taxon richness decreases with intensity of water level regulation; freezing and flushing of sediments in late winter can result in impoverished macroinvertebrate fauna; invertebrates with long life cycles seem especially vulnerable to unnatural water level fluctuations (Aroviita and Hämäläiien 2008).<br><br>Low mobility organisms and filter feeders decrease with increasing drawdown (White et al. 2011).<br><br>Benthic organisms increase more than threefold after drawdowns are reduced (Benson and Hudson 1975).<br><br>Drawdowns can strand benthic invertebrates, resulting in mortality; diversity is reduced in drawdown zones (Kraft 1988).<br><br>Benthic invertebrates may be susceptible to water-level changes that alter sediment exposure, temperature regime, wave-induced sediment distribution, and basal productivity (McEwan and Butler 2010).<br><br>Haxton and Findlay 2011:<br>▪ Macroinvertebrate abundance is lower in zones or areas that have been dewatered as a result of water fluctuations, or low flows.<br>▪ Hypolimnetic draws are associated with reduced abundance of aquatic invertebrate communities and macroinvertebrates downstream of a dam<br>▪ Altered flows are associated with reduced abundance of fluvial specialists, but not habitat generalists | Incorporate hydropower ramping rates that result in lengthier reduction times for drawdowns, which allow macroinvertebrates to remain, or have access to, water as levels recede. Consider current flows, season, and air and water temperatures such that a rapid change in river height is avoided, adequate water is maintained in the river channel to prevent mortality, or exposure to extreme air and water fluctuations. |

| Species | Potential Effects on Key Life Stages and Critical Habitats | Species-specific BMPs |
|---|---|---|
| Fish | Fall and spring spawners, juvenile life stages in littoral zones, and insectivorous fish can be sensitive to drawdowns.<br><br>Littoral spawning in the fall—Low water levels in spring can prevent fish access to spawning areas; the amount of fall to late spring drawdown is inversely correlated to year-class strengths of coregonid fishes (Gaboury and Patalas 1984). Fish that spawn on reservoir bottoms with winter drawdowns can experience dissolved oxygen deficiency in late winter, which affects survival of eggs and year-class strength (Sutela et al. 2002). Late winter drawdowns reduced lake whitefish abundance by more than 80% during three years of drawdowns because of reduced recruitment and decreased survival (Mills et al. 2002).<br><br>Littoral spawning in the spring—Dewatered areas in early spring can limit the recruitment of spring spawners, such as northern pike (Kallemeyn 1987). Spring spawning could be negatively impacted by the effects of drawdowns that occur during years when winter and spring droughts occur (McDowell 2012).<br><br>Littoral juvenile life stage—Different species of fish use differing behavioral strategies to address water fluctuations in natural and man-made lakes. One study tested fish behavior when lake level was decreased in the fall; larger burbot were more successful competing for suitable shelter than smaller burbot until a certain level, at which the largest fish abandoned shelter use while smaller fish persisted in sheltering behavior (Fischer and Öhl 2005). In contrast, stone loach showed no hierarchical order, or size-related shelter use (Fischer and Öhl 2005).<br><br>Insectivorous fish—Hypolimnetic draws are associated with reduced abundance of aquatic fish and invertebrate communities and macroinvertebrates downstream of a dam (Haxton and Findlay 2008). | Consider life history needs of native fish to avoid drawdown times that could affect spawning, or juvenile life stages. |

**Manual and Mechanical Dreissenid Removal**

Physical harvesting of dreissenids can reduce the diversity and abundance of soft-sediment benthic community taxa (Wittman et al. 2012). Following best management practices for manual removal minimizes any effects on non-target organisms (Culver et al. 2013). Steps involved in manual removal (Culver et al. 2013) include: organize divers, train divers, conduct pre-implementation surveys, prepare target site, manually remove mussels using hand-held tools, collect removed mussels, dispose of removed mussels, decontaminate persons and gear, and evaluate efficacy of effort.

Effort to remove mussels manually can be minimized by using a suction pump made from PVC and a SCUBA tank to vacuum the mussels into collection bags, however, use of this technique can significantly disrupt benthic macroinvertebrate community structure (Wittman et al. 2012).

Suction harvesting side effects can include high turbidity, reduced clarity, and algae blooms from nutrient release caused by disturbance of bottom sediment, which can reduce oxygen conditions and ultimately affect ecosystem communities (New York State Department of Environmental Conservation 2005). Suction harvesting also has the potential to release sediment-bound heavy metals into the water column, which can affect the food chain in the water body (New York State Department of Environmental Conservation 2005).

## Oxygen Deprivation

Bottom/benthic barriers or mats can be installed on portions of lake bottoms and weighted, resulting in oxygen deprivation. This tactic is used for low to moderate mussel infestations in difficult to access locations, and can be enhanced by combining it with tactics that target larval stages (Culver et al. 2013). This method is not as effective in locations with large infestations.

Steps involved in oxygen deprivation (Culver et al. 2013) include: organize divers and boat operators, locate needed supplies, review the need for area closures, determine mussel distribution, conduct pre-implementation survey, conduct a pilot study, install tarps, add chemicals/biocides if needed, monitor during installation, remove tarp, decontaminate persons and gear, and evaluate efficacy of effort.

Benthic barriers interfere with respiration in fish and macroinvertebrates. Benthic barriers comprised of anchored textile/plastic are generally placed over vegetation to prevent the growth and establishment of plants whereas benthic barriers can be created by depositing silt to smother bottom-dwelling organisms (US Army Corps of Engineers 2012). Response to silt barriers can include feeding inhibition, reduced metabolism, avoidance, or mortality (Collins et al. 2011).

Although studies have shown that benthic barriers may impact non-target organisms, especially benthic dwellers, and will affect chemistry at the sediment-water interface, impacts are limited to the area of installation, and because only a small percentage of lake bottoms are typically exposed to benthic barriers, lake-wide impacts are not expected and have not been observed (Mattson et al. 2004).

Table 6. Examples of results of sediment dose-response experiments for fish and macroinvertebrates.

| Organism | Suspended sediment concentration (mg 1-1) | Duration (h) | Impact | Reference |
|---|---|---|---|---|
| **Fish - Chinook salmon** | 207 000 | 1 | 100% mortality of juveniles | Newcomb and Flagg 1983 |
| **Fish - Cyprinids** | 100 000 | 168 | Some survival | Wallen 1951 |
| **Copepod – Cladocera** | 25 000 | Unknown | Feeding inhibition | Alabaster and Lloyd 1982 |
| **Mollusk – Bivalvia** | 600 | Unknown | Feeding inhibition and reduced metabolism | Aldridge et al. 1987 |
| **Benthic invertebrates** | 743 | Unknown | Reduce population (85%) | Wagener and LaPerriere 1985 |

## Tables 5 and 6 References


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# CHAPTER 5. BEST MANAGEMENT PRACTICES

## Practices that avoid or minimize impacts to listed species and critical habitats

Federal agencies must ensure actions are not likely to jeopardize the survival of listed species nor adversely modify critical habitats. Best management practices (BMPs) are intended to reduce adverse effects to wildlife, plants, and their habitats. The following list of BMPs includes general measures from the Environmental Protection Agency (EPA 1993) as well as nationwide standard conservation measures[20] intended to reduce impacts to listed species and associated critical habitats.

All BMPs should be reviewed before any rapid response action to identify those BMPs that would avoid and minimize take. All BMPs pertinent to a specific control action should be reviewed during discussions initiating the emergency consultation process with the USFWS and in advance of the action to ensure optimal protections for listed species.

**General Best Management Practices**

**1. Properly Handle and Remove Hazardous and Solid Waste**

a. Provide enclosed solid waste receptacles at all project areas. Non-hazardous solid waste (trash) would be collected and deposited in the on-site receptacles. For more information about solid waste and how to properly dispose of it, see the EPA Non-Hazardous Waste website.

b. Develop a written contingency plan for all project sites where hazardous materials (e.g., pesticides, herbicides, petroleum products) will be used or stored. To clean up small-scale accidental hazardous spills, ensure appropriate materials/supplies (e.g., shovel, disposal containers, absorbent materials, first aid supplies, clean water) are available on site. Report all hazardous spills. Emergency response, removal, transport, and disposal of hazardous materials shall be done in accordance with the U.S. Environmental Protection Agency. Store at least 150 feet from surface water and in areas protected from runoff hazardous materials and petroleum products in approved containers, or

20 https://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

chemical sheds.

c. All chemicals shall be handled in strict accordance with label specifications. Proper personal protection (e.g., gloves, masks, protective clothing) shall be used by all applicators. The safety data sheet (SDS) from the chemical manufacturer shall be readily available to the project coordinators for detailed information on each chemical to be used, in accordance with applicable Federal and State regulations concerning the use of chemicals.

d. To protect the health of workers, pesticide applicators shall wear appropriate personal protective gear (e.g., clothing, gloves, and masks) in accordance with state applicators' licensing requirements when applying, mixing, or otherwise handling pesticides.

e. Avoid chemical contamination of the project area by implementing a spill prevention, control, and countermeasures (SPCC) plan. A copy of the plan will be maintained at the work site.

    i. Outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. Take corrective actions in the event of any discharge of oil, fuel, or chemicals into the water, including:

        a. Containment and cleanup efforts will begin immediately upon discovery of the spill and will be completed in an expeditious manner, in accordance with all local, state, and federal regulations. Cleanup will include proper disposal of any spilled material and used cleanup material.

        b. The cause of the spill will be determined, and appropriate actions taken, to prevent further incidents or environmental damage.

        c. Spills will be reported to the appropriate state and/or federal agency.

        d. Work barges will not be allowed to ground out.

        e. Excess or waste materials will not be disposed of or abandoned waterward of ordinary high water or allowed to enter waters of the state. Waste materials will be disposed of in an appropriate manner consistent with applicable local, state, and federal regulations.

f. Materials will not be stored where wave action or upland runoff can cause materials to enter surface waters.

ii. Outline the measures to prevent the release or spread of hazardous materials found on site and encountered during construction but not identified in contract documents, including any hazardous materials that are stored, used, or generated on the construction site during construction activities. These items include, but are not limited to, gasoline, diesel fuel, oils, and chemicals.

iii. Maintain at the site applicable spill response equipment and material.

**2. Minimize Disturbance and Restore Disturbed Areas**

a. Minimize construction impacts on fish and wildlife, including avoiding unnecessary disturbance to habitats by driving on existing roads, working only in the required area, and minimizing direct disturbance to streams and open water sources. Maximize use of disturbed land for all project activities (i.e., siting, lay-down areas, and construction).

b. Complete restoration activities at individual project sites in a timely manner to reduce disturbance and/or displacement of wildlife in the immediate project area. Minimize project creep by clearly delineating and maintaining project boundaries (including staging areas).

c. Use existing roadways or travel paths for access to project sites.

d. Avoid the use of heavy equipment and techniques that will result in excessive soil disturbances or compaction of soils, especially on steep or unstable slopes.

e. To avoid direct and indirect adverse effects to listed plants and habitats, delineate and cordone off the areas, and clearly communicate to equipment operators and project participants/volunteers.

f. Replant bank stabilizing vegetation that is removed or altered because of restoration activities with native vegetation and protect it from further disturbance until new growth is well established.

g. Source seedlings, cuttings, and other plant propagules for restoration from local ecotypes.

h. Implement pre-watering, and other preparations at project site and staging areas, prior to ground-disturbing activities, to maintain surface soils in stabilized conditions where support vehicles and equipment will operate.

i. Apply water, or an approved dust palliative during ground-disturbing activities including clearing, grubbing and earth moving activities, to keep soils moist throughout the process and immediately after completion.

j. Incorporate the use of sediment barriers, or other erosion control devices, downstream of ground-disturbing activities.

k. Limit stream crossings to designated and existing locations.

l. Obliterate all temporary roads and paths upon project completion

**3. Comply with all Terms, Conditions, and Stipulations in Permits and Project Authorizations**—Eliminate or reduce adverse effects to endangered, threatened, and sensitive species and their critical habitats.

**4. Protect Wetland Areas**

a. Avoid contaminating natural aquatic and wetland systems with runoff by limiting all equipment maintenance, staging laydown, and dispensing of fuel, oil, etc., to designated upland areas, i.e., equipment shall be stored, serviced, and fueled a minimum of 150 feet from aquatic habitats and other sensitive areas.

b. Implement sedimentation and erosion controls, when and where appropriate, during wetland restoration or creation activities to maintain the water quality of adjacent water sources.

c. Avoid removal of riparian vegetation.

d. Complete any construction associated with the project onsite in compliance with each state’s water quality standards, including:

i. Petroleum products, fresh cement, lime, concrete, chemicals, or other toxic or deleterious materials will not be allowed to enter surface waters or onto land where there is a potential for reentry into surface waters.

ii. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc., will be checked regularly for leaks, and materials will be maintained and stored properly to prevent spills.

iii. When fill (e.g., gravel) is required in the staging area and water access location, only clean rock is permitted, and all fill will be removed post-action. Fill would not be permitted to enter the water. During construction activities, the minimum amount of vegetation will be removed to gain access. Wetland sites will be avoided to the extent possible.

**5. Monitor Post-Action**—Monitoring is required during restoration project implementation and for at least one year following the action to ensure that restoration activities implemented at individual project sites are functioning as intended and do not create unintended consequences to fish, wildlife, and plant species and their critical habitats or adversely impact human health and safety. Corrective actions, as appropriate, shall be taken to address potential and existing adverse effects to fish, wildlife, and plants.

**6. Train Personnel**—Provide environmental awareness training program to all personnel to brief them on the status of the special status species and the required avoidance measures.

**7. Notify the Public and Post Action Areas**

a. Temporarily close staging and action areas to public use for public safety. Make information available to the public on the purpose and timing of the closure.
b. Flag and identify sensitive resource areas, equipment entry and exit points, road and stream crossings, staging, storage and stockpile areas, and no-spray/application areas and buffers.

**8. Ensure Responsible Use of Clean Equipment**

a. Provide vehicle wash stations prior to entering sensitive habitat areas to prevent accidental transport of non-native and invasive species.
b. Avoid soil contamination by using drip pans underneath equipment and containment zones at construction sites and when refueling vehicles or equipment.
c. Consistently check equipment for leaks and other problems that could result in the discharge of petroleum-based products or other material into the water or

riparian area.

**9. Protect the Integrity of the Water Body**

a. Contain the in-water treatment area by installing a vertical floating curtain barrier that extends from the surface of the water to the bottom of the water body, restricting flow and open water exchange. The barrier outlining the treatment area should contact the shoreline and encompass any existing public boat ramps, docks, or other infrastructure.

**10. Protect Disturbance/Effects to Listed Species During Key Vulnerable Life History Stages—**In-water work treatment windows are designated for each state by state and federal agencies. The treatment window guidelines restrict in-water work during certain periods to protect fish and wildlife resources during vulnerable and critical life stages. In-water work should be conducted only during the approved in-water work window, as described by each of the four CRB states or federal agencies (listed below). **If an action is proposed outside of the recommended windows, the action entity should receive approval for all appropriate variances to these windows to avoid any potential effects on listed species and their habitats. Also note that each state has designated state-listed species in addition to federal listed species and critical habitats. Contact your state fish and wildlife agency to ensure protections for state-listed species are implemented.**

**Washington**

The Washington Department of Fish and Wildlife (WDFW) provides recommended treatment windows for aquatic herbicide treatment. WDFW recognizes that aggressive treatment of emerging invasive species may sometimes be advisable during these treatment windows. In these situations, the Washington Department of Ecology and the permittee must consult WDFW to determine ways to minimize or mitigate treatment impacts to fish and wildlife. Contact the local WDFW regional office. **The annual treatment window is July 15–October 31, unless the specific water body is listed in the treatment window table.** If an action is proposed outside of this window, the Department of Ecology and the permittee must consult WDFW to determine an alternate timing window or if priority species are present, potential species impacts and appropriate mitigation.

**Oregon**

The Oregon Department of Fish and Wildlife (ODFW), under its authority to manage Oregon's fish and wildlife resources, developed the Oregon Guidelines for Timing of In-Water Work to assist the public in minimizing potential impacts to important fish, wildlife, and habitat resources. The guidelines are based on ODFW district fish biologists' recommendations. Primary considerations are given to important fish species including anadromous and other game fish and threatened, endangered, or sensitive species. Time periods are established for in-water work to avoid the vulnerable life stages of these fish including migration, spawning, and rearing.

ODFW, on a project-by-project basis, may consider variations in climate, location, and category of work that would allow more specific in-water work timing recommendations. The appropriate ODFW district office will make these more specific timing recommendations through the applicable planning or permitting process. ODFW in-water timing guidelines are typically applied to activities that are proposed in streams, rivers, upstream tributaries, and associated reservoirs and lakes. The timing guidelines are not typically applied in ocean waters or wetlands.

**Montana**

The US Fish and Wildlife Service has established in-water timing work with the US Army Corps of Engineers. **In bull trout feeding, migrating, overwintering habitat:** In-channel work can only occur from July 1 to September 30.

**In bull trout spawning and rearing habitat:** In-channel work can only occur from May 1 to August 31.

**Idaho**

National Marine Fisheries Service (NMFS) staff provide guidelines for in-water work in Idaho.

Instream work windows for all other streams in the project area (Lower Salmon River, Lower Snake River, and Clearwater River Basins).

| Stream type | Instream work window |
|---|---|
| Perennial, no listed fish | Base the timing on the nearest listed fish found downstream from the project area |
| Perennial, listed steelhead only | Preferred window is August 1 through October 30; exceptions may be made on a project-specific basis to begin work as early as July 15. |
| Perennial, listed steelhead and salmon | August 1 through October 30 when unlisted Chinook and coho spawning habitats are not present in the action area; July 15 through August 15 when Chinook spawning habitat is present in action |

| | |
|---|---|
| | area; August 1 through September 15 when coho spawning habitat is present in the action area. |
| Perennial, listed steelhead as well as listed salmon or bull trout | July 15 through August 15<br>Intermittent August 1 to October 30, or any time work can be completed while the stream is not flowing |

**11. Mitigation**—Any native fish and wildlife habitat destroyed in the development of an access corridor would be restored with appropriate, native species once the final treatment is completed. Replacement plant species will be recommended by a local state botanist. Mitigation methods may include:

- Mowing the site for ease of planting and to reduce initial plant competition during establishment.
- Removal of any fill using proper equipment.
- Planting to include hand tools, a power auger, hydraulic auger operated by equipment, or stinger operated by equipment. A 1 m buffer of herbaceous vegetation will be left between the shoreline and upland plantings to prevent potential sediment runoff.
- Installing weed matting or plant protection material to keep competition down while plants establish, and keep any loose sediment in place.
- Seeding, either via top seeding or seed drill depending upon herbaceous species and site characteristics.
- Seed native grasses, forbs, and pollinator species as available.
- Silt fence or weed-free straw will be used to contain runoff, if necessary.
- Monitoring plant establishment with adaptive management to ensure appropriate plant survival of 80% at 24 months.

# Best Management Practices to Avoid the Spread of Invasive Species

Agencies throughout North America should institute best management practices to reduce the likelihood of introducing invasive species, particularly via plant seed or propagules, during maintenance, construction and vegetation management activities. The following general best management practices, adapted from a variety of sources (British Columbia Ministry of the Environment 2011; US Forest Service 2012; Halloran et al. 2013; Elwell and Phillips 2016; New York State Department of Environmental Conservation 2018; Creative Resource Strategies, LLC 2019), can help prevent the spread of invasive species.

## A. Education and Support

Knowledge of invasive species and techniques to avoid their spread is critical to the implementation of all BMPs.

A.1 Provide trainings and educational materials for staff and contractors.

- Conduct training sessions on sanitation procedures for other equipment.
- Provide brochures and other materials on weed identification.
- Provide checklists and instructions for execution of BMPs in the field.
- Communicate the impact of invasive species and the importance of prevention.

## B. Planning and Records

B.1 Include an invasive species risk evaluation as a component of initial project planning.

Evaluate the risk of:

- Spreading invasive seeds and other propagules from the project site to new areas. Identify invasive species in and surrounding the site. Identify control and sanitation measures that would reduce risk.
- Bringing invasive propagules into the site during project activities. Consider any use and transportation of project vehicles outside of the project area. Identify sanitation measures that would reduce this risk.

B.2 Incorporate design components that minimize the movement of invasive propagules into or out of the site.

B.3 Incorporate sanitation and invasive control measures into plans, budgets, and contracts.

- Consider the use of specialized gear and clothing, tools for sanitation, and any staff training.
- Allocate time for prevention and sanitation activities.

B.4 Schedule activities to minimize the potential for spread of invasive propagules into or out of the site.

- Consider life stages of invasive plants. Avoid activities that may spread propagules when plants are fruiting.
- Consider the toxicity, ecological fate, persistence, and unintended consequences of pesticides. Consider timing to avoid impacts to listed or at-risk species, pollinators, nesting birds and mammals, and to trail users, medicine and food harvesters, and other public use.

B.5. Record observations of all suspected priority invasive species and others of concern. Note the date, location in as much detail as possible, approximate size of the patch, species identity if known, and stage of the plant (flowering, fruiting, etc.).

**C. Soil Disturbance**

Disturbing soil creates opportunities for the establishment of weed species.

C.1 Minimize soil disturbance—Whenever possible, activities should be avoided in areas containing fruiting, or rhizomatous invasive plants.

When soil must be disturbed, use proper erosion control practices—Minimize soil disturbance in areas containing invasive plants. Should invasive plants be detected early, use a certified pesticide applicator and spray within limits of pesticide permit, and/or take other actions as may be deemed appropriate.

Stabilize disturbed soils as soon as possible by seeding, mulching or using stone or other materials that are free of invasive plant materials. Site-specific revegetation efforts should address site preparation, species selection, and overall maintenance of the area. The activities to reduce invasive plants are intended to complement other practices addressing erosion control, proper drainage, and protecting infrastructure. Materials, such as fill, loam, gravel, mulch or hay should not be brought into project areas from sites where invasive plants are known to exist or have existed.

C.2 Manage and contain any water runoff, which can carry weed propagules.

C.3 Plan for cleaning time.

**D. Project Materials**

Project materials are common dispersal vectors for weed propagules to new locations. Soils, erosion control materials (especially if reused), landscape materials, water, and other materials can all contain propagules. Use of these BMPs can prevent the introduction of weed species to a project site through contaminated materials.

D.1 Use project materials that are known to be weed free.

Whenever possible, re-use weed-free materials from onsite rather than importing new materials. When re-using materials is not possible, obtain materials from local vendors, ideally those offering weed-free materials. Inspect materials for weed propagules.
Use certified weed-free seed. Monitor for weeds after the installation of new materials.
Treat any state/local-listed priority weeds found at early stages to maximize effectiveness of control.

D.2 Prevent contamination and germination of weed propagules in unused stockpiles of materials.

Cover exposed materials to protect from wind and rain. Inspect stockpiles prior to use. Treat any weeds found before the material is used.

D.3 Prevent contamination when transporting project materials.

Never move materials from a weed-infested to an un-infested location.
Cover materials during travel to prevent either contamination of clean materials, or spread of propagules from infested materials.

**E. Travel and Maintenance of Equipment—Disinfection Protocols**

Workers can spread invasive species as they travel from site to site. These BMPs should be implemented at all visits to sites known to, or suspected to, contain invasive species.

All vehicles should be examined for potential weed propagules: mud, soil, vegetation on vehicle undercarriages, wheel wells, bumpers and grills. Wearing appropriate clothing, boots, and other gear, and cleaning them before leaving a site can prevent them from transporting weeds to new sites. Following these BMPs will minimize introduction of invasive species by equipment, vehicles, and people traveling among project sites.

E.1 Locate and use a staging area that is free of invasive plants.

E.2. Avoid driving off-road, or parking in areas infested with invasive species. Arrange routes to travel to uninfested sites first, when the vehicle is clean. Visit weedy/infested sites last.

E.3. Inspect and Clean

Designate cleaning areas for tools, equipment and vehicles—Ideal locations include paved or sealed surfaces. Avoid waterways and sensitive habitat areas. If equipment must be used or staged in areas where invasive plants occur, all equipment, gear (i.e., boots), machinery, and hand tools should be cleaned of all viable soil, plant, and animal material before leaving the project. Acceptable methods of cleaning include but are not limited to:

- Portable wash station that contains runoff from washing equipment (containments must be in compliance with wastewater discharge regulations). If on-site cleaning is not an option, clean equipment at a commercial car wash facility. For vehicles and other large equipment, pay particular attention to the undercarriage and treads of tracks and tires.

- High pressure air.

- Brush, broom or other tool (used without water) – this is likely to be the BMP most practiced to avoid unintentional transport of invasive species as equipment moves from site to site.

Aquatic sites— Before leaving any aquatic site or any site in wet condition, thoroughly remove all organic matter (e.g., mud, plants, algae) from nets, sampling devices, boots (especially the tread), and any other equipment or clothing that has come into contact with water or aquatic sediments.

- Watercraft—Inspection and decontamination procedures for watercraft entering and leaving waterbodies should follow the Uniform Minimum Standards and Protocols for Watercraft Inspection and Decontamination Programs for Dreissenid Mussels in the Western United States (Elwell and Phillips 2016).

- Firefighting activities—US Forest Service and Bureau of Land Management prevention activities associated with the transport of water during firefighting activities should be used to prevent the spread of invasive species, sanitize equipment, and address disposal and safety concerns.

- Working in water bodies:

    - Sample from least to most invasive species-contaminated areas within the water body, for example, sample upstream to downstream or from areas of less weed growth to dense weed growth.

    - Minimize wading and avoid running boats onto sediment. For example, use bank sampling poles instead of wading.

    - Avoid getting plants and sediment inside boats or other sampling gear.

    - Use a catch pan underneath dredges, etc., to keep potential invasive species off boat decks and out of bilges.

    - Clean, Drain, Dry

        - CLEAN – Remove any visible vertebrates, invertebrates, plants, plant fragments, seeds, algae, and dirt. If necessary, use a scrub brush and rinse with clean water either from the site or brought for that purpose. Continue this process until the equipment is clean.

        - DRAIN – Drain all water in bilges, samplers, and other equipment that could hold water before leaving the site.

        - DRY – Fully wipe down all equipment until dry.

    - Decontaminate, if possible—Decontaminate using options for aquatic invasive species (Elwell and Phillips 2016).

### F. Transport & Disposal of Plants

After invasive plant removal, plant parts must be properly disposed of to prevent establishment in other locations.

F.1 When disposing on site, minimize the chance of viable material spreading by choosing a location where viable plant material will be contained, buried, or destroyed. Conduct monitoring at and near debris piles to treat any weeds that may have spread during the disposal and degradation process.

**Drying/Liquefying:** For large amounts of plant material, or for plants with rigid stems, place the material on asphalt, and under tarps, or heavy plastic to prevent the material from blowing away. For smaller amounts of plant material, or for plants with pliable stems, bag the material in heavy- duty (3 mil or thicker) garbage bags. Keep the plant material covered or bagged for at least one month and up to 3 months. Material is nonviable when it is partially decomposed, very slimy, or brittle. Once material is nonviable, it can be disposed of in an approved landfill or brush pile.

**Brush Piles:** Plant materials from most invasive plants can be piled on site to dry. However, for some species, care must be taken to pile stems so that the cut surfaces are not in contact with soil. This method is not recommended for any invasive plant with seeds or fruit attached, unless plants can be left within the limits of the infestation.

**Burying:** Plant material from most invasive plants can be buried a minimum of three feet below grade. This method is best used on a job site that is already has disturbed soils.

**Burning:** Plant material should be taken to a designated burn pile. (All necessary permits must be obtained before burning).

F.2 Herbicides—If herbicides are applied at the disposal sites, only licensed applicators are allowed to apply herbicide treatments. Ensure herbicides are contained such that they do not come into contact with native plants and wildlife.

F.3 When disposing off site, select appropriate disposal locations and transport properly. Invasive plant material must be covered during transport and transport vehicles swept clean at the transported location.

## G. Revegetation and Landscaping

Proper revegetation and landscaping work can create weed-resistant plant communities. Without proper care, however, landscaping activities and materials can serve as vectors for invasive species.

G.1 Select vegetation appropriate to the site to maximize weed resistance.

G.2 Use plants from a local source.

Use local ecotypes whenever possible for best plant establishment. Verify the taxonomy of species to be planted. Ensure all species to be used are approved.

G.3 Mitigate the risks of unintentional invasive species introductions during site preparation activities.

Whenever possible, time site preparation activities when invasive species are not producing seed.

Treat any invasive species found during the site preparation process.

Minimize soil disturbance to the amount necessary for planting.

## Chapter 5 References

British Columbia Ministry of Environment. 2011. Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors.

Bureau of Land Management. 2017. Handbook of Guidelines and Procedures for Inventory, Evaluation, and Mitigation of Cultural Resources. 39pp.

Creative Resource Strategies, LLC. 2019. City of Portland Invasives 2.0 – A Strategic Investment in Portland's Future. 59pp.

Elwell, L., and S. Phillips. 2016. Uniform Minimum Protocols and Standards for Watercraft Inspection and Decontamination for Dreissenid Mussels in the Western United States (UMPS III). Pacific States Marine Fisheries Commission, Portland, OR 53pp.

Environmental Protection Agency. 1993. Guidance Manual for Developing Best Management Practices. IPA 833-B-93-004.

Halloran, J., H. Anderson, and D. Tassie. 2013. Clean equipment protocol for industry. Peterborough Stewardship Council and Ontario Invasive Plan Council. Peterborough, ON.

National Marine Fisheries Service (NMFS). 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. National Marine Fisheries Service, Portland, Oregon, and Santa Rosa, California.

New York State Department of Environmental Conservation. 2018. Inter-agency Guidelines for Implementing Best Management Practices to Control Invasive Species on DEC Administered Lands of the Adirondack Park.

Reynolds, J.B. 1996. Electrofishing. Pages 221–253 *in* B. R. Murphy and D. W. Willis, eds. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

US Forest Service. 2012. Non-native Invasive Species Best Management Practices. 282pp.

# CHAPTER 6. POST-EMERGENCY CONSULTATION

As soon as practical after the emergency event is under control, the action agency initiates consultation if the emergency response may affect listed species and/or critical habitat. If adverse effects to a listed species are necessary to respond to the emergency, consultation should begin as soon as possible after the emergency to discuss effects to any listed species that may have occurred.

The action agency drafts a biological assessment that includes a justification for expedited consultation, a description of activities that occurred during the emergency, documentation of how the USFWS recommendations were implements, and resulting effects to listed species and their habitats.

Because emergency consultations are "after the fact" consultations, they do not strictly follow the standard Biological Opinion format. Rather, they focus on assessing the effects, identifying restoration opportunities, and re-evaluating environmental baselines.

An emergency consultation includes an estimate of the amount of take that occurred during the emergency, documentation of USFWS recommendations to minimize effects, an evaluation of the action agency's success in implementing the recommendations, and a determination of the ultimate effect of the take of listed species.

Take or other adverse effects resulting from the emergency are not attributable to the Federal action agency. Rather, incidental take by the Federal agency could only occur because of the response to the emergency. Because the incidental take statement is issued after-the-fact, reasonable and prudent measures are not included in the biological opinion for the emergency actions unless ongoing actions will result in incidental take.

# APPENDIX A. 50 CFR §17.21 - PROHIBITIONS

Section (c) (5):

**(5)** Notwithstanding paragraph (c)(1) of this section, any qualified employee or agent of a State Conservation Agency which is a party to a Cooperative Agreement with the Service in accordance with section 6(c) of the Act, who is designated by his agency for such purposes, may, when acting in the course of his official duties take those endangered species which are covered by an approved cooperative agreement for conservation programs in accordance with the Cooperative Agreement, provided that such taking is not reasonably anticipated to result in:

> **(i)** The death or permanent disabling of the specimen;
> **(ii)** The removal of the specimen from the State where the taking occurred;
> **(iii)** The introduction of the specimen so taken, or of any progeny derived from such a specimen, into an area beyond the historical range of the species; or
> **(iv)** The holding of the specimen in captivity for a period of more than 45 consecutive days.

# APPENDIX B. U.S. FISH AND WILDLIFE SERVICE REGIONAL OFFICE CONTACTS

The contact list below is for USFWS staff within the Ecological Services (ES) Program that coordinate on activities within the CRB. The Ecological Services Program administers the ESA inclusive of the section 7 consultation program. Consultation on emergency response actions for dreissenid mussels would be administered through the ES Program.

The CRB Plan (Heimowitz and Stephens 2008) provides contacts for the USFWS Fish and Aquatic Conservation (FAC) Program. In the event of a rapid response, we anticipate that both the FAC and ES Programs would be closely involved and part of internal coordination as well as participation with procedures outlined in the CRB Plan (e.g., MAC calls).

| | |
|---|---|
| **Region 1 - Pacific**<br><br>U.S. Fish and Wildlife Service<br>Ecological Services<br>Eastside Federal Complex<br>911 N.E. 11th Avenue<br>Portland, OR 97232-4181<br>www.fws.gov/pacific/ecoservices/<br>*Assistant Regional Director - Ecological Services:*<br>(503) 231-6151 | **Region 6 - Mountain Prairie**<br><br>U.S. Fish and Wildlife Service<br>Ecological Services<br>134 Union Boulevard, Suite 650<br>Lakewood, CO 80228<br>www.fws.gov/mountain-prairie/es<br>*Assistant Regional Director - Ecological Services:*<br>(303) 236-7400 |

# APPENDIX C. LISTED SPECIES AND CRITICAL HABITAT EXCLUDED FROM FURTHER ANALYSIS

## Mammals

### Black-footed Ferret (*Mustela nigripes*) (MT)

The historic range of this species aligned with the colonies of three species of prairie dogs—black-tailed, white-tailed, and Gunnison's (*Cynomys* spp.) (Anderson et al. 1986). Their habitat, and the associated habitat of prairie dogs, is primarily open mixed grass, or short grass prairie, and is classified as "black-tailed prairie dog town grassland complex." The most recent distribution of black-footed ferrets in Montana can be accessed at http://fieldguide.mt.gov/speciesDetail.aspx?elcode=AMAJF02040.

### Canada Lynx (*Lynx canadensis*) (OR, WA, ID, MT)

The Canada lynx is a boreal forest carnivore, and occurs across most of North America. Its habitat is moist, cool, boreal spruce-fir forests in northwestern Montana/northern Idaho and north-central Washington.[21] The distribution of Canada lynx can be accessed at https://wildcatconservation.org/wild-cats/north-america/canada-lynx/.

### Gray wolf (*Canis lupus*) (OR, WA)

The gray wolf (*Canis lupus*) was once found throughout much of the continental United States and are listed as endangered in the western 2/3 of Oregon and Washington. Gray wolves are one of the most wide-ranging land animals. They occupy a wide variety of habitats, from arctic tundra to forest, prairie, and arid landscapes. Click on the following links for additional information on wolves in Oregon and Washington.

### Grizzly bear (*Ursus arctos horribilis*) (WA, ID, MT)

There are five areas where grizzlies remain today—Yellowstone ecosystem, Northern Continental Divide ecosystem, Cabinet-Yaak ecosystem, Selkirk ecosystem, and Northern Cascades ecosystem.[22] Grizzly bears are found many different habitats, from dense forests to subalpine meadows, open plains and arctic tundra.

### Mazama pocket gopher (*Thomomys azama pugetensis, glacialis, tumuli, and yelmensis*) (WA)

The Olympia, Roy Prairie, Tenino, and Yelm pocket gophers are regionally endemic subspecies of the Mazama pocket gopher found only in Washington. The Olympia,

[21] https://www.fws.gov/mountain-prairie/es/canadaLynx.php

[22] https://www.fws.gov/mountain-prairie/es/grizzlyBear.php

Tenino, and Yelm pocket gophers are only found in Thurston County whereas the Roy Prairie pocket gopher is only found in Pierce County. Preferred habitat is prairies, grasslands, and meadows. The Joint Base Lewis-McChord and Olympia airport contain the largest areas occupied by any of the four listed species.

### Northern Idaho ground squirrel (*Urocitellus endemicus*) (ID)

Populations of the northern Idaho ground squirrel have been found in Adams and Valley Counties of western Idaho, though the species historic range extends into neighboring Washington County.[23] It occurs in dry meadows surrounded by ponderosa pine and Douglas-fir forests, including lands managed by the U.S. Forest Service—Payette National Forest (1,500 to 7,500-foot elevations).

### Northern long-eared bat (*Myotis septentrionalis*) (MT)[24]

Northern long-eared bats spend winter hibernating in caves and mines, called hibernacula. They use areas in various sized caves or mines with constant temperatures, high humidity, and no air currents. Within hibernacula, surveyors find them hibernating most often in small crevices or cracks, often with only the nose and ears visible. During the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags (dead trees). Males and non-reproductive females may also roost in cooler places, like caves and mines. Northern long-eared bats seem to be flexible in selecting roosts, choosing roost trees based on suitability to retain bark or provide cavities or crevices. This bat has also been found rarely roosting in structures, like barns and sheds.

### Columbia Basin Pygmy rabbit (*Brachylagus idahoensis*) (Columbia Basin Distinct Population Segment (DPS)) (WA)

Pygmy rabbits are typically found in areas that include tall, dense stands of sagebrush (*Artemisia* spp.), which provide food and shelter year-round. Pygmy rabbits dig their own burrows in deep, loose soils, but occasionally make use of burrows abandoned by other species (USFWS 2012).

### Southern Selkirk Mountains woodland caribou (*Rangifer tarandus caribou*) (WA, ID)

The southern Selkirk Mountains population of woodland caribou occupies high-elevation habitat in the Selkirk Mountains of northern Idaho and northeastern Washington.[25] In 2018, three male animals were documented in the herd.[26]

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23 https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=A0EK

24 https://www.fws.gov/midwest/Endangered/mammals/nleb/nlebFactSheet.html

25 https://www.fws.gov/idaho/promo.cfm?id=177175825

26 https://www.opb.org/news/article/caribou-continental-united-states-south-selkirk-extinct/

**Wolverine (*Gulo gulo luscus*) (WA, ID, MT, OR)**

In North America, wolverines occur within a wide variety of habitats, primarily boreal forests, tundra, and western mountains throughout Alaska and Canada; however, the southern portion of the range extends into the contiguous United States. Currently, wolverines are found in the North Cascades in Washington and the Northern Rocky Mountains in Idaho, Montana, Oregon (Wallowa Range), and Wyoming.

## Birds

### Marbled murrelet (*Brachyramphus marmoratus*) (OR, WA)[27]

Marbled murrelets use forests that primarily include old-growth (characterized by large trees, a multi-storied stand, and moderate to high canopy closure), but also use mature forests with an old-growth component. Trees must have large branches or deformities for nest platforms, with the occurrence of suitable platforms being more important than tree size alone. Because marbled murrelets feed primarily on fish and invertebrates in nearshore marine waters, they require nearshore marine habitats with sufficient prey resources. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Northern spotted owl (*Strix occidentalis caurina*) (OR, WA)[28]

Northern spotted owls live in forests characterized by dense canopy closure of mature and old-growth trees, abundant logs, standing snags, and live trees with broken tops. They prefer older forest stands with multi-layered canopies of several tree species of varying size and age, both standing and fallen dead trees, and open space among the lower branches to allow flight under the canopy. Typically, forests do not attain these characteristics until they are at least 150 to 200 years old. Although the breeding season varies with geographic location and elevation, spotted owls generally nest from February to June. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Short-tailed albatross (*Phoebastria albatrus*) (OR, WA)

The short-tailed albatross is a pelagic bird that nests on islands in Japan and moves to feeding areas in the North Pacific after they breed and their chicks fledge in June. Because their habitat is marine, this species is excluded from further analysis.

### Whooping crane (*Grus americana*) (MT)[29]

About 145 whooping cranes migrate across Montana from Wood Buffalo National Park to the Aransas National Wildlife Refuge. The spring migration occurs from late April to

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[27] USFWS (1997)

[28] https://www.fws.gov/oregonfwo/articles.cfm?id=149489595

[29] http://FieldGuide.mt.gov/speciesDetail.aspx?elcode=ABNMK01030

mid-June. Whooping cranes are occasionally sighted in southwestern Montana's Centennial Valley. The Whooping Crane has been observed in the marsh habitat present at Medicine Lake National Wildlife Refuge and Red Rock Lakes National Wildlife Refuge. Observations of individual birds in other areas of the state include grain and stubble fields as well as wet meadows, wet prairie habitat, and freshwater marshes that are usually shallow and broad with safe roosting sites and nearby foraging opportunities (Montana Bird Distribution Committee 2012). The Whooping Crane generally probes in the mud or sand in or near shallow water, but may also take prey from the water column, or pick items from the substrate (Ehrlich et al. 1992).

### Streaked horned lark (*Eremophila alpestris strigata*) (OR, WA)[30]

The streaked horned lark was listed as a threatened species on October 3, 2013. Habitat used by streaked horned larks is generally flat with substantial areas of bare ground and sparse low-stature vegetation primarily composed of grasses and forbs. Suitable habitat is generally 16-17% bare ground and may be even more open at sites selected for nesting. A key attribute of habitat used by larks is open landscape context. Critical habitat was designated for the streaked horned lark October 3, 2013, for 16 sites; in the Willamette Valley, designated critical habitat is located on the Service's Willamette Valley National Wildlife Refuge Complex at the William R. Finley, Ankeny and Baskett Slough units. The current range and distribution of the streaked horned lark can be divided into three regions: 1) the south Puget Lowlands in Washington; 2) the Washington coast and lower Columbia River islands (including dredge spoil deposition and industrial sites near the Columbia River in Portland, Oregon); and 3) the Willamette Valley in Oregon. The largest known populations of streaked horned larks breed in the southern Willamette Valley at the Corvallis Municipal Airport and on the Fish and Wildlife Service's Willamette Valley National Wildlife Refuge Complex. **Avoid disruption during the breeding season (late March into June).**

## Invertebrates

### Fender's blue butterfly (*Icaricia icarioides fender)* (OR)

Fender's blue butterfly occurs in native prairie habitats. Most Willamette Valley prairies are early seral (one stage in a sequential progression) habitats, requiring natural or human-induced disturbance for their maintenance. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Taylor's checkerspot butterfly (*Euphydryas editha taylori*) (OR, WA)

Habitat requirements for the Taylor's checkerspot consist of open grasslands and grass/oak woodland sites where food plants for larvae and nectar sources for adults are

[30] https://www.fws.gov/oregonfwo/articles.cfm?id=149489450

available. These sites include coastal and inland prairies on post-glacial, gravelly outwash and balds. Taylor's checkerspot larvae have been documented feeding on members of the figwort or snapdragon family (Scrophulariaceae), including paintbrush (*Castilleja hispida*) as well as native and non-native *Plantago* spp. in the plantain family (Plantaginacea). The last remaining population in Oregon also depends upon *P. lanceolate*. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Oregon silverspot butterfly (*Zpeyeria zerene hippolyta*) (OR, WA)

The Oregon silverspot occupies three types of grassland habitat. One type consists of marine terrace and coastal headland salt-spray meadows (e.g., Cascade Head, Bray Point Rock Creek-Big Creek and portions of Del Norte sites). The second consists of stabilized dunes as found at the Long Beach Peninsula, Clatsop Plains, and the remainder of Del Norte. Both of these habitats are strongly influenced by proximity to the ocean, mild temperatures, high rainfall, and persistent fog. The third habitat type consists of montane grasslands found on Mount Hebo and Fairview Mountains. Conditions at these sites include colder temperatures, significant snow accumulations, less coastal fog, and no salt spray. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Vernal pool fairy shrimp (*Branchinecta lynchi*) (OR)

Vernal pool fairy shrimp occur primarily in vernal pools, seasonal wetlands that fill with water during fall and winter rains and dry up in spring and summer. Typically, the majority of pools in any vernal pool complex are not inhabited by the species at any one time. Different pools within or between complexes may provide habitat for the fairy shrimp in alternative years, as climatic conditions vary. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Vernal pool tadpole shrimp (*Lepidurus packardi*) (OR)

Vernal pool tadpole shrimp occur primarily in vernal pools (seasonal wetlands that fill with water during fall and winter rains and dry up in spring and summer). Typically, the majority of pools in any vernal pool complex are not inhabited by the species at any one time. Different pools within or between complexes may provide habitat for the tadpole shrimp in alternative years, as climatic conditions vary. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Western glacier stonefly (*Zapada glacier*) (MT)

Western glacier stoneflies are known to occur in 16 streams; 6 in Glacier National Park, Montana, 4 in Grand Teton National Park, Wyoming and 6 in the Absaroka/Beartooth Wilderness, Montana. All occupied streams are high-elevation, alpine streams originating from cold water sources, including glaciers and small icefields, permanent and seasonal snowpack, alpine springs, and glacial lake outlets. Recent collections of the western glacier stonefly were in habitats with daily maximum water temperatures less than 6.3°C (43°F). Western glacier stoneflies occupy the most upstream reaches of alpine streams, typically occurring within the first one half mile of stream, starting at the meltwater source. Therefore, they are sensitive to temperature changes and are considered to be a barometer for the effects of climate change in the alpine environment. Dreissenids would not occupy habitat occupied by the western glacier stonefly.

### Meltwater lednian stonefly (*Lednia tumana*) (MT)

This species is listed as proposed threatened. Its habitat is alpine snow-melt streams at the base of glaciers in Glacier National Park. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Bruneau hot springsnail (*Pyrgulopsis bruneauensis*) (ID)

It is only found in 89 of the 155 small geothermal springs and seeps along an 8-kilometer length of the Bruneau River, extending about 2.5 miles above and below the confluence of Hot Spring, in Owyhee, County, Idaho (USFWS 2007). It prefers wetted rock faces of springs and flowing water, with large cobbles and boulders. The principal threat to the Bruneau hot springsnail is the reduction and/or elimination of its geothermal habitats as a result of groundwater withdrawal, primarily for agriculture. Spring temperatures are the predominant factor that determines the springsnail's distribution and abundance; the springsnail requires constant springwater temperatures to survive. Dreissenids would not occupy habitat occupied by the Bruneau hot springsnail.

## Plants

### Applegate's milk-vetch (*Astragalus applegatei*) (OR)

Applegate's milk-vetch occurs in flat-lying, seasonally moist, strongly alkaline soils dominated by greasewood (*Sarcobatus vermiculatus*) with sparse, native bunch grasses and patches of bare soil. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Cook's lomatium (*Lomatium cookii*) (OR)

This plant occurs only where soil types have a hard pan or clay pan layer close to the soil surface, creating seasonally wet soils and vernal pools. This species is known from the Agate Desert near Medford, Jackson County, Oregon and French Flat in the Illinois Valley in Josephine County, Oregon on land owned by The Nature Conservancy (Agate Desert Preserve), Jackson County, Oregon Department of Fish and Wildlife, City of Medford, Oregon Department of Transportation, Bureau of Land Management

(French Flat), and private landowners. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Gentner's fritillary (*Fritillaria gentneri*) (OR)

Gentner's fritillary occurs within a broad array of plant associations but often occupies grassland and chaparral habitats within, or on the edges of, dry, open, mixed-species woodlands at elevations below 1,544 meters (5,064 feet). Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Golden paintbrush (*Castilleja levisecta*) (OR, WA)

Golden paintbrush occurs in upland prairies, on generally flat grasslands, including some that are characterized by mounded topography. Low deciduous shrubs are commonly present as small to large thickets. In the absence of fire, some of the sites have been colonized by trees, primarily Douglas-fir, and shrubs, including wild rose and Scotch broom, an aggressive non-native shrub. The mainland population in Washington occurs in a gravelly, glacial outwash prairie. Other populations occur on clayey soils derived from either glacial drift or glacio-lacustrine sediments (in the northern end of the species' historic range). All of the extant populations are on soils derived from glacial origins. At the southern end of its historic range, populations occurred on clayey alluvial soils, in association with Oregon white oak woodlands. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Greene's tuctoria (*Tuctoria greenei*) (OR)

This grass typically occurs in vernal pools in open grassland and is threatened by the destruction of rare vernal pool habitat. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Howell's spectacular thelypody (*Thelypodium howellii* spp. *spectabilis*) (OR)

Howell's spectacular thelypody occurs in moist, moderately well-drained, somewhat alkaline meadow habitats, typically growing with salt tolerant species. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Kincaid's lupine (*Lupinus sulphureus* spp. *kincaidii*) (OR, WA)

Kincaid's lupine is found mainly in the Willamette Valley, Oregon where it occupies native grassland habitats. Kincaid's lupine is typically found in native upland prairie. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Large-flowered woolly meadowfoam (*Limnanthes pumila* spp. *grandiflora*) (OR)

Woolly meadowfoam occurs at the edge of vernal pools at elevations of 375 to 400 meters (1,230 to 1,310 feet). Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

**MacFarlane's four o'clock (*Mirabilis macfarlaneil*) (OR, WA)**
Macfarlane's four-o-clock grows on rockslides, canyon walls, and sandy to gravelly talus slopes. Elevation ranges from 300 to 900 m (980 to 2050 feet). Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

**Malheur wire-lettuce (*Stephanomeria malheurensis*) (OR)**
Malheur wirelettuce occurs in the high desert of the northern portion of the Great Basin and is located in an area south of Burns, Oregon. It occurs on top of a dry, broad hill on volcanic soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush (*Artemisia tridentata*), gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and, more recently, invasive cheatgrass (*Bromus tectorum*). Malheur wirelettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

**Marsh sandwort (*Arenaria paludicola*) (WA)**
Marsh sandwort is a coastal species that was historically known to occur in wetlands, and in freshwater marshes. Plants have been documented in areas with or without standing water and in acidic, organic bog soils and sandy substrates with high organic content. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

**McDonald's rockcress (*Arabis macdonaldiana*) (OR)**
This species is restricted to soils derived from ultramafic rocks, chiefly peridotite. Soils may range from recently exposed serpentine to very old weathered lateritic soils. A pronounced red color is often evident in the lateritic soils because of the abundance of iron. These soils are also high in heavy metals such as copper, chromium and nickel. The habitat is often very steep and unstable, with an open tree canopy of generally less than 5 percent cover. Elevation ranges up to about 4,900 feet on the slopes of Preston Peak and Sanger Peak in the Siskiyou Mountains. Vegetation association ranges from dry Jeffrey Pine, knobcone pine, or incense cedar woodlands to brushy or very open, rocky scree slopes. In addition to scattered trees, associated vegetation includes a diverse array of herbs and shrubs, such as montane penny-cress, Bolander's lily, and multiple species of buckbrush, fescue grass, iris, snakeroot, lomatium, stonecrop, violet, phlox, onion, and others. Serpentine barren habitats in general often support a great variety of endemic plants, many of which are sensitive or rare. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Rough popcornflower (*Plagiobothrys hirtus*) (OR)

Rough popcornflower grows in open, seasonal wetlands in poorly- drained clay or silty clay loam soils at elevations ranging from 30 to 270 m (100 to 900 ft). The taxon depends on seasonal flooding and/or fire to maintain open habitat and to limit competition with invasive native and non-native plant species. This plant occurs in open microsites within the one-sided sedge (*Carex unilateralis*)-meadow barley (*Hordeum brachyantherum*) community type within interior valley grasslands. The plant occurs on soils in the Conser Silty Clay Loam Series (NRCS mapped soil unit SSURGO 44A). Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Showy stickweed (*Hackelia venusta*) (WA)

Showy stickseed grows on sparsely vegetated, granitic scree on unstable, steep slopes on the east slope of the central Cascade Mountains of Washington. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Slender Orcutt grass (*Orcuttia tenuis*) (OR)

*O. tenuis* is dependent on vernal pools; however, it has been reported from other natural and artificial wetlands such as stock ponds, and borrow pits. The plants tolerate inundation and therefore live in deeper pools or in deeper areas of pools than Green's tuctoria. Primary habitat requirement appears to be inundation of sufficient duration and quantity to eliminate most competition and to meet the plant's physiological requirements for prolonged inundation, followed by gradual desiccation. Occupied pools are or were underlain by iron-silica cemented hardpan, tuffaceous alluvium, or claypan. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Slickspot peppergrass (*Lepidium papilliferum*) (ID)

The native plant occurs in specialized habitats known as slickspots, which are mini-playas or natric (high sodium soil) sites with distinct clay layers. Slickspots tend to be highly reflective, are usually relatively light in color and occur dispersed throughout the sagebrush-steppe ecosystem in southwest Idaho. More than 90 percent of the occupied slickspot peppergrass habitat occurs on federal lands with the remaining occupied habitat owned by the state of Idaho private land owners. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Spalding's catchfly (*Silene spaldingii*) (OR, WA, ID, MT)

This species grows on mesic grassland prairies at low- to mid- elevations. Associated species include Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), Nutka rose (*Rosa nutkana*), purple avens (*Geum triflorum*), sticky geranium (*Geranium viscosis*sum), balsamroot (*Balsamorhiza sagittata*), and scattered Ponderosa pine (*Pinus ponderosa*). Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Umtanum desert buckwheat (*Eriogonum codium*) (WA)

The solitary population occurs between 340–400 m (1,120–1,300 ft) on flat to gently sloping microsites near the top of a steep, north-facing basalt ridge overlooking the Columbia River. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Wenatchee Mountains checker-mallow (*Sidalcea oregana var. calva*) (WA)

The Wenatchee Mountains checker-mallow (*Sidalcea oregana* var. *calva*) is an endemic plant found only in mid-elevation wetlands and moist meadows within Chelan County in eastern Washington State. This plant is currently known from only five populations. The largest population has an estimated 11,000 plants and the remaining 4 populations range in size from 8 to 300 individuals. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### Western lily (*Lilium occidentale*) (OR)

This species has been reported from sites in a narrow band along the Pacific Coast no more than four miles inland from Coos County, Oregon about 200 miles south to Humboldt County, California. Western lily typically occurs within, or at the edges of fens and in poorly drained forest or thicket openings. It also grows in coastal prairie/scrub near the ocean. Fens are composed of highly organic soils with a fluctuating water table, and often situated above Blacklock or other soils that serve to perch a seasonal water table. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

### White bluffs bladderpod (*Physaria douglasii* spp. *tuplashensis*) (WA)

The buckwheat is a woody plant that can live up to 150 years and is limited to a weathered basalt outcrop on the top edge of the Umtanum Ridge in Benton County, where it is threatened by fire, invasive species, off-road vehicle destruction and stray cattle. Because the habitat of this species is not habitat in which dreissenids would be found, this species is excluded from further analysis.

# APPENDIX D. LIFE HISTORY INFORMATION FOR SPECIES AND CRITICAL HABITATS ASSOCIATED WITH COLUMBIA RIVER BASIN WATER BODIES

## Mammals

### Columbian white-tailed deer (*Odocoileus virginianus leucurus*) (OR, WA)

Information provided here is summarized in USFWS (1983) and from USACE and USFWS (2018).

#### Listing History

On March 11, 1967, the Secretary of the Interior identified the Columbian white-tailed deer (CWTD) as an endangered species under the authority of the Endangered Species Preservation Act of October 15, 1966. On March 8, 1969, the Secretary of the Interior again identified the CWTD as an endangered species. On August 25, 1970, the Acting Secretary of the Interior proposed to list the CWTD as an endangered subspecies under the authority of new regulations implementing the Endangered Species Conservation Act of 1969. The CWTD was automatically listed under the ESA when it was enacted in 1973.

On July 24, 2003, the Douglas County, Oregon, population was delisted due to recovery. October 17, 2016, the USFWS published a final rule to "downlist" the CWTD to threatened status.

#### Life History/Biological Requirements

Islands and bottomlands along the lower Columbia River around 9.8 ft (3 m) above sea level with vegetation over 2.3 ft (0.7 m) high in the vicinity of forage species are preferred. Native vegetation of the Columbia River tidal area includes dense, tall shrub and tree community including Sitka spruce, dogwood, cottonwood, red alder, and willow species. These and other species such as rose, sumac, and elderberry are common food and cover sources.

Breeding occurs from mid-September through late February, with a peak in November. Does reach sexual maturity by 6 months of age or when their weight reaches approximately 80 pounds [lbs (36 kilograms (kg))]. Maturation and fertility depends on the nutritional quality of available forage. Fawns are born in early summer after a 200-day gestation period.

**Distribution and Critical Habitat**

Columbian-white tailed deer are associated with riparian habitats in the Lower Columbia River and Douglas County, Oregon.[31] This species occupies tidal spruce habitats—densely forested swamps covered with tall shrubs and scattered spruce, alder, cottonwood, and willows—on islands along the Columbia River. Islands and bottomlands along the lower Columbia River around 9.8 ft (3 m) above sea level with vegetation over 2.3 ft (0.7 m) high near forage species are preferred. Native vegetation of the Columbia River tidal area includes dense, tall shrub and tree community including Sitka spruce, dogwood, cottonwood, red alder, and willow species. These and other species such as rose, sumac, and elderberry are common food and cover sources.

In Douglas County, Oregon, this species uses willow and cottonwood habitat along rivers and streams as well as oak-savannah habitats in upland areas.

Although habitat types and locations have been identified for the Columbian white-tailed deer, no critical habitat has been designated. Currently, the Columbia River DPS has a discontinuous range of approximately 149 mi² (240 km²) or about 60,000 ac² (24,281 ha²) in limited areas of Clatsop, Multnomah, and Columbia Counties in Oregon, and Cowlitz, Wahkiakum, Pacific, Skamania, and Clark Counties in Washington. Within that range, CWTD currently occupy an area of approximately 16,000 ac² [6,475 ha²].

**Threats**

Conversion of brushy riparian land to agriculture, urbanization, uncontrolled sport, commercial hunting, and other factors caused the extirpation of CWTD over most of its range. A lack of dense woody cover between open pastures has been identified as a major limiting habitat factor. The population had also been severed into two small, spatially separated groups, historically, making genetic diversity another risk factor.

Other potential threats include catastrophic flood damaging suitable habitat, as well as hoof rot, which is a crippling hoof disease exacerbated by wet conditions that has plagued the Columbia River population.

[31] https://www.fws.gov/oregonfwo/articles.cfm?id=149489413

# Birds

## Piping plover (*Charadrius melodus*) (MT)

Information provided here is summarized in Atkinson and Dood (2006).

### Breeding Season Habitat

In north-central North America, plovers typically nest on barren sand and gravel beaches along the Great Lakes, and on alkali flats, gravel shorelines and river sandbars in the Great Plains (USFWS 2002c). While data suggests that habitat use by plovers is dynamic (USFWS 2002c), alkali lakes and wetlands associated with the Missouri Coteau landform, located inside the Prairie Pothole Region, appear to support a significant portion (34 -75%) of the Great Plains population in any given year (Haig and Plissner 1993, Murphy et al. 2000, Plissner and Haig 2000, Haig et al. 2005, Skagen and Thompson 2005). Remaining nest sites occur primarily along rivers and reservoirs although fresh water lakes, dry alkali lakes, sandpits, industrial ponds and gravel mines may also be utilized (Haig et al. 2005).

Piping plovers are a migratory species. Piping Plovers primarily select unvegetated sand or pebble beaches on shorelines or islands in freshwater and saline wetlands. Vegetation, if present at all, consists of sparse, scattered clumps (Casey 2000). Open shorelines and sandbars of rivers and large reservoirs in the eastern and north-central portions of Montana provide prime breeding habitat. In Montana, and throughout the species' range, nesting may occur on a variety of habitat types. If conditions are right, alkali wetlands, lakes, reservoirs, and rivers can all provide the essential features required for nesting. The alkali wetlands and lakes found in the northeastern corner of the state generally contain wide, unvegetated, gravelly, salt-encrusted beaches. Rivers that flood adequately can supply open sandbars or gravelly beaches, as can large reservoirs, with their shoreline beaches, peninsulas, and islands of gravel or sand. Sites with gravel substrate provide the most suitable sites for nesting (Montana Piping Plover Recovery Committee 1994). One of the most limiting factors to nesting site selection is vegetational encroachment. Piping Plovers avoid areas where vegetation provides cover for potential predators. Fine-textured soils are easier to treat mechanically than rocky or gravelly soils when vegetation is determined as a limiting factor in an area's ability to provide suitable nesting habitat, but fine soils are not typically a preferred nesting substrate (Montana Piping Plover Recovery Committee 1994). Nests are simple scrapes dug into the nest substrate which may or may not be lined with pebbles (Montana Piping Plover Recovery Committee 1994, 1995, Haig 1992).

Migrants begin arriving at breeding areas in southern Washington in early March and in central California as early as January, although the main arrival is from early March to late April. Since some individuals nest at multiple locations during the same year, birds may continue arriving through June. Males make a nest scrape, which is a depression in the sand or substrate made by leaning forward on his breast and scratching his feet while rotating his body axis. The earliest nests on the California coast occur during the first week of March in some years and by the third week of March in most years. Peak initiation of nesting is from mid-April to mid-June. Hatching lasts from early April through mid-August, with chicks reaching fledging age approximately 1 month after hatching.

**Riverine Habitat**
Characteristic riverine nesting sites include reservoir beaches and large dry, barren sand or gravel bars within wide, unobstructed river channels (USFWS 1988). Nests are usually located after the spring and early summer flows recede and dry areas on sandbars are exposed. Along the Platte River, Nebraska, relatively large sandbars, averaging 286 m long and 55 m wide, appear to be selected when available (Faanes 1983). In addition, preferred vegetative cover at nest sites is generally low (Schwalbach 1988). Although Faanes (1983) reported vegetative cover of 25% on nesting sandbar habitat along the Platte River, other research suggests that the optimum range is much lower: estimates range from 0-10% (Armbruster 1986). Likewise, along the Missouri River in South Dakota, plover colony sites were characteristically barren or with short (<10cm) sparse (<10%) vegetative cover (Schwalbach 1988).

**Foraging Habitat**
Plovers feed by pecking at or just below the substrate surface (Cairns 1977, USFWS 2002c, Haig and Elliot-Smith 2004) and require feeding grounds that are rich in surface invertebrates (Shaffer and Laporte 1994). While adults typically concentrate feeding efforts within 5 m of the water's edge (Whyte 1985), chicks tend to feed on firmer ground at greater distances from the shoreline (Cairns 1977).

**Critical Habitat**
In 2002, the USFWS officially designated critical habitat for the Northern Great Plains breeding population (USFWS 2002c). Under the Endangered Species Act, critical habitat refers to specific geographic locations that contain features essential for conserving a species and may require special management considerations. While critical habitat can be, and is, designated on private lands, it only relates to those activities on private lands that require federal permits or funding that are required to be reviewed under the Act. For piping plovers, primary constituent elements include components essential for courtship, breeding, sheltering, brood-rearing, foraging, roosting, intraspecific communication and migration. Furthermore, it stated that the one overriding primary biological element that must be present at all sites is the maintenance of the dynamic ecological processes that create and maintain piping plover habitat.

On prairie alkali lakes and wetlands the physical primary constituent elements include shallow, seasonally to permanently flooded, wetlands with sandy to gravelly, sparsely vegetated beaches as well as springs and fens along the edges of alkali lakes and wetlands. Along rivers, sparsely vegetated channel sandbars, sand and gravel beaches on islands and temporary pools on sandbars are considered primary. At reservoirs and inland lakes such elements include sparsely vegetated shoreline beaches, peninsulas, islands composed of sand and gravel or shale and their interface with the water bodies.
In its final ruling, the USFWS identified a total of 19 habitat units in the states of Minnesota, Montana, Nebraska, North Dakota, and South Dakota as critical to aiding piping plover recovery (USFWS 2002c).

Within Montana, 40,423.1 hectares (99,887.5 acres) including four separate units comprised of various ownership patterns are designated as critical habitat (Table 7).

Table 7. Land ownership within unit boundaries for critical piping plover habitat in Montana. Source: USFWS (2002).

| **Critical Habitat Unit** | **Ownership (in hectares)** | | | | |
|---|---|---|---|---|---|
| | Federal | State | Tribal | Private | Total |
| **MT-1 Sheridan County** | 5,405 | 119 | | 2,254 | 7,779 |
| **MT-2 Missouri River** | | | | | 202 |
| **MT-3 Fort Peck Reservoir** | 31,311 | | | | 31,311 |
| **MT-4 Bowdoin NWR** | 38,049 | 119 | | 2,254 | 40,423 |

Sheridan County (Unit MT-1), in the extreme northeastern corner of the state, includes 20 alkali lakes and wetlands. Essential nesting habitat is dispersed throughout this unit. The Missouri River units (MT-2 and MT-3) consist of both reservoir and river reaches: Fort Peck Reservoir is located entirely within the Charles M. Russel NWR, while unit MT-2 encompasses approximately 201.8 km of the Missouri River just west of Wolf Point to the Montana-North Dakota border.

The river reach below Fort Peck Reservoir to the confluence of the Milk River is not included as it is highly degraded and contains few sandbars. Bowdoin NWR is the site of the fourth critical habitat unit (MT-4). Despite sporadic breeding records at Alkali Lake in Pondera County, Bowdoin NWR, located in east-central Phillips County, represents the typical western edge of the Northern Great Plains breeding population of piping plovers.

In Phillips County, three historic lake beds at Nelson Reservoir most likely provided essential habitat to breeding piping plovers however this area was flooded when the reservoir was created for irrigation purposes. While Nelson Reservoir was originally proposed for critical habitat inclusion, it was excluded from the final listing as a Memorandum of Understanding (MOU) between the Bureau of Reclamation (BOR), the USFWS, and local Irrigation Districts was in place that would minimize the threat of flooding to active piping plover nest sites. Additionally, as part of the terms and conditions of a 1990 biological opinion on the operation of Nelson Reservoir by the BOR, conservation measures had been employed to minimize take, and would continue.

Occupied nesting habitat on North Alkali Lake in Pondera County occurs on Blackfeet tribal land and was not designated critical habitat at the request of the tribal government. Habitat on tribal lands determined essential to conserve the species may be designated. This was the case for sand bars along the Missouri River along the Fort Peck Reservation. The USFWS believes this designation is consistent with the special trust responsibility the Federal government has to Indian people to preserve and protect their lands and resources.

In Montana, spring arrival of the species most often occurs from late April through early May with departure occurring by late August (Montana Piping Plover Recovery Committee 1997). Recent analysis of migration data from banded Great Lakes birds suggests that critical habitat units are used heavily during migration (Stucker and Cuthbert 2006). Further, while stopover length could not be quantified in this study the authors speculate that it may be variable in length for the Great Lakes population, ranging from several days to one month based on anecdotal reports (Stucker and Cuthbert 2006).

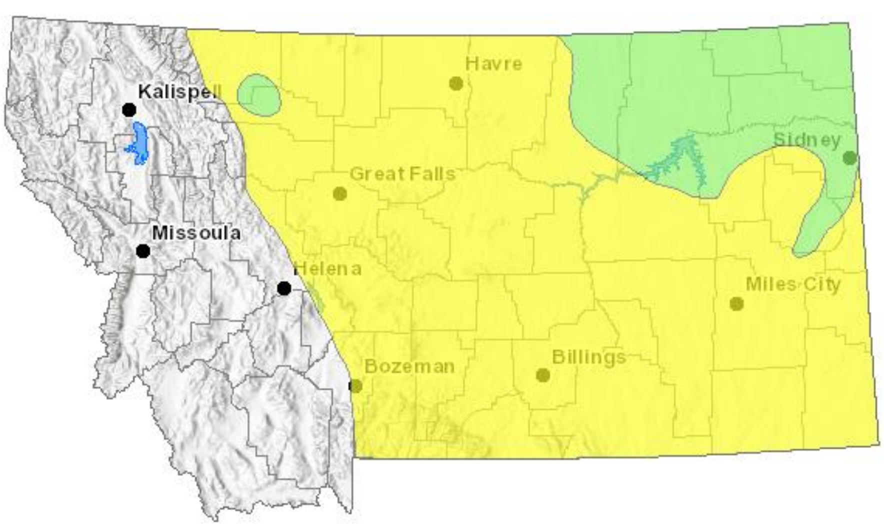


Figure 5. Summer range (green) and migratory range (yellow) of piping plovers in Montana. Source. Montana Natural Heritage Program.

## Red knot (Calidris canutus rufa)[32] (MT)

Information from this section is excerpted from Montana Field Guide (http://fieldguide.mt.gov/speciesDetail.aspx?elcode=ABNNF11020).

Red knots are a migratory species. Migratory stopovers in Montana are rare, but are most common at larger wetlands. A total of 60 percent of documented migratory stopovers in Montana have been at Freezeout Lake, Benton Lake National Wildlife Refuge, and Lake Bowdoin National Wildlife Refuge (Montana Natural Heritage Program Point Observation Database 2016). Red knots are rarely observed at Montana wetlands during migration in May or July through October (Montana Natural Heritage Program Point Observation Database 2016). There are only about 50 observations documented for individuals stopping at Montana wetlands, with only 0–4 for any given year since the 1970s; 60 percent of observations have been in May associated with northward migration (Montana Natural Heritage Program Point Observation Database 2016).

## Western snowy plover (*Charadrius alexandrines nivosus*)[33] (OR, WA)

Information included here is from USFWS (2007) and USACE and USFWS (2018).

### Listing History

On March 5, 1993, the Pacific coast population of the western snowy plover was listed as threatened. The Pacific coast population is defined as those individuals that nest within 50 mi (80.5 km) of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the United States and Baja California, Mexico.

### Life History/Biological requirements

The Pacific coast population of the western snowy plover breeds primarily above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes, beaches at creek and river mouths, and salt pans at lagoons and estuaries. Less common nesting habitats include bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and river bars.

Migrants begin arriving at breeding areas in southern Washington in early March and in central California as early as January, although the main arrival is from early March to late April. Since some individuals nest at multiple locations during the same year, birds may continue arriving through June. Males make a nest scrape, which is a depression in the sand or substrate made by leaning forward on his breast and scratching his feet while rotating his body axis.

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32 http://fieldguide.mt.gov/speciesDetail.aspx?elcode=ABNNF11020

33 Pacific coast population

The earliest nests on the California coast occur during the first week of March in some years and by the third week of March in most years. Peak initiation of nesting is from mid-April to mid-June. Hatching lasts from early April through mid-August, with chicks reaching fledging age approximately 1 month after hatching.

In winter, western snowy plovers are found on many of the beaches used for nesting as well as on beaches where they do not nest, in man-made salt ponds, and on estuarine sand and mud flats.

#### Distribution and Critical Habitat

Critical habitat was designated for the western snowy plover December 7, 1999, again on September 29, 2005, and most recently on June 6, 2012. The current Pacific coast breeding population extends from Damon Point, Washington, south to Bahia Magdalena, Baja California, Mexico [including both Pacific and Gulf of California coasts)]. The western snowy plover winters mainly in coastal areas from southern Washington to Central America.

#### Threats

Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have resulted in a decline in active nesting areas and in the size of the breeding and wintering populations.

### Yellow-billed cuckoo (*Coccyzus americanus*) (OR, WA, ID, MT)

Information in this section from USACE (2018).

#### Listing History

The western yellow-billed cuckoo was listed as threatened October 3, 2014, while critical habitat was proposed August 15, 2014, but a final designation has not been made. The western DPS includes Arizona, California (Baja California, Baja California Sur, Chihuahua, western Durango, Sinaloa, and Sonora), western Colorado, Idaho, western Montana, western New Mexico, Nevada, Oregon, western Texas, Utah, Washington, western Wyoming, and southwest British Columbia.

#### Life History/Biological requirements

As summarized by Cornell University (https://www.allaboutbirds.org/guide/Yellow-billed_Cuckoo/lifehistory): Yellow-billed cuckoos use wooded habitat with dense cover and water nearby, including woodlands with low, scrubby, vegetation, overgrown orchards, abandoned farmland, and dense thickets along streams and marshes. In the Midwest, look for cuckoos in shrublands of mixed willow and dogwood, and in dense stands of small trees such as American elm. In the Southwest, yellow-billed cuckoos are rare breeders in riparian woodlands of willows, cottonwoods and dense stands of mesquite to breed.

Yellow-billed cuckoo prey largely on caterpillars. On the east coast, periodic outbreaks of tent caterpillars draw cuckoos to the tent-like webs, where they may eat as many as 100 caterpillars at a sitting. Fall webworms and the larvae of gypsy, brown-tailed, and white-marked tussock moths are also part of the cuckoo's lepidopteran diet, often supplemented with beetles, ants, and spiders. They also take advantage of the annual outbreaks of cicadas, katydids, and crickets, and will hop to the ground to chase frogs and lizards. In summer and fall, cuckoos forage on small wild fruits, including elderberries, blackberries and wild grapes. In winter, fruit and seeds become a larger part of the diet.

Pairs may visit prospective nest sites multiple times before building a nest together. Nest heights can range from 0.98 yds (0.9 m) to as much as 30 yds (27.5 m) off the ground, with the nest placed on a horizontal branch or in the fork of a tree or large shrub. In the West, nests are often placed in willows along streams and rivers, with nearby cottonwoods serving as foraging sites.

The male and female yellow-billed cuckoo build a loose stick nest together, using twigs collected from the ground or snapped from nearby trees and shrubs. The male sometimes continues bringing in nest materials after incubation has begun. Clutch size can range from 1-5 eggs with up to 2 clutches per year.

**Distribution and Critical Habitat**

Critical habitat is proposed, but not yet designated for yellow-billed cuckoo. Critical habitat was proposed in 2013. The breeding range of the yellow-billed cuckoo formerly included most of North America from southern Canada to the Greater Antilles and northern Mexico (AOU 1957, 1998).

In recent years, the species' distribution in the west has contracted. The northern limit of breeding in the western coastal States is now in Sacramento Valley, California, and the northern limit of breeding in the western interior States is southern Idaho (AOU 1998, Hughes 1999). The species overwinters from Columbia and Venezuela, south to northern Argentina (Ehrlich et al. 1992; AOU 1998).

**Threats**

The greatest threat to the species has been reported to be loss of riparian habitat. It has been estimated that 90% of the cuckoo's stream-side habitat has been lost (USFWS 2018a). Habitat loss in the west is attributed to agriculture, dams, and river flow management, overgrazing and competition from exotic plants such as tamarisk.

# Amphibians

## Oregon spotted frog (*Rana pretiosa*) (OR, WA)

Information in this section from USACE (2018) and other sources.

### Listing History

The Oregon spotted frog was listed as threatened August 29, 2014.

### Life History/Biological requirements

Adult Oregon spotted frogs begin to breed by 1 to 3 years of age, depending on sex, elevation, and latitude. Males may breed at 1 year at lower elevations and latitudes, but generally breed at 2 years of age. Females breed by 2 or 3 years of age, depending on elevation and latitude. Breeding occurs in February or March at lower elevations and between early April and early June at higher elevations. Males and females separate soon after egg-laying, with females returning to fairly solitary lives. Males often stay at the breeding site, possibly for several weeks, until egg-laying is completed. Females may deposit their egg masses at the same locations in successive years.

The Oregon spotted frog life cycle requires shallow water areas for egg and tadpole survival; perennially deep, moderately vegetated pools for adult and juvenile survival in the dry season; and perennial water for protecting all age classes during cold wet weather. The Oregon spotted frog inhabits emergent wetland habitats in forested landscapes, although it is not typically found under forest canopy. Historically, this species was also associated with lakes in the prairie landscape of the Puget lowlands. This is the most aquatic native frog species in the Pacific Northwest, as all other species have a terrestrial life stage. Post-metamorphic Oregon spotted frogs are opportunistic predators that prey on live animals, primarily insects, found in or near the water.

### Distribution and Critical Habitat

Critical habitat was designated for the Oregon spotted frog May 11, 2016. Historically, the Oregon spotted frog ranged from British Columbia to the Pit River basin in northeastern California. Currently, the Oregon spotted frog is found from extreme southwestern British Columbia south through the Puget Trough and in the Cascades Range from south-central Washington at least to the Klamath Basin in southern Oregon. Oregon spotted frogs occur in lower elevations in British Columbia and Washington and are restricted to high elevations in Oregon.

Oregon Spotted Frogs are highly aquatic and live in or near permanent bodies of water, including lakes, ponds, slow streams and marshes. They prefer areas with thick algae and vegetation for cover, but may also hide under decaying vegetation. They are most often found in non-woody wetland plant communities (species such as sedges, rushes and grasses). Most Oregon Spotted Frogs hibernate and aestivate. Oregon Spotted Frogs distribute through a wide range of altitudes and in Washington have been found from 40 to 620 meters above sea level (McAllister and Leonard 1997). Adults eat insects, mollusks, crustaceans and arachnids. Larvae eat algae and organic debris. The timing of breeding is related to ice melt on lakes, ponds and marshes. Breeding occurs from February to March in the lower elevations, and from March to April in the higher elevations in the Cascade Range. Oregon Spotted Frogs lay their eggs in the shallows of a permanent water source.

Oregon Spotted Frogs are generally associated with wetland complexes > 4 ha (10 acres) in size with extensive emergent marsh coverage that warms substantially from spring to fall (Pearl and Hayes 2004). Hayes (1994a, b) stressed the reliance of this species on warm-water habitats. Washington's remaining populations of Oregon Spotted Frogs occupy palustrine wetlands connected to riverine systems. The perennial creeks and associated network of intermittent tributaries provide aquatic connectivity between breeding sites, active season habitat and overwintering habitat. Additionally, perennially flowing waters may provide the only suitable habitat during extreme summer drought or during winter when still-waters become hypoxic (low dissolved oxygen levels that are detrimental to aerobic organisms). Associated wetlands have a mix of dominance types including aquatic bed, emergent, scrub-shrub, and forested wetlands. The seasonally inundated wetland margins are frequently hay fields and pasture. The less disturbed sites have wet meadows and prairie uplands. Some occupied sites are engineered by American Beaver (*Castor canadensis*, hereafter "beaver"). All the remaining Oregon Spotted Frog sites have moderate to severe habitat alteration including a history of cattle grazing and/or hay production as well as encroaching or established rural residential development. Hydrology has been altered to some extent at all sites with the most extensive changes at Conboy Lake National Wildlife Refuge and surrounding area.

Watson et al. (2000; Black River) found that different life stages of Oregon Spotted Frogs had different hydrological needs that varied by season. For development of eggs and larvae, relatively stable water levels were needed during the breeding season. For survival of transformed frogs, deeper water pools were critical during the summer dry season. Adequate water levels over emergent vegetation were important for survival of all age classes during the wet season and coldest time of the year. In general, frogs selected sedge-dominated and hardhack (*Spiraea douglasii*)–dominated types and avoided reed canarygrass types, alder/willow, and deep water. Uplands were not used. During the breeding season, frogs preferred sedge-dominated habitat particularly sedge/rush found in association with breeding sites. During the dry season, frogs preferred hardhack-dominated habitats. The hardhack was in the deepest waters and these retained water during dry periods. Also, the hardhack shaded out reed canarygrass preventing dense, impenetrable grass cover. Aquatic connectivity was essential; frogs did not move terrestrially to isolated ponds. The predominant use of shallow water habitat by Oregon Spotted Frogs was illustrated by Watson et al. (1998, 2003), who found Oregon Spotted Frogs (n = 295 radio-telemetry locations) selected water depths of 10–30 cm (~4–11.7 in.) with less emergent vegetation and more submergent vegetation than adjacent habitats.

**Threats**

Habitat alteration appears to be the primary threat to the Oregon spotted frog. Breeding locations makes Oregon spotted frogs acutely vulnerable to fluctuating water levels, disease, predation, poor water quality, and extirpation from stochastic events. Hydrologic changes, resulting from activities such as water diversions and removal of beavers, increase the likelihood of fluctuating water levels and temperatures, and may also facilitate predators.

# Fish

## Bull trout (*Salvelinus confluentus*) (OR, WA, ID, MT)

Please refer to the USFWS Final Critical Habitat Designation for Bull Trout in Idaho, Oregon, Washington, Montana, and Nevada (USFWS 2015) for the latest information on bull trout distribution and critical habitat.

Bull trout (*Salvelinus confluentus*) were listed under the Endangered Species Act (Act) in 1999 as threatened throughout their range in Washington, Oregon, Idaho, Montana and Nevada. Bull trout are a cold-water fish of relatively pristine streams and lakes in northwestern North America. They are grouped with the char, within the salmonid family of fishes. They have more specific habitat requirements than most salmonids, including the "Four C's": Cold, Clean, Complex and Connected habitat. Bull trout require the coldest water temperatures; they require among the cleanest stream substrates for spawning and rearing; they require complex habitats, including streams with riffles and deep pools, undercut banks and lots of large logs; and they need connection from river, lake and ocean habitats to headwater streams for annual spawning and feeding migrations. Bull trout can be found throughout the Columbia and Snake river basins, extending east to headwater streams in Montana and Idaho, into Canada and in the Klamath River Basin of southcentral Oregon. However, the distribution of populations is scattered and patchy, primarily due to habitat degradation and fragmentation. They are excellent indicators of water quality; protecting and enhancing their habitat can improve the water quality of rivers and lakes throughout their range.

**Listing History**

The USFWS issued a final rule listing the Columbia River population of bull trout as threatened on June 10, 1998, while critical habitat for this species was listed on October 18, 2010. Bull trout are currently listed throughout their range in the United States as a threatened species.

**Life History/Biological requirements**

Most bull trout populations are migratory, spending portions of their life cycle in larger rivers or lakes before returning to smaller streams to spawn, while some populations complete their entire life cycle in the same stream. Some bull trout in the Coastal-Puget Sound population migrate between fresh water and the marine environment. Bull trout can grow to more than 20 pounds in lake environments and live up to 12 years. Under exceptional circumstances, they can live more than 20 years.

Of all the native salmonids in the Pacific Northwest of the United States, bull trout generally have the most specific habitat requirements (Rieman and McIntryre 1993), which are often referred to as "the four Cs": Cold, Clean, Complex, and Connected habitat. This includes cold water temperatures (often less than 12 degrees Celsius [54 degrees Fahrenheit]), complex stream habitat including deep pools, overhanging banks and large woody debris, and connectivity between spawning and rearing (SR) areas and downstream foraging, migration, and overwintering (FMO) habitats. Within the coterminous United States, bull trout currently occur in the Columbia River and Snake River basins in Washington, Oregon, Montana, Idaho, and Nevada; Puget Sound and Olympic Peninsula watersheds in Washington; the Saint Mary basin in Montana; and the Klamath River basin of south-central Oregon.

**Distribution and Critical Habitat**

Bull trout critical habitat was designated on October 18, 2010. In the Columbia River Basin, bull trout historically were found in about 60% of the basin. They now occur in less than half of their historic range. Populations remain in portions of Oregon, Washington, Idaho, Montana, and Nevada (Table 8).

Table 8. Acres and miles of Bull trout critical habitat in Idaho, Montana, Oregon and Washington.

| | Stream Miles | Acres of Lakes or Reservoirs |
|---|---:|---:|
| Idaho | 8,771.6 | 170,217.5 |
| Montana | 3,056.5 | 221,470.7 |
| Oregon | 2,835.9 | 30,255.5 |
| Washington | 3793.3 | 66,308.1 |

The USFWS designated about 18,975 miles of streams and 488,252 acres of lakes and reservoirs in Idaho, Oregon, Washington, Montana and Nevada as critical habitat for bull trout. In Washington, 754 miles of marine shoreline are included in the final designation. The designation identifies 32 critical habitat units and 99 sub-units on 3,500 water body segments across the five states. These areas are clustered into six recovery units where recovery efforts will be focused. By state, the designation covers approximately:

- Idaho: 8,772 stream miles and 170,218 acres of lakes or reservoirs
- Oregon: 2,836 stream miles and 30,256 acres of lakes or reservoirs
- Washington: 3,793 stream miles, 66,308 acres of lakes or reservoirs and 754 miles of marine shoreline
- Montana: 3,056 stream miles and 221,471 acres of lakes or reservoirs
- Nevada: 72 stream miles.

In some areas, the critical habitat designation shares Columbia or Snake river borders, including:

- Oregon/Idaho (Snake River): 108 stream miles
- Washington/Idaho (Snake River): 37 stream miles
- Washington/Oregon (Columbia River): 301 stream miles

Table 9. Stream/shoreline distance (miles/kilometers) designated as bull trout critical habitat by critical habitat unit.

| Critical Habitat Unit | Stream/Shoreline Kilometers | Stream/Shoreline Miles |
|---|---:|---:|
| Olympic Peninsula | 748.7 | 465.2 |
| Olympic Peninsula (Marine) | 592.2 | 328.8 |
| Puget Sound | 1,840.20 | 1,143.50 |
| Puget Sound (Marine) | 684 | 425 |
| Lower Columbia River Basins | 119.3 | 74.2 |
| Upper Willamette River | 312.4 | 194.1 |
| Hood River | 128.1 | 79.6 |
| Lower Deschutes River | 232.8 | 144.7 |
| Odell Lake | 27.4 | 17 |
| Mainstem Lower Columbia River | 340.4 | 211.5 |
| Klamath River Basin | 445.2 | 276.6 |
| Upper Columbia River Basins | 931.8 | 579 |
| Yakima River | 896.9 | 557.3 |
| John Day River | 1,089.60 | 677 |
| Umatilla River | 163 | 101.3 |
| Walla Walla River Basin | 383.7 | 238.4 |

| | | |
|---|---|---|
| Lower Snake River Basins | 270.8 | 168.3 |
| Grande Ronde River | 1,057.90 | 657.4 |
| Imnaha River | 285.7 | 177.5 |
| Sheep and Granite Creeks | 47.9 | 29.7 |
| Hells Canyon Complex | 377.5 | 234.6 |
| Powder River Basin | 296.5 | 184.2 |
| Clearwater River | 2,702.10 | 1,679.00 |
| Mainstem Upper Columbia River | 520.1 | 323.2 |
| Mainstem Snake River | 451.7 | 280.6 |
| Malheur River Basin | 272.3 | 169.2 |
| Jarbidge River | 245.2 | 152.4 |
| Southwest Idaho River Basins | 2,150.00 | 1,335.90 |
| Salmon River Basin | 7,376.50 | 4,583.50 |
| Little Lost River | 89.2 | 55.4 |
| Coeur d'Alene River Basin | 821.5 | 510.5 |
| Kootenai River Basin | 522.5 | 324.7 |
| Clark Fork River Basin | 5,356.00 | 3,328.10 |
| Saint Mary River Basin | 34.7 | 21.6 |

## **Kootenai River white sturgeon (*Acipenser transmontanus*) (ID, MT)**

Information in this section from USFWS (1999) and USACE (2018).

### Listing History

The Kootenai River population of white sturgeon was listed as endangered on September 6, 1994.

### Life History/Biological requirements

The Kootenai River White Sturgeon is a land-locked species found along 167.7 miles of the Kootenai River extending from Kootenai Falls, Montana, located 31 river miles below Libby Dam, Montana, downstream through Kootenay Lake to Corra Linn Dam at the outflow from Kootenay Lake in British Columbia. The Kootenai River population of white sturgeon became isolated from other white sturgeon in the Columbia River basin during the last glacial age (approximately 10,000 years ago). Once isolated, the population adapted to the predevelopment habitat conditions in the Kootenai River drainage.

The species has been declining since the mid-1960, and its population has experienced almost no reproduction since 1974 because of habitat fragmentation—construction of the Libby Dam in Montana altered river flow patterns and reduced river productivity, human development (which has contributed to loss of ecological functions), dikes constructed along the river channel (which reduced riparian function and floodplain interaction), and pollution.

Historically, spring runoff events re-sorted river sediments providing a clean cobble substrate conducive to insect production and sturgeon egg incubation. Side channels and low-lying deltaic marsh lands were un-diked at this time, providing productive, low velocity backwater areas. Nutrient delivery in the system was unimpeded by dams and occurred primarily during spring runoff. Floodplain ecosystems like the predevelopment Kootenai River are characterized by seasonal floods that promote the exchange of nutrients and organisms in a mosaic of habitats and thus enhance biological productivity.

### Distribution and Critical Habitat

Critical habitat was initially designated for white sturgeon September 6, 2001, with a revised designation July 9, 2008. The Kootenai River population is one of several land-locked populations of white sturgeon found in the Pacific Northwest. Although officially termed and listed as the "Kootenai River population of white sturgeon", this white sturgeon population inhabits and migrates freely in the Kootenai River from Kootenai Falls in Montana downstream into Kootenay Lake, British Columbia, Canada. A total of 18 miles of the Kootenai River in Idaho is designated critical habitat. Specific actions needed for recovery include spring flow augmentation during the reproduction period;

a conservation aquaculture program to prevent near-term extinction; habitat restoration, and research and monitoring programs to evaluate recovery progress (Duke et al. 1999).

**Threats**

Modification of the Kootenai River white sturgeon's habitat by human activities has changed the natural hydrograph of the Kootenai River, altering white sturgeon spawning, egg incubation, and rearing habitats; and reducing overall biological productivity. These factors have contributed to a general lack of recruitment in the white sturgeon population since the mid-1960's.

Spawning and rearing habitat are the key limiting factors for Kootenai River White Sturgeon. Spawning and incubation occur from mid-May to August (Duke et al. 1999). Depths for spawning white surgeon in the Lower Columbia River range from 3.5 to 25m—habitat suitability is poor for depths less than 2m, and moderate for depths of 2 to 4m (Parsley and Beckman 1994). Higher velocities are associated with more suitable substrate for white sturgeon egg incubation, greater egg dispersal, and reduction of egg predation (Barton et al. 2006). The greatest occurrence of white sturgeon spawning occurs in the area downstream of the mouth of Deep Creek at river kilometer mile 237.5 and 228.4 (Barton et al. 2006). Generally, habitat suitability is better in the straight reaches compared to meandering reaches because of coarser substrates and higher velocities (Barton et al. 2006). White sturgeon seldom spawn in the straight reach.

## Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) (OR)

Information in this section from USFWS (1995) and USACE (2018).

**Listing History**

The Lahontan cutthroat (LCT) was listed as endangered October 13, 1970 and downlisted to threatened status on July 16, 1975 to facilitate management and allow regulated angling.

**Life History/Biological requirements**

Historically, LCT were found in a wide variety of cold-water habitats: Large terminal alkaline lakes (e.g., Pyramid Lakes); oligotrophic alpine lakes (e.g., Lake Tahoe); slow meandering low-gradient rivers (e.g., Humboldt River); moderate gradient montane rivers (e.g., Carson, Truckee, Walker, and Marys Rivers); and small headwater tributary streams. Habitat preferences are similar to other salmonids. Lahontan cutthroat inhabit small streams characterized by cool water, pools in close proximity to cover and velocity breaks, well vegetated and stable stream banks, and relatively silt free, rocky substrate in riffle-run areas. Fluvial LCT generally prefer rocky areas, riffles, deep pools, and habitats near overhanging logs, shrubs, or banks.

Typical of cutthroat trout subspecies, Lahontans are an obligatory stream spawner. Spawning occurs from April through July, depending on stream flow, elevation, and water temperature. Females mature at 3 to 4 years of age, and males at 2 to 3 years of age. Consecutive year spawning by individuals is uncommon. Lake residents migrate up tributaries to spawn in riffles or tail ends of pools. Distance traveled varies with stream size and race of cutthroat trout. Populations in Pyramid and Winnemucca Lakes reportedly migrated over 100 mi (160.9 km) up the Truckee River into Lake Tahoe. Lahontan cutthroat trout spawning migrations have been observed in water temperature ranging from 41–60.8 °F (5–16 °C).

Stream resident LCT are opportunistic feeders, with diets consisting of drift organisms, typically terrestrial and aquatic insects. In lakes, small LCT feed largely on insects and zooplankton, and larger LCT feed on fish.

**Distribution and Critical Habitat**

No critical habitat has been designated for Lahontan cutthroat trout. The Lahontan cutthroat is an inland subspecies of cutthroat trout endemic to the physiographic Lahontan basin of northern Nevada, eastern California, and the Coyote Lake basin in southeast Oregon. Lahontan cutthroat trout currently occupy between 155 and 160 streams; 123 to 129 streams within the Lahontan basin and 32 to 34 streams outside the basin, with approximately 482 mi (775.7 km) of occupied habitat.

Major impacts to LCT habitat and abundance include: 1) reduction and alteration of stream discharge; 2) alteration of stream channels and morphology; 3) degradation of water quality; 4) reduction of lake levels and concentrated chemical components in natural lakes; and 5) introductions of non-native fish species. These alterations are typically associated with agricultural use, livestock and feral horse grazing, mining, and urban development. Alteration and degradation of LCT habitat have also resulted from logging, highway and road construction, dam building, and the discharge of effluent from wastewater treatment facilities.

Lahontan cutthroat trout are native to the following southeastern Oregon streams: Willow Creek, Whitehorse Creek, Little Whitehorse Creek, Doolitle Creek, Fifteen Mile Creek in the Coyote Lake Basin; and Indian Creek, Sage Creek, and Line Canyon Creek, tributaries of McDermitt Creek in the Quinn River basin (which flows into Nevada).

Lahontan cutthroat trout are obligate but opportunistic stream spawners. Typically, they spawn from April through July, depending on water temperature and flow characteristics. Autumn spawning runs have been reported from some populations. The fish may reproduce more than once, though post-spawning mortality is high (60 to 90 percent). Lake residents migrate into streams to spawn, typically in riffles on well washed gravels. The behavior of this subspecies is typical of stream spawning trout; adults court, pair, and deposit and fertilize eggs in a redd dug by the female. Although the Lahontan cutthroat in Oregon were originally classified as Willow-Whitehorse cutthroat trout, genetic and taxonomic investigations led to the re-classification in 1991 (Williams 1991).

Lahontan trout are stocked in Mann Lake, the only place in Oregon stocked with this desert race of cutthroat trout.[34]

The Quinn River Lahontan Cutthroat Trout SMU is comprised of four populations, three of which are now extinct due to hybridization with non-native rainbow trout. Sage Creek is the only population to persist in the SMU, has an extremely limited distribution and abundance, and is vulnerable to hybridization.[35] Distribution of Lahontan cutthroat trout in the Oregon portion of the Quinn River Basin is limited to 15 km in Sage and Line Canyon creeks.[36]

The Coyote Lake SMU is comprised of five native cutthroat trout populations. Distribution is naturally fragmented, restricted by barrier falls and a discontinuous stream network. Three populations have low abundance and limited productivity. Lahontan cutthroat trout are the only fish species present in Willow, Whitehorse, and Antelope basins.[37]

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[34] ODFW: https://myodfw.com/fishing/southeast-zone

[35] https://www.dfw.state.or.us/fish/ONFSR/docs/final/09-cutthroat-trout/ct-summary-quinn-river.pdf

[36] Ibid.

[37] https://www.dfw.state.or.us/fish/ONFSR/docs/final/09-cutthroat-trout/ct-summary-coyote-lake.pdf

## Pallid sturgeon (*Scaphirhynchus albus*) (MT)

Information in this section from listed sources and USACE (2018).

### Listing History

The Pallid sturgeon was listed as endangered under the Endangered Species Act on September 6, 1990. Since listing, the status of the species has improved and is currently stable.

### Life History/Biological requirements

The Pallid sturgeon is native to the Missouri and Mississippi rivers and adapted to the pre-development habitat conditions that historically existed in these rivers. These conditions generally can be described as large, free-flowing, warm-water, and turbid rivers with a diverse assemblage of dynamic physical habitats. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and a dynamic main channel formed the large-river ecosystem that met the habitat and life history requirements of Pallid Sturgeon and other native large-river fishes.

Historic data on preferred or occupied habitat is lacking. Recent data suggests Pallid sturgeon primarily utilize main channel, secondary channel, and channel border habitats throughout their range. Juvenile and adult Pallid sturgeon are rarely observed in habitats lacking flowing water which are removed from the main channel (i.e., backwaters and sloughs). Specific patterns of habitat use and the range of habitat parameters used may vary with availability and by life stage, size, age, and geographic location.

Habitat requirements of larval and young-of-year Pallid sturgeon remain largely undescribed across the species' range, primarily as a result of low populations of spawning adults and poor recruitment.

### Distribution and Critical Habitat

No critical habitat has been designated for the Pallid sturgeon. Since listing in 1990, wild and hatchery Pallid sturgeon have been documented in the Mississippi and Missouri Rivers.

Pallid Sturgeon are a migratory species that use the lower Yellowstone River primarily during spring and summer, but during fall and winter use the Missouri River below the confluence with the Yellowstone (Tews 1994, Bramblett 1996). Some Pallid Sturgeon use the Fort Peck tailrace yearlong, but others move downstream in spring (in one case more than 300 kilometers) (Tews 1994).

Pallid Sturgeon use large, turbid rivers over sand and gravel bottoms, usually in strong current; also impoundments of these rivers (FWP). In Montana, Pallid Sturgeon use large turbid streams including the Missouri and Yellowstone rivers (Brown 1971, Flath 1981) (Figure 6). They use all channel types, primarily straight reaches with islands (Bramblett 1996). They primarily use areas with substrates containing sand (especially bottom sand dune formations) and fines (93% of observations) (Bramblett 1996). Stream bottom velocities ranged between 0.0 and 1.37 meters per second, with an average of 0.65 meter per second (Bramblett 1996). Depths used were 0.6 to 14.5 meters and averaged 3.30 meters, and they seem to move deeper during the day (Bramblett 1996). Channel widths from 110 to 1100 meters are used and average 324 meters (Bramblett 1996). Water temperatures used ranged from 2.8 to 20 degrees C (Tews 1994, Bramblett 1996). Water turbidity ranged from 12 to 6400 NTU (Turbidity Units) (Tews 1994). Once Pallid Sturgeon spawn, the resulting larvae have a strong tendency to drift great distances downstream over a long period of time (Kynard 1998).

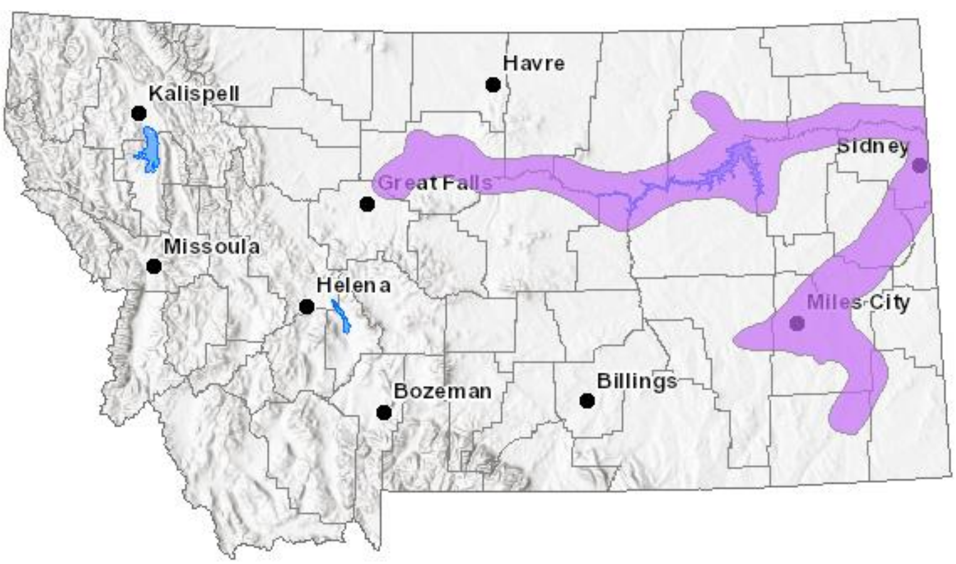


Figure 6. Pallid sturgeon use of the Missouri and Yellowstone Rivers.

**Threats**

Limiting factors include: 1) activities which affect in-river connectivity and the natural form, function, and hydrologic processes of rivers; 2) illegal harvest; 3) impaired water quality and quantity; 4) entrainment; and 5) life history attributes of the species (i.e., delayed sexual maturity, females not spawning every year, and larval drift requirements). The degree to which these factors affect the species varies among river reaches.

# Invertebrates

### Banbury Springs limpet (*Lanx spp.*) (ID)

Currently this species only exists at four cold-spring locations along the Snake River in Idaho that are isolated from each other: Thousand Springs, Box Canyon Springs, Briggs Springs and Banbury Springs. Primary factors affecting the Banbury Sprigs limpet in its four remaining coldwater spring complexes and tributaries are habitat modification, spring flow reduction, groundwater quality, the invasive New Zealand mudsnail and inadequate regulatory mechanisms.

### Bliss Rapids snail (*Taylorconcha serpenticola*) (ID)

ECOS—The Bliss Rapids snail occurs in cold water springs and spring-fed tributaries to the Snake River, and in some reaches of the Snake River. The Bliss Rapids snail is primarily found on cobble boulder substrate, and in water temperatures between 59–61 degrees Fahrenheit. Recent surveys indicate the species is distributed discontinuously over 22 miles, from River Mile (RM) 547-560, RM 566-572, and at RM 580 on the Snake River. The species is also known to occur in 14 springs or tributaries to the Snake River. The species does not occur in reservoirs.

It lives on stable rocks in flowing waters in the free-flowing reaches of the Snake River and in several cold-water springs in the Hagerman Valley (Bogan 2000). During the daytime, the snail resides on the sides and undersides of rocks.

Historically, this species occurred from Indian Cove Bridge to Twin Falls (Hershler et al. 1994). Populations occur in the lower reaches of the Malad River and in the Snake River between the springs above Hagerman and King Hill[38].

### Snake River physa snail (*Physa natricina*) (ID)

The Snake River physa snail is a freshwater mollusk found in the middle Snake River of southern Idaho. It has an ovoid shell that is amber to brown in color, and has 3 to 3.5 whorls (curls or turns in the shell). The physa can reach a maximum length of about 6.5 millimeters. The Snake River physa is believed to have evolved in the Pliocene to Pleistocene lakes and rivers of northern Utah and southeastern Idaho. While much information exists on the family Physidae, very little is known about the biology or ecology of this species. It is believed to be confined to the Snake River, inhabiting areas of swift current on sand to boulder-sized substrate. In 1995, the Service reported the known modern range of the species to be from Grandview, Idaho (RM 487) to the Hagerman Reach of the Snake River (RM 573). More recent investigations have shown this species to occur outside of this historic range to as far downstream as Ontario,

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[38] http://fishandgame.idaho.gov/ifwis/cwcs/pdf/Bliss%20Rapids%20Snail.pdf

Oregon (RM 368), with another population known to occur downstream of Minidoka Dam (RM 675). While the species' current range is estimated to be over 300 river miles, the snail has been recorded in only 5% of over 1,000 samples collected within this area, and it has never been found in high densities. The species' status is uncertain within the current known range, but portions of the middle Snake River (e.g., Milner Reservoir, RM 663 to Lower Salmon Falls Reservoir, RM 572) are of questionable habitat value given current water quality and water use issues. In addition, the sampling in this reach has been limited. Very few live specimens have been recovered from reservoirs which have been extensively sampled. The recovery area for the species extends from Snake River mile 553 to Snake River mile 675. It is currently listed as an Endangered species.

The species historical range included Idaho.

## Plants

### Bradshaw's desert parsley (*Lomatium bradshawii*) (OR, WA)

The majority of Bradshaw's desert parsley populations occur on seasonally saturated or flooded prairies, adjacent to creeks and small rivers in the southern Willamette Valley. Soils at these sites are dense, heavy clays, with a slowly permeable clay layer located 15-30 cm (6-12 in) below the surface. This clay layer results in a perched water table during winter and spring, and is critical to the wetland character of these grasslands, known as tufted hair-grass (*Deschampsia cespitosa*) prairies. Bradshaw's desert parsley occurs on alluvial (deposited by flowing water) soils. The species occurs on soils in the Wapto, Bashaw and Mcalpin Series (NRCS mapped soil unit STATSGO 81). Note: The distribution of this species should be reviewed prior to any actions along creeks and small rivers in the southern Willamette Valley to determine presence and the potential to affect this species as a result of any activities associated with an action.

### Nelson's checker-mallow (*Sidalcea nelsoniana*) (OR, WA)

Within the Willamette Valley, Nelson's checkermallow most frequently occurs in Oregon ash (*Fraxinus latifolia*) swales and meadows with wet depressions, or along streams. The species also grows in wetlands within remnant prairie grasslands. Some populations occur along roadsides at stream crossings where non-native plants, such as reed canarygrass (*Phalaris arundinacea*), blackberry (*Rubus* spp.), and Queen Anne's lace (*Daucus carota*), are also present. Nelson's checkermallow primarily occurs in open areas with little or no shade and will not tolerate encroachment of woody species. Note: The distribution of this species should be reviewed prior to any actions streams in its distribution in Oregon and Washington to determine presence and the potential to affect this species as a result of any activities associated with an action.

### Ute Ladies'-tresses (*Spiranthes diluvialis*) (WA, ID, MT)

Information in this section from the USFWS ECOS database and USACE (2018).

#### Listing History

Ute ladies'-tresses was listed as threatened on January 17, 1992. On October 12, 2004 there was a petition filed to delist Ute ladies'-tresses. The petition states that there is substantial new information indicating that the population size and distribution are much larger than known at the time of listing; there is more information on life history and habitat needs, allowing for better management, and threats are not as great in magnitude or imminence as understood at the time of listing. This plant remains listed as threatened.

Ute ladies'-tresses is a perennial herb with erect, glandular-pubescent stems 5-24 in (12.7 to 61 cm) tall arising from tuberous-thickened roots. It reproduces exclusively by seed. The plant's life cycle consists of four main stages: seedling, dormant, vegetative, and reproductive. Fruits are produced in late August or September with seeds shed shortly thereafter. Seeds are microscopic, dust-like, and readily dispersed by wind or water. This plant may remain dormant for eight to eleven years and may revert to below ground existence for one to four or more growing seasons before re-emerging with new above-ground shoots.

The vegetative shoots are produced in October and persist through the winter as small rosettes. These resume growth in the spring and develop into short-stemmed, leafy plants. It blooms from early July to late October. Flowering typically occurs earlier in sites that have an open canopy and later in well-shaded sites. Bees are the primary pollinators of Ute ladies'-tresses, particularly solitary bees.

In perennial streamside populations, Ute ladies'-tresses typically occur on shallow sandy loam, silty-loam, or clayey-silt alluvial soils overlying more permeable cobbles, gravels, and sediments. It is dominated by perennial graminoids and forbs, particularly *Agrostis stolonifea, Elymus repens, Juncus balticus, and Equisetum laeigatum*. Ute ladies'-tresses populations may persist for a short time in the grassy understory of woody riparian shrublands, but do not appear to thrive under these conditions (Ward and Naumann 1998).

#### Distribution and Critical Habitat

No critical habitat has been designated for this species. Populations of Ute ladies'-tresses orchids are known from three broad general areas of the interior western United

States—near the base of the eastern slope of the Rocky Mountains in southeastern Wyoming and adjacent Nebraska and north-central and central Colorado; in the upper Colorado River basin, particularly in the Uinta Basin; and in the Bonneville Basin along the Wasatch Front and westward in the eastern Great Basin, north-central and western Utah, extreme eastern Nevada, and southeastern Idaho. The species is also known to occur in Bonneville, Fremont, Jefferson, and Madison counties along the Snake River, has been discovered in southwestern Montana, and in the Okanogan area and along the Columbia River in North Central Washington.

The orchid occurs along riparian edges, gravel bars, old oxbows, high flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers. It also is found in wetland and seepy areas near freshwater lakes or springs. Note: The distribution of this species should be reviewed prior to any actions along riparian areas, rivers, and streams in its known distribution to determine potential to affect this species as a result of any activities associated with an action.

### Water howellia (*Howellia aquatilis*) (OR, WA, ID, MT)

Information in this section from USFWS ECOS database and USACE (2018).

#### Listing History

Water howellia was listed as threatened on July 14, 1994.

#### Life History/Biological requirements

Water howellia is an annual aquatic species in the bellflower family (Campanulaceae). Individuals are mostly submerged and rooted in bottom sediments. Stems branch near the soil surface and are 1.5-2.8 in (4-7 cm) long. The leaves are numerous and linear to linear-filiform, measuring 0.4-0.6 in (1-5 cm) long, with an entire margin or with a few teeth. The flowers are axillary, 0.08-0.11 in (2-2.7 mm) long, and a corolla is present (in emergent flowers) or lacking (in underwater flowers). The corolla is white to pale lavender and is deeply cleft on one side. The fruit is 0.3-0.4 in (8-10 mm) long. The seeds number 1-5 and are 0.08-0.2 in (2-4 mm) long. This species typically blooms May through August.

Information on herbarium labels or Oregon collections describe the habitat as "ponds in woods", "pond in shaded woods", and "stagnant ponds in the timber". Information from other locales indicate that this species is restricted to small, vernal, freshwater wetlands, glacial pothole ponds, or former river oxbows that have an annual cycle of filling with water over the fall, winter and early spring, followed by drying during the summer months. These habitats are generally small [< 2.47 ac (1 ha)] and shallow [< 3.3 ft (1 m deep)]. Bottom surfaces are reported as firm, consolidated clay, and organic sediments. Most locations were surrounded by deciduous trees and howellia was found in shallow water or around the edges of deep ponds. Associated species include duckweed (*Lemna* spp.), water starworts (*Callitriche* spp.), water buttercup (*Ranunculus aquaticus*), yellow water-lily (*Nuphar polysepalum*), bladderwort (*Utricularia vulgaris*), and pondweeds (*Potamogeton* spp.).

**Distribution and Critical Habitat**

No critical habitat has been designated for this species. Historically, water howellia was known to occur in one location in Mendocino County, California, four locations in northwest Oregon, two additional locations in Washington, and one location in northern Idaho.

As of drafting the recovery plan for this species in 1995, water howellia was known to occur in six locations; one in Idaho, three in Washington, and one in Montana, and one in California.

**Threats**

Habitat destruction appears to be the main threat and cause for decline of water howellia. Road and pasture development, grazing and trampling, timber harvest, invasive species, and wetland succession have been documented as potential factors.

## Willamette daisy (*Erigeron decumbens* var. *decumbens*) (OR)

This species occurs on alluvial soils (deposited by flowing waters). The Willamette daisy occurs on soils in the Wapto, Bashaw and Mcalpin Series (NRCS mapped soil unit STATSGO 81). The species is known to have been extirpated (destroyed or no longer surviving) from an additional 19 historic locations. Willamette daisy populations are known mainly from bottomland, but one population is found in an upland prairie remnant. Currently, 18 sites are known, distributed over an area of 700,000 hectares (1.7 million acres), between Grand Ronde and Goshen, Oregon. Note: The distribution of this species should be reviewed prior to any actions along riparian areas, rivers, and streams in its known distribution to determine potential to affect this species as a result of any activities associated with an action.

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