US Army Corps of Engineers ®
Walla Walla District
BUILDING STRONG®

DREISSENID MUSSEL RAPID RESPONSE ACTION PLAN PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

U.S. Army Corps of Engineers

Northwestern Division

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ACRONYMS

AIS	Aquatic Invasive Species
BCR	Benefit-To-Cost Ratio
BPA	Bonneville Power Administration
CEQ	Council on Environmental Quality
CO2	Carbon Dioxide
Corps	U.S. Army Corps of Engineers
CRB	Columbia River Basin
CRBIRRP	Columbia River Basin Interagency Invasive Species Response Plan: Zebra Mussels and Other Dreissenid Species
CRB Team	100th Meridian Initiative – Columbia River Basin Team
EA	Environmental Assessment
EDRR	early detection and rapid response
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
CFR	Code of Federal Regulations
FONSI	Finding of No Significant Impact
km	Kilometer
MBTA	Migratory Bird Treaty Act
mgd	Million Gallons Per Day
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRA	National Recreation Area
NWPCC	Northwest Power and Conservation Council
NWD	Northwestern Division
NWP	Corps Portland District
NWW	Corps Walla Walla District
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
PNWER	Pacific Northwest Economic Region
PSMFC	Pacific States Marine Fisheries Commission
Reclamation	U.S. Bureau of Reclamation
RHA	River and Harbor Act
SHPO	State Historic Preservation Office
STS	Submerged Traveling Screen
USACE	U.S. Army Corps of Engineers

USDA	U.S. Department of Agricultural
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VBS	Vertical Barrier Screen
WDFW	Washington Department of Fish and Wildlife
WRRDA	Water Resources and Reform Development Act

1 Introduction

1.1 Background Information

The US Army Corps of Engineers, Walla Walla District (Corps), proposes to implement a Rapid Response Action Plan (Plan) for the eradication of potential zebra (*Dresissena polymorhpa*) and quagga mussel [*D. bugensis* (collectively referred to as dreissenids)] infestations in the Columbia River Basin (CRB), as well as across infested waterbodies in the states of Washington, Oregon, Idaho, and Montana. Authorized through Section 104 of the River and Harbor Act of 1958, as amended by Section 1039(d) of the Water Resources Reform and Development Act of 2014 and Section 1178 of Water Infrastructure Improvements of the Nation Act of 2016, the Corps began laying the ground work for the Plan in 2017 by developing the *Final Integrated Letter Report and Programmatic Environmental Assessment for Federal Participation in Watercraft Inspection Stations, Columbia River Basin* (Appendix A). The potential is high for dreissenid invasion in the four-state area (FSA - Idaho, Montana, Oregon, and Washington), as recreational watercraft from across the country transport invasive species into other waterbodies. For example, between 1993 and 1999, the California Department of Food and Agriculture found live and dead zebra mussels on 18 different trailered watercraft that were inspected coming into the state. For this reason, inspection stations are now common throughout the northwest. Considering past data from California alone, it is assumed that dreissenids being introduced into the CRB at some point is not only possible, but highly probable.

The Columbia River Basin and the Four-State Area – What is the Difference?
These terms come up a lot in this EA, so it is best to be clear about the distinction between the Columbia River Basin (CRB) and the Four-State Area (FSA). The CRB is the catchment basin of the Columbia River. It includes the southeastern portion of the Canadian province of British Columbia, most of the U.S. states of Idaho, Oregon, and Washington, the western part of Montana, and very small portions of Nevada, Utah, and Wyoming. The FSA is simply the combined states of Idaho, Montana, Oregon, and Washington. Though these two areas often overlap, the CRB is defined by topographic and natural processes while the FSA is a political distinction.

This Environmental Assessment (EA) was prepared in accordance with Engineer Regulation (ER) 200-2-2, *Procedures for Implementing NEPA,* and the Council on Environmental Quality (CEQ) *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA),* Title 40 Code of Federal Regulations (CFR), Part 1500-1508. The objective of the EA is to evaluate potential environmental effects of the proposed Plan and determine if significant effects would result. If such effects are less than significant, a Finding of No Significant Impact (FONSI) would be issued and the Corps would proceed with the proposed action. If the environmental effects are determined to be significant, an Environmental Impact Statement (EIS) would be prepared before a decision is reached on whether to implement the proposed action. Applicable laws under which these effects would be evaluated include but are

not limited to, NEPA, the Endangered Species Act, the Clean Water Act, the Clean Air Act, and the National Historic Preservation Act.

The National Environmental Policy Act is a full disclosure law, providing for public involvement in the NEPA process. All persons and organizations that have a potential interest in this proposed action – including the public, other Federal agencies, state and local agencies, Native American Tribes, and interested stakeholders – are encouraged to participate in the NEPA process.

1.1.1 Dreissenid Mussel Presence and Life History in North American

1.1.1.1 Presence

Dreissenids are native to the Black Sea region of Eastern Europe and spread to the Great Lakes through cargo ship ballast water. The first zebra mussel detection in the Great Lakes occurred between 1986 and 1989. Quagga mussels were first detected in Lake Erie in 1989.

In the years post detection, these two dreissenids completely infested Lake Erie, Lake Huron, Lake Michigan, and Lake Ontario. By the early 1990s, it was feared that the aggressive expansion of the zebra mussel would be so rapid that by the year 2000, the zebra mussel could be expected to have colonized all North American rivers, lakes, and reservoirs that fit its broad ecological requirements. Currently, the Great Lakes, their tributaries, and major rivers in the mid-west have infestations (Figure 1).

The 100th Meridian Initiative spearheaded dreissenid vigilance through boat inspection stations in an attempt to keep dreissenids from becoming established west of the 100th meridian in the United States. Dreissenids have occurred west of the 100th meridian in the southwest, and more recently, Montana, but efforts appear to have slowed their spread.

1.1.1.2 Life History and Requirements

Zebra and quagga mussels share similar environmental requirements, but quagga mussels are known to colonize deeper waters, up to 425 feet, where zebra mussels typically occur no deeper than about 360 feet. Both mussels can colonize a variety of substrates, but are more likely to colonize softer substrates beyond 130 feet deep.

While dreissenids can produce eggs at temperatures as low 35° Fahrenheit (F), egg fertilization does not occur below 50°F. Spawning occurs with warmer temperatures and greater food availability. A single female can produce over 1 million eggs in a season and can spawn multiple times a year. Eggs develop into larvae, which develop into a free-swimming larval stage known as veligers, and maturation occurs over 12-18 months.

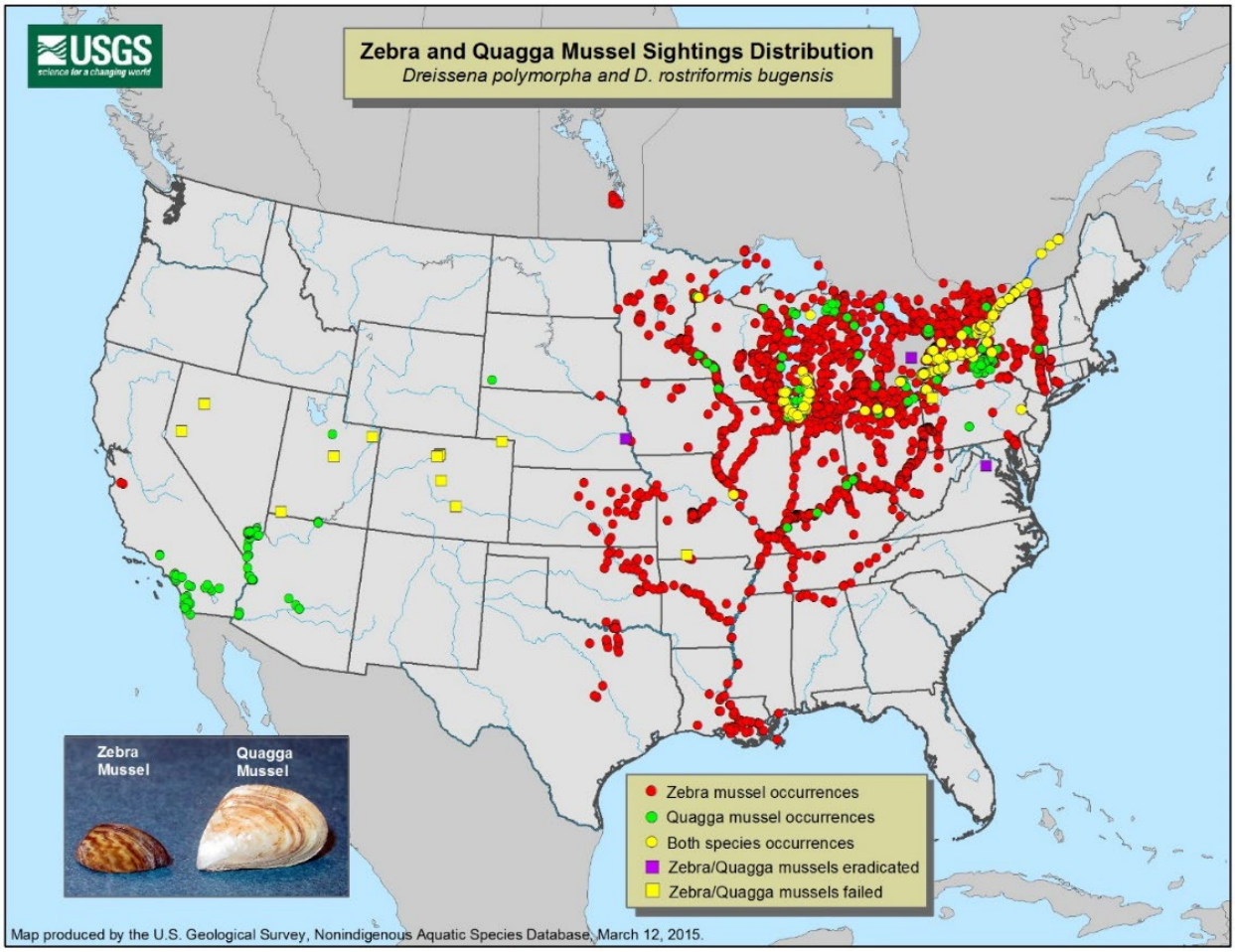

Figure 1. Zebra and quagga mussel occurrences in the Unites States and Canada since their first identification about twenty years ago. Occurrences in Montana are not shown because they were documented in 2017, after this map was created.

At the veliger stage, zebra and quagga mussels settle out of the water column and attach to a variety of substrates; the highest densities are found on gravel, boulder, and other hard substrates (similar to what can be found in shallow waters in the CRB and other waters throughout the region).

Water temperature limits are up to 86°F for quagga mussel, and 95°F for zebra mussel. Temperatures above this are fatal to dreissenids mussels. They can tolerate salinity up to 10 parts per million (ppm). A pH range of 6.0-8.5 and calcium ranges of at least 12 ppm is generally considered a requirement for adult survival and reproductive success.

Calcium is the most widely studied factor in dreissenid establishment and success and has led to subsequent calcium-based predictions of the likelihood of invasion in dreissenid-free waterways in the United States. A number of studies suggest that establishment is unlikely below 15 ppm. However, adult dreissenids are sometimes present in waters with lower dissolved calcium than this threshold.

1.1.2 Invasion Risk

Dreissenid mussels are successful across a broad range of depths, temperatures, and calcium concentrations. Studies suggest that in North America, dreissenids thrive in waters with much lower calcium levels than European countries. A study conducted at the University of Notre Dame predicted moderate to high invasion risk for the CRB based on a number of environmental risk factors (Figure 2). Invasion risk was found to be highest near the mainstem Columbia and Snake Rivers and in all waters west of the Cascades.

Currently, among the four states included in the Plan, only Montana has a single waterbody where dreissenid mussels have been detected. However, the threat of mussels being introduced is high. The primary means by which dreissenids establish in new waterbodies is transportation on or in recreational watercraft, typically encrusted on entangled aquatic vegetation or within live wells. Ultimately, anything that transports water from outside the CRB into the basin has the potential to bring invasive mussels with it.

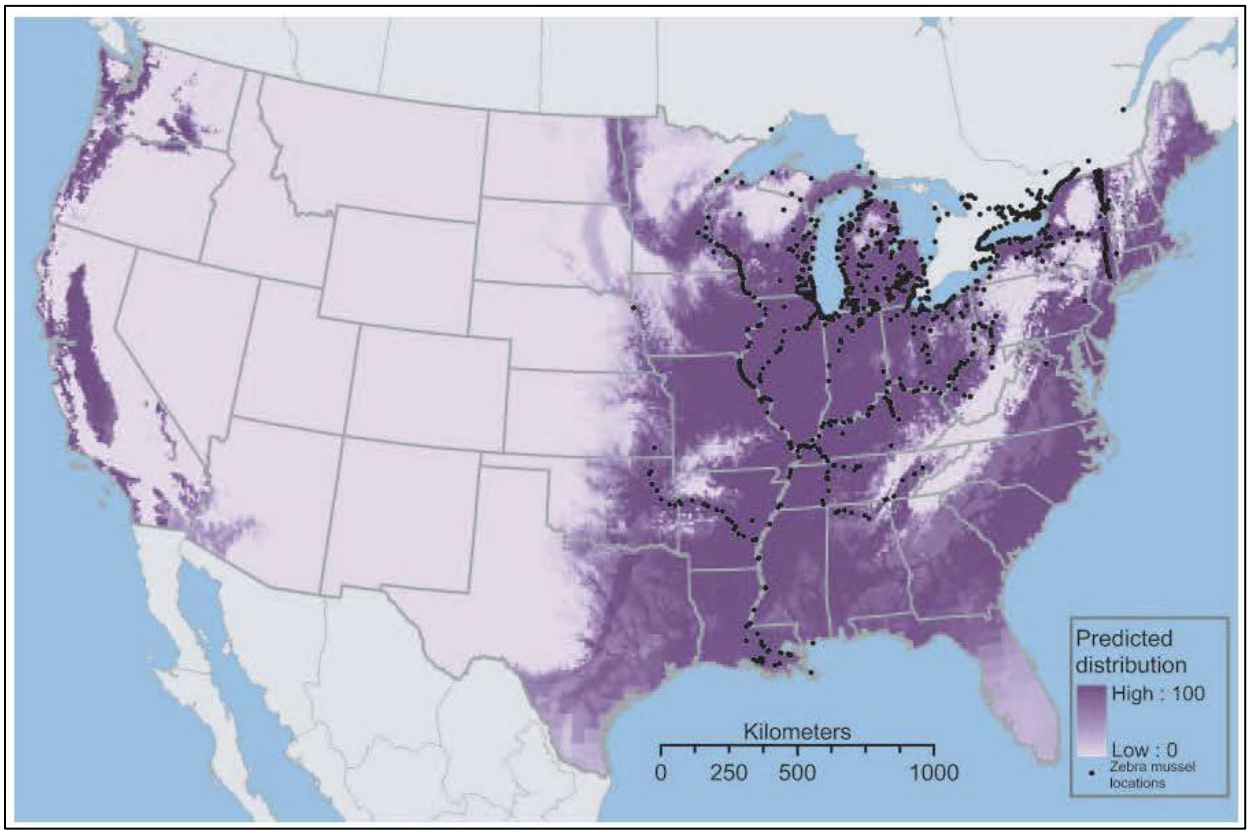

Figure 2. Estimated dreissenid invasion risk in the CRB and west of the Cascades (Drake and Bossenbroek, 2004). Predicted distribution is from 0 – 100%.

Watercraft inspection stations help indicate the scale of the problem and risk of potential invasion. Watercraft from across the nation enter the Pacific Northwest, including from many areas already home to invasive dreissenids. The diversity of the homeports of

these vessels is indicated in Figures 3 – 5. In 2015, over 120,000 watercraft were inspected entering the four-state area with 40 boats found to be contaminated with dreissenid mussels. Dreissenids have been intercepted entering the four-state area since 2015, and as inspections have scaled, so have detections. Inspections in Idaho alone totaled 83,840 in the first half of the 2018 season with dreissenids detected in 45 separate incidents.

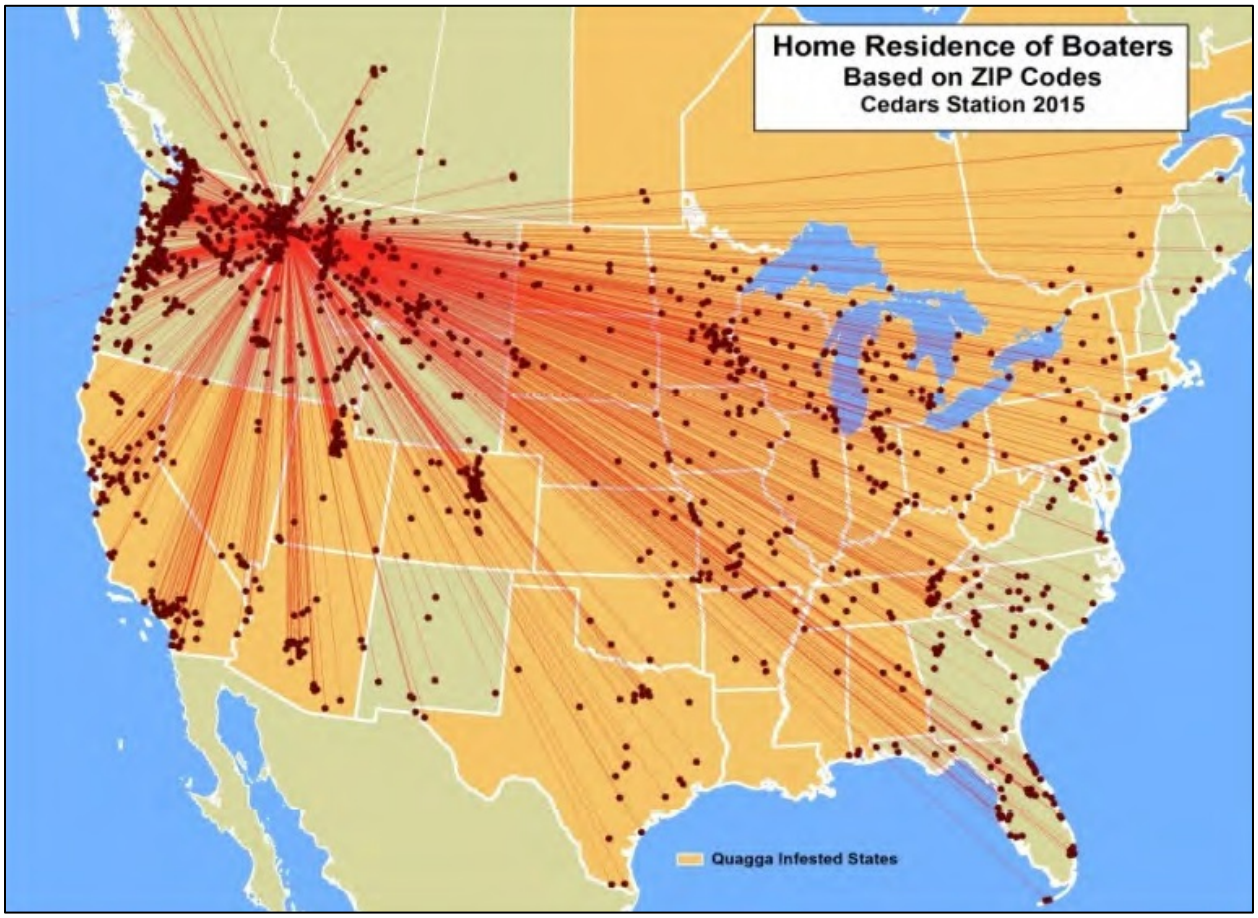

Figure 3. Geographic locations of boats entering Idaho based on owner zip codes of inspected watercraft at the Cedars check station in 2015 (Kootenai Environmental Alliance, 2018).

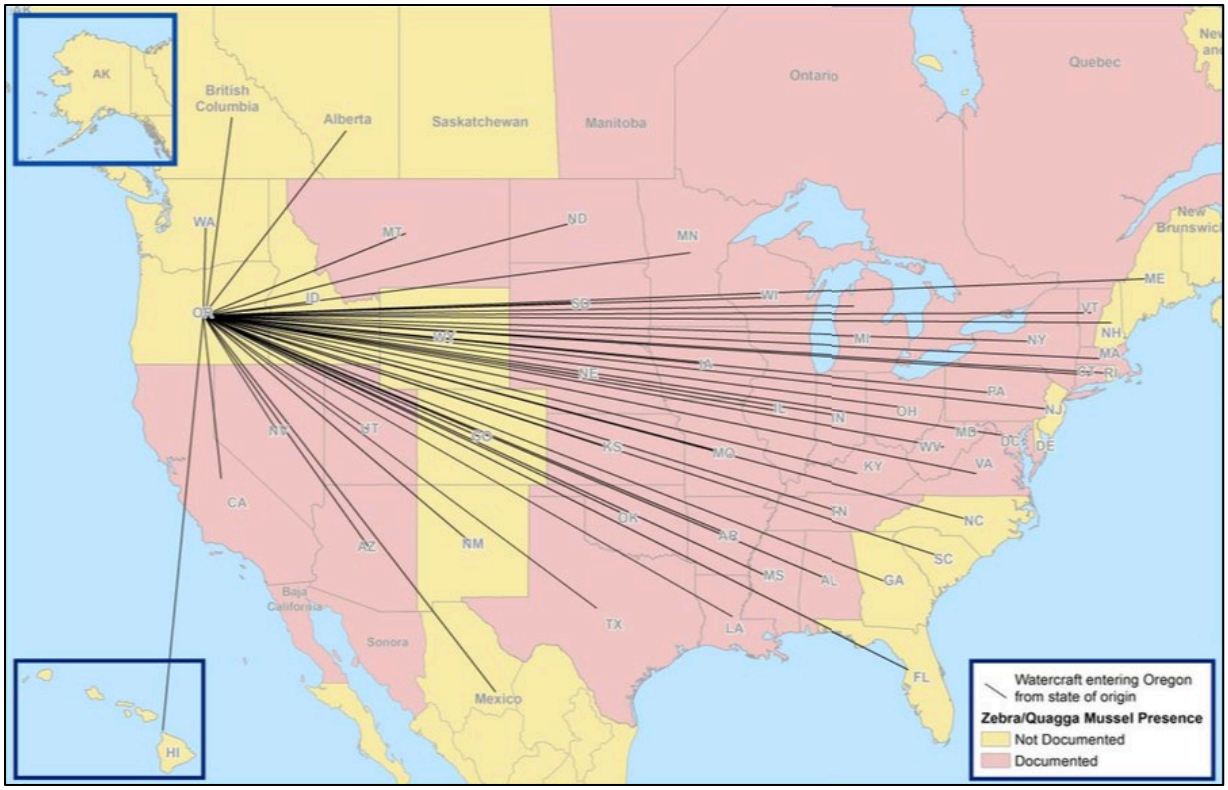

Figure 4. Geographic locations of boats entering Oregon based on owner zip codes of inspected watercraft in 2016 (Oregon Invasive Species Council, 2017).

Table 1. Watercraft Inspections and Dreissenid Detections in 2015.

State	Watercraft Inspected	Dreissenid Detections
Idaho	64,157	25
Montana	36,997	5
Oregon	12,671	10
Washington	8,943	0
Total	122,768	40

1.1.3 Effects of the Establishment of Dreissenid Mussels in the Four State Area

The significance and impact of the establishment of dreissenid mussels in the CRB and surrounding region cannot be overstated. They threaten the diversity or abundance of native species, ecological processes, and natural resources as well as commercial, agricultural, aquaculture, cultural, and recreational activities. Their rapid reproduction, prodigious capacity to filter the water, and biofouling behavior would permanently harm the region's aquatic ecosystems and create costly and logistically difficult maintenance concerns throughout the region's waterways.

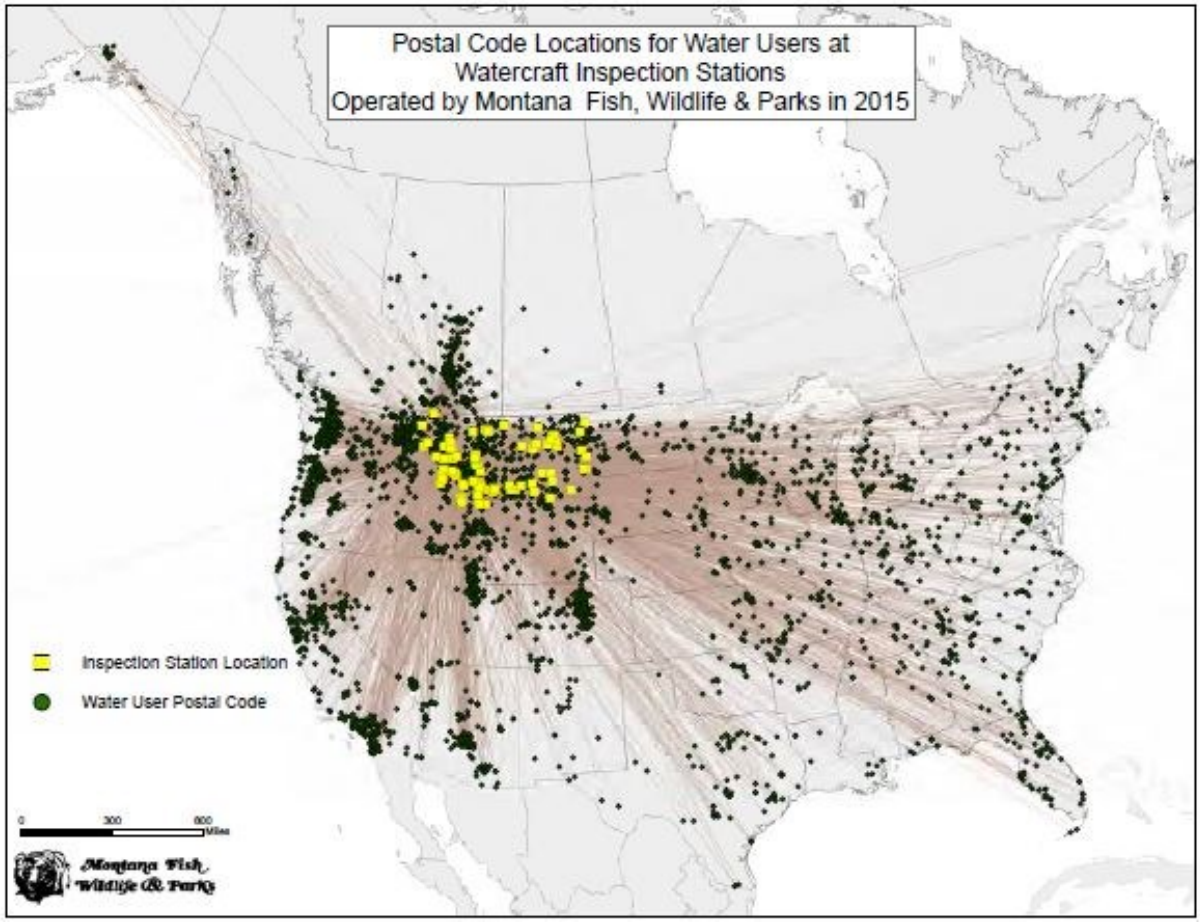

Figure 5. Geographic locations of boats entering Montana based on owner zip codes of inspected watercraft in 2015 (National Parks Service, 2017).

1.1.3.1 Economic Impacts of an Invasion

Dreissenid mussels are a tremendous source of biofouling (Figure 6). They accumulate on underwater and wetted structures, preventing those structures from operating as intended. Many facilities located in basins already infected by dreissenids face high costs from control measures and additional maintenance required to manage the infestation. These costs are typically passed on to consumers or taxpayers. From 1993 to 1999, estimated direct costs associated with zebra mussels in the Great Lakes cost the power industry alone $3.1 billion, with a total economic impact on industries, businesses, and communities of more than $5 billion. Similar costs are expected in the west in the event of an invasion. Given the vast amount of infrastructure in waterways of the four-state area, these costs could conceivably run even higher than an estimate built on a Great Lakes model. Examples of infestation impacts include:

- Major hydropower components at risk of being fouled or damaged by a dreissenid infestation including:
    - Raw water systems, which could result in a powerhouse shutdown (Figure 7).

- Flap gates, which could result in water entering protected areas (Figure 6).
- Instrumentation, which could result in plant operation problems.

- Major navigation lock components at risk of being fouled or damaged by a dreissenid infestation include raw water systems, instrumentation, and gate seals.
- Major ESA-listed fish passage and recreational and mitigation hatchery facility components at risk of being fouled or damaged by a dreissenid infestation include all submerged surfaces in low velocity areas, screens, and fish bypass systems (Figure 8).
- Major and minor water supply (municipal, industrial, and irrigation) and treatment facilities components at risk of being fouled or damaged by a dreissenid infestation include all submerged surfaces and screens.

Figure 6. Quagga Mussel Biofouling on Davis Dam Penstock Gate in California (Bureau of Reclamation, 2007)

Mussel infestations in other infested regions of the country have resulted in water users needing to expend significant resources on mitigation. For example:

- Quagga and zebra mussels have cost more in prevention and control than any other aquatic species to invade the United States, costing an estimated $5 billion in prevention and control efforts since their arrival in the 1980s.

- The quagga mussel infestation of water supply pipes, dams, and other infrastructure has cost the Metropolitan Water District of Southern California about $35 million over the last six years, with costs expected to continue into the future.

- The Bureau of Reclamation at Hoover Dam spends $1 million annually on quagga mussel control.

Figure 7. An Industrial Pipe Fouled with Mussels (Photo: Marrone Bio Innovations)

Economic effects would not be limited to public infrastructure. Any water user could be at risk of ongoing maintenance and control costs. Private marinas and boat launches, privately owned boats, golf courses, and ports would all be at risk of having any submersed structure fouled with mussels. At particular risk would be irrigated cropland. Six percent of the CRB's annual flow is diverted to irrigate approximately 7.8 million acres of cropland with an annual value of over eight billion dollars. Irrigation intakes,

Figure 8. An Intake Screen Fouled by Dreissenid Mussels (Photo: ISI Inc.).

grates, screens, pumps, valves, and aqueducts are all subject to biofouling, even miles upstream of the intake.

Also at risk would be commercial navigation on the Columbia and Snake Rivers. Commercial navigation on the Columbia and Snake Rivers is important to the majority of the four-state area. Commercial traffic serves 54 ports from the mouth of the Columbia River to Lewiston, Idaho. Approximately 50 million tons of commercial cargo is shipped on the Columbia-Snake River system each year with an annual value of at least $24 billion. Downstream movements of grain account for most of this cargo, of which the largest share is wheat. Approximately half of all the wheat exported from export terminals on the Lower Columbia River arrives by barge. Other major commodities dependent upon water born navigation include soy, pulses, pulp, milled lumber, minerals, and automobiles.

Navigation in the CRB is made possible by a series of navigation locks at dams along the Columbia and Snake Rivers - Bonneville Dam, John Day Dam, The Dalles Dam, McNary Dam, Ice Harbor Dam, Lower Monumental Dam, Little Goose, Dam, and Lower Granite Dam. Each of these locks has multiple critical structures that could be fouled by zebra or quagga mussels including miter valves, lock culverts, and raw water systems

(Figure 9). Biofouling of these structures could result in increased corrosion, the inability of the lock to fully open or close, and clogged waterways. Significant delays in movement of cargo would be likely to occur if Navigation Locks were fouled, decommissioned for cleaning, or rendered inoperable.

Figure 9. A Turbine Gate, Decommissioned after Becoming Encrusted with Dreissenid Mussels.

1.1.3.2 Ecological Impacts of an Invasion

Dreissenids would have a significant effect on aquatic ecosystems. One of the major impacts of dreissenid infestation comes from the large reduction in primary productivity that can disrupt entire food webs. Briefly, dreissenids filter plankton and other suspended items from the water column and excrete wastes that remain in the benthic zone, or bottom areas. This shift aquatic systems to favor species that forage along the river bottom (certain aquatic insects, some fish species such as sturgeon and suckers) instead of those that feed higher in the water column (juvenile and adult salmon and steelhead). Where dreissenids to establish in the CRB, the likely result would be steep declines in the abundance of salmon and steelhead. A full discussion of these effects is presented in *Appendix B: Dreissenid Mussel Rapid Response Action Plan Biological Assessment.*

Native freshwater mollusks and especially Unionid mussels are likely the group most at risk in the event of a dreissenid invasion in the FSA. The hard shells of freshwater mussels and snails serve as colonization site for zebra and quagga mussels (Figure 10), inhibiting filter feeding, respiration, movement, and reproduction. Dreissenids also compete directly with freshwater mussels for food and substrate. Unionid mussels and dreissenids coexist in Europe, but North American mussels have not evolved

mechanism to defend against colonization by dreissenid mussels. The result has been dramatic declines in native mussel abundance in North America following the introduction of zebra and quagga mussels, with projections forecasting a tenfold increase in the rate of extinction of Mississippi basin mussel species. In Lake St. Clair, a 430 square mile lake that connects Lake Huron to Lake Erie, freshwater mussels, previously abundant, were nearly extirpated from the lake within 8 years of the introduction of zebra mussels.

Nearly three-quarters of all 297 native freshwater mussel species in North America are imperiled and nearly 35 went extinct in the last century. They are one of the most endangered groups of animals on Earth. Native mussels have important cultural value to many northwestern Native American tribes as evidenced by archeological investigations and current cultural practices.

1.1.4 Current Prevention Efforts

1.1.4.1 Corps Monitoring Protocol

Early detection is critical for mussel containment and eradication. Therefore, the Corps monitors for dreissenids at locations throughout the FSA. Veliger settlement plates are deployed at Corps boat ramps and parks, and within fish passage systems at Corps dams. Settlement plates are checked weekly for veligers.

Figure 10. Native Unionid Mussels Encrusted with Zebra Mussels. Photo by Lon Horwedel/Associated Press.

1.1.4.2 State Level Monitoring

Idaho, Montana, Oregon, and Washington all conduct early detection and watercraft inspection for aquatic invasive species, primarily dreissenid mussels. Since 2016, these efforts have been cost-shared with the Federal government. Early detection methods including veliger sampling via tow nets, adult monitoring via settlement plates and substrate surveys, and environmental DNA amplification or Polymerase Chain Reaction. In addition to early detection, all four states operate watercraft inspection stations, which have been cost shared with the Federal government since 2016.

1.1.5 Need for coordinated action and path forward

Significant evidence identifies the risks and effects of a dreissenid mussel invasion. From the economic burden of maintaining infrastructure function and a possible collapse in sport fisheries, to the dramatic changes in natural ecosystems and endangered species, there is a significant vulnerability in the northwest United States. Species protected under the ESA are at particular risk from ecosystem disruption. Considering the above information, standing by as dreissenids invade the West is unacceptable as it puts public infrastructure and ESA-listed species in peril.

The invasion of dreissenids requires a coordinated, cross-jurisdictional plan of action to have any hope of successfully preventing establishment. As mussels are able to quickly spread from waterbody to waterbody, carried by boats, trailers, or even boots, the successful establishment of dreissenids in even a solitary, isolated location would provide a launching pad by which the could quickly establish throughout the FSA.

Precise accounting of boating use in the CRB is difficult to track, but reported trips to the mainstem Columbia and Snake Rivers in Oregon accounted for an estimated 561,313 boater-days (individual trips by a recreational boater) of an estimated annual total of 1,625,827 state-wide, or about 35 percent of total boating in 2008. Detailed estimates are not available for other states, but in Washington, boating activity is split evenly between the Columbia and Snake Rivers and other waterbodies. Even without a detailed analysis of use patterns, this would suggest that many, if not most, boaters use both the mainstem Columbia River system and a variety of other, smaller bodies of waters.

These boating patterns mean that a multi-jurisdictional approach is vital to preventing colonization of the entire FSA by dreissenids. Were dreissenids to establish anywhere in the mainstem Columbia or Snake Rivers the size and connectivity of the system would allow for rapid colonization of the entire basin. From there, it is only a matter of time before boaters carry dreissenids to all suitable lakes, rivers, and reservoirs in the FSA. Similarly, if dreissenids were to colonize one or more isolated waterbodies in the region, boaters would quickly carry the invaders to the Columbia and Snake Rivers. Effective mussel control requires quick action wherever they are discovered. Piecemeal efforts and poorly coordinated actions taken only with jurisdictional boundaries are doomed failure.

1.1.6 Authority

Section 1039(d) of the Water Resources Reform and Development Act (WRRDA) of 2014 (Public Law [PL] 113-121) amended Section 104 of the Rivers and Harbors Act (RHA) of 1958 (33 U.S.C. 610) to include aquatic invasive species in addition to noxious aquatic plant growths; to provide for prevention as well as control and progressive eradication. In addition, it authorized the Secretary of the Army to establish watercraft inspection stations in the Columbia River Basin in the States of Idaho, Montana, Oregon, and Washington at locations with the highest likelihood of preventing the spread of aquatic invasive species at reservoirs operated and maintained by the Secretary (i.e., Corps managed reservoirs).

Section 1178(b) of the Water Infrastructure Improvements of the Nation (WIIN) Act of 2016 (PL 114-322) further amended Section 104 of the RHA of 1958 to allow the Secretary to operate and maintain existing watercraft inspection stations, and to allow stations to be located anywhere within the States of Idaho, Montana, Oregon, and Washington. Section 1178(b) also authorized the Secretary to assist those states in early detection of and rapid response to aquatic invasive species, including quagga and zebra mussels. 33 U.S.C. 610 now reads:

> (d) Watercraft inspection stations
> (1) In general
> In carrying out this section, the Secretary may establish, operate, and maintain new or existing watercraft inspection stations to protect the Columbia River Basin to be located in the States of Idaho, Montana, Oregon, and Washington at locations, as determined by the Secretary in consultation with such States, with the highest likelihood of preventing the spread of aquatic invasive species at reservoirs operated and maintained by the Secretary. *The Secretary shall also assist the States referred to in this paragraph with rapid response to any aquatic invasive species, including quagga or zebra mussel, infestation*. . . .
>
> (e) Monitoring and contingency planning -- In carrying out this section, the Secretary may. . . .(3) *assist States in early detection of aquatic invasive species, including quagga and zebra mussels*. . . .

1.2 Purpose and Need

The Corps is proposing to assist the states of Idaho, Montana, Oregon, and Washington with establishing and executing a rapid response plan (Plan) if discovery of dreissenid mussels within the four-state area occurs. Once a waterway is infected, dreissenids can reproduce rapidly and spread. The purpose of the action would be to protect water bodies and related facilities in the CRB from the economic and ecological damages caused from dreissenid mussel infestation. Funding for rapid response actions may be cost-shared with the States of Idaho, Montana, Oregon, and Washington, or other local bodies that entered into a cost-share agreement with the Corps, at 50 percent Federal / 50 percent non-Federal, in accordance with Section 1178(b) of the Water Resources

Development Act of 2016. Rapid response actions could also be conducted by the Corps or other Federal agencies at federally owned/managed water resources projects and related facilities (e.g., dams, boat ramps, etc.) within the CRB.

The proposed action is needed because the risk of water bodies, and ultimately Corps reservoirs, in the CRB being infected is high and the introduction and establishment of dreissenids has the potential to cause billions of dollars in damage and increase operation and maintenance costs to water-related infrastructure, recreation, and untold damage to the ecosystem and the species dependent upon it. Dreissenids present a direct threat to Corps authorized purposes including hydropower, navigation, and fish and wildlife mitigation.

Alternatives considered must: (1) act aggressively and effectively to prevent the establishment or spread of dreissenid mussels (2) be technically feasible, and (3) be environmentally acceptable. Localized adverse environmental impacts may be tolerated due to the extraordinary potential for adverse environmental impacts from the establishment of dreissenids mussels.

2 Alternatives

The three alternatives under detailed consideration are:

1) Alternative 1: No Action/No Change (States act alone-current practice)

   a) States act under their plans for non-Federal water areas and related facilities within their respective states.

   b) Corps does not implement its own plan (Plan) for Corps owned and managed Federal submerged lands and water related facilities (e.g., dams).

   c) Corps does not implement a cost share program to assist the states.

2) Alternative 2: (States act alone plus the Corps acts independently)

   a) States act under their plans for non-Federal water areas and related facilities within their respective states.

   b) Corps acts under the Plan for Corps owned and managed Federal submerged lands and water related facilities.

   c) Corps does not implement a cost share program to assist the states.

3) Alternative 3: (States act with Federal cost share and the Corps acts independently)

   a) States act under their plans for non-Federal water areas and related facilities within their respective states, or under the Corps' rapid response Plan and supplemented by the Federal cost share program.

   b) Corps acts under the Plan for Corps owned and managed Federal submerged lands and water related facilities.

These alternatives are discussed in more detail below.

2.1 Alternative 1 – No Action (Current Practice)

The No Action Alternative represents a continuation of the states' current practice, in which the Corps would not cost share state efforts to respond to the detection of dreissenid mussels to protect the CRB or Corps' water management infrastructure therein. Nor would the Corps or other Federal agencies implement rapid response plans of their own.

2.1.1 Action Area

Each state would operate within their own state boundaries and jurisdiction separate from and federally managed jurisdictions. All four state action plans address all waterbodies within the state. The state plans do not prevent state engagement with the

Corps, but under current practices, there is no mechanism by which the Corps can assist the states or cost-share state mussel eradication efforts. There is currently no response plan for a dreissenid control response on Corps controlled waters within the four state area, nor is their currently a mechanism by which the states could engage in treatment options on Corps controlled waters.

2.1.2 Alternative Description

The current framework for a state response to the discovery of dreissenid mussels is the *Columbia River Basin Invasive Species Interagency Response Plan: Zebra Mussels and Other Dreissenid Species* (CRBIRP) prepared by the 100th Meridian Initiative's Columbia River Basin Team (CRBT), an interagency group composed of the States of Idaho, Montana, Oregon, and Washington, the Province of British Columbia, NOAA Fisheries, the U.S. Fish and Wildlife Service, and the Columbia River Inter-Tribal Fish Commission. The CRBIRP outlines a framework where discovery of invasive dreissenids within the CRB by a state monitoring agency would be communicated to a central coordinator that could then facilitate the implementation of a state's own rapid response plan.

Oregon and Washington have adopted the plan outlined in the CRBIRP, while the States of Montana and Idaho have developed their own similar plans.

2.1.3 Alternative Activities

All of the state action plans feature similar objectives/actions (Table 2), focusing on verifying reports of dreissenids, marshalling resources, defining the extent of colonization, quarantining the affected area, initiating control actions, and post-action monitoring. Control actions are not specified but referenced examples include chemical treatments such as copper sulfate, endothall-amine, potassium chloride, and waterbody drawdown. The CRBIRP lists 13 categories of potential treatment options.

2.1.4 Project Timeline

The State and CRBIRP Plans specify treatment initiating control actions within two weeks of initial detection, but do not offer detailed timelines for treatment.

2.1.5 Impact Minimization Measures

The State and CRBIRP Plans do not outline specific Impact Minimization Measures or Best management Practices.

The No Action Alternative does not meet the project purpose and need. However, it is carried forward for comparative purposes as required by NEPA.

Table 2. Summary of Rapid Response Plan activities.

	CRBIRP, OR, WA	ID	MT
Objective 1	Make Initial Notifications	Verify Reported Introduction	Verification
Objective 2	Activate Appropriate Organizational Elements	Make Initial Notifications	Notify Affected Parties
Objective 3	Verify Reported Introduction	Activate Appropriate Organizational Elements	Activate Command Team
Objective 4	Define Extent Of Colonization	Define Extent Of Colonization	Activate Appropriate Organizational Elements
Objective 5	Establish External Communications	Establish External Communications	Define Extent Of Colonization
Objective 6	Obtain and Organize Resources	Prevent Further Spread	Establish External Communications
Objective 7	Prevent Further Spread	Initiate Control Actions	Prevent Further Spread
Objective 8	Initiate Control Actions		Initiate Control Actions
Objective 9	Institute Long-Term Monitoring		Stand Down and Evaluate
Objective 10	Stand Down and Evaluate		

2.2 Alternative 2 - The Corps implements a Rapid Response Plan upon discovery of invasive dreissenid mussels within Corps controlled water resources projects and related facilities in the Columbia River Basin.

Under Alternative Two, the states would proceed as described under Alternative 1, but the Corps would also unilaterally implement a Rapid Response Action Plan (Plan), but only when there is a detection of dreissenids at Corps controlled water resources projects and related facilities in the CRB under the jurisdiction of the Corps. Other Federal land managing agencies could consider implementing similar actions within their own jurisdictions. The Plan provides specific types of treatment actions that may be implemented by the Corps or authorized cooperating agencies/entities within waters managed by the Corps. Alternative Two represents a continuation of the states' current practice, in which the Corps would support state efforts only by responding to the detection of dreissenid mussels within Corps controlled water resources projects and related facilities within the FSA to protect the CRB and Corps' water management infrastructure therein. Other Federal land managing agencies could consider acting in a

similar manner within their own jurisdiction as the effects described later in this analysis apply anywhere in the FSA.

2.2.1 Action Area

The action area of Alternative 2 is the same as Alternative 1, and also includes any Corps controlled and operated water resources projects (where the Corps owns/controls the underlying submerged lands) within the four-state area, including treatment areas, riparian access routes, and staging areas. (Figure 11, Corps facilities in red). Other Federal land managing agencies in the FSA could consider implementation of a similar rapid response plan as described herein within their own jurisdictions.

The vast majority of waterbodies that may be at risk of dreissenid invasion have public access with designated watercraft access (boat ramps). A boat ramp is any site with public access to launch watercraft and vary in construction from a concrete or asphalt ramp with a dock, to a simple dirt ramp. Dreissenids may also be detected at sites not yet identified and without pre-existing access that could require new access through riparian areas to isolate and treat the invasion.

Figure 11. Corps controlled waters and reservoirs in the CRB. Corps controlled waters are indicated in red.

2.2.2 Alternative 2 Description

The Plan for Corps or other Federal land managing agencies is more conservative and proposes more specific rapid response treatments than the CRBIRP. The Plan includes the rapid response actions of detection, treatment area isolation, fish and wildlife salvage, mussel treatment, water quality treatment (if necessary), and riparian restoration should riparian access development be required. Three mussel treatment types are proposed: 1) Chemical treatment (Endothall, EarthTec QZ, potash, Zequanox); 2) intense ultraviolet B radiation (UV-B); and 3) Ozone. These treatments would be used in combination with one another for best effect.

Treatment areas would be isolated up to 45 days depending on which treatment is applied to maximize dreissenid exposure time. Isolated treatment areas would be 30 acres or less to maintain treatment effectiveness. Multiple treatment areas may be

treated in the same waterbody, and retreatments made as appropriate (discussed below).

Because no known infestations of dreissenid mussels have been identified within the Columbia River Basin to date, it is unknown how many sites may need to be treated on an annual basis. However, based on available funding for rapid response, is anticipated that a maximum of six treatments no larger than 30 acres in a given year.

2.2.3 Alternative 2 Activities

When there is evidence of dreissenid presence (regardless of life stage) anywhere in the Corps controlled waters (or those controlled by other Federal agencies, should they decide to adopt the Plan), the extent of the invasion would first need to be assessed, through veliger sampling, watercraft inspection, shoreline surveys, snorkeling, or self-contained underwater breathing apparatus (SCUBA) surveillance for established adults. Potential access requirements (non-marina or boat ramp) for treatment could also be identified during this process as well. Once the severity of invasion and access requirements were determined, rapid response could be initiated. Details are provided below.

Mobilize to the site.

In the vast majority of cases, mussel invasion and identification would occur at or near boat access points, making site access relatively simple using existing roads and boat ramps for approach and staging. In the rare chance that dreissenids are detected in an isolated waterbody or area of a waterbody without boat or vehicle access an access route that avoids and minimizes adverse environmental effects would be established. Those areas of a waterbody without boat or vehicle access are referred to as “unidentified sites,” as they have not been identified as a likely/expected infestation site.

In rare cases, fill (e.g. gravel) may be required in the staging area and water access location. Only clean gravel would be permitted as fill, and would be removed post-action. Fill would not be permitted to enter the water.

For unidentified sites, the minimum amount of vegetation would be removed to gain access. An access road a maximum of 12 feet wide would be created. A qualified botanist would identify and flag ESA-listed and rare plant species to be avoided prior to vegetation removal. Wetland sites would be avoided to the fullest extent possible, unless a wetland or vernal pool with standing water had a positive detection. At water’s edge, vegetation would be removed a maximum of 60 linear feet of shoreline if necessary to allow adequate access for treatment equipment.

Wildlife salvage would occur if the creation of a riparian access route became necessary. Trained biologists would conduct all surveys necessary to identify the abundance and distribution of ESA-listed taxa and species of State concern. Where possible, all nest trees/shrubs would be avoided, and all mobile wildlife would either be relocated from the immediate access route or encouraged to depart the site. Qualified

wildlife biologists and technical staff would move through the area ahead of equipment to avoid and minimize impacts to individuals and species to the maximum extent possible.

Equipment would be expected to include: 1) Vehicles, boats, trailers, and generators; 2) Small fuel and oil containers for small engines; 3) Pumps, hose material, silt curtains, portable water tanks, other barrier material; 4)Treatment chemicals.

Restoration in the form of site restoration would occur at a 1:1 ratio. Any rock fill placed during treatment would be removed during restoration. More discussion on restoration is presented below in the Restoration section.

Methods for vegetation removal could include:

- Chopping or cutting of woody vegetation via chainsaw or flail mower potentially operated by large equipment
- Mowing of herbaceous vegetation
- Rock fill placement and removal

Treatment Area Isolation

Treatment site isolation would be critical for three reasons. One, isolation would improve treatment efficacy by maintaining chemical concentrations and mussel exposure times efficiently; this would reduce the overall amount of chemical that would need to be applied to achieve dreissenid mortality. Two, isolation would greatly reduce the potential that veligers or juveniles could escape the treatment area. This is particularly important when the invasion is detected early and eradication is most likely. Finally, site isolation would contain treatment chemicals within the isolated treatment area, limited effects outside the treatment area.

Once site access was secured, a number of methods may be deployed to isolate the site. To maintain effective isolation, a barrier must be able to significantly limit or eliminate water transfer from the treatment area to the main waterbody. Complete elimination of connectivity for the duration of treatment would be preferred. Two specific methods that allow for rapid deployment are impervious silt curtains which would be deployed via boat (e.g., commercial silt curtain or HDPE material anchored in place); or inflatable bladder dams [e.g. PLUG (Portable Lightweight Ubiquitous Gasket) and Tiger (PVC-coated fabric) dams, HDPE liner material] which would be deployed by humans on foot. Site isolation would occur up to 45 days per treatment. More discussion is provided below in the post-treatment monitoring section.

Fish salvage

In most cases, electrofishing would be employed as a fish salvage technique before treatment. The guidelines and protocols identified in Reynolds (1996) and National Marine Fisheries Service (2000) would be implemented during fish salvage.

Electrofishing effectiveness varies greatly among waterbodies and across species and sizes. In a small, closed system (e.g. isolated treatment area), it may be possible to achieve up to 60% capture efficiency, based on professional judgment and experience electrofishing salmonids in low-conductivity waters.

Gastropods would not be salvaged. Sites within the distribution of these species are anticipated to be unidentified requiring ESA consultation prior to treatment. This would allow for conservation measures minimizing impacts to these species to be developed ahead of implementation.

Treatment

All equipment would be clean, drained, and dry prior to entering and exiting the treatment site. A mobile hot water pressure treatment system to sterilize boats and equipment would be implemented following the decontamination protocols of Elwell and Phillips (2016). Sterilization water would be retained and treated. Treatment types would include chemical, ultraviolet light (UV-B), and ozone application.

- Chemical (Endothall, EarthTec QZ, potash, Zequanox) applications: Chemical solutions would be mixed on shore prior to application. Chemicals would be applied directly to water from a tank pressurized by an electric pump through submerged hoses, wands, or booms. Pressurized application would allow for greater mixing within the contained treatment area. Treatment duration would vary to maintain mixed concentration rates.

- UV-B: UV-B would be applied via boat using submerged UV-B-emitting light panels. Panel depth can be adjusted to treat more of the water column in a high position, or concentrate the intensity on the benthic zone by lowering the panel near the substrate.

    - This method may be used as a veliger treatment before or during application of another method targeting adults.

- Ozone: Ozone would be applied through a bubbler system that would be used as fish exclusion barrier or noise attenuation screen for pile driving. Lines would be deployed by boat to cover a large part of the treatment area sufficient that treatment would mix the entire water column. The lines would run onshore to a truck carrying the appropriate volume of pressurized ozone that would feed through the lines treating the water column.

    - This method may be used as a site containment and veliger treatment before or during application of another method targeting adults.

    - This method may be restricted to 1.2 acres or smaller treatment areas due to the rapid dissipation of ozone in water.

Treatments would be applied at times rates and durations specified in Table 3.

Table 3. Application rate and contact time for the proposed dreissenid treatments.

Treatment	Application Rate	Contact/Application Time
Endothall	0.3 – 5 mg/L	5 – 144+ hours depending on rate
EarthTec QZ	0.5 – 2 mg/L	30 days
Potash (KCL)	95 – 115 mg/L	21 days
Potash (KH2PO4)	160 – 640 mg/L	21 days
Potash (KOH)	≤ 10 mg/L	21 days
Zequanox	100 mg/L	8 hours
UV-B/C	0.3 – 0.6 Ws/in²	5 days
Ozone	0.5 mg/L	7 days
Rhodamine WT Dye	0.01 mg/L	53.9 hours (half-life)

Post-treatment monitoring

Post-treatment monitoring would be required in the form of water sample collection and microscopy for veligers (monthly), settlement plate placement checks (monthly), watercraft inspection, shoreline surveys, and additional snorkeling or SCUBA for veligers and adults at two, four, and six months post-treatment. Additionally, water chemistry analysis would be required weekly to evaluate all relevant water chemistry and toxin levels within the treatment area.

Re-treatment

Up to four treatments could be made in one year in a single treatment area. Multiple treatment areas could occur within the same body of water at a given time, not to exceed treatment product warnings on the proportion of total water volume that may be treated in a single event.

Restoration

Any riparian 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 would be recommended by a local state botanist. No ground disturbance outside of the area previously opened for treatment site access would be required.

Restoration methods could include mowing, removal of previously placed fill, planting with hand tools or power tools, instillation of weed cloth, and seeding. Restoration sites would be monitored for 24 months to verify 80% survival of newly established vegetation.

Preparation

Mussel control and treatment requires a carefully coordinated response among multiple agencies as well as a large quantity of dedicated and specialized equipment. Prior to implementation of the above actions participating states would likely need to train personnel and purchase equipment. These activities would also be eligible for a federal cost-share.

- Training

State response teams would need practice and be trained in proper use and handling of the response equipment to perform the most effective rapid response. This would require personnel to gain experience in mobilizing and demobilizing to a site. Proper handling, deploying, monitoring, and decontaminating equipment of equipment and materials, along with mimicking an actual treatment with dye. This would require knowledge and training in the Incident Command System. This training could vary from classroom sessions to multiple-day, hands-on field exercises in deploying and using equipment. Training exercises would not be conducted in areas that provide habitat to protected species.

- Equipment

Any equipment described in Section 2 would be eligible for Federal cost sharing. This would include, but not be limited to trailers, tow-vehicles, silt curtains, bladder dams, anchors, bubble curtains, UV-generators, ropes, buoys, chains, spray tanks, dyes, and personal protective equipment.

It is anticipated that training and equipment would be the first expenses to be funded. It is imperative that state responders were in possession of suitable equipment and training before dreissenid mussels are detected.

2.2.3.1 Project Timeline

The Plan would be implemented immediately upon detection of dreissenids in the action area. Physical activity onsite is expected to occur for up to 60 days, including determination of the severity of invasion through initial treatment and extended treatment area isolation. Additional treatments may be required for 100% effectiveness. Isolation barriers would remain in place a minimum of 45 days, or until monitoring suggests 100% mussel mortality has occurred and water chemistry is acceptable for barrier removal.

Treatment may occur at any time of the year and is not proposed to adhere to an in-water work window in any state or waterbody; however, it is more likely that mussel detection and treatment would occur during the warmer months in correlation with increased recreation and mussel growth and activity (approximately April through September), as well as associated with appropriate conditions for effective treatment.

Restoration would occur only after the final treatment in the case of a site requiring riparian access. Plant restoration would occur October – March.

2.2.4 Impact Avoidance and Minimization Measures

The following Best Management Practices and Conservation Measures would be employed during treatments to avoid and minimize impacts to species and habitats.

Best Management Practices

1. Upon mussel detection, consult waterbody type treatment considerations described in USFWS and PSMFC *Manual for Endangered Species Act (ESA) Compliance for Quagga/Zebra (QZ) Mussel Response in the Columbia River Basin States* (2019).
    a. A draft version of this manual is projected to be available in 2019.
2. Application recommendations from product labels will be applied during treatment.
3. No more than four repeat treatments may be made in a single treatment area annually, consistent with product label warnings. Mussel monitoring results would be used to determine if additional treatments are warranted.
4. Apply Rhodamine WT dye with all chemical treatments to aid in proper mixing during application, as well as assist with identifying leaks or breaches in the isolation barriers to prevent unintentional effects outside of the treatment area.
5. Watercraft treatment systems would be onsite to sterilize all electrofishing and work boats, trailers, and other gear or equipment as appropriate prior to entry and departure following the decontamination protocols of Elwell and Phillips (2016) to prevent the spread of invasive species.
6. Fueling and lubrication of equipment and motor vehicles would be conducted in a manner that affords the maximum protection against spills. A portable containment berm would be used when fueling equipment and motor vehicles.
    a. Store, fuel, and maintain vehicles more than 150 feet (46 m) from water and wetlands.
7. Emergency Spill Response Kit must be immediately available while performing work. Kits would include product to absorb or encapsulate up to 25 gallons of hydrocarbons (oils, coolants, solvents). Spill absorbent mats would be carried on board boats and be in the immediate vicinity of all equipment performing work.
8. The guidelines and protocols identified in Reynolds (1996) and NMFS (2000) will be implemented during fish salvage.

9. Any water pumping actions would follow the guidelines provided by NMFS (2001).
10. Check equipment for leaks daily. If equipment leaks or drips occur, they shall be cleaned up immediately.
11. Drip pans shall be utilized when equipment is parked.
12. Corrective actions will be taken 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 ascertained and appropriate actions taken to prevent further incidents or environmental damage.
    c. Spills will be reported to the appropriate state Department of Ecology.
        i. Washington Department of Ecology Northwest Regional Spill Response Office 425-649-7000.
        ii. Montana Department of Environmental Quality enforcement 406-444-0379.
        iii. Idaho Department of Health and Welfare, State Communication 208-846-7610.
        iv. Idaho Department of Environmental Quality Hotline 888-997-7888.
    d. Work barges will not be allowed to ground out.
    e. Excess or waste materials will not be disposed of or abandoned water ward of ordinary high water or allowed to enter waters of the state.
    f. Waste materials will be disposed of in an appropriate manner consistent with applicable local, state, and federal regulations.
    g. Materials will not be stored where wave action or upland runoff can cause materials to enter surface waters.
13. 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.
14. Use existing roadways and paths, if possible, and minimize number and length of temporary roads and paths through riparian/floodplains.
15. Implement any needed dust abatement measures.

16. Any construction associated with the project onsite will be completed in compliance with the appropriate State Water Quality Standards. The State of Washington is presented here (Washington Administrative Code [WAC] 173-201A), including:

    a. 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.

    b. 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.

    c. A spill prevention, control, and countermeasures (SPCC) plan will be prepared by the contractor and used during all in-water demolition and construction operations. A copy of the plan will be maintained at the work site.

        i. The SPCC plan will outline BMP, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan will also outline management elements, such as personnel responsibilities, project site security, site inspections, and training.

        ii. The SPCC plan will 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. Applicable spill response equipment and material designated in the SPCC plan will be maintained at the job site.

17. Treatment area isolation barriers would not be removed until water chemistry analysis results indicate there would be no effect to species outside of the treatment area.

18. Use appropriate sediment containment such as silt fence or weed-free straw around staging areas and the restoration planting as appropriate.

Conservation Measures

1. Implementation of this Plan is a conservation measure within itself. While there will be localized adverse impacts to species and habitat, allowing dreissenids to invade waters of the western United States without taking action risks region-wide ecological collapse of keystone endangered species and threatens to endanger populations of other stable aquatic species.

2. ESA consultation would be conducted on a site-specific basis for unidentified sites. The USFWS would be consulted with prior to treatment at unidentified sites to develop conservation measures for affected species and critical habitats.
3. Unidentified sites needing riparian access development would be sited in the least environmentally damaging location practicable.
4. No more than 60 feet (18 m) of shoreline vegetation would be disturbed during riparian access development.
5. Fish and wildlife salvage (removal) would be conducted by trained biologists prior to riparian access or dreissenid treatment.
6. Nesting surveys for bald and golden eagle and migratory birds would be conducted by trained biologists following Corps protocols prior to riparian access development. Nest sites would be avoided where practicable.
    a. Corps would follow Migratory Bird Treaty Act (MBTA) Executive Order 13186 and associated Memorandum of Understanding between the Corps and the USFWS dated 2006. The Corps would further adhere to buffers defined by the USFWS for eagle nesting as an appropriate conservation measure.
7. The proposed treatment methods are the most environmentally friendly relative to other available methods.
8. Avoidance of wetlands and nests during access route development.
9. Avoidance of removing mature riparian trees during access route development.
10. Corps and states implement dreissenid monitoring programs consistent with that outlined by Elwell and Phillips (2016).

Restoration

1. Riparian access corridors created for the purpose of the Plan will be restored with native vegetation post-treatment. Restoration would occur at a 1:1 ratio.
2. Obliterate all temporary roads and paths upon project completion.

2.3 Alternative 3 - The Corps implements a Rapid Response Plan (Plan) and Cost Shares Implementation of the Plan with the States of Idaho, Montana, Oregon, or Washington upon discovery of invasive dreissenid mussels in any waterbody in the four-state area (Proposed Action).

This alternative includes the actions described under Alternative 2. The Corps would also implement a cost share program for rapid response with the states according to the provisions of the Plan. The Plan provides specific types of treatment actions that may

be implemented by the Corps or cooperating or adopting agencies/entities within the states of Idaho, Montana, Oregon, and Washington. Treatment actions conducted by State or Local governments that are outside the parameters outlined in the Plan described in Section 2.3.2 could not be cost-shared by the Federal government unless further evaluated under NEPA and ESA and related environmental laws. Other Federal land managing agencies could consider acting within their own jurisdiction as the effects described later in this analysis apply anywhere in the FSA.

The Corps has identified 4,174 boat access locations from available geographic information systems (GIS) data and associated likely treatment areas (i.e., shallow areas within close proximity to public use access sites) within the action area where a dreissenid detection may be likely to occur (Figure 12). These locations are referred to as “identified locations.” Areas that have not been previously identified as a potential infestation site (e.g., docks, boat ramps, etc.) are referred to as “unidentified sites.”

However, dreissenids may be detected at sites that require riparian access to isolate and treat the invasion. Treatment and effects at these sites would reasonably be expected to occur as described below, but is not certain to occur because the site of initial introduction or detection cannot be predicted. Sites requiring riparian access are referred to as unidentified sites and would fit a programmatic framework Opinion where ESA consultation would occur on a site-specific basis.

Alternative 3 includes the Federal cost share for treatment and the effects of rapid response actions under the Plan. Those actions include detection area isolation, sample collection, site monitoring, site preparation, fish and wildlife salvage, mussel control, equipment decontamination, any site restoration activities associated with the control action, and implementation of conservation and minimization measures and BMPs to avoid and minimize adverse environmental effects.

Alternative 3 would also include sharing costs with the states for training and equipment required for implementing the Plan. This would include acquisition of vehicles, structures, and hardware required for mussel eradication actions, as well as labor costs incurred during training events. Training would only be cost shared if the training was conducted at a location with no ESA listed species or critical habitats present.

2.3.1 Action Area

The action area encompasses any waterbody under state or Federal jurisdiction where dreissenids are detected within the States of Idaho, Montana, Oregon, and Washington (Figure 12).

2.3.2 Project Description

The proposed action is the same as described in Section 2.2, with the exception of the cost share element and expanded action area. In Alternative 3, the actions described in

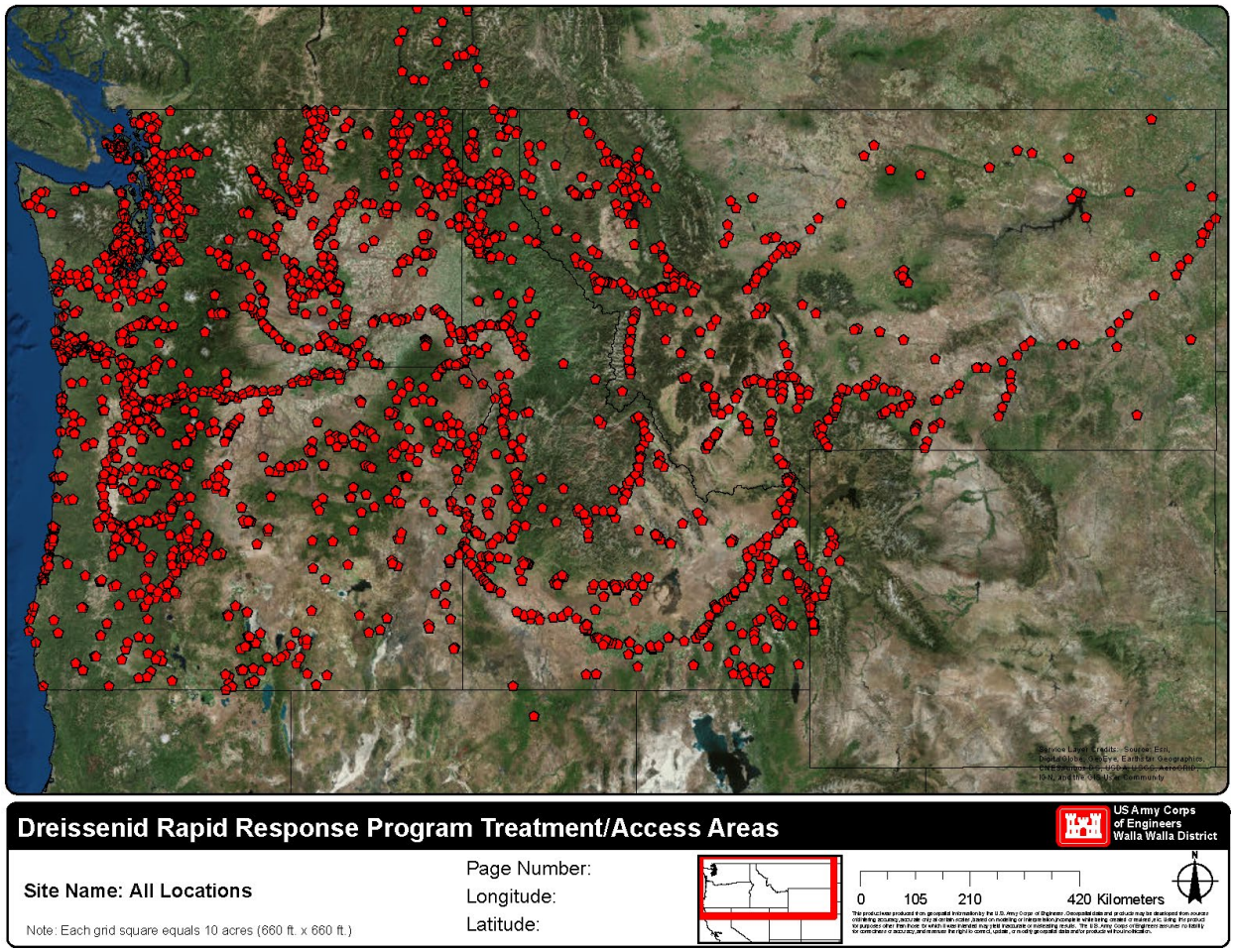

Figure 12. The action area showing all 4,174 sites identified in the Plan. Sites that occur outside of Idaho, Montana, Oregon, or Washington are not included in the total number of sites or treatment under the Plan. Interactive map available at: https://arcg.is/0SWX5u

Section 2.2 would be implemented at any waterbody in the four-state area, either by the Corps or other Federal land managing agencies at water resources projects/facilities within their jurisdictions, or federally cost-shared with a state agency. Because the expense of treatment actions on state controlled waters would be cost-shared with the Federal government, it is expected that available funding would allow for additional sites to be treated annually, to a maximum of twelve sites of 30 acres.

Project activities, treatment dose rates, project timelines, and impact avoidance measures would be the same as outlined for Alternative 2 in Section 2.2.

2.4 Screening of Alternatives

The Corps developed screening criteria to evaluate alternatives as part of identifying the purpose and need for the proposed action. The screening criteria were applied to the range of alternatives described above to determine which alternatives would satisfy the identified purpose and need (see Section 1.3). In this case, the criteria applied were:

1. The Alternative must be aggressive enough to prevent the establishment or spread of dreissenid mussels to Corps reservoirs in the CRB.

2. Alternative must be technically feasible, that is the alternative selected must have a high probability of success in preventing the establishment or spread of dreissenid mussels to Corps reservoirs in the CRB.

3. Alternative must be environmentally acceptable, though a certain amount of environmental risk is acceptable given the tremendous threat that the establishment of zebra or quagga mussels presents.

The criteria would eliminate those alternatives that could not reasonably or practically meet the project purpose and need. Only those alternatives that met the three screening criteria were moved forward for further evaluation. The exception was the No Action Alternative. As a requirement under NEPA, this alternative was carried forward to serve as a comparison. Alternative 2 may not act aggressively enough to satisfy all screening criteria. Given Corps ownership of shoreline along the lower Columbia and Snake Rivers, there is the potential for independent Corps action to address an infestation. Therefore, Alternative 2 was carried forward for consideration. Alternative 3 met all screening criteria and was carried forward for consideration.

3 Affected Environment and Environmental Consequences

3.1 Introduction

This chapter describes environmental resources/components, describes the affected environment and the potential environmental impacts of the No Action and the Proposed Action.

Sixteen environmental components/resources were identified as being relevant to this project: aesthetics and the visual environment, air quality, aquatic resources, climate change, environmental justice, geology and soils, historic and cultural properties, noise, recreation, socioeconomics, terrestrial resources and wildlife, threatened and endangered species, transportation, vegetation, water quality, and cumulative effects.

However, after review and initial assessments of potential impacts to environmental components, only aesthetics and the visual environment, aquatic resources, historic and cultural properties, recreation, socioeconomics, terrestrial resources and wildlife, threatened and endangered species, water quality, and cumulative effects were identified as needing further assessment including consultation and/or coordination with other Federal, state, and tribal regulatory entities. Environmental components that were dismissed from further analysis are briefly discussed below and the rationale for their dismissal is provided.

3.1.1 Resources Not Examined in Detail

3.1.1.1 Air Quality

Air Quality is broadly excellent within the FSA. The Environmental Protection Agency (EPA) has designated only a few isolated areas in each state as out of attainment – i.e. they do not meet non-pollutant criteria (USEPA 2018).

Dreissenid mussel treatment activities would not introduce any new stationary sources of air emissions to the region or contribute to a violation of any Federal, state, or local air regulation. Further, the Corps would employ standard best management practices for treatment applications, riparian access, and mitigation. These BMPs further assure the protection of air quality. Treatment and any associated emissions would occur throughout at most a handful of times across a vast and mostly rural or remote project area. Air quality impacts would be temporary and negligible and are not analyzed in further detail in this EA.

3.1.1.2 Climate Change

Indications are that average global atmospheric temperatures are trending upward over the previous several decades, and are correlated to increased atmospheric carbon dioxide levels (USGCRP, 2017). In the Pacific Northwest, changes in snowpack, stream flows, and forest cover are already occurring. Future climate change will likely continue to influence these changes. However, these changes are not likely to modify or exacerbate the effects of any alternative. The effects of dreissenid mussel treatment

are localized and temporary in nature, and are not likely to be substantially affected by climate change.

The effects of the alternatives on climate change are also not substantial. The alternatives have no activities that produce significant emissions, and would not be subject to quantitative analysis. Mechanized equipment would be utilized to create riparian access and apply treatments, but use would be infrequent and the equipment would be small in size and few in number, and only in use for very brief periods of time. The treatment activities supported by vehicular traffic would be similar to those of surrounding lands for recreational, agricultural, rural, and commercial activities. Therefore, climate impacts would be negligible and are not analyzed in further detail in this EA.

3.1.1.3 Geology and Soils

The alternatives involve activities that occur at the ground surface or in the water. There is no alteration of the topography caused by the performance of these activities. There would be no excavation associated with any of the alternatives. Any material brought in for riparian access would be removed following the completion of treatment activities. Therefore, geology and soils impacts would be negligible and are not analyzed in further detail in this EA.

3.1.1.4 Noise

None of the alternatives would cause any appreciable changes in the noise environment, nor would noise levels exceed Federal, state, or local government standards. The use of motorized equipment and vehicles to apply treatment, develop riparian access, and perform mitigation would generate transient increases of noise which would be dispersed throughout the project area and of short duration. Treatment locations are primarily confined to boating access point and are subject to noise from vehicular and motorboat traffic. Noise generated from mussel treatment would be at a similar level. Therefore, noise impacts would be negligible and are not analyzed in further detail in this EA.

3.2 Aesthetics and the Visual Environment

3.2.1 Affected Environment

Aesthetics or visual resources are the natural and cultural features of the landscape that can be seen and that contribute to people's appreciative enjoyment of the environment. The aesthetic quality of an area is a subjective measure of one's perception of how pleasing an area is.

Treatment locations would be primarily located at boat access points along waterbodies in the region – boat ramps, boat basins, marinas, and other similar access points. The visual environment of these locations is generally considered very pleasant, especially by the more frequent users and members of the boating public. However, the majority of these locations would not be considered pristine natural areas, or areas that had not

been modified for human use. Typically, these sites are a mix of natural elements (waterbodies, shoreline, riparian zones) and human elements (roads, parking lots, vehicles, boats, docks, etc.).

Except for a portion of the Hells Canyon reach of the Snake River that is designated as wilderness, all of the reservoirs and river reaches in the CRB show evidence of human development (SOR 1995).

3.2.2 Environmental Effects

3.2.2.1 Alternative 1: No Federal Action / Current Practices.

Where dreissenids have infested waterways, they have had serious impacts on fresh water beaches. Impacts include beach goers getting severe cuts on their feet and the stench caused by massive dreissenid die-offs covering the shoreline. This would have a significant impact on the waterways of the Pacific Northwest, which depend on tourism and recreation revenue. Zebra and quagga mussels transform visual landscapes by covering any solid structure near the waterline. This includes docks, pilings, boats, seawalls, or nearly any firm structure on which they can anchor. Treatment would occur at initial detection sites; essentially “ground zero” for mussel invasions, these locations could become quickly completely fouled by empty mussels shells (Figure 13), as has occurred at many locations in the Great Lakes where entire beaches can be buried under several feet of mussel shells. In time, the entire CRB could be affected similarly. The No Action Alternative would have beneficial effects by preventing or at least delaying these effects, and temporary adverse effects from treatment actions themselves.

Adverse effects to aesthetic values from dreissenid control actions undertaken by the states would be limited to locations outside of Federal jurisdiction and would occur less frequently than with a Federal cost share program. Limited beneficial effects to aesthetics would be seen under the No Action Alternative as state control programs would slow the spread of invasive dreissenid mussels and the associated harm to the visual environment they represent. However, without treatment at Corps controlled locations along the Columbia and Snake River, and without access to Federal cost sharing, it is reasonable to assume that these actions might delay, but not prevent, the establishment of dreissenids in the FSA.

Figure 13. A Lake Michigan beach completely buried in dreissenid shells. Photo: John Karl, University of Wisconsin Sea Grant.

Under the No Action Alternative, adverse effects to visual resources resulting from individual state treatment actions in the event of a dreissenid detection and response would include minimal short-term negative aesthetic effects on treatment sites due to the presence of equipment needed for treatment or physical isolation. Equipment used to isolate sites would likely be brightly colored and pose a visual nuisance to alert boaters and recreational users to avoid the area. Equipment and vehicles used to conduct treatment may be visually intrusive and detract from natural aesthetics. Development of riparian access and possible loss of vegetation would detract from natural visual values of the riparian zones. These adverse aesthetic effects of dreissenid treatment would be minimal and short-term; isolation barriers and equipment would be removed following treatment, and, while not specified in state action plans it is possible that state agencies would restore riparian aesthetic values to ensure no significant visual impacts. Even in the absence of state-lead restoration, natural processes would likely return riparian areas to a state that at least appears similar to a pre-treatment condition.

3.2.2.2 Alternative 2: The Corps adopts a Rapid Response Plan.

Treatment locations beyond those described in Alternative 1 in this alternative would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas. Alternative 2 could have a greater adverse effect to visual resources in the four-state

area, if only through the addition of more potential treatment areas, as its effects would be additive to those seen in Alternative 1, Current Practices. It is impossible to predict where invasive dreissenids would be discovered, but Alternative 2 represents a larger area for potential treatments.

Beneficial effects to aesthetics would be similar to Alternative 1, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to the visual environment they represent.

Under Alternative 2, adverse effects to aesthetic and visual resources resulting from treatment actions in the event of a dreissenid detection and response would be the same as for Alternative 1, but would also include minimal short-term negative effects on treatment sites within Corps Federal jurisdiction and could include other Federal jurisdictions. The Corps Rapid Response Plan specifies BMPs and mitigation to preserve and restore aesthetic values of treatment locations to prior conditions. Effects to visual resources then, would likely be less than significant at Corps owned and controlled locations.

3.2.2.3 Alternative 3: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Action).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3 includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the FSA.

Similarly, Alternative 3 has the same temporary negative effects as Alternative 2, but would include additional effects for up to 12 cost-shared sites annually. Implementation of BMP's and mitigation to preserve and restore aesthetic values would be required during Corps controlled actions and at cost-share sites. This alternative would have the potential for the greatest amount of temporary adverse effects to aesthetic resources. However, implementation of BMPs and post treatment revegetation at cost-shared sites as well as Federal sites would ensure that effects to visual resources are less than significant.

3.3 Aquatic Resources

3.3.1 Affected Environment

CRB is home to a vast array of aquatic resources. The Columbia River is more than 2,000 kilometers in length and drains over 724,000 square kilometers across seven states and British Columbia. Major tributaries to the Columbia include the Snake, Yakima, Spokane, Kootenai, Pend Oreille, Willamette, Deschutes, and John Day Rivers. The CRB provides habitat for hundreds of species of native and non-native

aquatic organisms. The most notable fish species are salmon and steelhead, which migrate to and spawn throughout the CRB.

The four-state area is also home to extensive aquatic resources outside the CRB including the Rouge River Basin in Oregon, numerous small coastal drainages throughout western Oregon and Washington, and the Missouri River Basin, which encompasses most of Montana. Numerous aquatic species reside in the waters of the FSA. Aquatic species listed as endangered or threatened under the Endangered Species Act are presented in Table 4.

3.3.2 Environmental effects

3.3.2.1 Alternative 1: No Federal Action / Current Practices.

Adverse effects from state activities of dreissenid detection and response would include disturbance, direct injury, direct mortality, sublethal injury, reduced cover, reduced dissolved oxygen, reduced spawning habitat suitability, and reduced food sources. Adverse effects would be most substantial at treatable aquatic areas and their access points. Under this alternative, these effects would be limited to waters under the jurisdiction of state governments.

State level rapid response plans do not outline specific courses of chemical treatment for dreissenid control; instead, they list a broad range of treatments that could be employed. They do identify treatments they expect to be most effective, and to a large degree, these are the chemical treatment options employed in Alternatives 2 and 3. These treatments will be examined below.

Should state treatment actions include chemical controls not discussed below, they may have more or less adverse effects than presented here. Likewise, they may be more or less effective at preventing the establishment of dreissenids.

Adverse effects to aquatic resources

Toxicity

Adverse effects to aquatic wildlife are dependent on a number of factors including the dosage, duration, or exposure, and particular species being exposed. Site isolation wouldould prevent effective concentrations of treatment chemicals from occurring outside intended treatment areas. Therefore, the effects of the proposed treatments are anticipated only for the specific, isolated treatment area, and are not applicable to the remainder of the waterbody or associated species populations. Application recommendations from product labels would be applied during treatment to minimize non-target effects.

Table 4. Aquatic Endangered Species Act proposed, threatened, and endangered species in the FSA. Critical habitat designations are also listed. Under the Species Status column, E = Endangered, T = Threatened, PT = Proposed Threatened.

Fish			
Common	**Latin**	**Status**	**Critical Habitat**
Borax Lake Chub	*Gila boraxobius*	E	Final
Bull Trout	*Salvelinus confluentus*	T	Final
Chinook Salmon	*Oncorhynchus tshawytscha*	T/E	Final
Chum Salmon	*Oncorhynchus keta*	T	Final
Coho Salmon	*Oncorhynchus kisutch*	T	Final
Dolly Varden	*Salvelinus malma*	PT	NA
Foskett Speckled Dace	*Rhinichthys osculus ssp.*	T	NA
Hutton Tui Chub	*Gila bicolor ssp.*	T	NA
Lahontan Cutthroat	*Oncorhynchus clarkii henshawi*	T	NA
Lost River Sucker	*Deltistes luxatus*	T	Final
Palid Sturgeon	*Scaphirhynchus albus*	E	NA
Shortnose Sucker	*Chasmistes brevirostris*	E	Final
Sockeye Salmon	*Oncorhynchus nerka*	T/E	Final
Steelhead	*Oncorhynchus mykiss*	T	Final
Warner Sucker	*Catostomus warnerensis*	T	Final
White Sturgeon	*Acipenser transmontanus*	E	Final
Mollusks/Crustaceans			
Banbury Springs Limpet	*Lanx sp.*	E	NA
Bliss Rapids Snail	*Taylorconcha serpenticola*	T	NA
Bruneau Hot Springsnail	*Pyrgulopsis bruneauensis*	E	NA
Snake River Physa Snail	*Physa natricina*	E	NA
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	T	Final
Amphibians			
Oregon Spotted Frog	*Rana pretiosa*	T	Final
Insects			
Meltwater Lednian	*Lednia tumana*	PT	NA
Western Glacier Stonefly	*Zapada glacier*	PT	NA
Plants			
Water Howellia	*Howellia aquatilis*	T	NA

Toxicology data was reviewed from the National Institute of health's Toxicology Data Network (TOXNET) and is presented below for the likely (in the case of Alternative 1) and proposed treatments (in Alternatives 2 and 3).

- Endothall

Endothall is an aquatic-labeled herbicide that will kill aquatic vegetation in the treatment area, as well as aquatic organisms. Sublethal effects may include changes in behaviors or body functions that are not directly lethal to the aquatic species, but could have reproductive, juvenile to adult survival, predation susceptibility, or other consequences.

Endothall would be applied at a rate of 0.3 – 5 mg/L after mixing up to 6 days for effective mussel treatment. Applications may be made at the surface, mid-depth, or deep to ensure appropriate mixing and to maintain the desired concentration throughout the treatment area. At this concentration and duration of treatment, it is assumed that all aquatic species/individuals not salvaged would be killed during treatment.

There are no long-term effects of Endothall, meaning that neither Endothall nor substances produced as intermediates during its breakdown will not accumulate in the environment or provide lasting potential effects. The Endothall half-life (time required for half of the active ingredient to degrade) averages five to ten days, and complete degradation through microbial action occurs within 30-60 days.

Treatment area isolation would be left in place for 30-45 days for each treatment to ensure Endothall would degrade to 0.1 mg/L before removing the barrier to avoid effects outside of the treatment area.

- EarthTec QZ

EarthTec QZ is an aquatic labeled algaecide/bactericide that has been found highly effective on dreissenid mussels. The active ingredient in EarthTec QZ is copper sulfate pentahydrate at 19.8% of the solution per volume.

Target application rate would be 0.5 – 2 mg/L (equivalent to 0.06 – 0.1 mg/L as copper) for up to 30 days for effectiveness. Applications could be made at the surface, mid-depth, or deep to ensure appropriate mixing and to maintain the desired concentration throughout the treatment area. At this concentration and duration of treatment, it is assumed that all aquatic species/individuals not salvaged would be killed during treatment.

There are no long-term accumulation effects associated with EarthTec QZ, meaning the copper will not precipitate into substrates. The product will remain suspended until bacteria and algae take it up. Dispersion into the waterbody would quickly reduce concentrations to below effect levels outside of the isolated treatment area. The maximum applied copper concentration would be 0.1 mg/L, and multiple treatments within the same waterbody following label recommendations and other BMPs would not allow copper concentrations to reach a sustained level that may affect aquatic species before being taken up by microorganisms. Treatment area isolation would be left in place for 30-45 days for each treatment to ensure effectiveness.

- Potash

Potassium is a plant fertilizer commonly referred to as potash and comes in a few different compounds. The compounds proposed for dreissenid treatment are potassium chloride (KCL), potassium hydroxide (KOH), and potassium sulfide (KS_2PO_4).

Target application rates would be 95-115 mg/L (KCL), ≤ 10 mg/L (KOH), and 160-640 mg/L (KS_2PO_4) after mixing for up to 21 days for effectiveness. Applications could be

made at the surface, mid-depth, or deep to ensure appropriate mixing and to maintain the desired concentration throughout the treatment area.

A fact sheet for potash states that "…test results indicate that the compound is practically nontoxic to birds and freshwater fish, and, at most, slightly toxic to aquatic invertebrates. Low toxicity, the proposed rate of application, and mitigating label language present minimal to nonexistent risk to wildlife". While the fact sheet provided no citation of studies, toxicity thresholds collected from TOXNET indicate that potash does not pose a serious threat to aquatic species at the proposed concentration and duration of treatment.

- Zequanox

Zequanox is a natural molluscicide (a pesticide that effects mollusks) comprised of killed *Pseudomonas fluorescens* strain CL145A bacteria cells and spent fermentation media at 50% of product volume. This is a naturally occurring bacteria that breaks down the digestive tract of dreissenid mussels in all life stages as they are filtered from the water column and consumed by the mussels. Target application rate is 100mg/L concentration within the treatment area after mixing. The Environmental Protection Agency approved Zequanox for open water treatments in 2014.

Current research indicates that Zequanox is virtually nontoxic to other invertebrate species, including native freshwater mussels. One study found adverse effects to rainbow trout at dosages below the recommended treatment rate. At the proposed treatment concentration and duration it can be assumed that salmonids not salvaged from the treatment site would be adversely effected and potentially killed, but other aquatic species would likely not be harmed.

- UV-B

UV-B would be applied at a target intensity rate of 50 – 100 mJ/cm². While there would be no long-term negative effects to habitat from UV-B treatment, it can be very damaging to aquatic species.

Given the studies that suggest UV-B or C is effective for killing dreissenid mussels, it can be assumed to be harmful to non-target aquatic organisms within treatment areas by basically causing severe sunburn. However, at the intensity and time period proposed for mussel treatment, all organisms exposed would be killed. It should be noted that the effects of intense UV would be limited to immediate exposure. Organisms entering the treatment area post-treatment would not be negatively affected.

- Ozone

Ozone is a natural atmospheric compound that is commonly used as a disinfectant in wastewater treatment and hatchery facilities. It is known to kill aquatic microorganisms and viruses. Little ecotoxicology information exists for ozone, but laboratory studies on small mammals suggest ozone acts as a cancer-causing carcinogen when directly

exposed. Ozone has some advantages because it has a rapid reaction rate, produces few harmful reaction by-products in freshwater, and oxygen is produced as a reaction end-product (Durán et al., 2010; Summerfelt, 2003).

Because ozone is used as a wastewater treatment method to kill aquatic organisms, Treatment with ozone may affect, and is likely to adversely affect aquatic species.

- Rhodamine WT Dye

Rhodamine WT is a red dye that is sometimes used as a fluorescent water tracer. This dye may be included in to assist with identifying leaks or breaches in the isolation barriers to prevent unintentional effects outside of the treatment area.

Little research has been conducted on the toxicity of Rhodamine WT, but the information available suggests that at our proposed treatment concentration, adverse effects are not certain to occur from Rhodamine WT and would likely be insignificant.

State Action plans do not specify mitigative actions, but it reasonable to assume they would adhere to BMPs specified by the product labels of the chemicals being applied during treatment.

In the case of all proposed treatments, adverse effects of treatments in the isolated areas would dissipate quickly, posing no long-term or wide-spread contamination.

Monitoring

Post-treatment monitoring would consist of occasional SCUBA or snorkeling events to detect adult mussels. These events would be short duration, likely on the scale of hours, and would not isolate any particular habitats from listed species. Only minor disturbance would be expected. Settlement plate checks and boat inspections may disturb species at most. Therefore, monitoring is not predicted to have substantial adverse effects on aquatic resources.

Beneficial effects to aquatic resources

Dreissenid mussels, were they to become established in the FSA, would cause extensive adverse effects to native aquatic species. Zebra and quagga mussels proliferate rapidly and can quickly reach extremely high densities. The sheer number of individual mussels combined with their ability to filter a quart of water per day per individual mussel can cause rapid changes to ecosystems with dramatic effects to native aquatic species.

A main effect of the establishment of dreissenids would be a significant reduction in primary productivity, as the mussels would filter much of the plankton from the water. Plankton are tiny aquatic organisms that drift water, forming the basis of the aquatic food chain. Larger invertebrates, juvenile fish, and, in turn, adult fish depend on these tiny organism for their food and survival. Disruptions at the base of the food chain

would have cascading effects that would significantly impair the ability of aquatic species, including ESA-listed salmon and steelhead, to persist and thrive.

Native freshwater mollusks and especially Unionid mussels are likely the group most at risk in the event of a dreissenid invasion in the FSA. The hard shells of freshwater mussels and snails serve as colonization sites for zebra and quagga mussels (Figure 14), inhibiting filter feeding, respiration, movement, and reproduction. Dreissenids also compete directly with freshwater mussels for food and space. Freshwater mussels and dreissenids have coexisted in Europe, but North American mussels have no evolved mechanisms to defend against colonization by zebra and quagga mussels. The result has been dramatic declines in native mussel abundance following the introduction of zebra and quagga mussels.

Under Alternative 1, state actions would cause both beneficial and temporary adverse effects to aquatic resources. State level control programs would slow the spread of dreissenids and the associated significant harm to the aquatic environment they represent, as described earlier in this document. However, without treatment in Federally-managed waters along the Columbia and Snake River, and without access to Federal cost-sharing, it is assumed that these actions may delay, but may not prevent, the establishment of dreissenids in the CRB, and the impacts to aquatic resources.

Figure 14. A Native Unionid Mussel Infested with Zebra Mussels. Photo by B.R. Smith.

Direct effects to aquatic resources would be high in impact and short in duration. Indirect affects to aquatic species from implementation proposed action could come from riparian access development, treatment area isolation, and treatment application and would be minor and of moderate duration, and potentially beneficial long term if state level actions can significantly delay the establishment of dreissenids in the FSA.

Effects to threatened and endangered species would follow the same pattern. Short-term direct and indirect effects of current practices would be likely to adversely affect special status species, though delaying the establishment of dreissenids would be beneficial.

Overall impacts to aquatic resources from implementing state monitoring and treatments would be less than significant and would contribute to the prevention of significant impacts from dreissenids.

3.3.2.2 Alternative 2: The Corps adopts a Rapid Response Plan.

Treatment locations beyond those described in Alternative 1 in this alternative would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas. Alternative 2 would have a greater adverse effect to aquatic resources in the four-state area, if only through the addition of more potential treatment areas, as its effects would be additive to those seen in Alternative 1, Current Practices.

Beneficial effects to aquatic resources would be similar to Alternative 1, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to the visual environment they represent.

Under Alternative 2, adverse effects to aquatic resources resulting from treatment actions in the event of a dreissenid detection and response would be the same as for Alternative 1, but would also include minimal short-term negative effects on treatment sites within Corps Federal jurisdiction and could include other Federal jurisdictions.

3.3.2.3 Alternative 3: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Action).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3 includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the CRB.

Similarly, Alternative 3 would have the same temporary negative effects as Alternative 2, but would include additional effects for up to 12 cost-shared sites annually. Effects at these six additional potential sites would be the same as those described at up to six

sites in Alternative 1. This alternative would have the potential for the greatest amount of temporary adverse effects to aquatic resources. However, restoration described in Section 2.2.3 would restore pre-existing conditions to ensure no lasting adverse effects to aquatic resources.

Effects to threatened and endangered aquatic species would follow the same pattern. Short-term direct and indirect effects of the proposed action would be likely to adversely affect special status species, though restoration efforts would prevent the effects from rising to significance. Long-term effects would be greatly beneficial. A detailed analysis of effects to threatened and endangered species can be found in the attached *Dreissenid Mussel Rapid Response Action Plan Biological Assessment*.

Overall, while the effects of dreissenid mussel control would be locally harmful to aquatic resources in the short-term, the consequences of not treating would be devastating system-wide. As such, the effects of the proposed action on aquatic resources would be substantially beneficial.

3.4 Historic and Cultural Resources

3.4.1 Affected Environment

The FSA, in its entirety, encompasses an area of over 400,510 square miles, almost entirely drained by the Columbia and Snake rivers. These two rivers and their tributaries have provided the resources needed for human occupation for thousands of years. During their extensive occupation along the rivers and tributaries of the Columbia River, Native Americans subsisted on the abundant salmon and aquatic resources available, and Traditional Cultural Properties (TCPs) and Historical Properties of Religious and Cultural Significance to Indian Tribes (HPRCSITs) reflect important fishing locations and fishing villages native peoples occupied for collecting such resources.

When the first European settlers arrived, the FSA was reformed to support agricultural practices. This transformation was aided through the impoundment of water by creating reservoirs within the major rivers of the CRB. This was done so through the construction of dams, locks and other facilities throughout the CRB. The construction of these structures began as far back as the late 19th century and continued into the mid-20th century, as dams were desired to control the rivers. Many of these dams are complex units with intakes, fish passages, locking mechanisms, and countless other components; all of which can be considered in evaluating their eligibility for the National Register of Historical Properties. Unfortunately, zebra and quagga mussels have the potential to infest these facilities.

3.4.2 Environmental Effects

3.4.2.1 Alternative One: No Federal Action / Current Practices.

Under Current Practices, there would be minimal effects to historic and cultural resources. State treatment plans do not propose ground disturbance, nor would

treatment actions involve these resources. Therefore, adverse impacts to cultural and historic resources would remain as they are today, which is minimal.

Beneficial effects to historic and cultural properties could come from the prevention or delay of establishment of dreissenids in the FSA. Dreissenids have caused substantial damage to in-water structures throughout the Great Lakes and Midwest. Damage from structures can occur both directly due to mussel attachment, and during maintenance actions taken to remove dreissenids. Were dreissenids to establish in the CRB, they would negatively affect historic in-water structures, including the locks and dams of the Federal Columbia River Power System (FCRPS). However, without treatment in Federally-managed waters along the Columbia and Snake River, and without access to Federal cost-sharing, it is assumed that these actions may delay, but may not prevent, the establishment of dreissenids in the CRB, and the impacts to cultural and historic resources.

3.4.2.2 Alternative Two: The Corps adopts a Rapid Response Plan.

Treatment locations beyond those described in Alternative 1 in this alternative would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas. Alternative 2 would have a similar minimal effect to historic and cultural resources in the four-state area to those seen in Alternative 1, Current Practices. No ground disturbance is proposed in the alternative, but if any ground disturbing activity were proposed, the Corps would complete a separate NEPA analysis to include National Historic Preservation Act (NHPA) Section 106 review. After the site-specific analysis is complete and corresponding consultation with appropriate entities (State Historic Preservation Officers [SHPO], Tribal Historic Preservation Officers, and concerned Tribes) concur with the findings, the action would be authorized.

Beneficial effects to historic and cultural resources would be similar to Alternative 1, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to the visual environment they represent.

3.4.2.3 Alternative Three: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Action).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3 includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the CRB.

Alternative 3 would have the same minimal negative effects to historic and cultural resources as Alternative 2, and would require additional site-specific NHPA review were ground-disturbing activities to be proposed as part of dreissenid treatment.

3.5 Recreation

3.5.1 Affected Environment

The four-state area provides a variety of opportunities for outdoor recreation, which in turn provides intrinsic value to residents as well as economic opportunities through tourism. Estimates of the economic value of outdoor recreation reports that outdoor recreation generates 522,000 jobs, $57.5 billion in consumer spending, $17.2 billion in wages, and $3.7 billion in state and local tax revenue in the four-state area. In addition to generating tourism and economic benefits, approximately 70% of FSA residents participate in outdoor recreational activities.

Recreation facilities and land available for recreational use in the FSA are managed and operated by the Corps, USFWS, local and state recreation agencies, and public port authorities. Recreation sites in the FSA include parks, rivers, trails, forests, lakes/reservoirs, marinas, boat ramps, and wildlife areas. The Corps owns most of the water-based recreation areas and facilities located along the Columbia and Snake River reservoirs and manages many of them. Some Corps-owned facilities are managed under lease agreements by other agencies or organizations.

Recreational facilities adjacent to CRB reservoirs provide opportunities such as picnicking, camping, boating, swimming, hiking, wildlife viewing, fishing, and hunting. Most recreation is related to the water resources provided by the Columbia and Snake Rivers. Recreation activities take place throughout the year, with the most use occurring during the late spring, summer, and early autumn when fair weather is typical.

3.5.2 Environmental Effects

3.5.2.1 Alternative 1: No Federal Action / Current Practices.

Under Current Practices, recreational activities such as power boating, kayaking, sailing, swimming, hiking, and picnicking would be restricted due to quarantines of detection and treatment sites. Equipment and vehicles used to conduct treatment or mitigation may also impair recreation, as the public would need to be kept away from equipment for their own safety. It is likely that recreational opportunities would not be entirely precluded as users may elect to recreate at other locations during periods where preferred recreational sites were quarantined. These locations may be other shoreline locations removed from the treatment site, or upland locations. That said, additional transportation time to an alternate site, or foregoing preferred aquatic recreation for upland activities, can be a substantial burden on certain members of the public.

Adverse effects to recreation from mussel treatment would be temporary in nature and would not persist past the duration of isolation, treatment, monitoring, and restoration. Treatment and isolation would last a minimum of 105 days, but would persist until the verifiable eradication of dreissenids. Adverse effects to recreation from dreissenid control actions undertaken by state or local governments would be limited to locations outside of Federal jurisdiction.

Beneficial effects to recreation would be seen under the No Action Alternative through the delay or prevention of dreissenid mussels establishing in the FSA. The establishment of dreissenid mussels in the FSA would be unquestionably detrimental to recreation. Once established, zebra and quagga mussels can transform landscapes by covering any solid structure at or near the waterline. This includes docks (Figure 15), pilings, boats (Figure 16), seawalls, or nearly any firm structure on which they can anchor. This would substantially impede and in many cases prevent recreation on shorelines and in waters of the FSA.

Figure 15. A Dock Covered in Invasive Dreissenid Mussels. Photo by Chris McCarrus.

Throughout the Great Lakes, zebra and quagga mussel shells cover entire shorelines to multiple feet deep (Figure 17). These shells are thin and sharp, and prevent sandy shorelines from being used as intended. This represents a hazard for beachgoers and impedes recreation. Further, selective diet patterns of invasive mussels combined with an abundance of nutrients in the form of mussel psuedofeces can create blooms of toxic and foul-smelling cyanobacteria, rendering waters and shorelines completely unsuitable for recreation.

Figure 16. An Outboard Motor Propeller Fouled with Dreissenid Mussels. Photo by the National Park Service.

Effects to recreation resulting from the establishment of dreissenid mussels in the FSA would not be temporary, nor would they be limited to treatment sites. Invasive mussels spread quickly through water systems, and once established would likely colonize the majority of the FSA. This risk is escalated should invasive mussels be found on Corps controlled waters in the CRB. The connectivity present in the Columbia River system would provide simple vectors for the spread of invasive mussels throughout the basin, and recreation would be adversely affected throughout the region. Additionally, these effects would likely be permanent. Once established, it would likely be impossible to completely eradicate dreissenid mussels outside of small, isolated waterbodies.

While there would be temporary, site-specific adverse effects to recreation from state-directed dreissenid control treatments, the system-wide benefits from the delay of the establishment of dreissenid mussels would have substantial beneficial effects.

State level control programs would slow the spread of invasive dreissenid mussels and the associated harm to recreational opportunities they represent. However, without treatment at Corps controlled locations along the Columbia and Snake River, and without access to Federal cost-sharing, it can be assumed that these actions might delay, but not prevent the establishment of zebra and quagga mussels in the FSA.

Figure 17. A Shoreline Buried Under Empty Dreissenid Shells. Photo by Cody Warner.

3.5.2.2 Alternative 2: The Corps adopts a Rapid Response Plan.

In this alternative, treatment locations beyond those described in Alternative 1 would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas, although other Federal agencies could adopt this framework as well. Alternative 2 would have a greater adverse effect to recreation in the FSA, if only through the addition of more potential treatment areas, as its effects would be additive to those seen in Alternative 1, Current Practices.

Beneficial effects to recreation would be similar to Alternative 1, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to recreation they represent. However, without access to Federal cost-sharing for other action agencies, it can be assumed that these actions might delay, but not prevent, the establishment of zebra and quagga mussels in the FSA

Under Alternative 2, adverse effects to recreation resulting from treatment actions in the event of a dreissenid detection and response would be the same as for Alternative 1 – the quarantining of boat launches, marinas, or shoreline recreation areas, but would also include minimal short-term negative effects on treatment sites within Corps Federal jurisdiction and could include other Federal jurisdictions.

3.5.2.3 Alternative 3: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Alternative).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3

includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the CRB.

Similarly, Alternative 3 has the same temporary negative effects to recreation as Alternative 2, but would include additional effects for up to 12 cost-shared sites annually. If these additional sites where geographically clustered this may create an additional burden if users are required to travel greater distances to find shorelines and boat basins that are not quarantined. As such, this alternative would have the potential for the greatest amount of temporary adverse effects to recreation. While there would be temporary, site-specific adverse effects to recreation from the proposed action, the system-wide benefits from the prevention of the establishment of dreissenid mussels would have substantial and long lasting beneficial effects.

3.6 Socioeconomics

3.6.1 Affected Environment

The population of the FSA has grown continually over the last 20 years, with a trend of migration from rural areas into urban centers. The population of the FSA is less racially diverse than the national average and has a greater percentage of persons living in poverty, but otherwise is generally similar to national averages in most other demographic measures. Area employment has been largely recovered from the national recession in 2008-2010, and incomes have continued to increase throughout the region.

The following sections describe the current socioeconomic conditions of the communities in the watershed study area. Socioeconomic conditions that are considered include population demographics, employment and income, and environmental justice concerns. This section also presents information on commercial navigation, and its role in the regional economy.

3.6.1.1 Population and Demographics

Population for each state is presented in Figure 18, below. The FSA is generally rural in nature with generally low population densities. The main population centers in the FSA are Boise, Idaho; Portland, Eugene, and Salem, Oregon; and Seattle, Tacoma, and Spokane, Washington. While population densities are relatively low, the FSA has experienced rapid growth since 1980, paced by Idaho, the fastest growing state in the United States from July 1, 2016 to July 1, 2017.

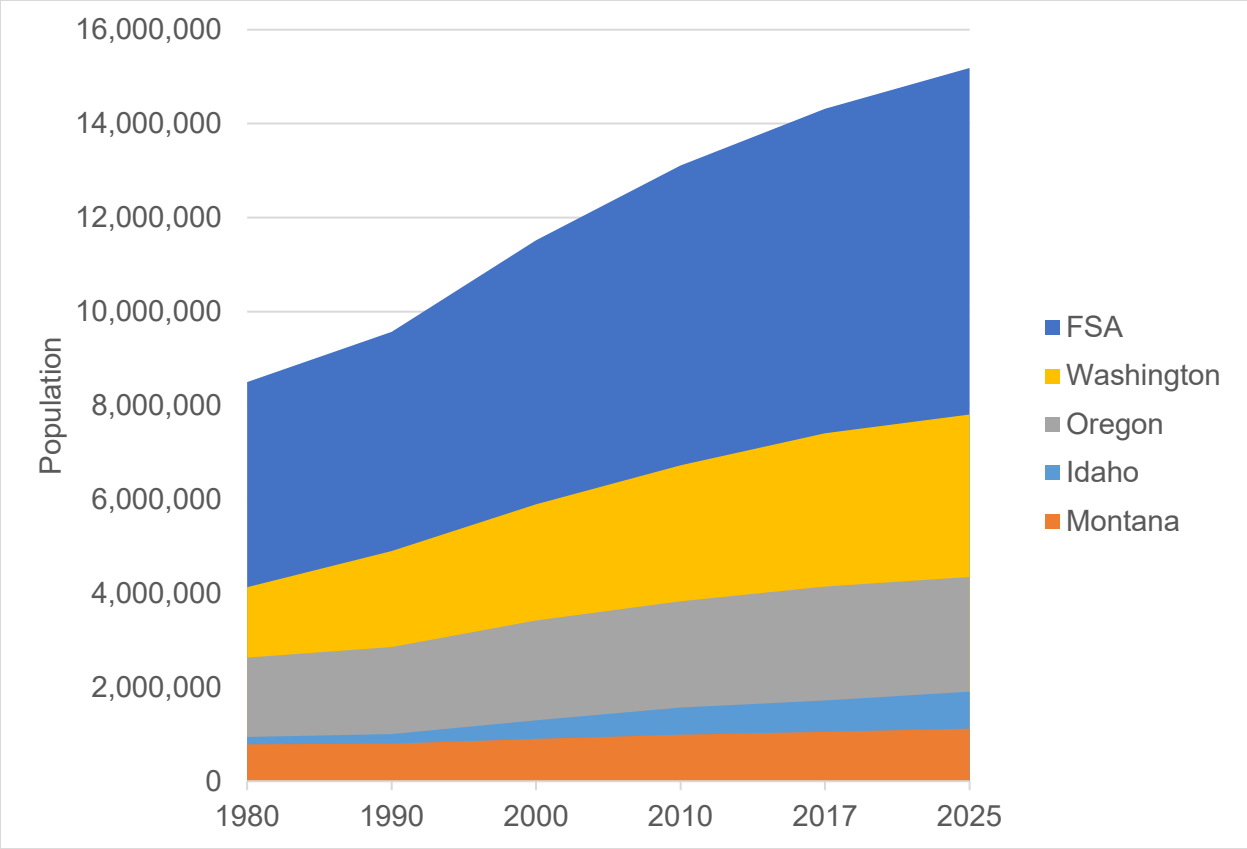

Figure 18. Population trends in the four-state area, 1980 - 2025.

The majority of the population in the four-state area identifies as white as shown in Table 5. While less racially diverse than other areas of the country, the FSA is home to people of a broad variety of racial identifications.

Education and income levels in the FSA are roughly comparable with national averages (Table 6). Educational attainment and median income are both higher in the coastal states of Oregon and Washington, even though Washington has the greatest percentage of persons living in poverty in the FSA.

Table 5. Racial Identification in the FSA. Note that percentages do not add to 100, as categories are not mutually exclusive (U.S. Census Bureau, 2016).

	White	Black or African American	American Indian and Alaskan Native	Asian	Native Hawaiian and Other Pacific Islander	Hispanic or Latino
Idaho	91.3%	0.6%	1.3%	1.3%	0.1%	12.0%
Montana	89.1%	0.4%	6.6%	0.7%	0.1%	3.4%
Oregon	85.1%	1.9%	1.1%	4.0%	0.4%	12.4%
Washington	77.3%	3.6%	1.3%	7.8%	0.6%	12.1%

Table 6. Education and Income in the Four-State Area, 2016 (U.S. Census Bureau, 2016).

	Idaho	Montana	Oregon	Washington	FSA
Population	1,716,943	1,050,493	4,142,776	7,405,743	14,315,955
Persons under 18	25.8%	21.8%	21.1%	22.2%	22.3%
Persons Over 65	15.4%	18.1%	17.1%	15.1%	15.9%
Percent Minority	18.0%	13.8%	24.2%	31.3%	26.4%
High School Graduates	90.0%	92.9%	90.0%	90.6%	90.5%
Bachelors Degree or Higher	26.2%	29.9%	31.4%	33.6%	31.8%
Percent In Labor Force	62.3%	63.2%	61.9%	63.3%	62.8%
Median Household Income	$49,174	$48,380	$53,270	$62,848	$57,375
Persons in Poverty	14.4%	13.3%	13.3%	22.2%	18.0%

3.6.1.2 Environmental Justice Communities

As outlined in Executive Order 12898, Federal agencies must evaluate environmental justice issues related to any project proposed for implementation. This evaluation includes identification of minority and low-income populations, identification of any negative project impacts that would disproportionately affect these low-income or minority groups, and proposed mitigation to offset the projected negative impacts. The evaluation of environmental justice issues includes an identification of high minority and low-income populations in the watershed study area. The identification of any negative project impacts that would potentially have disproportionately high and adverse effects on these low-income or minority groups is presented in Section 3.6.2.

Counties in the FSA with poverty percentages that are more than double the state level include Madison County in Idaho, Glacier County in Montana, and Whitman County in Washington. Counties in the FSA with a percentage of minority residents greater than twice the state average are Clark, Jerome, Minidoka, Owyhee, and Power Counties in Idaho; Big Horn, Blaine, Chouteau, Glacier, Hill, Lake, Roosevelt, and Rosebud Counties in Montana; and Adams County in Washington.

3.6.1.3 Transportation

An overview of regional transportation systems likely to be affected is presented in this section. Commercial barge navigation on the Columbia and Snake Rivers is the only form of transportation likely to be affected by dreissenid mussel treatment. Neither aviation nor roadway traffic is addressed, as mobilization to treatment sites would have a negligible effect on road traffic and aviation.

The Snake River Federal navigation channel extends approximately 140 miles, from the confluence of the Columbia and Snake Rivers at Pasco, Washington to the confluence of the Clearwater River with the Snake River at Lewiston, Idaho. The Snake River channel is the eastern end of the Columbia-Snake River shallow-draft channel, which

extends 330 miles from Portland, Oregon and Vancouver, Washington to Lewiston, Idaho. Deep-water ports on the Lower Columbia River are major international export terminals and are the destination of most of the barge traffic originating on the Snake River. Locks are located at Bonneville Dam, John Day Dam, The Dalles Dam, McNary Dam, Ice Harbor Dam, Lower Monumental Dam, Little Goose, Dam, and Lower Granite Dam (Figure 19).

Commercial navigation on the Columbia and Snake Rivers is important to the majority of the FSA. Commercial traffic serves 54 ports from the mouth of the Columbia River to Lewiston, Idaho. Approximately 10 million tons of commercial cargo is shipped on the inland portion of the Columbia-Snake River system each year with an annual value of between $1.5 and $2 billion. Down bound movements (i.e., movements from upstream ports toward the Columbia River) of grain account for most of this cargo, of which the largest share is wheat. Approximately half of all the wheat exported from export terminals on the Lower Columbia River arrives by barge. Other major commodities include soy, legumes, pulp, milled lumber, minerals, and automobiles.

3.6.2 Environmental Effects Pertaining to Environmental Justice.

Mussel control activities would be completed using industry standard health and safety protocols that would minimize hazardous exposure to applicators and nearby populations, so there would be no adverse effect on human health and safety and no disproportionate adverse impacts on minority and low-income populations. Further, dreissenid mussel treatment inherently seeks to lessen the potential environmental effects from the establishment of invasive mussels at recreational sites in the FSA. Preserving low-cost outdoor recreational access would be beneficial to low income groups. Therefore, environmental justice impacts would be negligible (positive for the preferred alternative), and are not analyzed in further detail in this EA.

3.6.2.1 Alternative 1: No Federal Action / Current Practices.

Under Current Practices, there are both beneficial and adverse effects to socioeconomics. Adverse effects to socioeconomics resulting from treatment actions in the event of a dreissenid detection and response would include short-term negative effects at treatment sites due to the need to isolate sites physically. The primary socioeconomic resource affected would be commercial navigation. Commercial shipping was the original means of introduction of dreissenid mussels to the United States, and commercial navigation facilities are potential sites for the establishment of invasive mussels in the CRB.

Figure 19. The Columbia-Snake Inland Waterway runs from the mouth of the Columbia to Lewiston, Idaho. Black dots indicate Columbia River locks, red indicate Snake River locks, the yellow dot is the terminus of the waterway in Lewiston, Idaho.

Were dreissenid mussels to be detected at a port or dock used by commercial navigation, not managed by the Corps, current practices would very likely include quarantining that site for the duration of treatment. These quarantines would be limited to sites not on Corps-managed reservoirs, primarily below Bonneville Dam in the mainstem Columbia River. Quarantine could pose significant obstacles to the transportation of goods and commodities through the Columbia River corridor as support infrastructure is in place to serve these routes. It may be difficult or impossible to quickly establish the road, rail, or loading networks needed to load or unload a container ship or barge.

The No Action Alternative would have beneficial effects to socioeconomics if it delayed or prevented dreissenid mussels from invading the FSA. The establishment of dreissenids in the FSA would be unquestionably detrimental to socioeconomics. While state treatment would offer limited direct benefits to commercial navigation, once established, zebra and quagga mussels would quickly impair commercial navigation on the Columbia and Snake Rivers. The locks at FCRPS dams have navigation multiple

critical structures that could be fouled by zebra or quagga mussels including miter valves, lock culverts, and raw water systems (Figures 7, 8, and 9). Biofouling of these structures could result in increased corrosion, the inability of the lock to fully open or close, and clogged waterways. Significant delays in movement of cargo would be likely to occur if navigation locks were fouled, decommissioned for cleaning, or rendered inoperable.

State level control programs would slow the spread of invasive dreissenid mussels and the associated harm to socioeconomic opportunities they represent. However, without treatment at Corps controlled locations along the Columbia and Snake Rivers, and without access to Federal cost-sharing, it can be assumed that these actions would delay, but not prevent the establishment of zebra and quagga mussels in the FSA.

3.6.2.2 Alternative 2: The Corps adopts a Rapid Response Plan.

Treatment locations beyond those described in Alternative 1 in this alternative would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas.

Beneficial effects to socioeconomics would be similar to Alternative 1, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to socioeconomics they represent.

Under Alternative 2, adverse effects to socioeconomics resulting from treatment actions in the event of a dreissenid detection and response would be the same as for Alternative 1, but would also include minimal short-term negative effects on treatment sites within Corps Federal jurisdiction and could include other Federal jurisdictions. Site isolation would create similar adverse effects to socioeconomics as seen in the No Action Alternative, but the effects from Alternative 2 would take place on Corps-controlled reservoirs along the Columbia and Snake Rivers. This would have the potential to create substantially greater adverse effects due to the greater potential action area and the greater quantity of commercial navigation infrastructure in the Corps controlled portion of the CRB. A quarantine of commercial navigation infrastructure would have direct impacts on navigation through the FCRPS, stopping or slowing navigation through the system.

3.6.2.3 Alternative 3: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Alternative).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3 includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the CRB.

Similarly, Alternative 3 has the same temporary negative effects to socioeconomics as Alternative 2, but would include additional effects for up to 12 cost-shared sites annually. This alternative would have the potential for the greatest amount of temporary adverse effects to socioeconomics due to the potential for additional treatment sites, but also the greatest chance of averting irreparable harm to navigation and socioeconomic resources in the FSA.

3.7 Terrestrial Resources

3.7.1 Affected Environment

Terrestrial habitat within the FSA includes many types, from desert to rainforest, and mountainous forests to wide river valleys. The large quantity of water in the rivers of the basin make irrigated agriculture possible. There are now millions of acres of irrigated agriculture, which has dramatically altered native prairie habitats. Wildlife present throughout the FSA includes both large and small mammals, birds, and reptiles. There are numerous protected species. Other terrestrial resources, such as plants, including a variety of trees, shrubs, forbs, and grasses, can be found near the many and diverse habitat types throughout the states in the proposed action area.

Specific terrestrial habitat likely to be affected by the alternatives is that which is located adjacent to a body of water with the potential for infestation by invasive dreissenid mussels, and much of the wildlife in the FSA is generally found to be dependent on tree-shrub riparian habitat associated with the reservoirs and river systems. In general, habitats associated with water, e.g., riparian and wetland areas, support higher population densities and species numbers than dry grassland and shrub community habitat. Habitats associated with waterbodies generally support trees/shrub or dense hydrophytic emergent grass-forb cover, which provides more structurally complex habitat and more abundant forage resources than adjacent uplands. Terrestrial species listed as endangered or threatened under the Endangered Species Act are presented in Table 7.

3.7.2 Environmental Effects

3.7.2.1 Alternative 1: No Federal Action / Current Practices.

Under Current Practices, there are both beneficial and adverse effects to terrestrial resources and wildlife. While no State or Local level treatments have been attempted to date, adverse effects resulting from dreissenid detection and response would include disturbance, displacement, direct injury, direct mortality, sublethal injury, disrupted reproduction, reduced food sources, reduced cover, reduced nesting habitat, increased predation, and habitat fragmentation. There would be localized adverse effects resulting from treatment actions in the event of a dreissenid detection and response. Adverse effects would be confined to habitats near treatable aquatic areas and their access points; on waterbodies not controlled by the Corps. Adverse effects to terrestrial resources would be caused primarily by riparian access development, but could also occur from isolation, monitoring, and treatment. State action plans do not detail all specific measures that would be taken to isolate and access sites, but reasonable

conclusions can be made about the least impactful approaches that could be employed. These actions are analyzed here, although state actors may choose methods not outlined here that could have more significant adverse effects to terrestrial resources.

Table 7. Terrestrial Endangered Species Act proposed, threatened, and endangered species in the FSA. Critical habitat designations are also listed. Under the Species Status column, E = Endangered, T = Threatened, PT = Proposed Threatened, C = Candidate.

Mammals			
Common	**Latin**	**Status**	**Critical Habitat**
Black-footed Ferret	*Mustela nigripes*	E	NA
Canada Lynx	*Lynx canadensis*	T	Final
Columbia Basin Pygmy Rabbit	*Brachylagus idahoensis*	E	NA
Columbian White-tailed Deer	*Odocoileus virginianus leucurus*	T	NA
Gray Wolf	*Canis lupus*	E	Final
Grizzly Bear	*Ursus arctos horribilis*	T	Proposed
North American Wolverine	*Gulo gulo luscus*	PT	NA
Northern Idaho Ground Squirrel	*Urocitellus brunneus*	T	NA
Olympia Pocket Gopher	*Thomomys mazama pugetensis*	T	Final
Red Tree Vole	*Arborimus longicaudus*	C	NA
Roy Prairie Pocket Gopher	*Thomomys mazama glacialis*	T	Final
Tenino Pocket Gopher	*Thomomys mazama tumuli*	T	Final
Woodland caribou	*Rangifer tarandus caribou*	E	Final
Yelm Pocket Gopher	*Thomomys mazama yelmensis*	T	Final
Birds			
Least Tern	*Sterna antillarum*	E	NA
Marbled Murrelet	*Brachyramphus marmoratus*	T	Final
Northern Spotted owl	*Strix occidentalis caurina*	T	Final
Streak Horned Lark	*Eremophila alpestris strigata*	T	Final
Western Snowy Plover	*Charadrius alexandrinus nivosus*	T	Final
Yellow-billed Cuckoo	*Coccyzus americanus*	T	Proposed
Insects			
Fender's Blue Butterfly	*Icaricia icarioides fenderi*	E	Final
Meltwater Lednian	*Lednia tumana*	PT	NA
Oregon Silverspot Butterfly	*Speyeria zerene hippolyta*	T	Final
Taylor's (whulge) Checkerspot	*Euphydryas editha taylori*	E	Final
Plants			
Applegate's Milk-Vetch	*Astragalus applegatei*	E	NA
Gentner's Fritillary	*Fritillaria gentneri*	E	NA
MacFarlane's Four-o'clock	*Mirabilis macfarlanei*	T	NA
Slickspot Peppergrass	*Lepidium papilliferum*	T	Proposed
Spalding's Catchfly	*Silene spaldingii*	T	NA
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	NA
Western Lily	*Lilium occidentale*	E	NA
Whitebark Pine	*Pinus albicaulis*	C	NA

Riparian access development would require herbaceous vegetation mowing, woody shrub removal, and potentially tree removal which would cause disturbance. For terrestrial species, this could reduce available nesting habitat, food sources, and cover. Species inhabiting the area where vegetation may be removed would be disturbed by equipment operation. Species that are able to leave the area likely would do so ahead of vegetation removal. Small mammals may be less able to vacate the area, along with plant species. These species would be susceptible to direct injury or mortality. The operation of equipment in soft soils that may be occupied by small mammals poses a risk of collapsing and compacting soils, which may harm burrowing mammals, amphibians, and reptiles. Vegetation removal from cutting and mowing may harm these species as well.

Additionally, the reduction in cover may fragment the habitat and expose species to predation risk as they move between cover areas. This risk would be temporary during active treatment and mitigation, and would be eliminated post-mitigation.

Site isolation may also have limited adverse effects to terrestrial species. The act of tying off a silt curtain to existing vegetation may damage vegetation, as well as if blocks or sandbags were placed on top of vegetation. This may reduce cover and food sources for terrestrial species, but the likely footprint of the disturbance would be minor, on the scale of square feet, and would likely have insignificant effects. The operation of the boat to set the silt curtain, operation of a pump to fill an inflatable bladder dam, or operation of any other equipment to place material would likely cause noise disturbance sufficient that terrestrial species would avoid the area. This may pose an inconvenience to terrestrial species, but would not disturb adjacent areas.

While much of the effects to terrestrial species would come from the development of site access and staging areas, there could also be direct effects from the in- and on-water treatment. Effects to terrestrial species from dreissenid treatment may include disturbance, displacement, and injury. The operation of a boat, pressure washer, and other necessary equipment to apply treatments would likely cause noise disturbance sufficient that terrestrial species would avoid the treatment area. This may pose an inconvenience to terrestrial species, but would not disturb adjacent areas. Mussel treatment would kill aquatic food sources for some waterfowl, but the treatment area in most cases would make up an insignificant portion of feeding area.

Post-treatment monitoring would consist of occasional SCUBA or snorkeling events, settlement plate checks, water sampling, and watercraft inspection to detect adult mussels. These events would be of short duration, likely on the scale of hours, and would not require significant species or habitat disturbance while accessing the waterbody. Only minor disturbance would be expected.

In addition to adverse effects, some beneficial effects to terrestrial species would be seen under the No Action Alternative if it delays or prevents the establishment of dreissenid mussels. Dreissenids, were they to become established in the FSA, would cause extensive adverse effects to native aquatic species. While most terrestrial species would not be substantially affected, species that depend on aquatic food webs

would be harmed by dreissenids, primarily waterfowl and shore birds. In addition to the disruption of feeding patterns, dreissenid mussels can directly poison waterfowl.

In areas where they are established, dreissenids, especially zebra mussels which are typically limited to areas less than 45 feet deep, present an abundant and readily available food source for diving ducks, placing them within reach of most subsurface feeding waterfowl. Ducks known to consume zebra mussels include mergansers, scaups, redheads, canvasbacks, and Goldeneyes. Unfortunately, zebra mussels are indiscriminate filter feeders and this has serious adverse consequences for birds that consume them. Even in waters with undetectable contaminant loads, zebra mussels are known to accumulate extremely high levels of numerous toxins including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), arsenic, chromium, barium, mercury, cadmium, lead, uranium, and selenium. When birds consume a toxin-laced diet these pollutants rapidly build up in the birds' tissues. Lesser and greater scaups collected from the Great Lakes following the introduction of zebra mussels have been shown to have elevated contaminant burdens and selenium levels high enough to impair reproduction. Dreissenids have also been implicated in outbreaks of avian botulism and die-offs of eagles, gulls, loons, and cormorants throughout the Great Lakes region, though their role in this process is poorly understood.

Effects to threatened and endangered species would follow the same pattern. Short-term direct and indirect effects of current practices would be likely to adversely affect special status species, though delaying the establishment of dreissenids would be beneficial.

State level control programs would slow the spread of invasive dreissenids and the associated harm they represent. However, without treatment at Corps controlled locations along the Columbia and Snake River, and without access to Federal cost-sharing, it can be assumed that these actions might delay, but not prevent, the establishment of zebra and quagga mussels in the FSA.

3.7.2.2 Alternative 2: The Corps adopts a Rapid Response Plan.

Treatment locations beyond those described in Alternative 1 in this alternative would be limited to federally controlled waters, primarily reservoirs and adjacent land on the Columbia and Snake River systems, and would emphasize Corps managed areas. Alternative 2 would have a greater adverse effect to terrestrial resources in the four-state area, if only through the addition of more potential treatment areas, as its effects would be additive to those seen in Alternative 1, Current Practices.

Under Alternative 2, adverse effects to terrestrial resources resulting from treatment actions in the event of a dreissenid detection and response would be the same as for Alternative 1, but would also include minimal short-term negative effects on treatment sites within Corps Federal jurisdiction and could include other Federal jurisdictions. Under Alternative 2, there would also be short-term negative effects to terrestrial resources from mitigative measures specified in the Corps action plan.

Temporary effects to terrestrial species from mitigation actions may include disturbance, displacement, direct injury, direct mortality, sublethal injury, reduced food sources, reduced cover, reduced nesting habitat, increased predation, and habitat fragmentation. Mitigation would include the same effects to terrestrial species as riparian access development as detailed in Alternative 1; however, the benefit of mitigation is restoring the disturbed site to a condition likely better than pre-disturbance. While adverse effects would be temporary, and restored habitat would not be fully functional for at least two years, the 80% plant survival standard and native species replanted may improve vegetation composition in the area overall, which would improve habitat function once established. While mitigation would provide long-term benefits, the temporary adverse effects and potential harm to terrestrial resources species cannot be avoided.

Effects to threatened and endangered species would follow the same pattern. Short-term direct and indirect effects of the proposed action would be likely to adversely affect special status species, though mitigative efforts would prevent the effects from rising to significance.

Beneficial effects to terrestrial resources would be similar to Alternative 2, but would also include areas under Federal jurisdiction. Corps or other Federal agency actions would increase the likelihood of preventing or at least slowing the spread of invasive dreissenids and the associated harm to the visual environment they represent. However, without access to Federal cost-sharing for other action agencies, it can be assumed that these actions might delay, but not prevent, the establishment of zebra and quagga mussels in the FSA.

3.7.2.3 Alternative 3: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Alternative).

Alternative 3 is identical to Alternative 2 except that more state treatments could occur as a result of making the Federal cost share available. This alternative would therefore have similar but increased beneficial effects to those described above. Alternative 3 includes treatment at all Corps controlled locations and effectively doubles funding available for state level treatments. As such, Alternative 3 presents the best chance of preventing establishment of dreissenids in the CRB.

Similarly, Alternative 3 the same temporary negative effects to as Alternative 2, but would include additional effects for up to 12 cost-shared sites annually. This alternative would have the potential for the greatest amount of temporary adverse effects to terrestrial resources. However, mitigation would restore pre-existing conditions to ensure no lasting adverse effects to terrestrial resources.

Effects to threatened and endangered species would follow the same pattern. Short-term direct and indirect effects of the proposed action would be likely to adversely affect special status species, though mitigative efforts would prevent the effects from rising to significance. Long-term effects would be greatly beneficial. A detailed analysis of effects to threatened and endangered species can be found in the attached *Dreissenid Mussel Rapid Response Action Plan Biological Assessment*.

Overall, while the effects of dreissenid mussel control would be locally harmful to terrestrial resources in the short-term, the consequences of not treating would be devastating system-wide. As such, the effects of the proposed action on aquatic resources would be substantially beneficial.

3.8 Water Quality

3.8.1 Affected Environment

The physical, chemical, or biological condition of water is referred to as water quality. Quality affects whether water should be used by humans, aquatic organisms, or wildlife. The quality of water in the FSA is important for several reasons: fish and aquatic plants require relatively clean water to live; treatment costs for drinking and industrial supplies are higher if water is polluted; people want clean, attractive water for recreation; farmers need clean water to irrigate crops; and wildlife depend on rivers for clean, safe drinking water.

Water quality in the FSA is dominated by the Columbia River system where water quality is generally good. The river carries a large volume of relatively unpolluted surface water. Compared to many other rivers in the United States, there are fewer sources of industrial and municipal wastes. Nevertheless, several types of water quality issues remain in the basin today, including: (1) nonpoint source additions, (2) water withdrawal for irrigation, (3) impoundments, and (4) point source effluents.

Nonpoint source pollution comes from a wide variety of sources; including irrigation return flows, forestry practices, malfunctioning septic systems, urban runoff, and mining leaches. Irrigation is the dominant nonpoint source of pollutants in the Columbia River Basin.

Diversions from rivers and lakes for irrigation and municipal and industrial supply have depleted instream flows in the basin. While not large, the effect is measurable, particularly in selected locations. With less water, secondary problems affect water quality more because there is less dilution and higher concentrations of pollutants. Applications for water rights are expected to increase as the region grows.

Impoundments (reservoirs) have interrupted the free-flowing river system and altered the seasonal variations in water discharge patterns. Some water quality conditions that can be affected by dams and reservoirs include water temperature, dissolved oxygen, nutrient availability, dispersion of hazardous chemicals, turbidity, and sanitary quality. Water temperatures can increase or decrease downstream of a dam. Compared to natural inflows, large reservoirs typically release cooler water in the spring and summer, and warmer water in the fall and winter.

Waste effluents from municipal and industrial plants can constitute a continuous source of water pollution. Municipal sewage treatment plant effluents primarily affect water bodies in urban areas, while mining wastes can seriously affect aquatic communities in rural areas. Significant industrial discharges can occur in either urban or rural areas.

The Columbia River in general is not highly urbanized, although there are some significant population centers along the mainstem and some of the tributaries

3.8.2 Environmental Effects

3.8.2.1 Alternative 1: No Federal Action / Current Practices.

Under current practices, there are both beneficial and adverse effects to water quality. While no State or local level treatments have been attempted to date, adverse effects resulting from dreissenid detection and response could from development of riparian access, site isolation, application of chemical treatments, and post-treatment monitoring. Adverse effects would be most substantial at treatable aquatic areas and their access points. Under current practices, these effects would be limited to waters under the jurisdiction of State and local governments. These effects would also occur, but less substantially, in aquatic areas in the immediate vicinity of treatment areas.

Conversely, if a breach or overtopping of the isolation barrier were to occur when the treatment was thoroughly mixed at the target concentration, it can be assumed that water quality would be adversely affected outside of the treatment area. If a breach were to occur, the duration of water quality impairment would be brief, as quick dilution would occur during water exchange. The full volume of the treatment area would not be immediately released, making large-scale impacts unlikely. If a breach were to occur, water chemistry in the surrounding area would need to be evaluated to ensure repeated treatments would not exceed the recommended maximum concentration for a waterbody at a given time.

In the case of all proposed treatments, adverse effects of treatments in the isolated areas would dissipate quickly, posing no long-term or widespread contamination.

Riparian access development could adversely affect water quality at and near treatment locations in several ways. The removal of riparian vegetation to create a staging area would adversely affect water quality at the staging site. Riparian vegetation stabilizes stream banks, traps contaminants and sediment, and shades the water. Its removal can lead to increased sedimentation and turbidity, elevated water temperatures, and reduced dissolved oxygen. Additionally the use of riparian staging areas creates the potential for a spill or release of hazardous materials into the waterbody. These effects would be localized and short-term in nature. Spill risks would last only as long as the treatment; while the effects of riparian vegetation removal would persist until vegetation re-established.

Chemical treatment to control zebra and quagga mussels would have direct adverse effects on water quality, though the degree would be dependent on the treatment applied. Isolation barriers would remain in place until water quality at treatment sites returned to background levels.

While direct effects to water quality would arise from the application of treatment chemicals, successful treatment of invasive mussels by any means may lead to adverse effects on water quality. Given sufficient biomass, a sudden die-off of any creature in

an aquatic environment can introduce enough decomposing matter to deplete a waterbody of oxygen. This is most widely seen when large algal blooms collapse, leading to “dead zones”, or sections of water completely devoid of dissolved oxygen. While a possibility, this scenario would be highly unlikely to result from dreissenid mussel rapid response. Rapid response actions would take place immediately after detection, before dangerous levels of dreissenid biomass developed. In a worst case scenario, where there were very high dreissenid densities, removal of the isolation barriers would allow for mixing and the return of dissolved oxygen to baseline levels.

Site isolation and monitoring, could adversely affect water quality, primarily through increased turbidity and suspended sediments. Silt barriers, bladder dams, zone bubblers, and other isolation barriers would generate pulses of turbidity during both their installation and removal. Post-treatment monitoring involving the use of watercraft, divers, and wading personal could equally generate short-term sediment pulses. These effects would be localized and short-term in nature. Suspended sediments would likely settle out in the near vicinity of the action area, or within the action area if the isolation barriers were in place. Turbidity would return to background levels following the cessation of the action.

Beneficial effects to aquatic resources would be seen under the No Action Alternative. State level control programs would slow the spread of invasive Dreissenid mussels and the associated harm to the water quality they represent. Dreissenid mussels, were they to become established in the FSA, would cause extensive adverse effects to water quality. Due to their rapid spread and prodigious filtering capabilities, zebra and quagga mussels can transform entire aquatic ecosystems. Filter feeding by even a modest population of dreissenids consumes suspended phytoplankton and particulate nutrients and excretes increasing concentrations of dissolved inorganic nutrients, primarily ammonium and nitrate. Zebra and quagga mussels can also consume a significant portion of available dissolved oxygen. The result is often clear, inorganic nutrient-rich, oxygen-poor systems, dominated by invasive mussels.

However, without treatment at Corps controlled locations along the Columbia and Snake River, and without access to Federal cost-sharing, it can be assumed that these actions might delay, but not prevent, the establishment of zebra and quagga mussels in the FSA.

3.8.2.2 Alternative Two: The Corps adopts a Rapid Response Plan.

Under Alternative 2, there would be both adverse and beneficial effects to water quality. Adverse effects to water quality could result from riparian access development, site isolation, monitoring, or treatment, similar to Alternative 1. Additional adverse effects may be seen from post treatment mitigation effects if shoreline plantings created temporary pulses of turbidity. Adverse effects would be most substantial at treatable aquatic areas and near their access points, on waterbodies controlled by the Corps. Employment of BMPs as described, and post treatment site restoration, would help to ensure that adverse effects to water quality are short lived, and that baseline conditions return following treatment.

Limited beneficial effects to water quality would be seen under Alternative Two. Corps actions would slow the spread of invasive dreissenid mussels and the associated harm to water quality they represent within much of the Columbia and Snake River systems. However, with limited treatment outside Corps controlled locations along the Columbia and Snake River, and without access to Federal cost-sharing for other action agencies, it can be assumed that these actions might delay, but not prevent, the establishment of zebra and quagga mussels in the FSA.

3.8.2.3 Alternative Three: The Corps adopts a Rapid Response Plan and Cost-Share Agreement (Proposed Alternative).

Under the Proposed Alternative, adverse effects to water quality resulting from treatment actions in the event of a dreissenid detection and response would include all the adverse effects on treatment sites due to treatment actions detailed in Section 3.8.2.2. Furthermore, the Proposed Alternative would have the potential for the greatest amount of adverse effects among the alternatives. While Alternative 2 would not preclude current practices, the Proposed Action would enhance current practices by sharing the costs of these actions with the State and local governments. While it cannot be determined how many treatment actions may be conducted in a given year, as zebra and quagga mussels have not yet been detected in the majority of the action area, the Proposed Alternative would likely drive more treatments actions than the other alternatives, as it is effectively Alternative 2 combined with an enhanced version of the current practices alternative (Alternative 1). As adverse effects to water quality are one result of dreissenid treatments, more treatments would generate a greater amount of adverse effects. Similar to Alternative 2, these effects would be localized and short-term.

Alternative 3 would also have long-term beneficial affects to water quality by preventing, or substantially delaying, the establishment of dreissenid mussels in the FSA.

Overall, while the effects of dreissenid mussel control would be locally harmful to water quality in the short-term, the consequences of not treating would be detrimental region-wide and likely a permanent change. As such, the effects of the Proposed Action on water quality would be beneficial on balance.

3.9 Cumulative Affects

The National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) regulations implementing the Act require Federal agencies to consider the cumulative effects of their actions. Cumulative effects are defined as effects “on the environment which result from incremental impact of an action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time” (40 CFR § 1508.7).

The primary goal of a cumulative effects analysis is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and reasonably foreseeable future actions.

The Corps used the technical analysis conducted in this EA to identify and focus on cumulative effects that are "truly meaningful" in terms of local and regional importance. While the EA addresses the effects of alternatives on the range of resources representative of the human and natural environment, not all of those resources need to be included in the cumulative effects analysis – just those that are relevant to the decision to be made on the Proposed Action. Truly meaningful resources considered in this section are aesthetics and the visual environment, aquatic resources, recreation, socioeconomics, terrestrial resources, special status species, and water quality.

Resources are discussed in terms of their cumulative effect boundary (spatial and temporal), the historic condition and impacts to the resources, present condition and impacts to the resources, reasonably foreseeable future actions that may affect the resources, and the effects to the resource by the various alternatives when added to other past, present, and future actions.

This section evaluates the cumulative effects of actions that could potentially affect the same environmental resources as those discussed earlier in this EA. The scope of this analysis extends beyond the proposed action area to other areas that sustain the resources of concern. A resource may be differentially impacted in both time and space. The implication of those impacts depends on the characteristics of the resource, the magnitude and scale of the project's impacts, and the environmental setting (EPA 1999).

3.9.1 Geographic and Temporal Scope of Cumulative Effects Analysis

Guidance for setting appropriate boundaries for a cumulative effects analysis is available from CEQ (1997) and EPA (1999). Generally, the scope of cumulative effects analysis should be broader than the scope of analysis used in assessing direct or indirect effects. "Geographic boundaries and time periods used in cumulative impact analysis should be based on all resources of concern and all of the actions that may contribute, along with the project effects, to cumulative impacts" (EPA 1999). The analysis should delineate appropriate geographic areas including natural ecological boundaries, whenever possible, and should evaluate the time period of the project's effects. Due to the expansiveness of the action area, the analysis here will not look beyond the four-state area and will primarily focus on the CRB. The time period for analysis is 2008 – 2028, Ten years before and after the present time was chosen to limit the effects on the analysis of major infrastructure changes and settlement patterns in the region to better examine the proposed actions contributions in the context of current and reasonably certain to occur system-wide environmental actors.

The resources assessed have experienced various impacts since the mid-1900s. Actions such as construction and operations of dams and associated levee systems, flood control projects, agricultural development, road building, logging, development of

cities, and fish harvest have all contributed to the current state of the resources in the area. These actions have negatively and positively affected the resources.

Discussed below are the past, present, and reasonably foreseeable future actions that were considered for the cumulative effects analysis, the effects of the actions on the resources assessed, and a summary of the cumulative effects of the alternatives.

3.9.2 Aesthetics and the Visual Environment

Aesthetics or visual resources are the natural and cultural features of the landscape that can be seen and that contribute to the public's appreciative enjoyment of the environment. Past actions that have affected aesthetic resources are primarily development in viewsheds, including residential, commercial, and transportation uses, but can also include the more transitory effects of wildfires, weather, or other natural events, like tree diseases. Population in the FSA has increased by nearly 20% since 2008 (Figure 18, above). Given the high recreational and aesthetic value of shorelines, population increases lead to development of access to waterbodies where dreissenid treatment may be likely to occur. These trends are reasonably certain to occur over the next 10 years, as regional population is projected to exceed 16 million residents by 2025.

Treatment, and especially isolation barriers and Rhodamine dye, would have adverse effects to the visual environment, but would not persist beyond the duration of treatment. If multiple treatments were to occur at the same or nearby locations, or in consecutive years, this may represent a larger burden to the viewscape. The effect would not persist after dreissenid treatment is completed. It should be noted that establishment of invasive mussels in the FSA would present a lasting and substantial adverse effects to visual resources. The proposed action would have limited, short-term, less than significant, adverse cumulative impacts to aesthetic and visual resources.

3.9.3 Aquatic Resources

Aquatic species, and especially migratory fish including ESA listed salmon and steelhead, are exposed to a host of biological and physical stressors that reduce their survival and fitness (Johnson et al., 2012). Even nonlethal stressors when experienced repeatedly, or in combination quickly lead to measurable reductions in the health and wellbeing of aquatic organisms (Barton, 2002). Aquatic resources have been affected in the FSA by continuing development of and along riparian corridors, and through the creation of impervious surfaces, cropland, irrigation, and grazing, all of which create nonpoint source water pollution, defined in the Clean Water Act as "…sources of pollution which enter surface or groundwater through widely diffused small increments'". These actions have been ongoing including during the previous ten years and are reasonably certain to continue. The magnitude and cumulative effects of nonpoint source pollutants impart a profound impact on aquatic resources.

The Proposed Action, while a fraction of the volume of cumulative chemical and nutrient inputs to aquatic systems in the FSA, still has the potential to act in concert with existing and future pollution sources to adversely affect aquatic resources. Mixtures of pesticides and other aquatic pollutants often act in concert to have deleterious effects not seen in laboratory-based assessments of individual chemicals or pollutants (Laetz et al., 2009). There is no data examining the combined effects of the proposed treatments with preexisting and future contaminant inputs into aquatic systems in the FSA, but Crain et al. (2008) examined 171 studies that looked at the effects of multiple stressors in aquatic systems and found that in the majority of cases the effects were either additive or synergistic. As such, it is reasonable to conclude that aquatic species exposed to dreissenid treatments would be adversely effected through cumulative effects of the treatment and other stressors, though difficult to quantify the extent and duration of the effect.

These effects may rise to the level of significance, especially if treatments are repeated in a given location over several years, but BMPs and Impact Minimization Measures would be employed to reduce these effects. Site isolation and fish salvage would be two primary approaches to minimizing cumulative effects to aquatic resources. By containing treatment chemicals within a fixed area, aquatic organisms in nearby habitats would be physically isolated from treatment actions. Barriers would be left in place until water quality had returned to background levels for most treatments, and in the case of soluble chemicals such as Zequanox, mixing following removal of the isolation barriers would quickly reduce concentrations to background levels. By employing these ameliorative measures, it is likely that the Proposed Action would have short-term, less than significant, adverse cumulative impacts to aquatic resources

3.9.4 Recreation

The Proposed Action would create adverse effects to recreation in that dreissenid infestation is most likely to occur and be detected at public boat launches, marinas, boat basins, and other public recreation access sites. Isolation of these sites prior to treatment would prohibit their use by the public. These restrictions would be temporary and localized, and possibly minimized by prior and future development patterns. While it is difficult to quantify the development of new recreational locations along waterbodies in the FSA that may be subject to dreissenid infestation, it is not unreasonable to assume that as populations in the region increase new access to riverside recreational areas would and have been developed. This suggests that even repeated or multiple treatments for dreissenid mussels in an area would not substantially restrict recreational opportunities. As such, there would be no significant cumulative effects to recreation from the Proposed Action.

3.9.5 Socioeconomics

The main effects of the Proposed Action to socioeconomic resources would come from the potential restrictions to use of ports, locks, loading facilities and other navigation structures. Quarantines could pose significant obstacles to the transportation of goods and commodities through the Columbia River corridor as support infrastructure is in

place to serve these routes. It may be difficult or impossible to quickly establish the road, rail, or loading networks needed to load or unload a container ship or barge.

While there is little in the way of prior or reasonably certain to occur future actions that would act cumulatively with dreissenid treatment to generate additional effects on navigation, the Proposed Action may have its own cumulative effect in the case of repeated or geographically clustered treatments. Were treatment to occur repeatedly at a commercially important location, economic losses experienced by shippers, exporters, and importers would be sustained over a greater duration, resulting in additional costs. Similarly, if treatments where clustered and several commercial important sites in one region, commercial navigation may be prevented from accessing the area.

These effects, while burdensome to commercial navigation, would not be as significant as those seen if dreissenid mussels established in the CRB. Even if treatments were repeated over several years, following treatment navigation facilities would reopen and be used in the prior manner. Were dreissenid mussels to establish in the Columbia and Snake Rivers, costly and time-consuming maintenance measures would permanently impair and delay navigation. The Proposed Action would not be expected to have significant adverse cumulative effects to socioeconomics.

3.9.6 Terrestrial Resources and Wildlife

Terrestrial resources likely to be affected by the Proposed Action are those which are located adjacent to a body of water with the potential for infestation by invasive dreissenid mussels. Adverse effects to terrestrial resources would be caused primarily by riparian access development, but could also occur from isolation, monitoring, treatment, and mitigation to a lesser degree. Past actions that have affected terrestrial resources in the FSA include the ongoing anthropogenic manipulation of riparian habitats. While the vast majority of human alterations of riparian communities has occurred outside the temporal boundaries of this analysis, development in the past ten years has contributed to terrestrial habitat and vegetation loss. and increasing populations in the Northwest are projected to accelerate the pace of these losses in the near future (Everest and Reeves, 2006).

While the Proposed Action would result in localized and short-term adverse effects to terrestrial resources, there would be no significant adverse cumulative impacts to terrestrial habitats and species from dreissenid mussel treat. Access site restoration and impact minimization measures would limit harm and return riparian access sites to their prior condition. As these areas would be restored following treatment, this would not rise to the level of significance, even cumulatively.

3.9.7 Threatened and Endangered Species

Cumulative effects from multiple treatments would be species- and watershed-specific, but treatments would have to occur simultaneously or consecutively within the same subbasin sufficient to damage a large enough proportion of habitat that restoration would be unable to recover the damages within an appropriate amount of time.

A range of potential outcomes may occur at the population level. Threatened and endangered species in the FSA have a variety of population sizes, ranges, and habitats. A single treatment may impose significant ecological risk to species with small, restricted ranges (e.g. Foskett's speckled dace, Hutton tui chub, Borax Lake chub, and Snake River snail species), while dozens of treatments may not impose ecological risk or destroy critical habitat for species with larger ranges (e.g. salmon and steelhead).

With that said, multiple treatments at a single site are not expected to result in further degradation of critical habitat or expose species to greater levels of toxicity. The rapid degradation of Endothall, dilution and lack of precipitation seen in EarthTec QZ, the instantaneous dissipation of ozone and UV-B, and the low dose of potash relative to toxicological data suggest that multiple treatments would not cumulatively degrade the treatment area/critical habitat condition beyond that for a single treatment. Best management practices on chemical applications and riparian vegetation removal and the low likelihood of riparian access development minimize risk from cumulative effects.

3.9.8 Water Quality

While water quality is broadly excellent in the FSA, the same past and future actions and human-caused disturbances that can impair aquatic resources and riparian habitats also affect water quality. Urban, industrial, and agricultural development have and would continue to create sediment, nutrient, and chemical loading in waters of the FSA.

The Proposed Action would contribute to these effects in the form of short-term and localized adverse effects to water quality. Chemical treatment and riparian development would increase sedimentation at treatment sites and introduce treatment chemicals to the treated waterbody. These effects would be lessened through the application of BMPs and impact minimization measures. Isolation barriers would contain the worst of these effects to the treatment areas. Chemicals used for treatment and sediments suspended through access site develop or monitoring would be contained by the isolation barrier and settle out or degrade at the treatment site. Following removal of the isolation barriers, mixing of water would quickly alleviate any remaining effects. There would be no significant adverse cumulative effects to water quality from the Proposed Action.

4 Compliance with Applicable Laws and Regulations

Section 4 identifies the legal, policy, and regulatory requirements that could affect each proposed alternative. The implications for each requirement are discussed with respect to the proposed project. Summaries of compliance and coordination activities for each of the laws, policies, or regulation are also provided.

4.1 Treaties and Native American Tribes

Treaties are legally binding contracts between sovereign nations that establish those nations' political and property relations. Treaties between Native American tribes and the United States confirm each nation's rights and privileges. In most of these treaties, the tribes ceded title to vast amounts of land to the United States, but reserved certain lands (reservations) and rights for themselves and their future generations. Like other treaty obligations of the United States, Indian treaties are considered to be "the supreme law of the land," and they are the foundation upon which Federal Indian law and the Federal Indian trust relationship is based.

There are many treaties with Native American Tribes which may be applicable to the Aquatic Invasives Rapid Response Plan. These include treaties with 19 Tribes in the CRB. These Tribes explicitly reserved certain rights, including the exclusive right to take fish in streams running through or bordering reservations, the right to take fish at all usual and accustomed (U&A) places in common with citizens of the territory, and the right of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed lands. The treaty rights and resources potentially affected by the Proposed Action primarily relate to fish and fishing.

The proposed action could have minor short-term impacts on treaty rights or treaty resources, primarily in the form of potential minor, short-term impacts to salmonids and other fish. Dreissenid treatment could result in temporary restricted access to U&A fishing locations for the duration of the action. There would be no fishing restrictions once treatment is complete. Dreissenid treatment also has the potential to impact non-target aquatic plant species that may be harvested as food. These impacts would be limited to the treatment area and the impacts to non-target aquatic plant species would be reduced through conservation measures. The long-term effects of the Proposed Action would support treaty rights through the enhancement of aquatic habitats and the preservation of native fish and plant species.

4.2 Federal Laws

4.2.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires Federal agencies to use a systematic interdisciplinary approach to evaluate the environmental effects of a proposed Federal action prior to implementing that action. This is usually accomplished through preparation of a statement, either an Environmental Impact Statement (EIS) if

the action is a major Federal action significantly affecting the human environment, or an Environmental Assessment (EA) if the Federal agency has not yet determined the significance of the effects.

The Corps prepared this EA and will circulate it to other Federal, state and local agencies, Tribes, and the public for a 30-day review and comment period. While preparing the EA, the Corps did not identify any impacts that would significantly affect the quality of the human environment as long as mitigation is employed. If no such impacts are identified during the public review process, compliance with NEPA would be achieved upon the signing of a mitigated Finding of No Significant Impact (FONSI). However, if further significant impacts are identified during the public review that cannot be mitigated for, an EIS would be required. Completion of an EIS and the signing of a Record of Decision would then achieve compliance with NEPA.

4.2.2 Endangered Species Act

The Endangered Species Act (ESA) established a national program for the conservation of threatened and endangered fish, wildlife and plants and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS), as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. Section 7(c) of the ESA and the Federal regulations on endangered species coordination (50 CFR §402.12) require that Federal agencies prepare biological assessments of the potential effects of major actions on listed species and their critical habitat.

In compliance with Section 7(a)(2) of the Endangered Species Act, the Corps prepared a Biological Assessment (BA) and initiated Programmatic Framework consultation with the USFWS and NMFS (collectively, “the Services”) in May 2018. The Corps determined the preferred alternative, as proposed, “may affect, and is likely to adversely affect” 19 ecologically significant units of salmon and steelhead under the jurisdiction of the NMFS, 51 ESA-listed species under the jurisdiction of the USFWS, and critical habitat for all species. A complete listing of species is provided in Table 4 and Table 6.

As of July 2019, consultation with the Services has not been completed, though the Corps expects that, ultimately, a non-jeopardy biological opinion will be issued by both Services for activities under the Plan. The Services, however, have indicated a reluctance to consult on the Plan due to the lack of specificity regarding where and when treatment activities would occur in the action area. In fact, the USFWS has rejected programmatic consultation and have recommended the Corps pursue emergency ESA consultation if an infestation is discovered in the CRB. USFWS has stated that following emergency consultation, they would be more able to consult programmatically on the Plan. The Corps continues to request and pursue programmatic consultation.

The lack of specificity is driven by the impossibility of predicting exactly where dreissenids would be detected and the treatment activities that would be needed to address the infestation. It is specifically this lack of specificity that has persuaded the Corps to request programmatic consultation. As such, were dreissenids to be discovered in the FSA prior to the completion of programmatic consultation, the Corps would act to implement the Plan under emergency ESA consultation procedures. Under emergency consultation the following process, summarized from the ESA Section 7 Consultation Handbook, would be followed:

1. Upon detection of dreissenid mussels in the FSA, the Corps would notify the Services of the project location, a description of the emergency response action and timelines.

2. Within 48 hours will recommend actions that may be implemented to minimize the impacts to any listed species or critical habitat in the area.

3. The Corps would implement the Plan to contain and eradicate the dreissenid infestation, and the Services would evaluate the action. If this evaluation indicates that the emergency rapid response procedures may result in jeopardy to a listed species or adverse modification of critical habitat, and no means of reducing or avoiding this impact are available, the Services will advise the Corps of this and document this conclusion. The Corps would not stop or delay their emergency response because of this notification.

4. After treatment is complete, The Corps would identify any incidental take of a species or an adverse effect to critical habitat that resulted from the emergency response action and initiate formal consultation. This formal consultation would follow standard procedures, include a description of what action, and identify the final impacts to listed species.

5. The Services would prepare an after-the-fact biological opinion to cover any incidental take that occurred during the emergency response and document the final impacts to the listed species. This biological opinion could contain suggestions for after-the-fact remediation in the form of reasonable and prudent alternatives, or reasonable and prudent measures when incidental take of listed species or adverse modification of critical habitat attributable to the emergency response occurred. With the finalization of the biological opinion, compliance with the ESA would be considered complete.

Some elements of the Proposed Action, including sharing the cost of equipment purchases and training with state agencies in the FSA may have no potential to affect ESA listed species. Should a state request cost sharing for such preparatory actions, the Corps would evaluate the actions potential to affect listed species or critical habitats. If the Corp determines that an equipment purchase or training event would not have any effects on listed species or critical habitats, compliance with ESA would be complete for that purchase or training event, as long as such cost sharing does not result in irreversible or irretrievable commitment of resources under Section 7(d) of the ESA.

4.2.3 Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act (BGEPA) prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions, primarily for Native American Tribes. Take under the BGEPA includes both direct taking of individuals and take due to disturbance. Disturbance is further defined in 50 CFR 22.3.

The Proposed Action would be implemented with BMPs to avoid nests in accordance with the USFWS Bald Eagle Management Guidelines and Conservation for the Pacific Region (USFWS 2015b). Therefore, the Corps has determined there would be no disturbance or take of eagles as a result of Plan implementation.

4.2.4 Fish and Wildlife Coordination Act of 1958

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC 661 et seq.) requires consultation with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose. The USFWS and state agencies charged with administering wildlife resources are to conduct surveys and investigations to determine the potential damage to wildlife and the mitigation measures that should be taken. The USFWS incorporates the concerns and findings of the state agencies and other Federal agencies, including the NMFS, into a report that addresses fish and wildlife factors and provides recommendations for mitigating or enhancing impacts to fish and wildlife affected by a Federal project.

The proposed action would not impound, divert, control or modify any body of water and would not involve activities subject to the Fish and Wildlife Coordination Act.

4.2.5 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-712, as amended) prohibits the taking of and commerce in migratory birds (live or dead), any parts of migratory birds, their feathers, or nests. Take is defined in the MBTA to include by any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof.

Conservation measures would be implemented to avoid effects to migratory birds to greatest extent practicable, but there is potential for nest and egg take during the nesting season. Therefore, the proposed action may result in take of migratory birds. In the event that take may occur, the Corps would apply for a take permit.

4.2.6 Clean Air Act of 1970, As Amended

The Clean Air Act (CAA) (42 USC 7401 et seq.), amended in 1977 and 1990, was established “to protect and enhance the quality of the nation’s air resources so as to promote public health and welfare and the productive capacity of its population.” The CAA authorizes the EPA to establish the National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The CAA establishes emission

standards for stationary sources, volatile organic compound emissions, hazardous air pollutants, and vehicles and other mobile sources. The CAA also requires the states to develop implementation plans applicable to particular industrial sources.

Operation of equipment (trucks, loaders, skid steers) associated with the access development and mitigation would have localized, temporary, minor increases of emissions, but would not adversely affect air quality and would be in compliance with the CAA.

4.2.7 Noise Pollution and Abatement Act of 1972

The Noise Pollution and Abatement Act of 1972 initiated a Federal program of regulating noise pollution to protect health and minimize the hazards and annoyance of noise to the public. The act sets noise emission standards for a broad variety of activities.

The Proposed Action would not require the purchase of certified low-noise-emission products or consultation with the EPA Administrator.

4.2.8 Clean Water Act

The Federal Water Pollution Control Act (33 U.S.C. §1251 et seq., as amended) is more commonly referred to as the Clean Water Act (CWA). This act is the primary legislative vehicle for Federal water pollution control programs and the basic structure for regulating discharges of pollutants into waters of the United States. The act was established to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters and sets goals to eliminate discharges of pollutants into navigable water, protect fish and wildlife, and prohibit the discharge of toxic pollutants in quantities that could adversely affect the environment. The act has been amended numerous times and given a number of titles and codifications.

Section 402 of the Act, the National Pollutant Discharge Elimination System (NPDES) program, pertains to discharge of pollutants. Point source discharges of biological pesticides and chemical pesticides that leave a residue into waters of the U.S. are required to comply with NPDES requirements. Aquatic pesticide application would require approval for use under a NPDES permit, either the EPA's 2016 Pesticide General Permit (PGP) for treatments in Idaho, Washington, or on Tribal Reservations; the Montana Pollutant Discharge Elimination System Permit (MTG870000) in Montana, or the Oregon Department of Environmental Quality Pesticide General Permit (2300A).

Endothall, EarthTec QZ, and Zequanox are all currently covered by each of the PGPs. Potash compounds are covered by the PGPs for some uses, but were not submitted for approval as molluscicides. Presently, the Canadian province of Alberta is in the process of registering potash compounds as molluscicides in Canada. Were Alberta to register potash as a molluscicide in Canada, it is likely that the EPA, Oregon, and Montana could and would recognize the Canadian registration for use in the United States. Another option for the use of potash could be an emergency exception approval

from the EPA, as was utilized by the states of Virginia, Minnesota, and Texas in their dreissenid control efforts. Until registration is resolved, or an emergency exception granted, potash would not be used.

Section 402 of the Clean Water Act also regulates ground disturbance that could potentially cause storm water run-off into waters of the U.S. Activities involving construction or soil disturbance on the shoreline or upland have the potential for storm water runoff and would be subject to the storm water provisions of Section 402 if the area of soil disturbance would be more than an acre and would discharge storm water into surface water. While development of staging areas would cause soil disturbance, staging areas would be limited to 60 feet of shoreline per treatment, well under the one-acre threshold.

Discharge of dredged or fill material below the line of ordinary high water requires evaluation under Section 404 of the Clean Water Act. Proposed activities would not involve placement of fill below the ordinary high water mark of any water of the U.S., therefore, a 404 permit would not be needed.

Section 401 of the Act requires a certification from the applicable permitting agency that the discharge of a pollutant or dredged or fill material meets water quality standards for any new permit or license issued by a Federal agency, even if the issuing authority has been delegated to the state. If a permit under either Section 402 or 404 is needed for an action, Section 401 water quality certification is also needed. In this case, application of chemical treatments would be covered by existing PGPs, not new permits and Section 401 certification would not be required.

The Proposed Action would be in compliance with the CWA, and would not impede water quality improvement plan efforts by states, tribes, or the EPA.

4.2.9 National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended, directs Federal agencies to consider potential effects from the Federal undertaking on cultural properties under their jurisdiction. Implementing regulations, 36 Code of Federal Regulations (CFR) Part 800, requires an agency to consult with the State Historic Preservation Officer (SHPO), Tribes, and interested parties to ensure historic properties are adequately identified, evaluated, and considered in planning for proposed undertakings.

No ground disturbance is proposed for adoption of the Plan or generally for treatment actions under the Plan. If any ground disturbing activity were proposed for a treatment action (most likely at an unidentified site), the Corps would complete a separate National Historic Preservation Act (NHPA) Section 106 review, possibly under the emergency procedures established under 36 C.F.R. §800.12.

4.2.10 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 USCA. 3001) addresses the discovery, identification, treatment, and repatriation of Native American (and Native Hawaiian) human remains, associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony. This act also establishes fines and penalties for the sale, use, and transport of Native American cultural items.

Should human remains or associated objects be discovered during implementation of the Plan, all work would stop, and the Corps would notify the relevant Native American tribes and comply with the requirements of NAGPRA.

Relevant tribes would vary by location, but would include the Upper Snake River Tribes (USRT), the Shoshone-Bannock Tribes, the Colville Confederated Tribes (CCT), the Spokane Tribe, the Columbia River Inter-Tribal Fisheries Commission, the Nez Perce Tribe (NPT), the Kootenai Tribe, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Yakama Nation, the Shoshone Paiute Tribe, the Bureau of Indian Affairs, the Grand Ronde Tribe, the Cowlitz Tribe, the Kalispel Tribe, and the Confederated Salish Kootenai Tribe.

4.2.11 Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act requires that regulated activities conducted below the Ordinary High Water Mark elevation of navigable waters of the U.S. be approved/permitted by the Corps of Engineers Regulatory Division. Regulated activities include the placement/removal of structures, work involving dredging, disposal of dredged material, filling, excavation, or any other disturbance of soils/sediments or modification of a navigable waterway.

The proposed treatment work would be authorized by a Nationwide Permit. The permit number is 27 - Aquatic Habitat Restoration, Establishment, and Enhancement Activities. The Corps would adhere to all notification and reporting requirements of the permit.

4.2.12 Wild and Scenic Rivers Act of 1974

The National Wild and Scenic Rivers System was created by Congress (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Designation as a wild and scenic river is not the same as designation as a National Park, and does not generally does not confer the same level of protection as a Wilderness Area designation. Instead of enacting strict and mandatory conservation measures, the goal is often to preserve the character of a river.

Of 12,754 miles of designated rivers in the United States, 3,394 are in the proposed action area. In Idaho, designated rivers include Battle Creek, Big Jacks Creek, the Bruneau River, the West Fork Bruneau River, the Middle Fork Clearwater River,

Cottonwood Creek, Deep Creek, Dickshooter Creek, Duncan Creek, the Jarbridge River, Little Jacks Creek, the Owyhee River, the North Fork Owyhee River, the South Fork Owyhee River, the Rapid River, the St, Joe River, the Middle Fork Salmon River, Sheep Creek, the Snake River, and Wickahoney Creek for a total of 891 miles. In Montana designated rivers include east Rosebud Creek, the Flathead River, and the Missouri River for a total of 388 miles. In Oregon, designated Rivers include Big Marsh Creek, the Chetco River, the Clackamas River, the South Fork Clackamas River, the Collawash River, Crescent Creek, the Crooked River, the North Fork Crooked River, the Deschutes River, Donner and Blitzen River, Eagle Creek (Mt. Hood National Forest), Eagle Creek (Wallowa-Whitman National Forest), the Elk River, Elkhorn Creek, Fifteenmile Creek, Fish Creek, the Grande Ronde River, the East Fork Hood River, the Middle Fork Hood River, the Illinois River, the Imnaha River, the John Day River, the North Fork John Day River, the South Fork John Day River, Joseph Creek, the Klamath River, the Little Deschutes River, the Lostine River, the Malheur River, the North Fork Malheur River, the McKenzie River, the Metolius River, the Minam River, the North Powder River, the North Umpqua River, the Owyhee River, the North Fork Owyhee River, the Powder River, Quartzville Creek, the River Styx, the Roaring River, the South Fork Roaring River, the Rogue River, the Upper Rogue River, the Salmon River, the Sandy River, the North Fork Smith River, the Snake River, the Sprague River, Squaw Creek, the Sycan River, the Wallowa River, the Wenaha River, the West Little Owyhee River, Whychus Creek, the White River, Wildhorse & Kiger Creeks, the North Middle Fork Willamette River, and the Zigzag River, for a total of 1,918 miles. In Washington, designated rivers include Illabot Creek, the Klickitat River, the Pratt River, the Skagit River, the Middle Fork Snoqualmie River, and the White Salmon River, for a total of 197 miles.

While dreissenid mussels are possibly less likely to colonize Wild and Scenic Rivers, due to their comparatively fewer boat access points than more heavily trafficked rivers in the FSA, such as the Columbia and mainstem Snake Rivers, it is possible that treatment actions would occur on these systems. Should such a treatment occur, the Corps would employ impact avoidance, minimization, and restoration measures as described earlier in Section 2.2.3 and 2.2.4 to adhere to the water quality anti-degradation policy.

4.2.13 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA), along with the Reduction of Lead in Drinking Water Act and 40 CFR Part 141 - National Primary Drinking Water Regulations, are the Federal laws that protects public drinking water supplies throughout the nation. SDWA authorizes the US EPA to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water.

The Proposed Action would not involve public drinking water systems or groundwater injection and is therefore not subject to the Acts.

4.3 Executive Orders

4.3.1 Executive Order 11988, Floodplain Management

Each Federal agency has a responsibility to evaluate the potential effects of any actions it may take in a floodplain; to ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management; and to prescribe procedures to implement the policies and requirements of this EO.

Procedures under Engineering Regulation 1165-2-26 - Implementation of Executive Order 11988 on Flood Plain Management require a statement of findings, which is as follows:

The Proposed Action is located in the 100 year flood plain, and would affect the floodplain. Access to rivers and streams for invasive mussel treatment and riparian mitigation can only occur in or adjacent to floodplains. The Corps evaluated mussel treatment alternatives and determined riparian areas suitable for access and deployment of treatment equipment. The shoreline and associated nearshore habitat inherently must be within and part of a floodplain, and therefore conforms to, the State and local flood protection standards. The planning for and development of the treatment plan was in cooperation with numerous State, interstate, regional resource and management agencies including the 100th Meridian Initiative.

Development of riparian areas for dreissenid treatment inherently has negative effects to the natural environment that would be mitigated with habitat replacement programs and restored to the prior condition following the cessation of dreissenid treatment measures. Mitigation as proposed would ensure floodplain functions and values are restored and maintained.

4.3.2 Executive Order 11990, Protection of Wetlands

This order directs Federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands when undertaking Federal activities and programs. It has been the goal of the Corps to avoid or minimize wetland impacts associated with their planned actions.

Through the implementation of BMP’s and 1:1 mitigation of impacted riparian areas used for access, the Proposed Action would not result in the destruction, loss, or degradation of wetlands. Mitigation as proposed would ensure wetlands functions and values are restored and maintained.

4.3.3 Executive Order 12898, Environmental Justice

This order requires Federal agencies to consider and address environmental justice by identifying and assessing whether agency actions may have disproportionately high and adverse human health or environmental effects on minority or low-income populations. Disproportionately high and adverse effects are those effects that are predominantly borne by minority or low-income populations and are appreciably more severe or greater in magnitude than the effects on nonminority or non-low income populations.

This EA considers activities related to potential rapid response actions as a result of the detection of dreissenid mussels in the FSA. Alternatives, as proposed, would not disproportionately affect any particular demographic group.

4.3.4 Executive Order 13112, Invasive Species and Executive Order 13751, Safeguiding the Nation from the Impacts of Invasive Species, December 8, 2016.

This EO states that it is the policy of the United States to prevent the introduction, establishment, and spread of invasive species, as well as to eradicate and control populations of invasive species that are established. The order directs Federal agencies to refrain from authorizing, funding, or implementing actions that are likely to cause or promote the introduction, establishment, or spread of invasive species in the United States unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm would be taken in conjunction with the actions.

The Proposed Action is specifically intended to prevent the introduction, establishment, and spread of invasive species, as well as to eradicate and control populations of invasive species that are established. Best Management Practices as described would be implemented when necessary to ensure that the proposed action would comply with Executive Orders.

4.3.5 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments

This EO directs Federal agencies to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates upon Indian Tribes.

The Corps sent letters dated July 12, 2019 requesting comments on the proposed action to the Upper Snake River Tribes (USRT), the Shoshone-Bannock Tribes, the Colville Confederated Tribes (CCT), the Spokane Tribe, the Columbia River Inter-Tribal Fisheries Commission, the Nez Perce Tribe (NPT), the Kootenai Tribe, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Yakama Nation, the Shoshone Paiute Tribe, the Bureau of Indian Affairs, the Grand Ronde Tribe, the Cowlitz Tribe, the Kalispel Tribe, and the Confederated Salish Kootenai Tribe.

5 Coordination and Consultation

5.1 Agency / Tribal Consultation

5.1.1 NMFS and USFWS

The Corps is consulting with NMFS and USFWS for potential effects to ESA-listed species.

5.1.1 State and Tribal Historic Preservation Officers

No ground disturbance is proposed in the proposed action, but if any ground disturbing activity were proposed in the event of a rapid response action, the Corps would complete a separate NEPA analysis to include National Historic Preservation Act (NHPA) Section 106 review. After the site-specific analysis is complete and corresponding consultation with State Historic Preservation Officers, Tribal Historic Preservation Officers, and concerned Tribes concur with the findings, the action would be authorized.

5.1.2 Public Involvement

This EA is being distributed to Federal, state, and local agencies, Tribes and the public for a 30-day review and comment period. It is available on the Walla Walla District Corps of Engineers website at www.nww.usace.army.mil/Missions/Environmental-Compliance. The distribution list includes, but was not limited to, the following:

Northwest Power and Conservation Council
Idaho Parks and Recreation
Idaho Soil and Water Conservation Commission
Idaho Office of Species Conservation
Idaho Department of Water Resources
Idaho Department of Commerce
Idaho Department of Environmental Quality
Idaho Department of Lands
Montana Fish, Wildlife, and Parks
Montana Department of Environmental Quality
Montana Department of Natural Resources and Conservation
Oregon State Police
Oregon Department of Agriculture
Oregon Cultural Trust
Oregon Department of Energy
Oregon Department of Environmental Quality
Oregon Invasive Species Council
Oregon Parks and Recreation Department
Oregon Watershed Enhancement Board
Washington Department of Agriculture

Washington Department of Natural Resources
Washington Department of Ecology
Northwest Indians Fisheries Commission
Tri-state Steelheaders
Blue Mountain Land Trust
The Nature Conservancy
Bitterroot River Protection Association
Upper Missouri Waterkeeper
CREATE, a Columbia Riverkeeper Affiliate
Columbia Riverkeeper
Willamette Riverkeeper
Spokane Riverkeeper
Snake River Waterkeeper
Inland Northwest Land Conservancy
Conservation Northwest
Northwest Center for Alternatives to Pesticides
Save Our Wild Salmon
Audubon Society of Portland
Beyond Toxics
Sierra Club Oregon
Sierra Club Washington
WaterWatch of Oregon
Friends of the Columbia Gorge
Institute for Applied Ecology
The Freshwater Trust
Northwest Steelheaders
Washington Recreation and Conservation Office
Lower Columbia Fish Recovery Board
Upper Columbia Salmon Recovery Board
Idaho Conservation League
Friends of the Clearwater
Golden Eagle Audubon Society
Idaho Foundation for Parks and Lands
Idaho Native Plant Society
Idaho Rivers United
Palouse Audubon Society
Palouse-Clearwater Environmental Institute
Sierra Club Idaho
Idaho Wildlife Federation
Wood River Land Trust
Eastside Audubon Society
Lower Columbia Basin Audubon Society
Toxic-Free Future

Washington Wild
Washington Native Plant Society
Washington Office of the Governor
Oregon Governor's Office
Idaho Governor's Office
Montana Office of the Governor
Columbia River Steamship Operators' Association
American Association of Port Authorities
Association of Pacific Ports
Northwest Marine Terminal Association
Pacific Northwest Waterways Association
Merchant's Exchange of Portland
Washington Public Ports Association
U.S. Environmental Protection Agency
Northwest Public Power Association
Washington PUD Association
Washington Department of Fish and Wildlife
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
The 100th Meridian Initiative
Pacific States Marine Fisheries Commission
US Bureau of Reclamation
Idaho State Historic Preservation Officer
Oregon State Historic Preservation Officer
Montana State Historic Preservation Officer
Washington State Historic Preservation Officer
Upper Snake River Tribes
Shoshone-Bannock Tribes
Colville Confederated Tribes
Spokane Tribe
Columbia River Inter-Tribal Fisheries Commission
Nez Perce Tribe
Kootenai Tribe
Confederated Tribes of the Umatilla Indian Reservation
Yakama Nation
Shoshone Paiute Tribe
Bureau of Indian Affairs
Grand Ronde Tribe
Cowlitz Tribe
Kalispel Tribe
Confederated Salish Kootenai Tribe.
Nation Park Service
Bureau of Land Management

United State Forest Service
United States Department of Agriculture
Western Governors Association

6 References

Aquatic Bioassay and Consulting, 2016. Acute rainbow trout bioassay report. Aquatic Bioassay and Consulting, Ventura, California.

Barton, B.A., 2002. Stress in Fishes: A Diversity of Responses with Particular Reference to Changes in Circulating Corticosteroids. Integr. Comp. Biol. 42, 517–525. https://doi.org/10.1093/icb/42.3.517

Behrens, H., Beims, U., Dieter, H., Dietze, G., Eikmann, T., Grummt, T., Hanisch, H., Henseling, H., Käß, W., Kerndorff, H., Leibundgut, C., Müller-Wegener, U., Rönnefahrt, I., Scharenberg, B., Schleyer, R., Schloz, W., Tilkes, F., 2001. Toxicological and ecotoxicological assessment of water tracers. Hydrogeol. J. 9, 321–325. https://doi.org/10.1007/s100400100126

Blaustein, A.R., Romansic, J.M., Kiesecker, J.M., Hatch, A.C., 2003. Ultraviolet radiation, toxic chemicals and amphibian population declines. Divers. Distrib. 9, 123–140. https://doi.org/10.1046/j.1472-4642.2003.00015.x

Brim-Box, J., Wolf, D., Howard, J., O'Brien, C., Nez, D., Close, D., 2003. Distribution and Status of Freshwater Mussels in the Umatilla River System. Bonneville Power Administration, Portland, Oregon.

Bureau of Reclamation, 2011. Finding of no significant impact and final environmental assessment for controlling quagga mussels in the cooling water system at Davis Dam using Zequanox (MOI-401). Bureau of Reclamation, Boulder City, Nevada.

Bureau of Reclamation, 2007. Bureau of Reclamation: Lower Colorado Region - Quagga Mussels on the Lower Colorado River - Photos [WWW Document]. URL https://www.usbr.gov/lc/region/programs/quagga/photos.html (accessed 8.14.18).

California Science Advisory Panel, 2007. California's Response to the Zebra/Quagga Mussel Invasion in the West. California Department of Fish and Game, Sacremento, California.

Caraco, N.F., Cole, J.J., Raymond, P.A., Strayer, D.L., Pace, M.L., Findlay, S.E.G., Fischer, D.T., 1997. Zebra Mussel Invasion in a Large, Turbid River: Phytoplankton Response to Increased Grazing. Ecology 78, 588–602. https://doi.org/10.1890/0012-9658(1997)078[0588:ZMIIAL]2.0.CO;2

Chapman, W., Quistdorff, E., 1938. The food of certain fishes of north central Columbia River drainage, in particular, young Chinook salmon and steelhead trout. Washington Department of Fish and Wildlife, Olympia, Washington.

Chatters, J., Pokotylo, D., 1998. Prehistory: Introduction. , Volume 12: Plateau, in: Handbook of North American Indians. Smithsonian Institution, Washington, District of Columbia.

Claxton, W.T., Mackie, G.L., 1998. Seasonal and depth variations in gametogenesis and spawning of Dreissena polymorpha and Dreissena bugensis in eastern Lake Erie. Can. J. Zool. 76, 2010–2019. https://doi.org/10.1139/z98-150

Cohen, A., Weinstein, A., 2001. Zebra Mussels Calcium Threshold and Implications for its Potential Distribution in North America. San Francisco Estuary Institute, Richmond, California.

Connelly, N.A., O'Neill, C.R., Knuth, B.A., Brown, T.L., 2007. Economic Impacts of Zebra Mussels on Drinking Water Treatment and Electric Power Generation Facilities. Environ. Manage. 40, 105–112. https://doi.org/10.1007/s00267-006-0296-5

Cotter, A., Sihota, S., 2015. Valuing Ecosystem Goods and Services in the Columbia River Basin. ACT (Adaptation to Climate Change Team) , School of Public Policy, Simon Fraser University, Vancouver, British Columbia, Canada.

Craddock, D.R., Blahm, T.H., Parente, W.D., 1976. Occurrence and Utilization of Zooplankton by Juvenile Chinook Salmon in the Lower Columbia River. Trans. Am. Fish. Soc. 105, 72–76. https://doi.org/10.1577/1548-8659(1976)105<72:OAUOZB>2.0.CO;2

Crain, C.M., Kroeker, K., Halpern, B.S., 2008. Interactive and cumulative effects of multiple human stressors in marine systems. Ecol. Lett. 11, 1304–1315. https://doi.org/10.1111/j.1461-0248.2008.01253.x

Dermott, R., Munawar, M., 1993. Invasion of Lake Erie Offshore Sediments by Dreissena, and Its Ecological Implications. Can. J. Fish. Aquat. Sci. 50, 2298–2304. https://doi.org/10.1139/f93-254

Drake, J.M., Bossenbroek, J.M., 2004. The Potential Distribution of Zebra Mussels in the United States. BioScience 54, 931–941. https://doi.org/10.1641/0006-3568(2004)054[0931:TPDOZM]2.0.CO;2

Durán, C., Lanao, M., Anadón, A., Touyá, V., 2010. Management strategies for the zebra mussel invasion in the Ebro River basin. Aquat. Invasions 5, 309–316.

Earth Science Laboratories, 2016. Ecotoxicology report for Lake Piru stemming from United Water's Mussel Control Initiatives. Earth Science Laboratories, Bentonville, Arkansas.

Earth Science Laboratories, 2015. MASTER LABEL FOR EARTHTEC EPA REG. NO. 64962-1. United States Environmental Protection Agency, Washington, District of Columbia.

Effler, S.W., Brooks, C.M., Whitehead, K., Wagner, B., Doerr, S.M., Perkins, M., Siegfried, C.A., Walrath, L., Canale, R.P., 1996. Impact of Zebra Mussel Invasion on River Water Quality. Water Environ. Res. 68, 205–214.

Egan, D., 2017. The Cancer of the Great Lakes. Nautilus.

Elwell, L., Phillips, S., 2016. Uniform minimum protocols and standards for watercraft inspection and decontamination programs for dreissenid mussels in the western United States. Pacific States Marine Fisheries Commission, Portland, Oregon.

Everest, F., Reeves, G., 2006. Riparian and aquatic habitats of the Pacific Northwest and southeast Alaska: ecology, management history, and potential management strategies. U.S. Department of Agriculture, Portland, Oregon.

Getsinger, K.D., Turner, E.G., Madsen, J.D., Netherland, M.D., 1998. Restoring native vegetation in a Eurasian water-milfoil dominated plant community using the herbicide triclopyr. Regul. Rivers Res. Manag. 13, 357–375. https://doi.org/10.1002/(SICI)1099-1646(199707)13:4<357::AID-RRR446>3.0.CO;2-#

Glaser, D., Rhea, J.R., Opdyke, D.R., Russell, K.T., Ziegler, C.K., Ku, W., Zheng, L., Mastriano, J., 2009. Model of zebra mussel growth and water quality impacts in the Seneca River, New York. Lake Reserv. Manag. 25, 49–72. https://doi.org/10.1080/07438140802714411

Glllis, P.L., Mackie, G.L., 1994. Impact of the zebra mussel, Dreissena polymorpha, on populations of Unionidae (Bivalvia) in Lake St. Clair. Can. J. Zool. 72, 1260–1271. https://doi.org/10.1139/z94-168

Gregory, R.S., Levings, C.D., 1998. Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon. Trans. Am. Fish. Soc. 127, 275–285. https://doi.org/10.1577/1548-8659(1998)127<0275:TRPOMJ>2.0.CO;2

Haag, W., Berg, D., Garton, D., Farris, J., 1993. Reduced Survival and Fitness in Native Bivalves in Response to Fouling by the Introduced Zebra Mussel (Dreissena polymorpha) in Western Lake Erie. Can. J. Fish. Aquat. Sci. 50, 13–19.

Haskell, C.A., Tiffan, K.F., Rondorf, D.W., 2013. The Effects of Juvenile American Shad Planktivory on Zooplankton Production in Columbia River Food Webs. Trans. Am. Fish. Soc. 142, 606–620. https://doi.org/10.1080/00028487.2012.728164

Healy, M., 1991. Life history of Chinook salmon (Oncorhynchus tshawytscha), in: Groot, C., Margolis, L. (Eds.), Pacific Salmon Life Histories. UBC Press, Vancouver, British Columbia, Canada, pp. 311–391.

Heath, R.T., Fahnenstiel, G.L., Gardner, W.S., Cavaletto, J.F., Hwang, S.-J., 1995. Ecosystem-Level Effects of Zebra Mussels (Dreissena polymorpha): An Enclosure Experiment in Saginaw Bay, Lake Huron. J. Gt. Lakes Res. 21, 501–516. https://doi.org/10.1016/S0380-1330(95)71062-0

Higgins, S.N., Vander Zanden, M.J., 2010. What a difference a species makes: a meta—analysis of dreissenid mussel impacts on freshwater ecosystems. Ecol. Monogr. 80, 179–196.

Higgins, T., Grennan, J., McCarthy, T., 2008. Effects of recent zebra mussel invasion on water chemistry and phytoplankton production in a small Irish lake. Aquat. Invasions 3, 14–20.

Hillman, T.W., Griffith, J.S., Platts, W.S., 1987. Summer and Winter Habitat Selection by Juvenile Chinook Salmon in a Highly Sedimented Idaho Stream. Trans. Am. Fish. Soc. 116, 185–195. https://doi.org/10.1577/1548-8659(1987)116<185:SAWHSB>2.0.CO;2

Hincks, S.S., Mackie, G.L., 1997. Effects of pH, calcium, alkalinity, hardness, and chlorophyll on the survival, growth, and reproductive success of zebra mussel (Dreissena polymorpha) in Ontario lakes. Can. J. Fish. Aquat. Sci. 54, 2049–2057. https://doi.org/10.1139/f97-114

Horgan, M.J., Mills, E.L., 1997. Clearance rates and filtering activity of zebra mussel (Dreissena polymorpha): implications for freshwater lakes. Can. J. Fish. Aquat. Sci. 54, 249–255. https://doi.org/10.1139/f96-276

Idaho Aquatic Nuisance Species Taskforce, 2009. Estimated Potential Economic Impact of Zebra and Quagga Mussel Introduction into Idaho. Idaho Invasive Species Council, Boise, Idaho.

Idaho Department of Agriculture, 2018. Watercraft Inspections [WWW Document]. Invasive Species Ida. URL http://invasivespecies.idaho.gov/watercraft-inspection-stations/ (accessed 8.13.18).

Indiana Department of Natural Resources, 2005. Aquatic Invasive Species - Zebra Mussel. Indiana Department of Natural Resources, Indianapolis, IN.

Johnson, J.E., Patterson, D.A., Martins, E.G., Cooke, S.J., Hinch, S.G., 2012. Quantitative methods for analysing cumulative effects on fish migration success: a review. J. Fish Biol. 81, 600–631. https://doi.org/10.1111/j.1095-8649.2012.03369.x

Johnson, L.E., Carlton, J.T., 1996. Post-Establishment Spread in Large-Scale Invasions: Dispersal Mechanisms of the Zebra Mussel Dreissena Polymorpha. Ecology 77, 1686–1690. https://doi.org/10.2307/2265774

Kootenai Environmental Alliance, 2018. Protect Idaho's Waters, Support Idaho Invasive Species Control. Kootenai Environ. Alliance.

Laetz, C.A., Baldwin, D.H., Collier, T.K., Hebert, V., Stark, J.D., Scholz, N.L., 2009. The Synergistic Toxicity of Pesticide Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. Environ. Health Perspect. 117, 348–353. https://doi.org/10.1289/ehp.0800096

Leach, J., 1993. Impacts of the zebra mussel (Dreissena polymorpha) on water quality and fish spawning reefs in western Lake Erie, in: Nalepa, T., Schloesser, D. (Eds.), Zebra Mussels: Biology, Impacts, and Control. Lewis Publication, Chelsea, Michigan.

L. Ludyanskiy, M., McDonald, D., Macneill, D., 1993. Impact of the zebra mussel, a bivalve invader: Dreissena polymorpha is rapidly colonizing hard surfaces throughout waterways of the United States and Canada.

Lucy, F., Burlakova, L., Karatayev, A., Mastitsky, S., Zanatta, D., 2013. Zebra mussel impacts on Unionids: A synthesis of trends in North America and Europe.

Luoma, J., 2015. Exposure-Related Effects of Pseudomonas fluorescens, Strain CL145A, on Coldwater, Coolwater, and Warmwater Fish. United States Geological Survey, Reston, Virginia.

MacIsaac, H.J., 1994. Comparative Growth and Survival of Dreissena polymorpha and Dreissena bugensis, Exotic Molluscs Introduced to the Great Lakes. J. Gt. Lakes Res. 20, 783–790. https://doi.org/10.1016/S0380-1330(94)71196-5

Magen, H., 1997. “Ferti-K”, Soluble KCl for Fertigation: The Israeli Experience and Approach. Presented at the 8th Fertilizer Latin America International Conference.

Mangin, S., 2001. The 100th meridian initiative: a strategic approach to prevent the westward spread of zebra mussels and other aquatic nuisance species. United States Fish and Wildlife Service, Washington, District of Columbia.

May, B., Marsden, J.E., 1992. Genetic Identification and Implications of Another Invasive Species of Dreissenid Mussel in the Great Lakes. Can. J. Fish. Aquat. Sci. 49, 1501–1506. https://doi.org/10.1139/f92-166

Meehan, S., Shannon, A., Gruber, B., M. Rackl, S., E. Lucy, F., 2014. Ecotoxicological impact of Zequanox®, a novel biocide, on selected non-target Irish aquatic species. Ecotoxicol. Environ. Saf. 107, 148–153. https://doi.org/10.1016/j.ecoenv.2014.05.017

Mellina, E., Rasmussen, J.B., 1994. Patterns in the Distribution and Abundance of Zebra Mussel (Dreissena polymorpha) in Rivers and Lakes in Relation to Substrate and Other Physicochemical Factors. Can. J. Fish. Aquat. Sci. 51, 1024–1036. https://doi.org/10.1139/f94-102

Miller, A., Payne, B., 1992. Control Strategies for Zebra Mussel Infestations at Public Facilities. US Army Corps of Engineers, Vicksburg, Mississippi.

Miller, A., Payne, B., McMahon, R., 1992. The zebra mussel: biology, ecology, and recommended control strategies, U.S. Army Corps of Engineers, Waterways Experiment Station, Publications E-92-1. US Army Corps of Engineers, Vicksburg, Mississippi.

Mills, E.L., Rosenberg, G., Spidle, A.P., Ludyanskiy, M., Pligin, Y., May, B., 1996. A Review of the Biology and Ecology of the Quagga Mussel (Dreissena bugensis),

a Second Species of Freshwater Dreissenid Introduced to North America. Integr. Comp. Biol. 36, 271–286. https://doi.org/10.1093/icb/36.3.271

Minnesota Sea Grant, 2018. Zebra Mussels Threaten Inland Waters | Minnesota Sea Grant [WWW Document]. URL http://www.seagrant.umn.edu/ais/zebramussels_threaten (accessed 8.2.18).

National Marine Fisheries Service, 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. National Marine Fisheries Servic, Portland, Oregon.

National Park Service, 2017. Protecting the Greater Yellowstone Ecosystem from Aquatic Invasive Species (U.S. National Park Service) [WWW Document]. URL https://www.nps.gov/articles/protecting-the-greater-yellowstone-ecosystem-from-aquatic-invasive-species.htm (accessed 8.13.18).

Nicholson, M., 2018. Aquatic community response to Zequanox: a mesocosm experiment. Queen's University, Kington, Ontario, Canada.

Northwest River Partners, 2015. Northwest Hydropower and Columbia Basin River Benefits. Northwest River Partners, Portland, Oregon.

Oregon Department of Fish and Wildlife, 2015. Quagga and Zebra Mussel Invasive Species Fact Sheet.

Oregon Invasive Species Council, 2017. Prevention in action.

Pacific Northwest Waterways Association, 2017. Columbia Snake River System Facts.

Parker Jr., G.G., 1973. Tests of rhodamine WT dye for toxicity to oysters and fish. J. Res. US Geol. Surv. 1, 499–499.

Pejchar, L., Mooney, H.A., 2009. Invasive species, ecosystem services and human well-being. Trends Ecol. Amp Evol. 24, 497–504.

Pucherelli, S., Claudi, R., 2017. Evaluation of the effects of ultra-violet light treatment on quagga mussel settlement and veliger survival at Davis Dam. Manag. Biol. Invasions 8, 301–310.

Raikow, D.F., Sarnelle, O., Wilson, A.E., Hamilton, S.K., 2004. Dominance of the noxious cyanobacterium Microcystis aeruginosa in low-nutrient lakes is associated with exotic zebra mussels. Limnol. Oceanogr. 49, 482–487. https://doi.org/10.4319/lo.2004.49.2.0482

Ramcharan, C.W., Padilla, D.K., Dodson, S.I., 1992. Models to Predict Potential Occurrence and Density of the Zebra Mussel, Dreissena polymorpha. Can. J. Fish. Aquat. Sci. 49, 2611–2620. https://doi.org/10.1139/f92-289

Reynolds, J., 1996. Electrofishing, in: Murphy, B., Willis, D. (Eds.), Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, Maryland, pp. 221–253.

Ricciardi, A., Neves, R.J., Rasmussen, J.B., 1998. Impending extinctions of North American freshwater mussels (Unionoida) following the zebra mussel (Dreissena polymorpha) invasion. J. Anim. Ecol. 67, 613–619. https://doi.org/10.1046/j.1365-2656.1998.00220.x

Roberts, L., 1990. Zebra Mussel Invasion Threatens U.S. Waters. Science 249, 1370. https://doi.org/10.1126/science.249.4975.1370

Roe, S.L., MacIsaac, H.J., 1997. Deepwater population structure and reproductive state of quagga mussels (Dreissena bugensis) in Lake Erie. Can. J. Fish. Aquat. Sci. 54, 2428–2433. https://doi.org/10.1139/f97-151

Rosenberg, G., L. Ludyanskiy, M., 1994. A Nomenclatural Review of Dreissena (Bivalvia: Dreissenidae), with Identification of the Quagga Mussel as Dreissena bugensis.

Rowiński, P.M., Chrzanowski, M.M., 2011. Influence of selected fluorescent dyes on small aquatic organisms. Acta Geophys. 59, 91–109. https://doi.org/10.2478/s11600-010-0024-7

Schloesser, D.W., Nalepa, T.F., Mackie, G.L., 1996. Zebra mussel infestation of unionid bivalves (Unionidae) in North America. Am. Zool. 36, 300–310. https://doi.org/10.1093/icb/36.3.300

Schmidt, S., McLane, C., 2017. 2016 Report on Aquatic Invasive Species Monitoring. Montana Fish, Wildlife, and Parks, Helena, Montana.

Schwing, E., 2017. Outdoor Recreation A “Growing Economic Force” For Oregon, Washington Economies [WWW Document]. URL https://www.opb.org/news/article/oregon-washington-outdoor-recreation-economy-report-2017/ (accessed 9.10.18).

Southwick Associates, Inc., 2017. The Outdoor Recreation Economy. Outdoor Industry Association, Boulder, Colorado.

Sprung, M., 1987. Ecological requirements of developing dreissena polymorpha eggs. Arch. Fuer Hydrobiol. Suppl. 79, 69–86.

Stewart-Malone, A., Misamore, M., Wilmoth, S., Reyes, A., Wong, W.H., Gross, J., 2015. The Effect of UV-C Exposure on Larval Survival of the Dreissenid Quagga Mussel. PLOS ONE 10, e0133039. https://doi.org/10.1371/journal.pone.0133039

Stewart, T.W., Miner, J.G., Lowe, R.L., 1998. Quantifying Mechanisms for Zebra Mussel Effects on Benthic Macroinvertebrates: Organic Matter Production and Shell-Generated Habitat. J. North Am. Benthol. Soc. 17, 81–94. https://doi.org/10.2307/1468053

Strayer, D.L., 2009. Twenty years of zebra mussels: lessons from the mollusk that made headlines. Front. Ecol. Environ. 7, 135–141. https://doi.org/10.1890/080020

Strayer, D.L., Caraco, N.F., Cole, J.J., Findlay, S., Pace, M.L., 1999. Transformation of Freshwater Ecosystems by BivalvesA case study of zebra mussels in the Hudson River. BioScience 49, 19–27. https://doi.org/10.1525/bisi.1999.49.1.19

Strayer, D.L., Eviner, V.T., Jeschke, J.M., Pace, M.L., 2006. Understanding the long-term effects of species invasions. Trends Ecol. Evol. 21, 645–651. https://doi.org/10.1016/j.tree.2006.07.007

Summerfelt, S.T., 2003. Ozonation and UV irradiation—an introduction and examples of current applications. AES Issues Forum Spec. Issue 28, 21–36. https://doi.org/10.1016/S0144-8609(02)00069-9

Tiffan, K.F., Clark, L.O., Garland, R.D., Rondorf, D.W., 2006. Variables influencing the presence of subyearling fall Chinook salmon in shoreline habitats of the Hanford Reach, Columbia River. North Am. J. Fish. Manag. 26, 351–360. https://doi.org/10.1577/M04-161.1

TOXNET, 2018. National library of medicine's toxicology data network. Hazardous Substances Data Bank (HSDB). National Institute of Health, US Department of Health and Human Services, Bethesda, Maryland.

Trumbo, B., 2017. Habitat evaluation models. Appendix A in Clover Island feasibility report and integrated environmental assessment. US Army Corps of Engineers, Walla Walla, Washington.

Tyus, H.M., 1993. Feasibility of preventing further invasion of the zebra mussel into the western United States [microform] / Harold Tyus, William P. Dwyer, and Sharon Whitmore. U.S. Fish and Wildlife Service, Mountain-Prairie Region, [Denver, CO.

United States Environmental Protection Agency, n.d. Potassium dihydrogen phosphate (076413) Fact Sheet. United States Environmental Protection Agency, Washington, District of Columbia.

University of California Division of Agriculture and Natural Resources, 2018. Impacts to Water, Power, and Irrigation Infrastructure [WWW Document]. URL http://ucanr.edu/sites/WAEMAP/Impacts_to_Water,_Power,_and_Irrigation_Infrastructure (accessed 8.14.18).

US Army Corps of Engineers, 2017. Final integrated letter report and programmatic environmental assessment for federal participation in watercraft inspection stations, Columbia River Basin. US Army Corps of Engineers, Walla Walla, Washington.

U.S. Census Bureau, 2016. American FactFinder [WWW Document]. URL https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml (accessed 9.12.18).

U.S. Census Bureau QuickFacts: UNITED STATES [WWW Document], n.d. URL https://www.census.gov/quickfacts/fact/table/US/PST045217 (accessed 9.10.18).

USGCRP, 2017. Climate Science Special Report. U.S. Global Change Research Program, Washington D.C., USA.

Vanderploeg, H., Wilson, A.E., Johengen, T.H., Dyble Bressie, J., Sarnelle, O., Liebig, J., Robinson, S.D., Horst, G., 2014. Role of Selective Grazing by Dreissenid Mussels in Promoting Toxic Microcystis Blooms and Other Changes in Phytoplankton Composition in the Great Lakes.

Walker, Jr., D., 1998. Volume 12: Plateau, in: Handbook of North American Indians. Smithsonian Institution, Washington, District of Columbia.

Waller, D.L., Luoma, J.A., Erickson, R., 2016. Safety of the molluscicide Zequanox® to nontarget macroinvertebrates Gammarus lacustris (Amphipoda: Gammaridae) and Hexagenia spp. (Ephemeroptera: Ephemeridae). Manag. Biol. Invasions 7, 269–280.

Wells, S., Counihan, T., Puls, A., Sytsma, M., Adair, B., 2011. Prioritizing Zebra and Quagga Mussel Monitoring in the Columbia River Basin. Cent. Lakes Reserv. Publ. Present.

Western Regional Panel on Aquatic Nuisance Species, 2010. Quagga-Zebra Mussel Action Plan for Western U.S. Waters. Aquatic Nuisance Species Task Force.

Whittier, T.R., Ringold, P.L., Herlihy, A.T., Pierson, S.M., 2008. A Calcium-Based Invasion Risk Assessment for Zebra and Quagga Mussels (Dreissena spp). Front. Ecol. Environ. 6, 180–184.

Williams, J.D., Jr, M.L.W., Cummings, K.S., Harris, J.L., Neves, R.J., 1993. Conservation Status of Freshwater Mussels of the United States and Canada. Fisheries 18, 6–22. https://doi.org/10.1577/1548-8446(1993)018<0006:CSOFMO>2.0.CO;2

Wisconsin Department of Natural Resources, 2012. Endothall chemical fact sheet. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Zhu, B., Fitzgerald, D.G., Mayer, C.M., Rudstam, L.G., Mills, E.L., 2006. Alteration of Ecosystem Function by Zebra Mussels in Oneida Lake: Impacts on Submerged Macrophytes. Ecosystems 9, 1017–1028. https://doi.org/10.1007/s10021-005-0049-y