US Army Corps of Engineers ®
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DREISSENID MUSSEL RAPID RESPONSE ACTION PLAN

US ARMY CORPS OF ENGINEERS, NORTHWESTERN DIVISION

Federal Natural Resources Law Compliance
and
Biological Assessment

ADMINISTRATIVE RECORD – DO NOT DESTROY

FILE NUMBER: PM-EC-2018-0062

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EXECUTIVE SUMMARY

This Biological Assessment (BA) is prepared pursuant to section 7(a)(2) of the Endangered Species Act (ESA) to evaluate the effects of the U.S. Army Corps of Engineers, Walla Walla District (Corps), proposed Dreissenid Mussel Rapid Response Action Plan (Plan) on listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS). The Corps was authorized by the Water Resource Reform and Development Act of 2014 and 2016 to develop the Plan to protect the Columbia River Basin from invasive dreissenid mussels.

Summary of Proposed Action

WHO

The Corps proposes to implement the Plan when there is a detection of dreissenids in the Columbia River Basin (CRB) and/or waterbodies in the states of Washington, Oregon, Idaho, and Montana. The purpose of the Plan is to isolate and eradicate mussels in response to early detection, as control or management of an established dreissenid mussel invasion is unrealistic and would result in significant economic and ecological damage to the CRB. The Plan may be implemented by the Corps (reservoirs maintained and operated by the Corps), cost-shared with State and Local Governments (non-Corps managed waterbodies), and may be adopted by other federal agencies to initiate dreissenid eradication actions upon detection.

In the event of cost-share with States, the State would carry out rapid response under the Corps Plan and the Corps would reimburse the State 50 percent of the cost; thus, the cost-share is the federal nexus linking the Corps to the State action. Federal agencies could conduct rapid response actions independent of the States on federally managed submerged lands and facilities.

WHAT

The proposed action includes a maximum of 12 treatments per year (estimated on program funding). A maximum of 30 acres is proposed per treatment (based on effective treatment acreage in the Great Lakes region). A maximum of 4 consecutive treatments per site would occur and may include a combination of treatments (e.g. ozone and KCL or EarthTec QZ and Zequanox) or different consecutive treatments (see below).

The following treatments would be applied:

- Endothall would be applied at a rate of 0.3-5 mg/L for up to 6 days per treatment.
- EarthTec QZ is a copper sulfate pentahydrate compound of 19% active ingredient per volume. It would be applied at a rate of up to 2 mg/L, not to exceed 0.1 mg/L total copper.
- Potassium compounds [potash (KCL, KH2PO4, KOH)] would be applied at rates 10-640mg/L depending upon which compound was used. Concentrations may be

held constant up to 21 days to achieve effective treatment for all dreissenid life stages.

- Zequanox would be maintained at a rate of 100 mg/L for up to 8 hours for noticeable effects within 3-21 days. Two repeat treatments are expected. The label recommends no more than 4 treatments annually.
- Ultraviolet treatments would be applied at rates between 50 – 100 milliJoules per centimeter squared (mJ/cm²). Treatment would require continuous UV-B application for up to 120 hours and would only be partially effective on juvenile dreissenids.
- Ozone would be applied through a bubbler system at 0.5 mg/L for up to 7 days to achieve effective treatment for all dreissenid life stages.
- Rhodamine WT dye would be applied at a rate of 0.01 mg/L (Table 2) 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.

Table 1 summarizes the dose rates and application time required to achieve desired effectiveness.

Table 1. 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	50 – 100 mJ/cm²	5 days
Ozone	0.5 mg/L	7 days
Rhodamine WT Dye	0.01 mg/L	53.9 hours (half-life)

WHEN

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

Mussel detection is most likely to occur during the warmer months (approximately April through October), correlating with water recreation and mussel growth and activity. Therefore, **treatments would occur April through October**.

Any riparian access site restoration would occur after the final treatment and barrier removal. Plant restoration would occur from October through March, depending upon weather conditions.

WHERE

The Corps has identified 4,174 boat access locations (based on available GIS data) and associated likely treatment areas (i.e., shallow areas within close proximity to public use access sites) within the action area where dreissenid detection may be likely. The proposed action does not include treatment at dams, diversions, irrigation, or other water control structures as these sites are difficult to isolate and treat effectively and treatment would be considered an operations and maintenance action.

Exclusions: 1) The action area excludes saltwater habitats such as Puget Sound with a 100-foot upstream buffer; **2)** There are no proposed treatment sites within the (ESU) boundaries of ESA-listed Endangered Ozette Lake sockeye salmon.

Conservation Measure: Initial treatments within the ESU boundaries of ESA-listed Endangered fishes Upper Columbia River spring Chinook and Snake River Basin sockeye (222 sites) **would not include** EarthTec QZ or Endothall. Potash, Zequanox, ozone, and UV-B would be used as appropriate at each site. In the event that follow-up treatment with EarthTec QZ and/or Endothall is necessary, the Corps will develop site-specific conservation measures and coordinate appropriately with the Services prior to treatment.

HOW

Present monitoring programs throughout the action area would provide evidence of a dreissenid invasion. When there is evidence of dreissenid presence (regardless of life stage) anywhere in the action area, the extent of the invasion must first be determined, likely through veliger sampling, watercraft inspection, shoreline surveys, snorkeling, or self-contained underwater breathing apparatus (SCUBA) surveillance for established adults. Once the extent of the invasion is determined, the following project sequence is applicable to all treatments.

1. Mobilize to the site.
2. Treatment area isolation
    a. Deploy impervious silt curtain
    b. Deploy bladder dam
3. Fish salvage
    a. Fish salvage via electrofishing would occur at every treatment site
4. Treatment (one or a combination of the six above)
5. Post-treatment monitoring
6. Retreatment (if necessary)
7. Restoration (for disturbed riparian habitats)
8. Equipment sterilization (for all equipment)

A suite of best management practices and conservation measures would be implemented (see BA Section 2.1.6).

The Corps concludes that the proposed action “may affect, and is likely to adversely affect” 19 evolutionarily significant units of salmon and steelhead, and eulachon. The Corps further concludes the proposed action “may affect, but is not likely to adversely affect” green sturgeon and southern resident killer whales under the jurisdiction of NMFS.

The Corps concludes the proposed action “may affect, and is likely to adversely affect” 46 ESA-listed species under the jurisdiction of USFWS. The Corps further concludes the proposed action “may affect, but is not likely to adversely affect” Canada lynx, gray wolf, grizzly bear, North American wolverine, or woodland caribou.

Finally, the Corps concludes the proposed action “may affect” applicable critical habitat for all ESA-listed species except green sturgeon and southern resident killer whale (no effect) in the four-state action area. A complete list of species, critical habitats, and effects determinations are provided in Table 2.

In addition, this document analyzes the project's likely effects on essential fish habitat pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and the Fish and Wildlife Coordination Act. The Corps has also determined the proposed Plan would result in no take of species protected by the Migratory Bird Treaty Act, and no disturbance or take under the Bald and Golden Eagle Protection Act or the Marine Mammal Protection Act.

Table 2. Effects determination summary for Plan implementation. “LAA” represents likely to adversely affect, “NLAA” represents not likely to adversely affect, and NA represents not applicable as no critical habitat is designated or occurs within the action area.

Mammals		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Black-footed Ferret	LAA	NA
Canada Lynx	NLAA	May Affect
Columbia Basin Pygmy Rabbit	LAA	NA
Columbian White-tailed Deer	LAA	NA
Gray Wolf	NLAA	NA
Grizzly Bear	NLAA	May Affect
North American Wolverine	NLAA	NA
Northern Idaho Ground Squirrel	LAA	NA
Olympia Pocket Gopher	LAA	May Affect
Red Tree Vole	LAA	NA
Roy Prairie Pocket Gopher	LAA	May Affect

Mammals Continued		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Tenino Pocket Gopher	LAA	May Affect
Woodland Caribou	NLAA	May Affect
Yelm Pocket Gopher	LAA	May Affect
Southern Resident Killer Whale	NLAA	No Effect

Fish		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Borax Lake Chub	LAA	May Affect
Bull Trout	LAA	May Affect
Chinook Salmon	LAA	May Affect
Chum Salmon	LAA	May Affect
Coho Salmon	LAA	May Affect
Dolly Varden	LAA	NA
Eulachon	LAA	May Affect
Foskett Speckled Dace	LAA	NA
Green Sturgeon	NLAA	No Effect
Hutton Tui Chub	LAA	NA
Lahontan Cutthroat	LAA	NA
Lost River Sucker	LAA	May Affect
Pallid Sturgeon	LAA	NA
Shortnose Sucker	LAA	May Affect
Sockeye Salmon	LAA	May Affect
Steelhead	LAA	May Affect
Warner Sucker	LAA	May Affect
White Sturgeon	LAA	May Affect

Birds		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Least Tern	LAA	NA
Marbled Murrelet	LAA	May Affect
Northern Spotted owl	LAA	May Affect
Streak Horned Lark	LAA	May Affect
Western Snowy Plover	LAA	May Affect
Yellow-billed Cuckoo	LAA	May Affect

Gastropods		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Banbury Springs Limpet	LAA	NA
Bliss Rapids Snail	LAA	NA

Gastropods Continued		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Bruneau Hot Springsnail	LAA	NA
Snake River Physa Snail	LAA	NA
Vernal Pool Fairy Shrimp	LAA	May Affect

Amphibians		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Oregon Spotted Frog	LAA	May Affect

Insects		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Fender's Blue Butterfly	LAA	May Affect
Meltwater Lednian	LAA	NA
Oregon Silverspot Butterfly	LAA	May Affect
Taylor's (whulge) Checkerspot	LAA	May Affect
Western Glacier Stonefly	LAA	NA

Plants		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Applegate's Milk-Vetch	LAA	NA
Gentner's Fritillary	LAA	NA
MacFarlane's Four-o'clock	LAA	NA
Slickspot Peppergrass	LAA	May Affect
Spalding's Catchfly	LAA	NA
Ute Ladies'-tresses	LAA	NA
Water Howellia	LAA	NA
Western Lily	LAA	NA
Whitebark Pine	LAA	NA
MSA		
May Adversely Affect		
MMPA		
Not Applicable		
FWCA		
Coordination Required		
MBTA		
Potential for Take		
BGEPA		
No Take or Disturbance		

Therefore, the Corps requests formal consultation of both Services on implementation of the Plan. The Plan represents 4,174 specific sites identified for anticipated and repeatable dreissenid rapid response treatment actions, and considers rapid response for other parts of the action area where dreissenids could become established.

The Corps suggests a programmatic framework Opinion [with no Incidental Take Statement (ITS)] from both Services would best address the proposed action encompassing 4,174 identified sites. The Corps further requests that to-be-identified sites within the action area be covered as well, to include the Ozette Lake sockeye ESU. The follow on consultation would be completed through the Incidental Take Statement Request Form (Appendix C), or a similar form developed collaboratively with the Services, which would provide the site-specific details of the treatment needed when an infestation is identified.

The Corps proposes the following conditions under a programmatic framework Opinion from both Services. This process addresses casual detections, detections under supplemental monitoring, and any emergency response actions necessary under the Plan to ensure dreissenids are treated and prevented from infesting the Columbia River Basin.

All follow-on actions under a programmatic framework Opinion would be completed through the Incidental Take Statement Request Form, which provides the specific details of the treatment needed.

If additional information regarding this document is required, please contact Brad Trumbo, Biologist in the Environmental Compliance Section of the U.S. Army Corps of Engineers, Walla Walla District, at (509) 527-7257, or by email at bradly.a.trumbo@usace.army.mil. Other correspondence can be mailed to:

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Acronyms and Abbreviations

BA	Biological Assessment
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practices
°C	degree Celsius
CFR	Code of Federal Regulation
cm	centimeter
Corps	US Army Corps of Engineers, Walla Walla District
CRB	Columbia River Basin
CWTD	Columbian white-tailed deer
DNA	Deoxyribonucleic acid
DPS	Distinct Population Segment
EC50	Effect Concentration of 50% of the population (toxicity)
EFH	Essential Fish Habitat
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR	Federal Register
ft	feet
FWCA	Fish and Wildlife Coordination Act
GARP	Genetic algorithm for rule-set prediction model
Ha	Hectare
KCL	potassium chloride
Kg	kilogram
KOH	potassium hydroxide
K2SO4	potassium sulfate
in	inch
lbs	pounds
LC50	Lethal Concentration of 50% of the population (toxicity)
LCT	Lahontan cutthroat trout
m	meter
mi	mile
mm	millimeter
Maxent	Maximum Entropy model
MBTA	Migratory Bird Treaty Act
mg/L	milligram per Liter

mJ/cm²	milliJoules per centimeter squared

Acronyms and Abbreviations (Continued)

MPI	Matrix of Pathway Indicators
MSA	Magnuson-Stevens Act
NMFS	National Marine Fisheries Service
NOEC	No Observed Effect Concentration (toxicity)
OHWM	ordinary high water mark
PBF	Physical and Biological Features of critical habitat
ppm	parts per million
Plan	Dreissenid Mussel Rapid Response Action Plan
RNA	Ribonucleic Acid
SCUBA	Self-Contained Underwater Breathing Apparatus
SPCC	Spill prevention, control, and countermeasures
USFWS	U.S. Fish and Wildlife Service
UV-B	ultraviolet radiation, wavelength B
yds	yards
YOY	young-of-the-year

Summary of Changes to this Document

- The proposed action has been clarified throughout to address National Marine Fisheries Service (NMFS) comments dated June 28, 2018, topics discussed during the face-to-face meeting at the NMFS office in Boise, August 30, 2018, and during various phone conversations From July 1, 2018 to present.
- The Corps has voluntarily restricted the use of Endothall and EarthTec QZ from initial treatment within the ESU boundaries of ESA-listed endangered Upper Columbia River Spring Chinook Salmon and Snake River Basin Sockeye Salmon. The use of these chemicals within these ESUs would require further coordinating with the Services.
- The Corps further defined 222 of the 4,174 identified sites were located within the ESU boundaries, and that there are no identified treatment sites within the ESU boundary of endangered Ozette Lake Sockeye Salmon.
- A box was added to the top of page 17 providing additional instructions for viewing information on the interactive map described on page 16.
- The Corps defined a maximum width of 12 feet for any access roads created in riparian zones.
- Additional clarification was added to the efficiency of fish salvage relative to treatment area size and depth.
- The Corps clarified that salvage efforts would focus on ESA-listed species, but non-listed species may be salvaged concurrently.
- The Corps made the April through October treatment window explicit in Section 2.1.5.
- The Corps bolstered the language on BMPs 14 and 16, and conservation measure 7, and added conservation measures 4 and 9.
- The Corps added species Eulachon, Green Sturgeon, and Southern Resident Killer Whale to the species list and effects analysis at NMFS request.
- The Corps bolstered the effects analysis and determinations sections to be more specific to anadromous fish species and populations under NMFS jurisdiction at NMFS request. Table 11.1 was added to Appendix A providing effects determinations and likelihood of exposure to treatment for each population.
- The Corps added a cumulative effects discussion to sections 5.1, 5.2, and 5.3 addressing anticipated effects from multiple treatments within a single site or subbasin to provide clarity to the potential broader implications of treatment.
- The Corps added discussion of impacts to specific PBFs of critical habitat for ESA-listed fishes in section 5.3 at NMFS request.
- The Corps added a Consultation Request section to clarify what type of consultation the Corps is requesting for specific actions and treatment sites, as well as to propose a streamlined process for follow-on actions under the consultation.

1 Background

The US Army Corps of Engineers, Walla Walla District (Corps), proposes to implement a Rapid Response Action Plan (Plan) for the removal of prospective zebra (*Dresissena polymorhpa*) and quagga mussel [*D. bugensis* (collectively referred to as dreissenids)] incursions in the Columbia River Basin (CRB). The Plan also includes waterbodies in the states of Washington, Oregon, Idaho, and Montana.

The risk of dreissenid invasion is genuine as recreational watercraft from across the country transport invasive species into other waterbodies. In 2014, 3 watercraft were intercepted in Montana transporting dreissenids (Boos et al. 2014). This comports with an average interception rate for inspection stations in California (Mangin 2001). Inspection stations are now common throughout the northwest. Dreissenids being human introduced into the CRB at some point is not only possible, but probable.

The purpose of this Biological Assessment (BA) is to present 1) dreissenid life history and habitat requirements; 2) the invasion risk of dreissenids; 3) the potential ecological and economic consequences of an invasion; 4) the Corps Plan; and 5) the effects analysis of Plan implementation on potentially affected Endangered Species Act (ESA) listed species and critical habitats under the jurisdiction of the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) across Washington, Oregon, Idaho, and Montana.

1.1 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 River and Harbor Act (RHA) of 1958 (33 U.S.C. 610) and 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 Resources Development Act (WRDA) of 2016 (PL 114-332) further amended Section 104 of the RHA of 1958 and authorized the Secretary to assist those four 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 Dreissenid Mussel Presence and Life History in North American

1.2.1 Presence

Zebra mussels are native to the Azov and Black Sea region of Eastern Europe (Higgins and Vander Zanden 2010) and were introduced to the Great Lakes through cargo ship ballast water transfer (Roberts 1990). The exact year of identification in Lake Erie varies among studies, but numerous studies agree that the first zebra mussel detections occurred between 1986 and 1989 (MacIssac 1994; Mills et al. 1996; Roe and MacIssac 1997; Cohen and Weinstein 2001; Whittier et al. 2008). Similarly, quagga mussels originated in the South Bug and lower Ingulets Rivers off the Black Sea, Ukraine, but as presented by Mills et al. (1996), quagga mussels spread up the Dnieper River through a series of reservoirs behind dams as they were built, thus expanding into the entire Dnieper River drainage. Quagga mussels were first detected in Lake Erie in 1989 (May and Marsden 1992; Rosenberg and Ludyansiky 1994; Mills et al. 1996).

In the years post detection, these two dreissenids spread throughout the Great Lakes. Ludyanskiy et al. (1993) predicted 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. Presently, the Great Lakes, their tributaries, and major rivers in the mid-west have infestations (Figure 1).

The 100th Meridian Initiative (Mangin 2001) spearheaded dreissenid vigilance and response through boat inspection stations in an attempt to prevent establishment west of the 100th meridian in the United States. Dreissenids have occurred west of the 100th meridian in the southwest (Figure 1), and more recently Montana, but efforts appear to have slowed rapid spread.

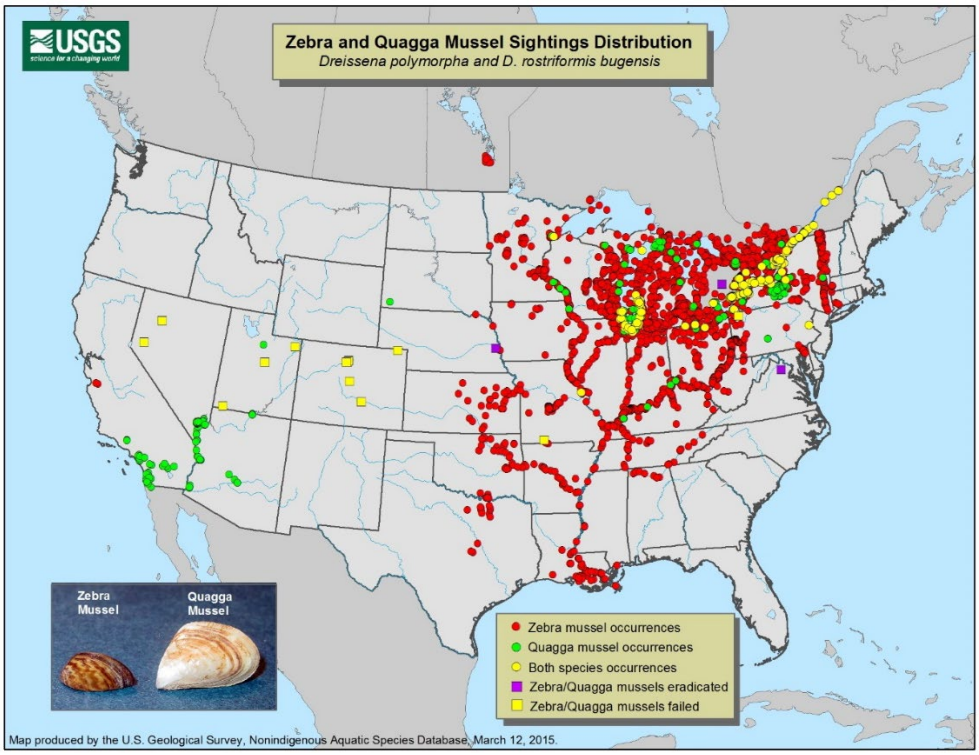

Figure 1. Dreissenid occurrences in the Unites States and Canada since their first identification about twenty years ago. Occurrences in Montana are not shown because they were documented in 2017, after this map was created.

1.2.2 Life History and Requirements

Zebra and quagga mussels share similar environmental requirements, but quagga mussels are known to colonize deeper waters, up to 426 feet [ft (130 meters (m))], where zebra mussels typically occur no deeper than about 361 ft [110 m (Mills et al. 1996)]. Both can colonize a variety of substrates, but are more likely to colonize softer substrates beyond 131 ft (40 m) deep (Dermott and Munawar 1993; Mills et al. 1996). This may correspond with turbulent waters being less likely at depth, thus attachment to a firm substrate is not necessary to remain in place as an adult.

While zebra mussel gametogenesis occurs at temperatures as low 35.6 degrees Fahrenheit [°F (2° Celsius (C))], egg fertilization doesn't occur below 50 °F [10°C (Sprung 1987)]. Spawning for both species appears to correlate with warmer temperatures and greater phytoplankton availability (MacIssac 1994; Claxton and Mackie 1998). A single female can produce over 1 million eggs in a season (Miller et al. 1992) and can spawn multiple times in a season [Mangin 2001 (Figure 2)]. Eggs develop into larvae, which develop into veligers, and maturation occurs within 12-18 months when conditions are favorable. The veligers are microscopic and are able to quickly spread since they are planktonic during this life stage being transported by current. They float freely for several weeks.

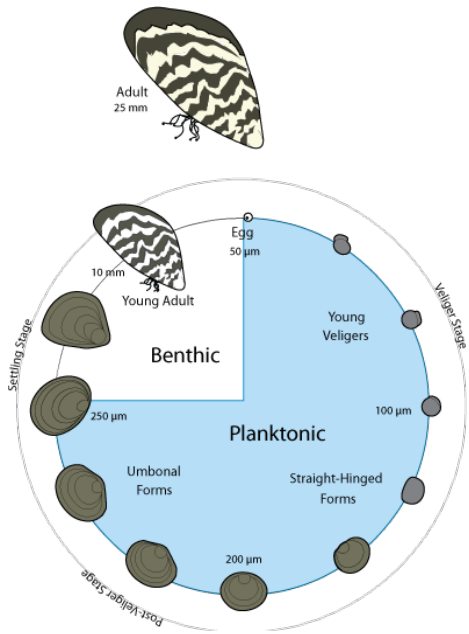

Figure 2. Zebra mussel life stages (http://www.100thmeridian.org)

At the end of the of the veliger stage, they settle out and attach via byssal threads to a variety of substrates including manmade structures, silt, rocks, cobble, other native mussels, crayfish carapaces, pipes, boat hulls, propeller blades, and fines. Interestingly, they may sever their threads and move via foot or current to another location (Tyus et al. 1993). Mellina and Rasmussen (1994) found that zebra mussel density varies with substrate type and size. Dreissenid densities on gravel and boulder substrates (similar to what can be found in shallow waters in the CRB) were orders of magnitude greater than on soft substrates. Upper thermal tolerance is around 30°C for quagga mussel, and 95 °F (35°C) for zebra mussel, where rapid mortality begins to occur (Mills et al. 1996).

Schloesser and Schmuckal (2012) developed a bibliography of dreissenid literature totaling 1,502 papers, and it can be assumed the list has since grown. While the Corps literature search was less extensive, papers on dreissenid environmental requirements were reviewed. Aside from thermal tolerance, studies have reported on salinity tolerance (Mills et al. 1996), calcium requirements (Sprung 1987; Neary and Leach 1992; Ramcharan et al. 1992; Mellina and Rasmussen 1994; Hincks and Mackie 1997; Cohen and Weinstein 2001; Whittier et al. 2008; Claudi et al. 2012), chlorophyll a concentration (Claxton and Mackie 1998), water protein content (Claxton and Mackie 1998), food availability (MacIssac 1994), inter- versus intra-specific competition (MacIssac 1994), and pH (Neary and Leach 1992; Ramcharan et al. 1992; Claudi et al. 2012).

Studies suggest a salinity tolerance up to 10 parts per thousand (ppt) for zebra mussels, and up to 8 ppt for quagga mussels; however, dreissenids in North America have been found less tolerant of salinity than in their native range. Spidle et al. (1995) reported that

neither species could survive longer than 18 hours in salinity greater than 5 ppt, but this does not dismiss the potential for dreissenids to establish in estuaries as the average salinity of the world's oceans is 3.5 ppt.

Chlorophyll-a and food availability was positively correlated with spawning time. Calcium concentration and pH were positively correlated with one another (higher pH with higher calcium) and with mussel survival. A pH range of 6.0-8.5 and calcium ranges ≥12 milligrams per liter (mg/L) is generally considered a requirement for adult survival and reproductive success (Hincks and Mackie 1997).

Calcium appears to be the most widely studied factor in dreissenid establishment as a critical requirement for shell development. This has led to subsequent calcium-based predictions of the likelihood of invasion in dreissenid-free waterways in the United States. Cohen and Weinstein (2001) summarized a number of studies across ranges of calcium and concluded that establishment is unlikely below 15 mg/L; however, dreissenids were present in some form, generally adults. Reproduction success does appear to correlate strongly with higher calcium concentration (Figure 3).

Whittier et al. (2008) concluded that waterbodies with less than 12 mg/L were at very low risk of invasion, and still at low risk when calcium levels were 12-20 mg/L. These concentrations are directly applicable to the CRB where calcium concentrations range from approximately 8 – 20 mg/L. One point of peculiarity is that standardized laboratory studies resulted in a 50% average success rate at calcium concentrations of 4-8 mg/L; however, success rates varied from 10-90% among the same cohort. This suggests that success rates are highly variable among dreissenids regardless of environmental conditions.

1.3 Invasion Risk

Invasive species are often able to adapt and invade quickly, partially because there are no natural predators in the new environment, so resources may be devoted to growth and reproduction (Strayer et al. 2006). Literature suggests that dreissenids inhabit a range of depths (Mills et al. 1996), temperatures (Mills et al. 1996; Roe and MacIssac 1997), and calcium concentrations (Cohen and Weinstein 2001) across continents. The calcium-based study results summarized by Cohen and Weinstein (2001) suggest that in North America, dreissenids thrive in waters with much lower calcium levels than European countries. They further predict the CRB is at low risk of invasion due to relatively low calcium; however, alternative modeling efforts suggest otherwise. Drake and Bossenbroek (2004) and Mingyang et al. (2008) developed dreissenid potential invasion predictions models [genetic algorithm for rule-set prediction (GARP)] based on environmental variables including temperature, but excluding calcium. Drake and Bossenbroek (2004) predicted moderate to high invasion risk for the CRB based on a combination of average annual temperature, frost frequency, solar radiation, minimum temperature, maximum temperature, bedrock geology, elevation, flow accumulation, slope, and surface geology (Figure 3).

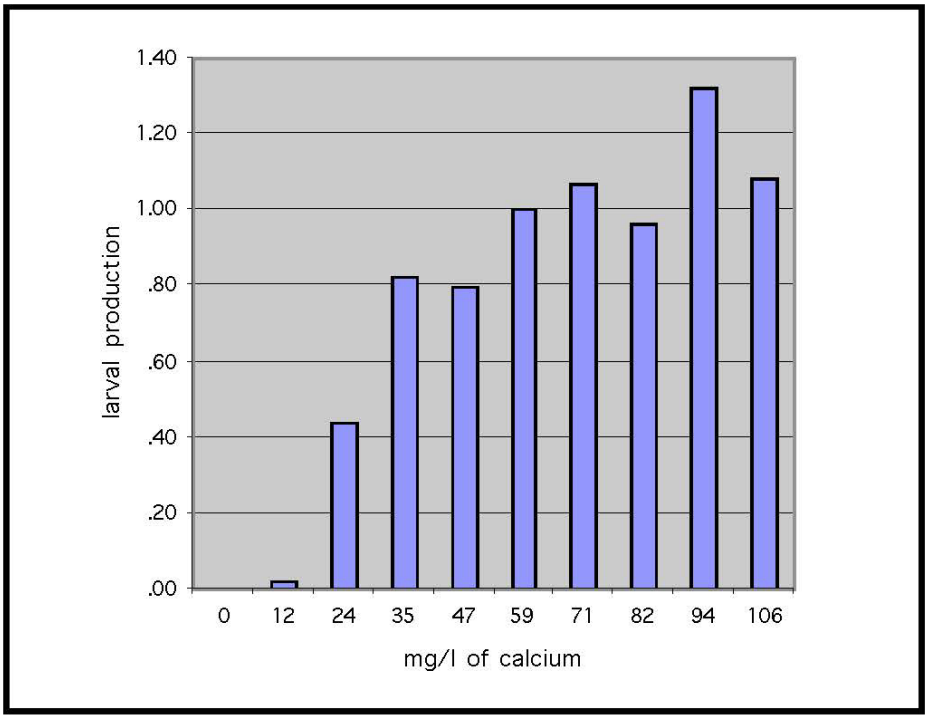

Figure 3. Larval production relative to calcium concentrations. Larval production is the number of healthy larvae produced after three days indexed to 59 mg/L. Cohen and Weinstein (2001) calculated these estimates from data presented by Sprung (1987).

Similarly, Mingyang et al. (2008) used GARP, but also maximum entropy (Maxent) to analyze distance to water, elevation, frequency of precipitation, solar radiation, temperature seasonality, precipitation seasonality, and range of enhanced vegetation index. The GARP model results compliment those of Drake and Bossenbroek (2004) estimating a moderate to high risk of invasion in the CRB (Figure 4). The Maxent model predicted a moderate invasion risk among less area of the CRB and was found to be a more robust model (Figure 5). While the CRB and Washington and Oregon coasts are predicted to have a moderate risk of invasion, more interior Idaho, Oregon, and Montana are not predicted to be at risk. Elevation was a driver in these models and may unnecessarily exclude suitable waterbodies (e.g. Tiber Lake in Montana).

Presently, only Montana has a single waterbody where dreissenids have been detected, among the four states included in the Plan; however, the threat of dreissenids being human introduced is high. Watercraft from across the nation enter the Pacific Northwest, making watercraft inspection stations critical in stopping the invasion (Figures 6-8).

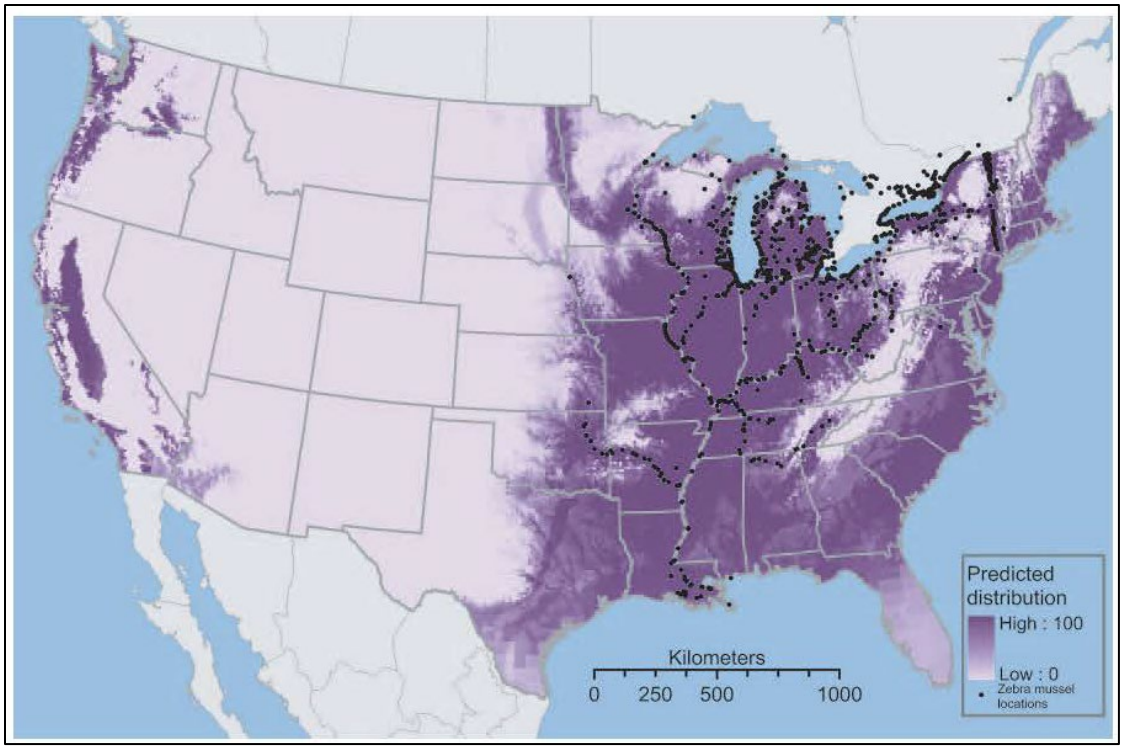

Figure 4. GARP model predicting moderate to high dreissenid invasion risk in the CRB and west of the Cascades (Drake and Bossenbroek 2004). Predicted distribution is from 0 – 100%. Note the suitability of the CRB in Washington is high.

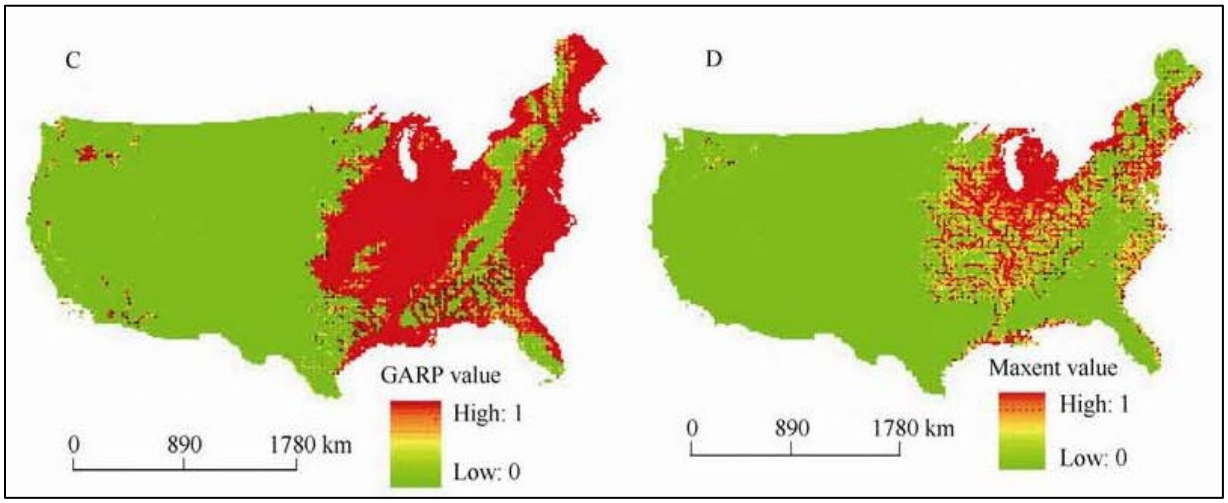

Figure 5. GARP and Maxent models presented by Mingyang et al. (2008). Note these models results are complimentary for the CRB and used several overlapping variables relative to those of Drake and Bossenbroek (2004). Value range represents habitat suitability. Note the suitability of the CRB in Washington is high.

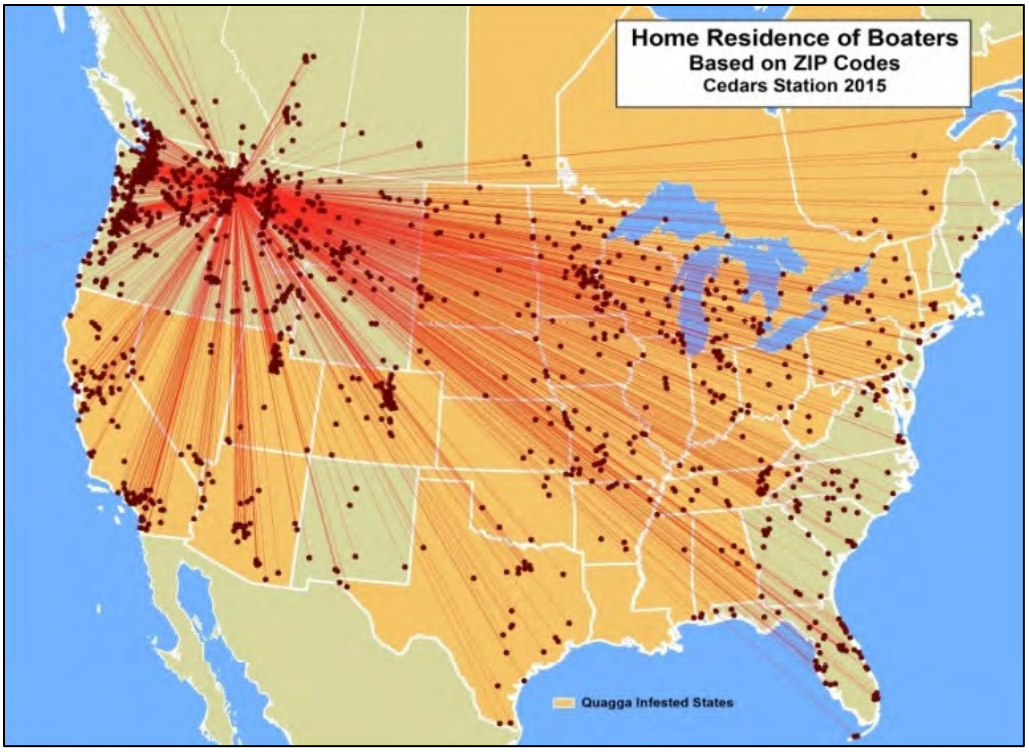

Figure 6. Geographic locations of boats entering Idaho based on owner zip codes of inspected watercraft at the Cedars check station in 2015 (Kootenai Environmental Alliance 2018).

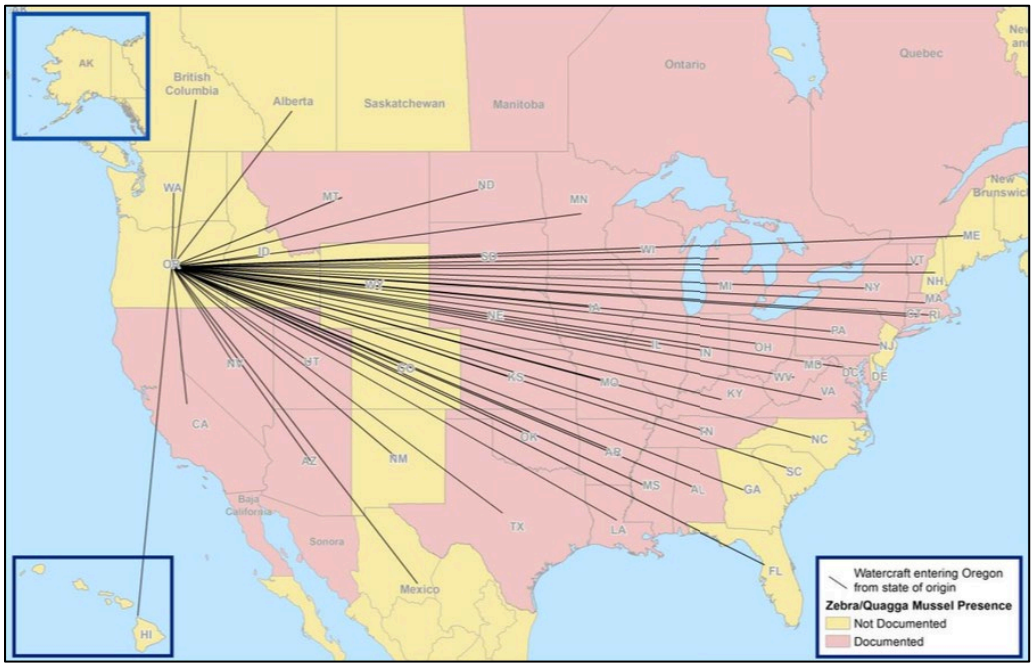

Figure 7. Geographic locations of boats entering Oregon based on owner zip codes of inspected watercraft in 2016 (Oregon Invasive Species Council 2017).

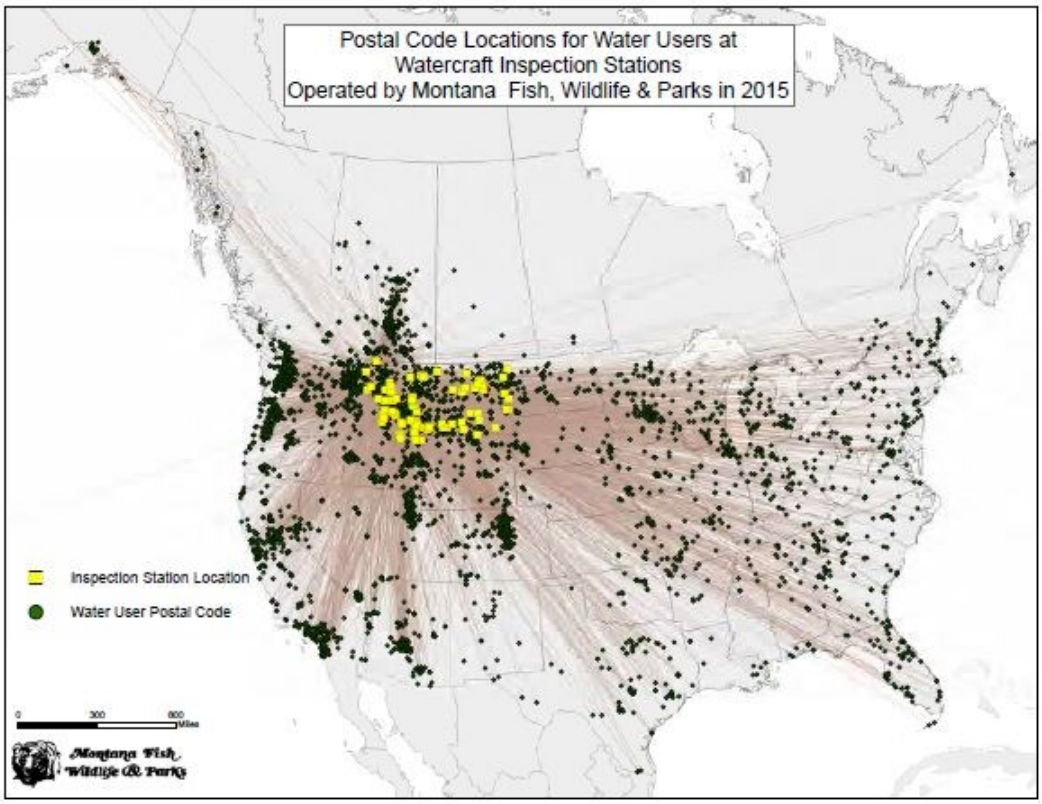

Figure 8. Geographic locations of boats entering Montana based on owner zip codes of inspected watercraft in 2015 (National Parks Service 2017).

1.4 Economic Impacts of an Invasion

Below is a summary of how dreissenids pose significant economic, environmental, and societal threats to inland, estuarine, and marine waters.

- They threaten the diversity or abundance of native species, ecological processes, and natural resources as well as commercial, agricultural, aquaculture, cultural, and recreational activities.
- They adversely affect the health, well-being and quality of life by disrupting ecological processes and food chains within aquatic ecosystems and access to healthy aquatic environments.
- They threaten fishery resources, including recovery efforts of salmon and steelhead (*Oncorhynchus mykiss*) listed under the ESA. A dreissenid infestation in any of these salmon-bearing watersheds would be a disastrous step backward for the recovery of these imperiled species, thus there is heightened urgency to implement management initiatives to halt further range expansion. There is particular concern about the impact of dreissenids on submerged fish passage facilities, such as fish ladders, screens and bypass infrastructure.
- Dreissenids also pose a significant threat to the Federal Columbia River Power System's hydropower and nuclear generation projects.

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

- Dreissenids 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.

Rosaen et al. (2012) estimated the cost of aquatic invasive species control in the Great Lakes States cost over $100 million annually (Table 1). Similarly, Ludyanskiy et al. (1993) cited U.S. Fish and Wildlife Service unpublished data estimating the cost of industrial, utility, and municipal-water-use reductions due to biofouling, plus the impact of the zebra mussel on navigation, boating, and sport fishing, could reach $5 billion by the year 2000 in the Great Lakes alone. These are the most recent, relevant estimates, but may presently be inaccurate due to inflation rates and advances in technology, treatments, etc.

Table 1. Estimated cost of aquatic invasive species control in the Great Lakes States by industry (Rosaen et al. 2012). These estimates do not include annual monitoring costs.

Industry Affected	Cost Examples
All Industries	* $50 million annual cost of reduced demand for industries and tourism in the Great Lakes * $34 million annual cost of control and research by the Great Lakes Fishery Commission
Sport and Commercial Fishing	* $18 million Great Lakes Fishery Commission sea lamprey control program. * $3.9 - $7.1 million annual benefit to anglers in the St. Mary's river system of a sea lamprey control program using sterile male release and lampricide.
Power Generation	* $1.2 million annual cost for one power plant to monitor and control zebra mussels * $1.7 million annual cost for researching better control methods for zebra mussels
Industrial Facilities	* $1.97 million to remove 400 yd^3 of zebra mussels from one Lake Michigan paper plant * $144,000 - $685,000 annual cost to monitor zebra mussels at an industrial facility * $21.6 million budget for AIS control for 2006 St. Lawrence Seaway Development Corp.
Water Treatment	* $480,000 - $540,000 annual cost of zebra mussel control for water treatment plant * $353,000 annual cost of zebra mussel control for municipal water treatment facility.
Households	* $355 cost of filtration system installation per lake-shore homeowner * $1,040 - $26,000 cost per acre of water milfoil removal

1.5 Ecological Impacts of an Invasion

Aside from the tremendous cost to industry and infrastructure, dreissenids have a significant effect on aquatic ecosystems. Their effects are pervasive and varied, changing variables such as the genetics and population size of individual species, diversity and structure of communities, disturbance regimes and biogeochemical cycles (Strayer et al. 2006). Acute and chronic effects of invasive species are both important to understand. Environmental impacts from chronic effects may assist with long-term management, but acute effects may be difficult to detect initially, and depending upon the severity of the impacts, could lead to severe consequences such as species extinction.

One of the major impacts of dreissenid infestation comes from the mass reduction in primary productivity that can disrupt entire food webs (Ramcharan et al. 1992). In a review conducted by Higgins and Vander Zanden (2010), studies show a major biomass shift from the profundal-pelagic to benthic zone. Phytoplankton and zooplankton reductions reached 78%, while tremendous increases occurred for algal communities (170%), macrophytes (180%), zoobenthic biomass (210%), and sediment bacterial biomass (2,000%). Caraco et al. (1997) estimated an 85% decline in phytoplankton biomass, Heath et al. (1995) estimated up to 60% decline, and Strayer et al. (2006) also reported a phytoplankton shift to mainly cyanobacteria. Most negatively affected by dreissenid invasion were rotifer, copepod nauplii, and flagellated protozoan abundance (-70% to -85%), while declines in cladoceran, copepod, and rotifer were linearly correlated with the decline in phytoplankton biomass (Higgins and Vander Zanden 2010).

A significant decrease in suspended solids dramatically increases water clarity as well. Leach (1993) found Secchi depth nearly doubled in Lake Erie with an associated 54% decrease in chlorophyll a. Zhu et al. (2006) similarly found Secchi depth nearly doubled in Lake Oneida post-invasion. Among 46 pre- versus post-invasion measurements reviewed by Higgins and Vander Zanden (2010), water clarity increased by an average of approximately 38%.

While it can be assumed that increased water clarity due to a lack of suspended solids would also increase aquatic macrophyte coverage, Zhu et al. (2006) found a significant correlation between Secchi depth and macrophyte depth, post-dreissenid invasion. Zhu et al. (2006) also reported that macrophyte species richness increased, the frequency of occurrence increased for most species, and the composition of the macrophyte community changed from low-light-tolerant species to those tolerating a wide range of light conditions. This effectively shifted the primary productivity from pelagic to benthic pathways. It should be noted that increased water clarity increases light penetration; however, this does not necessarily equate to increased water temperature. Water temperature is negatively correlated with depth, but a net increase at depth may occur on a case-by-case basis post-dreissenid invasion.

Given the evidence of a shift in productivity from pelagic to benthic, Stewart et al. (1998) studied the effects of zebra mussels on benthic macroinvertebrates and found no declines, but a 2-5 fold increase in biomass post-mussel invasion. The authors attribute this increase largely to the habitat created by spent mussel shells (presumably contributing to predator avoidance).

The findings of the above studies are alarming for areas in the CRB, such as Lake Wallula upstream of McNary Dam, where flowering rush (*Butomus umbellatus*) is impacting salmon and steelhead critical habitat. Flowering rush already occurs at deeper depths in Lake Wallula than areas outside of the CRB, and is spreading rapidly (D. Walter, US Army Corps of Engineers, Personal Communication, 28 March 2018). While the Corps is presently under consultation with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service [NMFS (collectively the Services)] on an *Aquatic Pest Management Plan* that would include chemical treatment of flowering rush, a dreissenid invasion could dramatically increase the spread of this, and similar noxious aquatic weeds through increased water clarity and the channeling of primary productivity into the benthic zone. This would effectively decrease the conservation value of designated critical habitat.

1.5.1 What does this mean for ESA-listed aquatic species?

As with any other invasive species, dreissenids are a formidable opponent for native species. In North America, native mussels of the Order Unionoida are the most imperiled faunal group. Two decades ago, Ricciardi et al. (1998) reported that 60% of described Unionoid species were listed as threatened or endangered and 12% were presumed extinct. The authors further reported that zebra mussel invasions have accelerated regional extinction rates of North American freshwater mussels 10-fold, and mussel establishment will extirpate native mussels from a waterbody within 4-8 years. Aside from general resource competition, dreissenids can colonize on top of native mollusks themselves making them immobile and unable to physically function.

Potential effects on fish species may not all be negative, but will certainly be profound, with juvenile salmonids potentially experiencing some of the more significant challenges. The Columbia River Basin provides a prime case study on the potential impacts to critical rearing habitat. A review of juvenile salmonid diet and habitat requirements and their responses to a dreissenid mussel invasion paints a grim picture.

Chapman and Quistdorff (1938) found dipteran larvae, beetle larvae, stonefly nymphs, and leaf hoppers made up the bulk of juvenile Chinook salmon [(*Oncorhynchus tshawytscha*) 42-152 millimeters (mm)] diet in Columbia River tributaries. Craddock et al. (1976) found crustacean zooplankton (particularly of Order *Cladocera*) to be a major diet component for juvenile Chinook in July and August in the lower Columbia River. Other similar studies outside of the CRB summarized by Healey (1991), suggest that insect larvae and pupa are important juvenile Chinook diet components. It was also

noted that the juvenile Chinook basic diet comports with that of coho (*O. kisutch*) and steelhead, and that species feed in the water column and on drifting food at the surface.

In response to a dreissenid invasion, the significant decline in phytoplankton and zooplankton, and the major shift in primary productivity from pelagic to benthic may require a hard adjustment to feeding strategies for rearing salmonids. While benthic macroinvertebrates may boom from the spent shell habitat and redirected energy, it may be difficult for fishes to capture benthic macroinvertebrate prey, particularly smaller species and life stages by smaller fish like subyearling fall Chinook. Juvenile salmonids employ feeding strategies similar to adults, but are clearly gape-limited relative to prey size. While salmonids do feed on benthic organisms, for juveniles switching from pelagic to primarily benthic feeding may require a behavioral adaptation across generations rather than individuals simply adjusting feeding location in the water column. Similar effects may be realized for juvenile ESA-listed Lahontan cutthroat (*O. clarkia henshawii*), dace (*Rhinichthys* spp.) and chub (G*ila* spp.) species. Other ESA-listed sucker (*Deltistes, Chasmistes, Catostomus* spp.) species may realize a food source benefit from increased benthic production.

Physically altered aquatic critical habitat is a consideration that may prove crucial to the success of fishes. In the CRB mainstem reaches, juvenile salmonids seek various substrates from sandy shoals and island shorelines to a mix of hard substrates (summarized in Trumbo 2017). With the exception of Hillman et al. (1987), none of the applicable habitat selection studies on juvenile Chinook salmon in the CRB made any correlation of fish presence to aquatic vegetation, and Hillman et al. (1987) found that juvenile spring Chinook overwintering in tributary habitats selected submerged grasses and sedges (i.e. non-emergent, low-growing species) only in the absence of cobble substrate. Similarly, Tiffan et al. (2006) found juvenile Chinook rearing habitat to include sparse, submerged terrestrial grasses and forbs. This suggests that a decline in native aquatic plants and the overtaking of substrates by dreissenids, and subsequently flowering rush, may have significant negative impacts on critical habitat rearing suitability in the mainstem Columbia and Snake Rivers, and presumably in other waterbodies relative to other ESA-listed fishes.

The potential physical alteration of critical habitat is a double-edge sword for juvenile salmonids. Juvenile anadromous salmonids in the CRB prefer rearing along the river margins [≤ 10 ft (3 m (see Trumbo 2017))] where water temperatures are slightly warmer than mid-channel (Tiffan et al. 2006), which enhances growth and development. When mature enough, these fish begin to move into faster, deeper habitats (Hillman et al. 1987). Therefore, effects on long-term fitness from the spread of aquatic invasive species could be dramatic for fishes like juvenile Chinook salmon for the following reasons: 1) Denser invasive aquatic vegetation may provide more edge-type habitats suitable for ambush predators like black basses (*Micropterus* spp.), as well as choke out preferred shallow water rearing areas. Similarly, increased water clarity corresponds to higher predation rates on juvenile salmonids (Gregory and Levings 1998). It can be

assumed that juvenile salmonids would seek shelter in dense vegetation if necessary, but are more likely to avoid this habitat given the results of habitat association data. 2) Flowering rush (for example) has been documented growing up to 20 ft (6.1 m) deep in the mainstem Columbia River. Juvenile Chinook salmon are expected to avoid dense flowering rush, and may be forced into deeper habitat. Therefore, the major risks are: 1) increased predation and 2) lower fitness due to being forced into deeper, colder water with less time spent rearing in optimal shallow water rearing habitats.

1.6 Corps Monitoring Protocol

Early detection is critical for dreissenid containment and removal. Therefore, the Corps implements monitoring protocols consistent with the California Department of Fish and Game (2008). 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.

1.7 Summary and Path Forward

It is evident that a dreissenid introduction substantially impacts aquatic environments and inhabitants. From the economic burden of maintaining infrastructure function and a possible collapse in sport fisheries, to the dramatic changes in natural ecosystems, 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, no action on behalf of the Corps is unacceptable as it puts public infrastructure and ESA-listed species in peril. Therefore, the Corps has developed the Dreissenid Mussel Rapid Response Action Plan (Plan).

This BA henceforth presents the Corps Plan, site (where available) and treatment-specific information, and the known effects to ESA-listed species in the area. This BA also presents best management practices (BMP) and conservation measures to minimize and avoid the impacts of Plan treatments.

2 Federal Action

2.1 Proposed Action

The Corps proposes to implement the Rapid Response Action Plan when there is a detection of dreissenids in the Columbia River Basin (CRB) and/or waterbodies in the states of Washington, Oregon, Idaho, and Montana. The purpose of the Plan is to isolate and eradicate mussels in response to early detection, as control or management of an established dreissenid mussel invasion is unrealistic and would result in significant economic and ecological damage to the CRB. The Plan may be implemented by the Corps (reservoirs maintained and operated by the Corps), cost-shared with State and Local Governments (non-Corps managed waterbodies), and may be adopted by other

federal agencies to initiate dreissenid eradication actions upon detection. In the event of cost-share with States, the State would carry out rapid response under the Corps Plan and the Corps would reimburse the State 70 percent of the cost; thus, the cost-share is the federal nexus linking the Corps to the State action. Federal agencies could conduct rapid response actions independent of the States on federally managed submerged lands and facilities.

The Plan provides specific types of treatment actions (Section 2.1.2, below) that may be implemented by the Corps or cooperating agencies/entities within the states of Idaho, Montana, Oregon, and Washington (the action area) and as described in state-specific rapid response plans (Draheim et al. 2013; DeBruyckere et al. 2014; State of Idaho 2017; State of Montana 2017).

The Corps has identified 4,174 boat access locations (based on available 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 9). The proposed action does not include treatment at dams, diversions, irrigation, or other water control structures as these sites are difficult to isolate and treat effectively.

The Plan includes the administrative action of federal cost share for treatment, but also includes the effects of rapid response actions. Those actions include detection area isolation, sample collection, site monitoring, site preparation, fish and wildlife salvage, mussel treatment, equipment sterilization, 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.

This section of the BA explains specific treatments, application rates, and associated activities that are reasonably certain to be replicated across the 4,174 sites and waterbodies any time dreissenids may be detected. Although it is unlikely rapid response actions will occur at all of the waterbodies identified, such actions could occur in any one of the waterbodies.

Identified sites are at risk of dreissenid invasion because each has public access with developed or identified watercraft access (boat ramp). A boat ramp site is any site recognized by a government agency with public launching access for transported watercraft. This could be a concrete or asphalt ramp with a dock, or a simple dirt or gravel launch. Habitat quality is typically highly degraded at these locations as a result of initial access construction, ongoing maintenance, and repeated disturbances from recreation activities. The habitat type and quality adjacent to the boat ramp sites can vary substantially across the CRB from areas that are urban and fully developed to areas that consist of high quality riparian forest and shrub-steppe.

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 are not certain to occur because the site of initial introduction or

detection cannot be predicted. Unpredictable sites requiring riparian access are referred to as “unidentified” sites in this Plan and would fit a programmatic framework Opinion where ESA consultation would occur on a site-specific basis.

2.1.1 Action Area

The action area encompasses 4,174 sites and associated waterbodies, riparian access routes (unidentified sites), and staging areas adjacent to locations where dreissenids are identified within the States of Idaho, Montana, Oregon, and Washington (Figures 9-10).

Exclusions: 1) The action area excludes saltwater habitats such as Puget Sound with a 100-foot upstream buffer around them; **2)** There are no proposed treatment sites within the (ESU) boundaries of ESA-listed Endangered Ozette Lake sockeye salmon.

2.1.2 Project Description

The existing dreissenid monitoring program, emphasis is placed upon monitoring high risk areas such as boat launches, and the states conduct water craft inspections.

The Plan includes the rapid response actions of site evaluation after 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 treatment types are proposed: 1) Chemical treatment (Endothall, EarthTec QZ, potash, Zequanox); 2) intense ultraviolet B radiation (UV-B); and 3) Ozone. These treatments are discussed in greater detail below, and may be used in combination with one another, depending upon the risk of infestation escaping the treatment area.

Treatment areas would be isolated for 45 days (or less) depending on which treatment is applied to maximize dreissenid exposure time and the site-specific risk. Isolated treatment areas would be 30 acres (ac) [12.1 hectares (ha)] or less to maintain treatment effectiveness, based on maximum treatment areas from literature in the Great Lakes Region. Multiple treatment areas could occur in the same waterbody, and retreatments made as appropriate (discussed below).

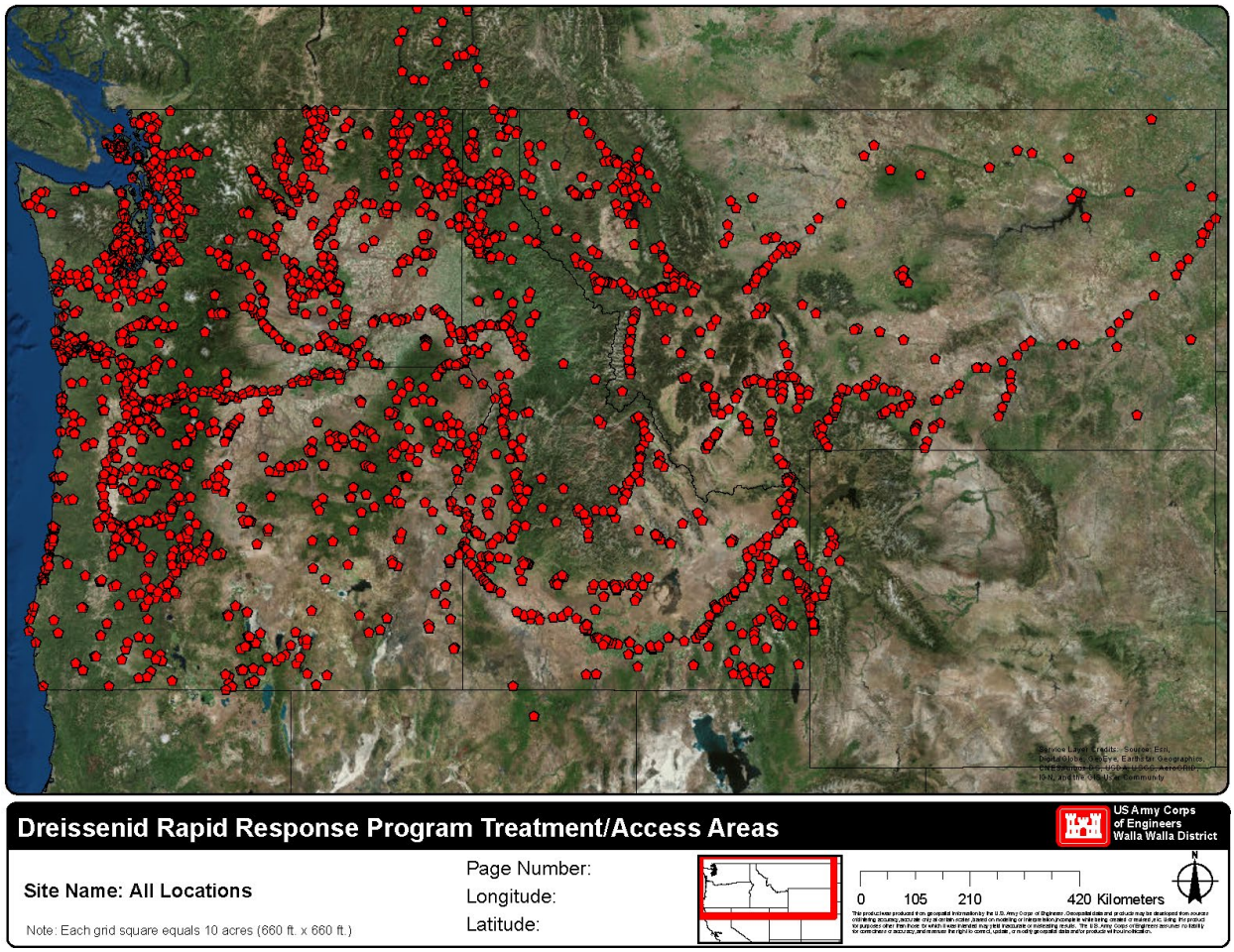

Figure 9. The action area showing all 4,174 sites included in the Plan. Sites that occur outside of Idaho, Montana, Oregon, or Washington are not included in the total number of sites or treatment under the Plan. The Corps has provided an online interactive map at: https://www.arcgis.com/home/webmap/viewer.html?webmap=c8d3d4489947430ea8f7d3066559981b&extent=-141.5086,22.8725,-86.7966,60.259.

Note: This is an imperfect dataset. Data were pulled from a number of public sources. Not all points intersect waterbodies or boat ramps perfectly. There may also be instances of duplicate or triplicate points.

To view species and critical habitat information for each site, select the “content” tab in the upper left corner of the page, select NatureServe Species by county or watershed, then zoom in and select a point on the map.

A box with the site information will pop up. On the top right of the box you will see an arrow for additional records. When at the last record, at the bottom of the box, select “show related records”. A table will appear at the bottom of the screen with associated species and critical habitat data.

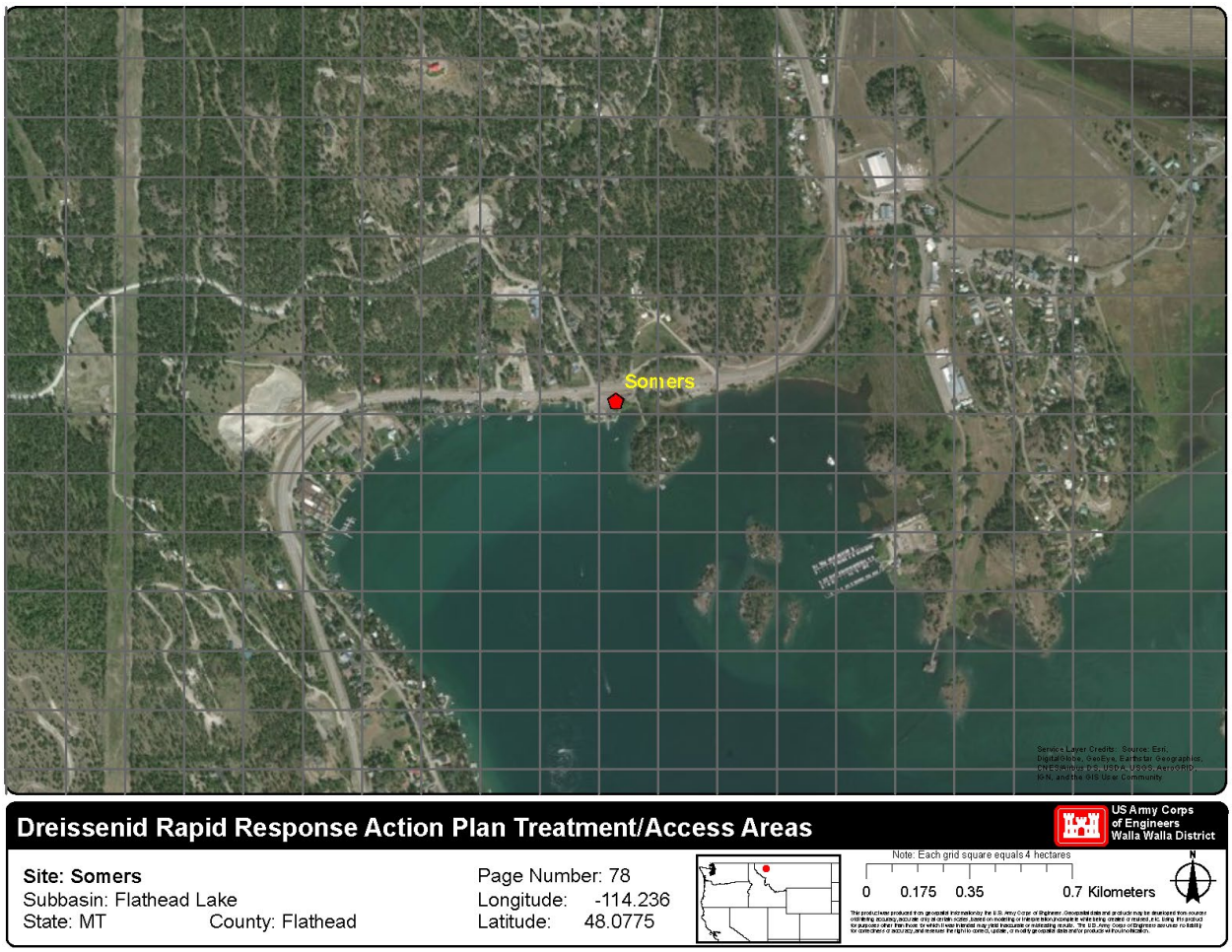

Figure 10. Example of a site-specific map. Grid lines represent 10 ac² (4 ha²). The treatment area may be at a boat ramp or an infested area nearby that can be access from the boat ramp. The Corps can provide map books for all identified sites upon request.

Because no established infestations of dreissenid mussels have been identified within the CRB 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, the Corps assumes that a maximum of 12 treatments of 30 ac (12.1 ha) would occur in a given year as the threat increases over time. We also assume that all of these treatments could occur in a single sub-basin (8 digit HUC) in a worst case scenario.

Conservation Measure:

Initial treatments within the ESU boundaries of ESA-listed Endangered fishes Upper Columbia River spring Chinook and Snake River Basin sockeye (222 sites) **would not include** EarthTec QZ or Endothall. Potash, Zequanox, ozone, and UV-B would be used as appropriate at each site. In the event that follow-up treatment with EarthTec QZ and/or Endothall is necessary, the Corps will develop site-specific conservation measures in cooperation with the Services and coordinate appropriately with the Services prior to treatment.

2.1.3 Project Activities

When there is evidence of dreissenid presence (regardless of life stage) anywhere in the action area, the extent of the invasion must first be determined, likely 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 can be identified during this process as well. Once the severity of invasion and access requirements are determined, rapid response can be initiated. The following steps are applicable to all treatments.

1. 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 (unidentified site), an access route that avoids and minimizes adverse environmental effects would be established.

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. Existing access would be used to the extent possible. If no access exists, a temporary access road a maximum of 12 feet (3 m) wide would be created. A Qualified botanist would identify and flag ESA-listed plant species to be avoided prior to vegetation removal. Wetland sites would be avoided to the fullest extent possible, unless a wetland with standing water had a positive detection. At water's edge,

vegetation may be removed to a maximum of 60 linear feet (18 m) of shoreline to allow adequate access for treatment equipment. The amount of vegetation would be minimized only to that necessary for adequate and safe access and treatment.

Wildlife and plant salvage would occur if the creation of a riparian access route became necessary and ESA-listed species are present. Trained biologists would conduct all appropriate surveys necessary to identify the abundance and distribution of ESA-listed taxa in the affected area. Where possible, all active 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 is 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 temporary barrier material (see below); 4)Treatment chemicals noted above.

Full site restoration would occur at a 1:1 ratio relative to disturbance. 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 may include:

- Chopping or cutting of woody vegetation via chainsaw, flail mower, hydro ax, or equivalent
- Mowing of herbaceous vegetation
- Temporary rock fill placement and removal

2. Treatment Area Isolation

Treatment site isolation by barrier is critical for two reasons. 1) 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. 2) 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.

A barrier must be able to significantly limit or eliminate water transfer from the treatment area to the main waterbody. Two specific methods that allow for rapid deployment are 1) an impervious silt curtain would be deployed via boat (e.g., commercial silt curtain or HDPE material anchored in place); or 2) inflatable bladder dams [e.g. PLUG (Portable Lightweight Ubiquitous Gasket) and Tiger (PVC-coated fabric) dams, HDPE liner material] would be deployed by hand. Site isolation would be 45 days per treatment, or less if risk assessment indicates the threat is eliminated. More discussion is provided below in the post-treatment monitoring section.

Silt curtain (Figure 11) deployment involves a curtain being secured to shore, stretched around the treatment area via boat, then secured to shore on the other end, or the boat can deploy the curtain in a circular fashion around a treatment area with no terrestrial attachment. Individual silt curtains can be up to 100 ft (30.5 m) in length, with a skirt of the same depth. Curtains can be fastened together to extend as far as necessary. The skirts have a bottom weight, and can be anchored to the substrate with sand bags.

In shallow water conditions, bladder dams (Figure 12) can be laid across the substrate and pumped full of water to effectively block connectivity. This isolation method will be depth-limited.

An ozone bubble curtain would be deployed just outside of the isolation barrier to deliver ozone during fish salvage and mussel treatment. Ozone is effective for killing dreissenid veligers and pelagic juveniles, and a bubble curtain as an additional protective measure would improve the likelihood of containment while activity is occurring within the isolated area. Ozone is discussed further in the treatment section below.

Figure 11. Example of a deployed silt curtain.

Figure 12. Example of a deployed inflatable bladder dam.

Methods for isolation barrier deployment may include:

- Silt Curtain
    - Anchoring to shoreline substrate via concrete blocks or sandbags.
    - Attaching to shoreline woody vegetation via ropes or cables.
    - Stretching the skirt around the treatment area via boat.
    - The skirt would be lowered and sandbag anchors placed once the curtain has been appropriately stretched. This would include dropping the weighted skirt by untying or cutting binding, and attaching and lowering sandbags into place.
    - Removal would work in the opposite fashion.
- Bladder dams
    - Bladder dams would be unrolled and hand-carried into place.
    - The bladders would be filled via water pumped into the bladder.
        - Any pump intake would be required to draw as specified by NMFS (2001) to protect juvenile fishes 0.7-1.2 inches [in (20-30 millimeters (mm))].
    - Removal would be the opposite actions. If water were used from the waterbody being treated, the bladder water would receive treatment before being discharged.
    - Bladder dam sealing may be facilitated by other methods, such as geotextile fabric filled with sandbags, native rock or other appropriate material.

- Additional methods of site isolation would include a combination of sandbags, PVC coated fabric curtains and eco-blocks, if local topography and substrate are too complex for curtains or bladders to be effective at isolating the treatment area.

3. Fish salvage

Electrofishing would be employed as a fish salvage technique before treatment. The guidelines and protocols identified in Reynolds (1996) and NMFS (2000) would be implemented during fish salvage. We assume it is possible to achieve up to 60% capture efficiency in depths shallower than approximately 8 feet (2.4 m). Capture efficiency would decrease substantially with deeper depths and increasing isolation area size.

Salvage efforts would focus on ESA-listed species, but non-listed species may be salvaged during the effort. Sites within the known distribution of ESA-listed gastropods may require additional consultation at time of treatment mobilization to allow for conservation measures minimizing impacts to these species to be developed and implemented. Gastropods are not proposed to be salvaged.

Fish salvage methods may include:

- Boat or backpack electrofisher calibrated to the specific onsite water conditions (i.e., conductivity).
- At least one team of three people would wade or operate a boat throughout the treatment area netting fish and placing them in containers of fresh water with air supply until no fish are captured for a period of 5-10 minutes. Number of teams and total collection effort would depend on size of the treatment area.
- Fish would be transferred to a separate holding tank with uncontaminated water calibrated to the ambient treatment area water temperature with oxygen supply.
- A clean water flush calibrated to the ambient treatment area temperature would completely replace the tank volume prior to fish release outside of the treatment area.
- A separate crew with sanitary equipment would conduct the fish transfer via nets and smaller containers adjacent to the treatment area.
- All equipment used during salvage would be sterilized onsite using the same methods as equipment sterilization (discussed below).

4. Treatment

- Chemical applications: Chemical solutions (Endothall, EarthTec QZ, potash, Zequanox) would be mixed on shore prior to application. All applications would follow established MSDS/label restrictions (See dose rates in Section 2.1.4 below). 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 (discussed in Section 2.2.4).

- UV-B: UV-B would be applied via boat using submerged UV-B-emitting light panels (Figure 13). 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 would also be used as a veliger treatment before or during application of other methods targeting adults.
- Ozone: Ozone can be applied through a bubbler system like those used as a 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 would also be used as part of site containment and as a veliger treatment before or during application of other methods targeting adults.
    - This method would be restricted to 1.2 ac (0.5 ha) or smaller treatment areas due to the rapid dissipation of ozone in water.

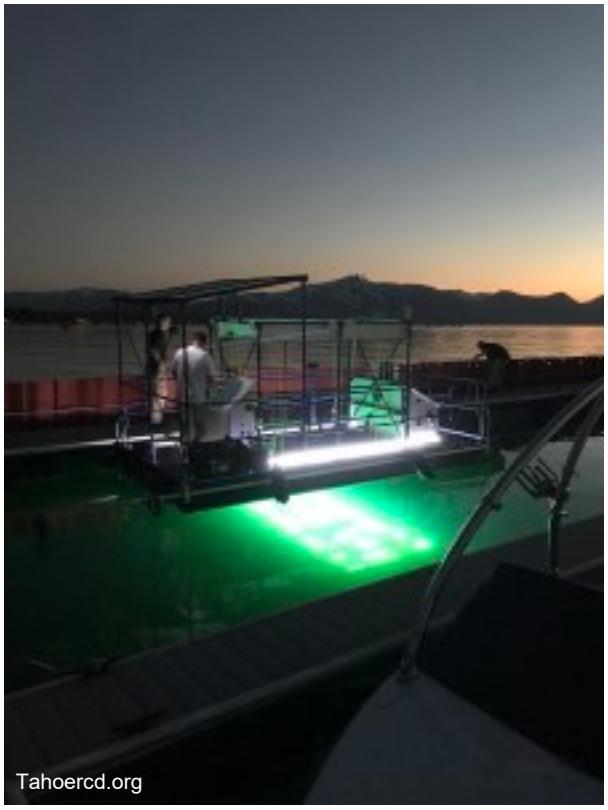

Figure 13. Example of UV-B application via boat.

5. Post-treatment monitoring

Post-treatment monitoring would be required to ensure the efficacy of rapid response treatments. Post-treatment monitoring would begin within the 45-day isolation and treatment period. Water chemistry analysis would be required weekly to evaluate all relevant water chemistry and toxin levels within the treatment area. Monthly monitoring would be conducted for veligers via water sample collection and microscopy, settlement plate placement checks. Further, watercraft inspection, shoreline surveys, and additional snorkeling or SCUBA for veligers and adults at two, four, and six months post-treatment would occur.

Snorkeling and SCUBA monitoring would require personnel to collect physical and observational samples in-water. The presence of a human in-water coinciding with ESA-listed species would disturb the species, but water samples, mussel collection, or substrate samples would not damage critical habitat. Other water quality and settlement plate samples would be collected from shore or boat. Settlement plates are typically anchored to a structure like a boat dock for ease of access, or placed nearby as these areas are likely dreissenid introduction sites.

If monitoring results indicate both mussel eradication and chemical toxin levels are below the Lowest Observed Effect Concentration (LOEC) for non-target species (i.e. ESA-listed aquatic species) isolation barriers would be removed. Rainbow trout LOEC would be the surrogate for salmonids, who are generally more sensitive to toxins. If additional treatments are required, the isolation barrier would remain in place until dreissenids have been eradicated, or the maximum number of treatments have been implemented in a 12-month period.

6. Re-treatment

Up to four treatments may be made in one year in a single treatment area (as described in the EarthTec QZ label), based on the effectiveness of the treatments as determined from the monitoring described above. Multiple (separate) treatment areas could occur within the same body of water at a given time as constrained by the product label on the proportion of total water volume that may be treated in a single event.

7. Restoration

Any riparian habitat destroyed or disturbed in the development of an access corridor would be restored with appropriate native species upon completion of treatment. Plant species for restoration would utilize state botanist recommendations.

Restoration methods may include:

- Mowing the site for ease of planting and to reduce initial plant competition during establishment.
- Planting to include hand tools, a power auger, or equipment mounted hydraulic auger or stinger (Figure 14).

- Installing weed matting or plant protection material to keep competition down while plants establish, and keep any loose sediment in place.
- Seeding, either via top seeding or seed drill depending upon herbaceous species and site characteristics.
    - Seed native grasses, forbs, and pollinator species as available.
- Monitoring plant establishment with adaptive management to ensure appropriate plant survival of 80% at 24 months.

Figure 14. Example of a “stinger” attached to a track-hoe boom opening holes for willow whips.

8. Sediment Containment

A 3.3 ft (1 m) buffer of herbaceous vegetation would be left between the shoreline and upland plantings to prevent potential sediment runoff. Other sediment containment measures would be used as necessary (presented in Section 2.1.6).

Silt fence or weed-free straw would be used to contain runoff, if soil disturbance is immediately adjacent to water or erodible soils are exposed.

9. Equipment Sterilization

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.

2.1.4 Treatment Dose Rates

The below sections describe dose rates for each specific proposed treatment. Table 2 summarizes the dose rates and application time required to achieve desired effectiveness.

Table 2. 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	50 – 100 mJ/cm²	5 days
Ozone	0.5 mg/L	7 days
Rhodamine WT Dye	0.01 mg/L	53.9 hours (half-life)

Endothall

Endothall would be applied at a rate of 0.3-5 mg/L for up to 6 days per treatment (Table 2). At this rate we would expect effective treatment for all dreissenid life stages. Endothall is toxic to fish, but rapidly degrades causing no long-term environmental accumulation. 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 (WDNR 2012).

EarthTec QZ

EarthTec QZ is a copper sulfate pentahydrate compound of 19% active ingredient per volume. It would be applied at a rate of up to 2 mg/L, not to exceed 0.1 mg/L total copper (Table 2). Concentrations may be held constant up to 30 days (depending on dose) to achieve effective treatment for all dreissenid life stages. EarthTec QZ copper is highly water soluble and does not precipitate out. The product will remain suspended until bacteria and algae take it up (Master Label for EarthTec, EPA Reg. No. 64962-1). It is anticipated that dispersion into the waterbody would quickly reduce concentrations to below effect levels outside of the isolated treatment area, but would be partially dependent on water exchange rate at each site.

Potash

Potassium compounds [potash (KCL, KH2PO4, KOH)] would be applied at rates 10-640mg/L depending upon which compound was used (Table 2). Concentrations may be held constant up to 21 days to achieve effective treatment for all dreissenid life stages.

Zequanox

Zequanox would be maintained at a rate of 100 mg/L (Table 2) for up to 8 hours for noticeable effects within 3-21 days. Two repeat treatments are expected. The label recommends no more than 4 treatments annually.

UV-B

Ultraviolet treatments would be applied at rates between 50 – 100 milliJoules per centimeter squared [mJ/cm² (Table 2)]. Treatment would require continuous UV-B application for up to 120 hours and would only be partially effective on juvenile dreissenids.

Ozone

Ozone would be applied through a bubbler system at 0.5 mg/L for up to 7 days (Table 2) to achieve effective treatment for all dreissenid life stages. 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. (Summerfelt 2002; Duran et al. 2010).

Rhodamine WT Dye

Rhodamine WT dye would be applied at a rate of 0.01 mg/L (Table 2) 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.

2.1.5 Project Timeline

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

Mussel detection is most likely occur during the warmer months (approximately April through October), correlating with water recreation and mussel growth and activity. Therefore, **treatments would also occur April through October**.

Any riparian access site restoration would occur after the final treatment. Plant restoration would occur from October through March, depending upon weather conditions.

2.1.6 Conservation Measures

Best Management Practices (incorporating from USFWS and PSMFC 2018)

1. Upon mussel detection, consult waterbody type treatment considerations described in USFWS and PSMFC (2018).
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 and would comply with product label restrictions. 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 visually identifying 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, or equivalent measure would be used when fueling equipment and motor vehicles.
    a. Store, fuel, and maintain vehicles more than 150 ft (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 (94.6 Liters) of hydrocarbons (oils, coolants, solvents). Spill absorbent mats would be carried on board boats and be in the immediate vicinity of all vehicles and equipment performing work.
8. Any water pumping actions would follow the guidelines provided by NMFS (2001).
9. Check equipment for leaks daily. If equipment leaks or drips occur, they shall be cleaned up immediately.
10. Drip pans shall be utilized when equipment is parked.

11. 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. Oregon Department of Environmental Quality Hotline 888-997-7888.
    d. Waste materials will be disposed of in an appropriate manner consistent with applicable local, state, and federal regulations.
    e. Materials will not be stored where wave action or upland runoff can cause materials to enter surface waters.
12. 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.
13. Use existing roadways and paths, if possible, and minimize number and length of temporary roads and paths through riparian/floodplains.
14. Gravel/rock fill for riparian access road or staging area would not be permitted to enter the water and would be removed upon the conclusion of treatments.
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, or other chemicals or toxic or deleterious materials aside from those proposed for dreissenid

treatment 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 any 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. The proposed treatment methods are the most environmentally friendly relative to other available methods.

2. Corps and states are implementing dreissenid monitoring programs consistent with that outlined by Elwell and Phillips (2016).

3. Initial treatments within the Evolutionarily Significant Unit (ESU) boundaries of ESA-listed Endangered fishes Upper Columbia spring Chinook, Ozette Lake Sockeye, and Snake River Basin Sockeye **would only use Potash, Zequanox, ozone, and UV-B**. In the event that follow-up treatment with EarthTec QZ and/or

Endothall is necessary, the Corps will develop site-specific conservation measures and coordinate appropriately with the Services prior to treatment.

4. ESA consultation would be conducted on a site-specific basis for unidentified sites. The Services would be consulted with prior to treatment at unidentified sites to develop conservation measures for affected species and critical habitats.
5. Unidentified sites needing riparian access development would be sited in the least environmentally damaging location practicable.
6. A qualified botanist would identify ESA-listed plant species and flag them for avoidance prior to riparian access development.
7. No more than 60 linear feet (18 m) of shoreline vegetation would be disturbed during riparian access development.
8. Riparian access roads would be a maximum of 12 feet (3.6 m) wide.
9. Fish and wildlife salvage (removal) would be conducted by trained biologists prior to riparian access treatment.
    a. The guidelines and protocols identified in Reynolds (1996) and NMFS (2000) will be implemented during fish salvage.
10. Nesting surveys for bald and golden eagle and migratory birds would be conducted by trained biologists following Corps protocols prior to riparian access development if work is needed in the nesting season. Active 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 in the 2007 National Bald Eagle Management Guidelines for eagle nesting.
11. Wetlands will be avoided during access route development. Unavoidable temporary impacts will be minimized and sites restored.
12. Removal of mature riparian trees will be avoided during access route development.

Restoration

1. All temporary roads and paths will be obliterated upon project completion.
2. 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.
3. Restoration activities would employ the above measures as applicable.

2.2 Consultation Request

The Corps requests formal, programmatic (framework) consultation of both Services on implementation of the Dreissenid Rapid Response Plan (Plan). The Plan represents a comprehensive, congressionally directed, program to identify/detect, isolate and eradicate dreissenid infestations in the CRB, generally under a cost-share agreement with the states of Washington, Oregon, Idaho, and Montana. The Plan focuses on 4,174 specific water related sites identified for anticipated and repeatable dreissenid rapid response treatment actions, but the Plan would apply to any water related site in the action area where dreissenids are identified or become established, as well as other listed species in those areas (e.g., the Ozette Lake sockeye ESU).

The ESA, implementing regulations (50 C.F.R. Part 402) and the ESA Section 7 Consultation Handbook (Handbook) all support the type of programmatic (framework) consultation being requested by the Corps. 50 C.F.R. §402.14(i)(2)(6) states:

> For a framework programmatic action, an incidental take statement is not required at the programmatic level; any incidental take resulting from any action subsequently authorized, funded, or carried out under the program will be addressed in subsequent section 7 consultation, as appropriate. For a mixed programmatic action, an incidental take statement is required at the programmatic level only for those program actions that are reasonably certain to cause take and are not subject to further section 7 consultation.

See, 50 C.F.R. §402.2 for definitions of framework and mixed programmatic actions. Also, the Handbook states:

> In programmatic . . . consultations, which evaluate planning documents or broad programs . . . the best available scientific data may not support the determination of any anticipated level of incidental take. In such instances, the incidental take statement should indicate that, based on the best available data, no incidental take is anticipated and that the issue will be reexamined during the consultation process for site-specific actions under the umbrella of the larger planning document. (See, p. 4-50).

See also Sections 5.1 and 5.5 of the Handbook. Finally, the Services are proposing revisions to the Joint Section 7 consultation regulations. The Services are proposing to add a definition of ‘‘programmatic consultation” (§ 402.14(c)(4)). That definition will explain that programmatic consultations can involve (1) multiple similar actions, or (2) a proposed federal program, plan or policy "providing a framework for future actions." Future consultations associated with the programmatic "framework" consultation will be referred to as a ‘‘step-down’’ or ‘‘tiered consultation.’’ Finally, the Notice states, "The Services encourage Federal agencies to coordinate with us in order to determine what programmatic approach would be applicable and streamline the consultation process for

their program or suite of actions." See, *Federal Register*, Vol. 83, No. 143, 35178-35193 (July 25, 2018)

The Corps does not anticipate the programmatic (framework) Opinions for rapid response actions would include an incidental take statement (ITS), unless NMFS or USFWS determine there are “mixed” components included in the consultation that may support an ITS. Absent an ITS, the Corps requests the Opinions adopt the Corps proposed “urgent” (emergency-like) consultation procedures for site-specific rapid response actions under the Plan. Such urgent rapid response action (URRAs) consultations will be tiered to the programmatic (framework) Opinions. Additionally, the Corps requests the Opinions establish general best management practices (BMPs) and potential conservation measures that can be quickly incorporated into proposed site-specific URRA consultations to allow for issuance of site-specific Opinions with ITSs in a timely manner, preferably before action must be taken and without the need to resort to formal emergency consultation procedures.

The Corps proposes the following URRA consultation procedures:

1. Site-specific information forms (Incidental Take Statement Request Form, hereafter the Form) would be submitted by the Corps to the Services prior to treatment. The Forms would be submitted within 3 days of reported detection to the Corps. The proposed Form (see Appendix C example) would include a brief description of the following requirements for ESA consultation (per the Consultation Handbook):
    a. a description of the action being considered;
        i. Including any access development, treatment area isolation actions, the specific treatment selected for this site, monitoring to be conducted, any mitigation to be completed in addition to conservation measures in the BA.
    b. a description of the specific area that may be affected by the action;
        i. Including area specific location, treatment area size, other geographic descriptors, such as water depth may be included if pertinent and known.
    c. a description of any listed species or critical habitat that may be affected by the action;
        i. Which is likely to refer to the BA and not reiterate species information in detail.
    d. a description of the manner in which the action may affect any listed species or critical habitat, and an analysis of any cumulative effects;

        i. Which is likely to refer the BA and not reiterate species information in detail.

    e. relevant reports, including any environmental impact statements, environmental assessments, biological assessment or other analyses prepared on the proposal;

        i. The Form will reference this BA and the associated EA/FONSI, as well as any new reference information developed over time, such as dreissenid risk assessments or monitoring reports.

    f. any other relevant studies or other information available on the action, the affected listed species, or critical habitat.

        i. Including any new relevant scientific information the Corps is aware of.

2. The Services agree to form review and issuance of an ITS with conservation measures within 3 calendar days of receipt of the Form from the Corps.

3. The Corps would implement our proposed conservation measures and reporting requirements, as well as conservation measures accompanying the issuance of an ITS and any applicable conservation measures from the Opinion.

The follow on consultation would be completed through the Incidental Take Statement Request Form (Appendix C), or a similar form developed collaboratively with the Services, which would provide the site-specific details of the treatment needed when an infestation is identified.

Upon detection of dreissenid mussels, the Corps will treat the detection as “urgent”, acting as quickly as possible to treat or initiate cost-share for treatment. The Corps assumes treatment will occur within 5-14 calendar days of a detection. Therefore, the Corps will act with or without an Opinion or ITS in hand, but not before providing the Services the site-specific Incidental Take request Form and consultation request.

3 Listed Species

3.1 Species Listed in the Action Area

The Corps reviewed the list of threatened and endangered species that pertain to the action area under the jurisdiction of NMFS and USFWS on 12 March, 2018, from 13 offices within the four-state area. Upon further review of species lists, 11 were retained as relevant to the action area. Reference numbers for the 11 relevant USFWS offices and species list are provided in Table 3, while ESA proposed, threatened, and endangered species are listed in Table 4, including those under the jurisdiction of NMFS. There are 51 species considered under the jurisdiction of the USFWS, and 5 species of salmon and steelhead under the jurisdiction of NMFS considered in this BA.

Table 3. USFWS offices and associated consultation codes for species lists relevant to this BA.

USFWS Office	Consultation Code
California – Arcata	08EACT00-2018-SLI-0155
California – Yreka	08EYRE00-2018-SLI-0092
Idaho - Boise	01EIFW00-2018-SLI-0733
Montana – Helena	06E11000-2018-SLI-0277
Nevada – Reno	08ENVD00-2018-SLI-0329
North Dakota – Bismarck	06E15000-2018-SLI-0163
Oregon – Klamath Falls	08EKLA00-2018-SLI-0040
Oregon – Portland	01EOFW00-2018-SLI-0280
Utah – West Valley City	06E23000-2018-SLI-0233
Washington – Lacey	01EWFW00-2018-SLI-0771
Wyoming – Cheyenne	06E13000-2018-SLI-0147

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

Mammals			
Common	**Scientific Name**	**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
Southern Resident Killer Whale	*Orcinus orca*	E	Final
Tenino Pocket Gopher	*Thomomys mazama tumuli*	T	Final
Woodland Caribou	*Rangifer tarandus caribou*	E	Final
Yelm Pocket Gopher	*Thomomys mazama yelmensis*	T	Final

Fish			
Common	**Scientific Name**	**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

Fish Continued			
Common	**Scientific Name**	**Status**	**Critical Habitat**
Eulachon	*Thaleichthys pacificus*	T	Final
Foskett Speckled Dace	*Rhinichthys osculus ssp.*	T	NA
Green Sturgeon	*Acipenser medirostris*	T	Final
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

Birds			
Common	**Scientific Name**	**Status**	**Critical Habitat**
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

Gastropods			
Common	**Scientific Name**	**Status**	**Critical Habitat**
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			
Common	**Scientific Name**	**Status**	**Critical Habitat**
Oregon Spotted Frog	*Rana pretiosa*	T	Final

Insects			
Common	**Scientific Name**	**Status**	**Critical Habitat**
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
Western Glacier Stonefly	*Zapada glacier*	PT	NA

Plants			
Common	**Scientific Name**	**Status**	**Critical Habitat**
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
Water Howellia	*Howellia aquatilis*	T	NA
Western Lily	*Lilium occidentale*	E	NA
Whitebark Pine	*Pinus albicaulis*	C	NA

3.2 NMFS Species and Critical Habitat Status

3.2.1 Chinook Salmon

The proposed action area contains six evolutionarily significant units (ESU) of Chinook salmon – Snake River spring/summer-run Chinook, Snake River fall-run Chinook, Upper Columbia River spring-run Chinook, Upper Willamette Chinook, Lower Columbia River Chinook, and Puget Sound Chinook.

Listing History

The Snake River spring/summer-run Chinook salmon ESU was listed as Threatened in 1992 (61 FR 56138). The Snake River fall-run Chinook salmon ESU was listed as Threatened in 1992 (57 CFR 34639). The Upper Columbia River spring-run Chinook salmon ESU was listed as Endangered in 1999 (64 FR 14308). The Upper Willamette Chinook salmon ESU was listed as Threatened in 1999 (64 FR 14308). The Lower Columbia River Chinook salmon ESU was listed as Threatened in 1999 (64 FR 14308). The Puget Sound Chinook salmon ESU was listed as Threatened in 1999 (64 FR 14308). All listings were reaffirmed in 2005 and 2014.

Life History and Biological Requirements

Chinook salmon historically ranged in North America from the San Joaquin River, California to Kotzebue Sound, Alaska. They typically spawn in large to medium rivers in coastal and inland locations. Chinook salmon hatch the largest fry of any salmon at emergence, and display two patterns as juveniles. Ocean-type Chinook salmon outmigrate immediately after emergence or after a few months in river and then reside in estuaries for a few weeks or more. Stream-type Chinook salmon rear in their natal river for a full year, and upon migration to the sea, rapidly exit the estuary. Ocean-type Chinook are found exclusively south of 56° North Latitude and spawn in lower reaches of rivers. Where they overlap, stream-type Chinook are found further inland. In the ocean, Chinook salmon feed for from one to five years, though two to four years is most common. Chinook salmon display multiple run types, with Spring-run Chinook entering

freshwater in late spring and sexually maturing in freshwater, while Fall-run Chinook salmon enter freshwater later in the year in an advanced state of maturity. Run type typically co-varies with juvenile type and length of spawning migration. Fall-run Chinook spawn in lower stream reaches and coastal rivers and frequently produce ocean-type juveniles, where spring and summer-run Chinook salmon spawn further inland and usually produce stream-type juveniles. All Chinook salmon spawn in the fall on a declining temperature cycle (Quinn 2005).

Distribution and Critical Habitat

Critical Habitat was designated for the six ESUs as follows.

- Snake River spring/summer-run Chinook: October 25, 1999
- Snake River fall-run Chinook: December 28, 1993
- Upper Columbia River spring-run Chinook: September 2, 2005
- Upper Willamette Chinook: September 2, 2005
- Lower Columbia River Chinook: September 2, 2005
- Puget Sound Chinook: September 2, 2005

The Snake River spring/summer-run Chinook salmon ESU includes all natural-origin populations in the Tucannon, Grande Ronde, Imnaha, Salmon, and mainstem Snake Rivers (Figure 15). Fish returning to fifteen hatchery programs are also listed, including those returning to the Tucannon River, Imnaha, and Grande Ronde River hatcheries and to the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River (NMFS 2016a).

The Snake River fall Chinook salmon ESU includes all natural-origin fall-run Chinook salmon from the mainstem Snake River below Hells Canyon Dam, and fall-run salmon from the Tucannon, Imnaha, Grande Ronde, Salmon, and Clearwater Rivers [NMFS 2016a (Figure 16)].

The Upper Columbia River spring-run Chinook ESU includes all natural-origin, stream-type Chinook salmon originating from Columbia River tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam, excluding the Okanogan River subbasin (Figure 17). Six artificial supplementation programs also contribute to the Upper Columbia River spring-run Chinook salmon ESU: the Twisp River Program; Chewuch River Program; Methow Program; Winthrop National Fish Hatchery Program; Chiwawa River Program; and the White River (NMFS 2016b).

The Upper Willamette River Chinook salmon ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls (Figure 18). Six artificial propagation programs also contribute to the ESU: the McKenzie River Hatchery; Marion Forks Hatchery/North Fork Santiam River Program; South Santiam Hatchery Program; Willamette Hatchery Program; and the Clackamas Hatchery Program (NMFS 2016c).

The Lower Columbia River Chinook salmon ESU includes all naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of a transitional point east of the Hood and White Salmon Rivers, and any such fish originating from the Willamette River and its tributaries below Willamette Falls [NMFS 2016d (Figure 19)].

The Puget Sound Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. Twenty-six artificial propagation programs also contribute to this ESU [NMFS 2016e (Figure 20)].

Table 5 presents the physical and biological features (PBF) of anadromous salmonid critical habitat.

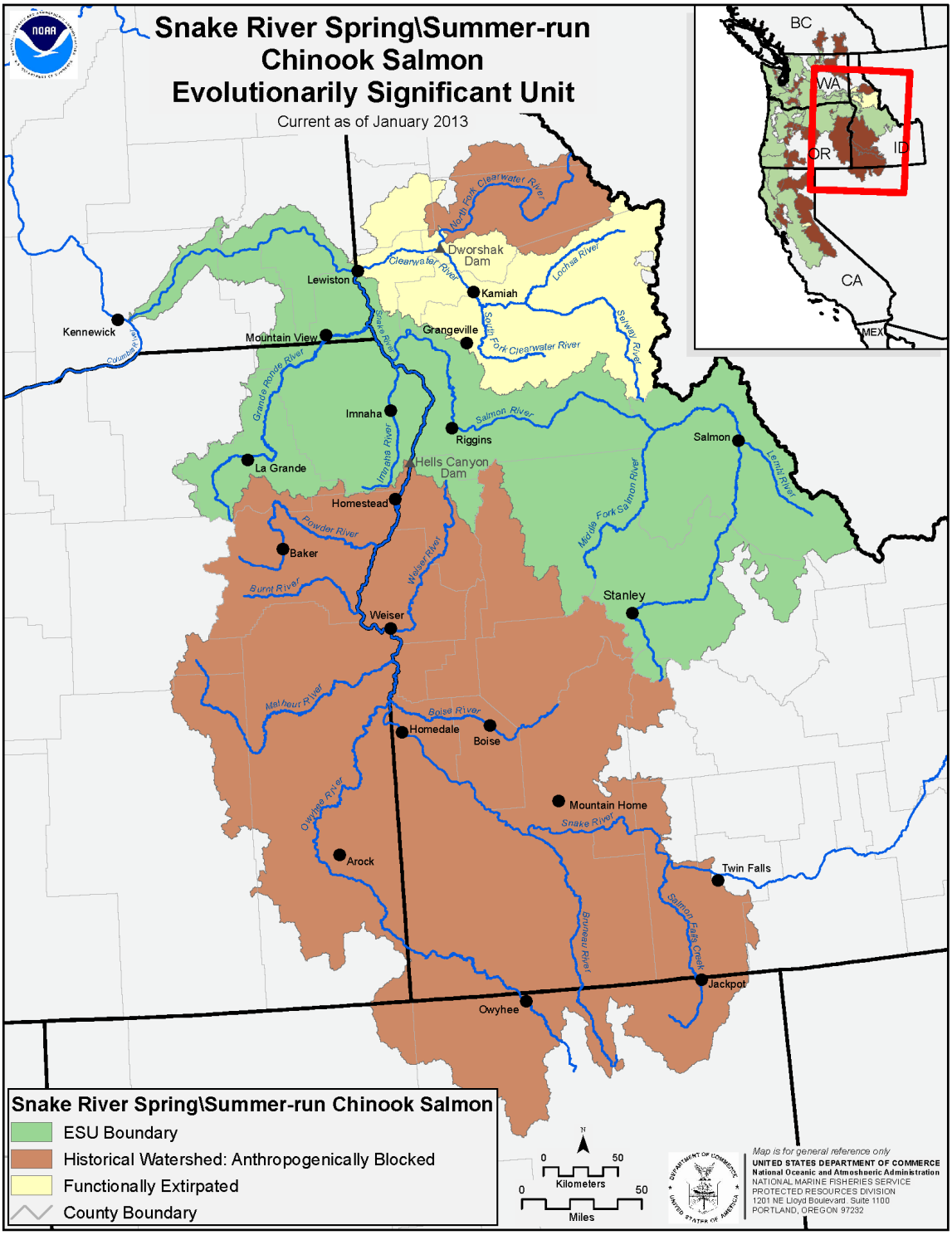

Figure 15. Snake River spring/summer run Chinook salmon ESU.

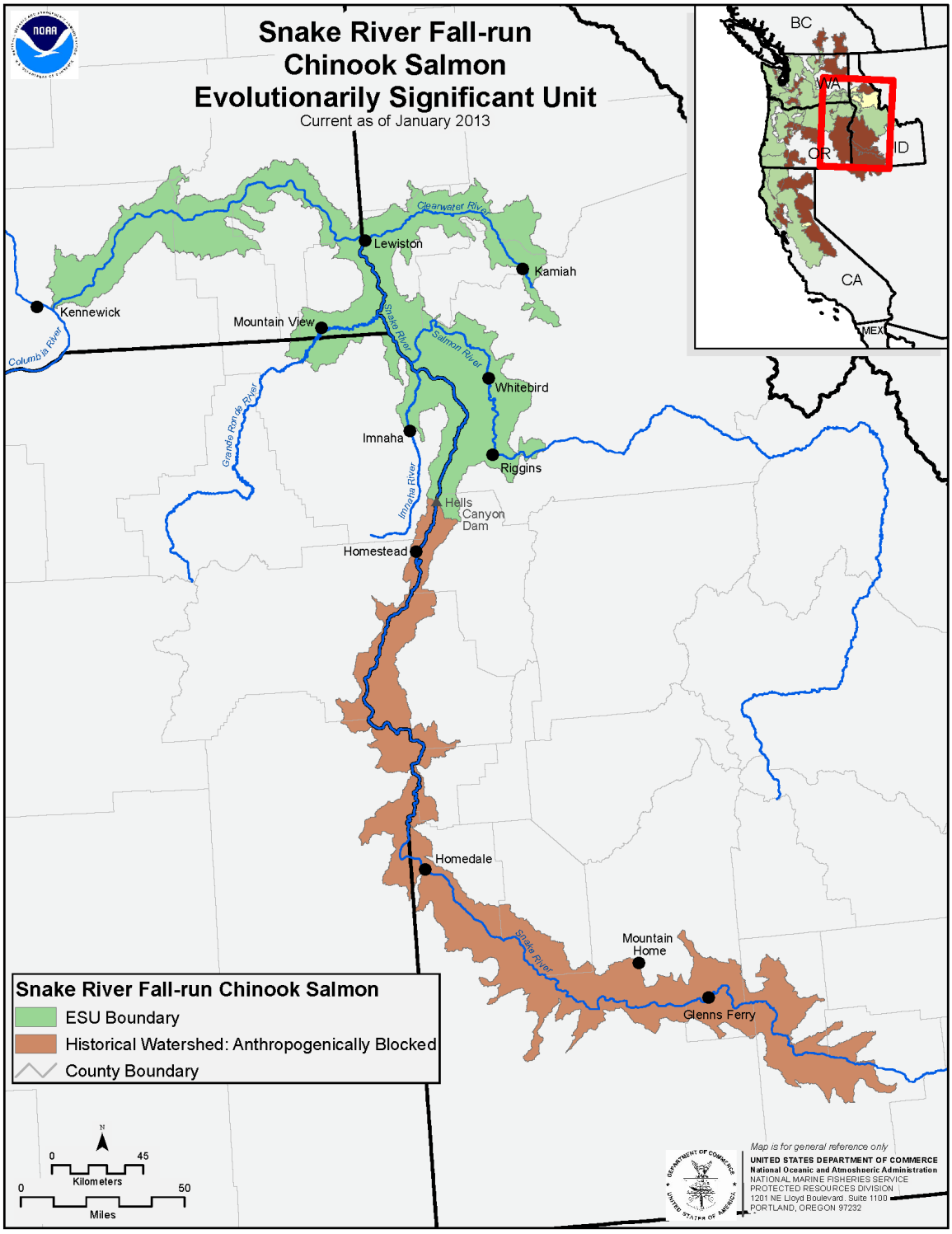

Figure 16. Snake River fall run Chinook salmon ESU.

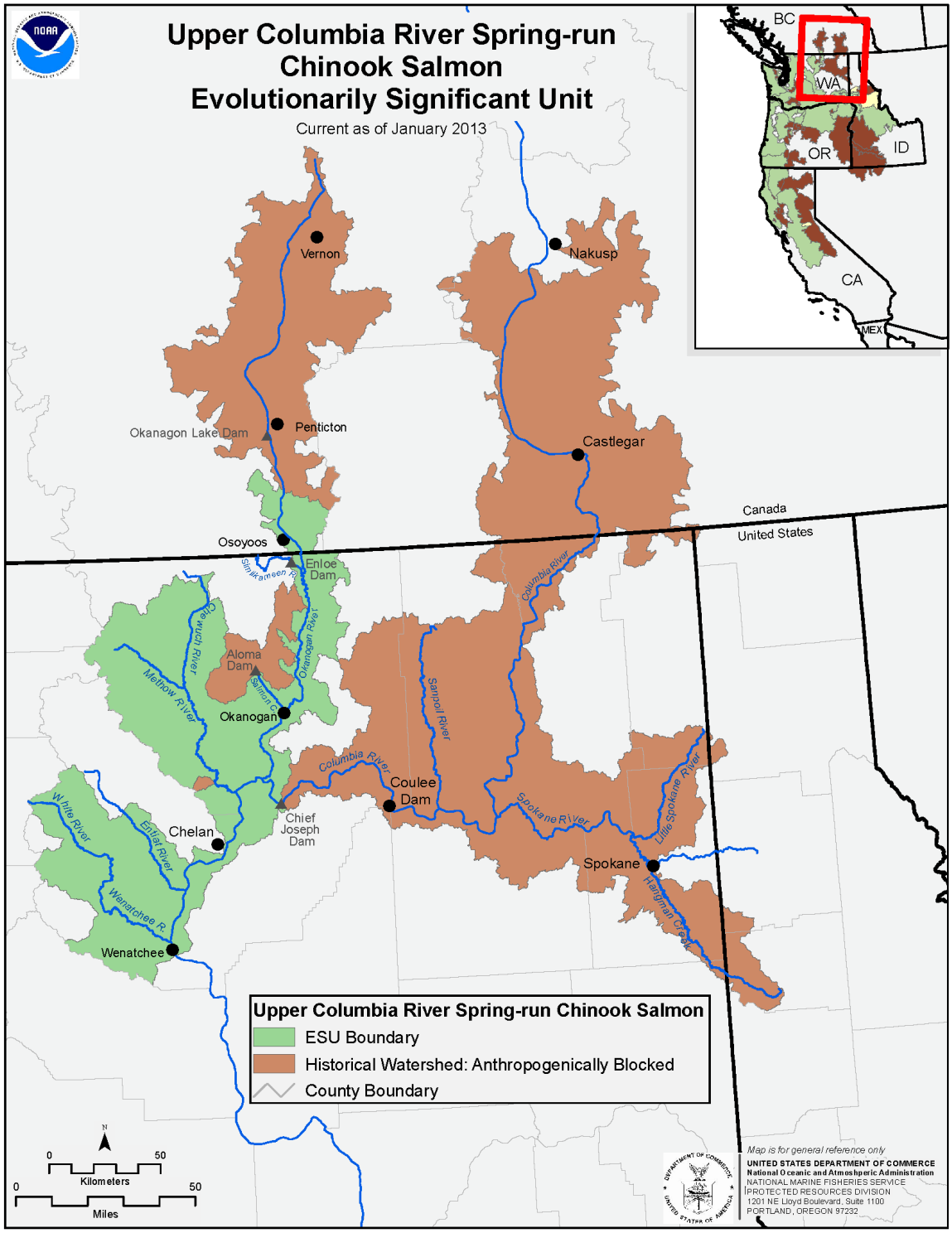

Figure 17. Upper Columbia River spring run Chinook salmon ESU. As a conservation measure, EarthTec QZ and Endothall would not be applied as an initial treatment within the boundaries of this ESU. Further consultation with NMFS is required prior to applying these two treatments.

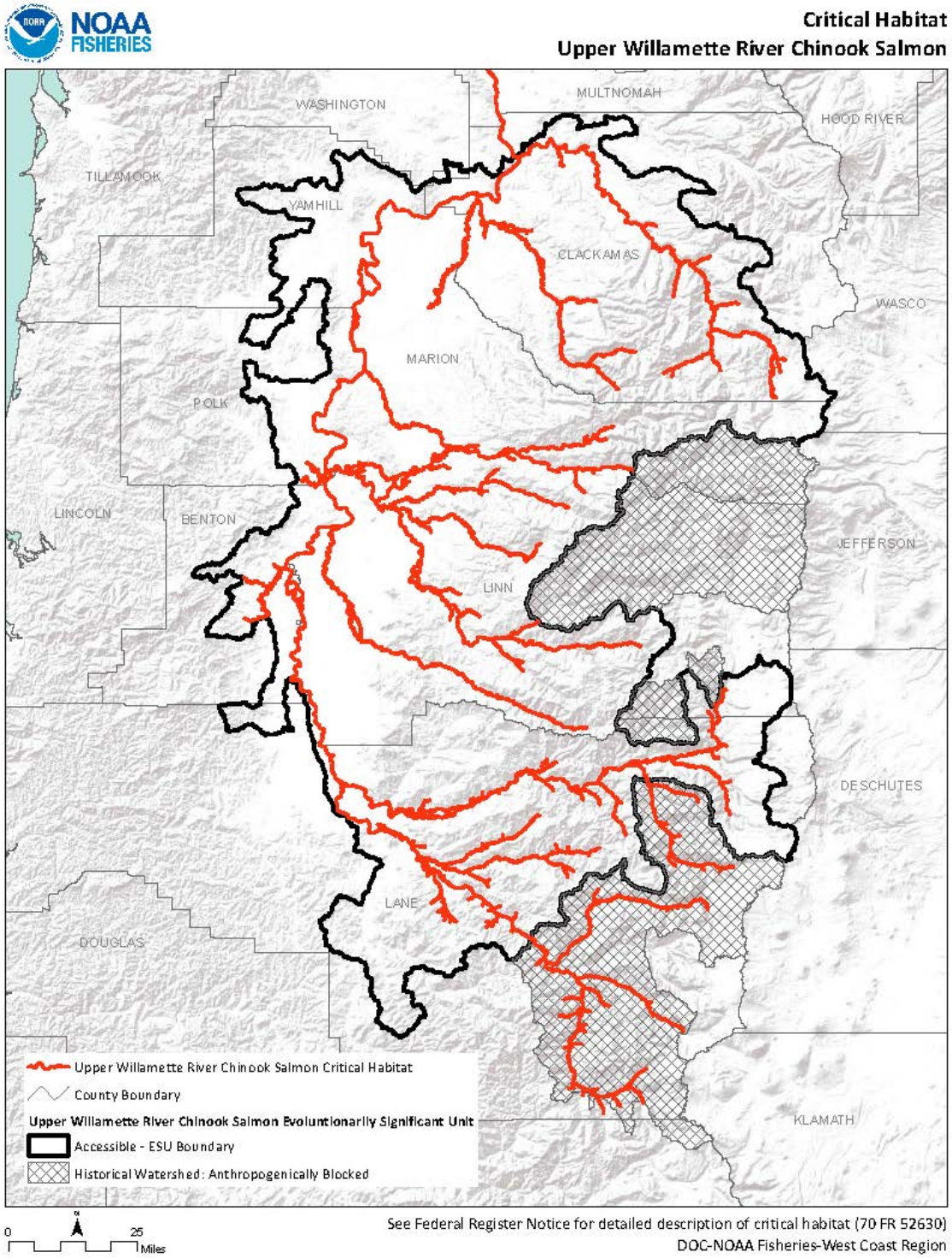

Figure 18. Upper Willamette River Chinook salmon critical habitat.

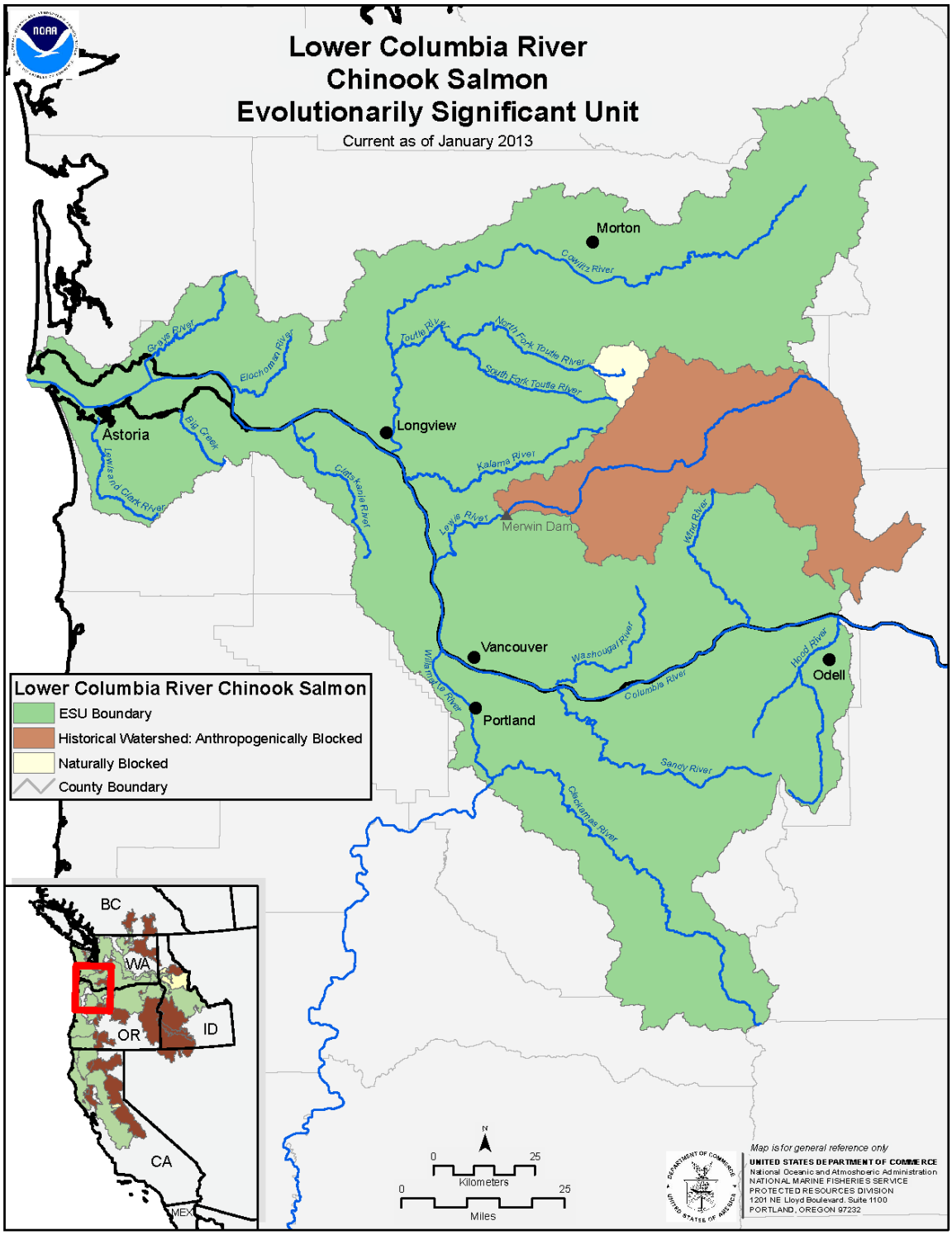

Figure 19. Lower Columbia River Chinook salmon ESU.

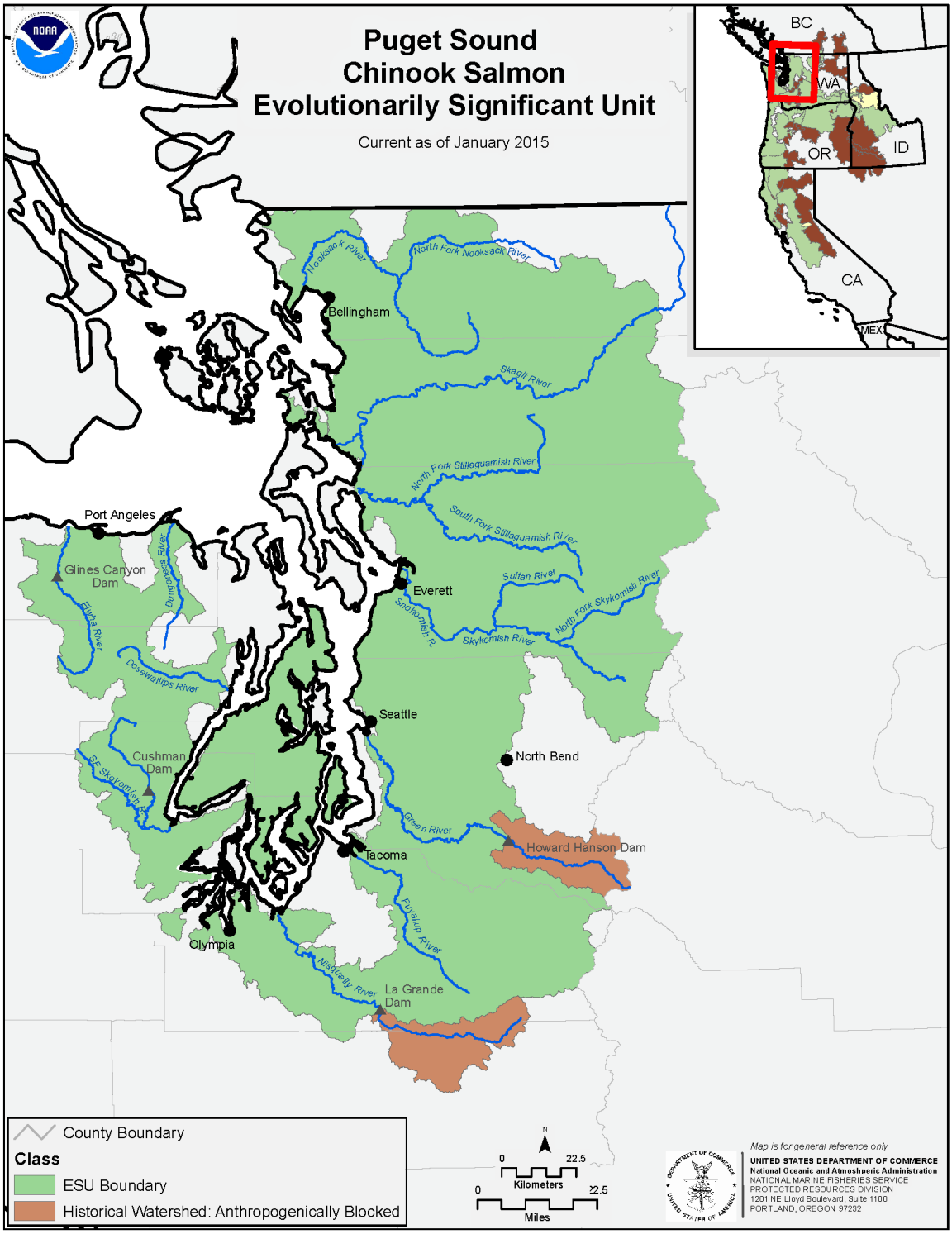

Figure 20. Puget Sound Chinook salmon ESU.

Table 5. Physical and biological features of critical habitat designated for anadromous species, and corresponding species life history events.

Physical and Biological Features			
	Site Type	**Site Attribute**	**Life History Event**
1	Freshwater spawning	Substrate, water quality, water quantity	Adult spawning, embryo incubation, alevin development
2	Freshwater rearing	Floodplain connectivity, forage, natural cover, water quality, water quantity	Fry emergence, fry/parr growth and development
3	Freshwater migration	Free of artificial obstructions, natural cover, water quality, water quantity	Adult sexual maturation, adult upstream migration and holding, kelt seaward migration, fry/parr seaward migration
4	Estuarine areas	Forage, free of obstruction, natural cover, salinity, water quality, water quantity	Adult sexual maturation, adult "reverse smoltification", kelt seaward migration, fry/parr seaward migration, fry/parr smoltification, smolt growth and development, smolt seaward migration
5	Nearshore marine areas	Forage, free of obstruction, natural cover, water quality, water quantity	Adult sexual maturation, smolt/adult transition
6	Offshore marine areas	Forage	Adult growth and development

3.2.2 Chum Salmon

The proposed action area contains two ESUs of chum salmon – Hood Canal summer chum salmon and Columbia River chum salmon.

Listing History

The Hood Canal summer chum salmon ESU was listed as Threatened in 1999 (64 FR 14508) and reaffirmed in 2005 and 2014. The Columbia River chum salmon ESU was listed as Threatened in 1999 (64 FR 14508) and reaffirmed in 2005 and 2014.

Life History and Biological Requirements

Chum salmon range in North America from the Sacramento River, California to the Mackenzie River, Alaska. Chum salmon generally return after one to three years at seas and spawn in lower stream reaches soon after leaving the ocean. All chum

salmon are anadromous. They deposit relatively large eggs, and produce large fry which migrate directly after emerging or rear in freshwater for a few weeks. Chum salmon juveniles typically rear for several weeks in the estuary before migrating offshore (Quinn 2005).

Distribution and Critical Habitat

Critical Habitat was designated for the two ESUs as follows.

- Hood Canal summer chum salmon: September 2, 2005
- Columbia River chum salmon: September 2, 2005

The Hood Canal summer chum salmon ESU includes all natural-origin populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula Rivers between Hood Canal and Dungeness Bay, Washington (Figure 21). Additionally, eight artificial propagation programs contribute to the ESU: the Quilcene National Fish Hatchery, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and Jimmycomelately Creek Fish Hatchery programs (NMFS 2016e).

The Columbia River chum salmon ESU includes all natural-origin populations of chum salmon from the Columbia River and its tributaries in Washington and Oregon (Figure 22). Two artificial propagation programs contribute to the ESU: the Grays River program and the Washougal River Hatchery program (NMFS 2016d).

Table 5 presents the physical and biological features (PBF) of anadromous salmonid critical habitat.

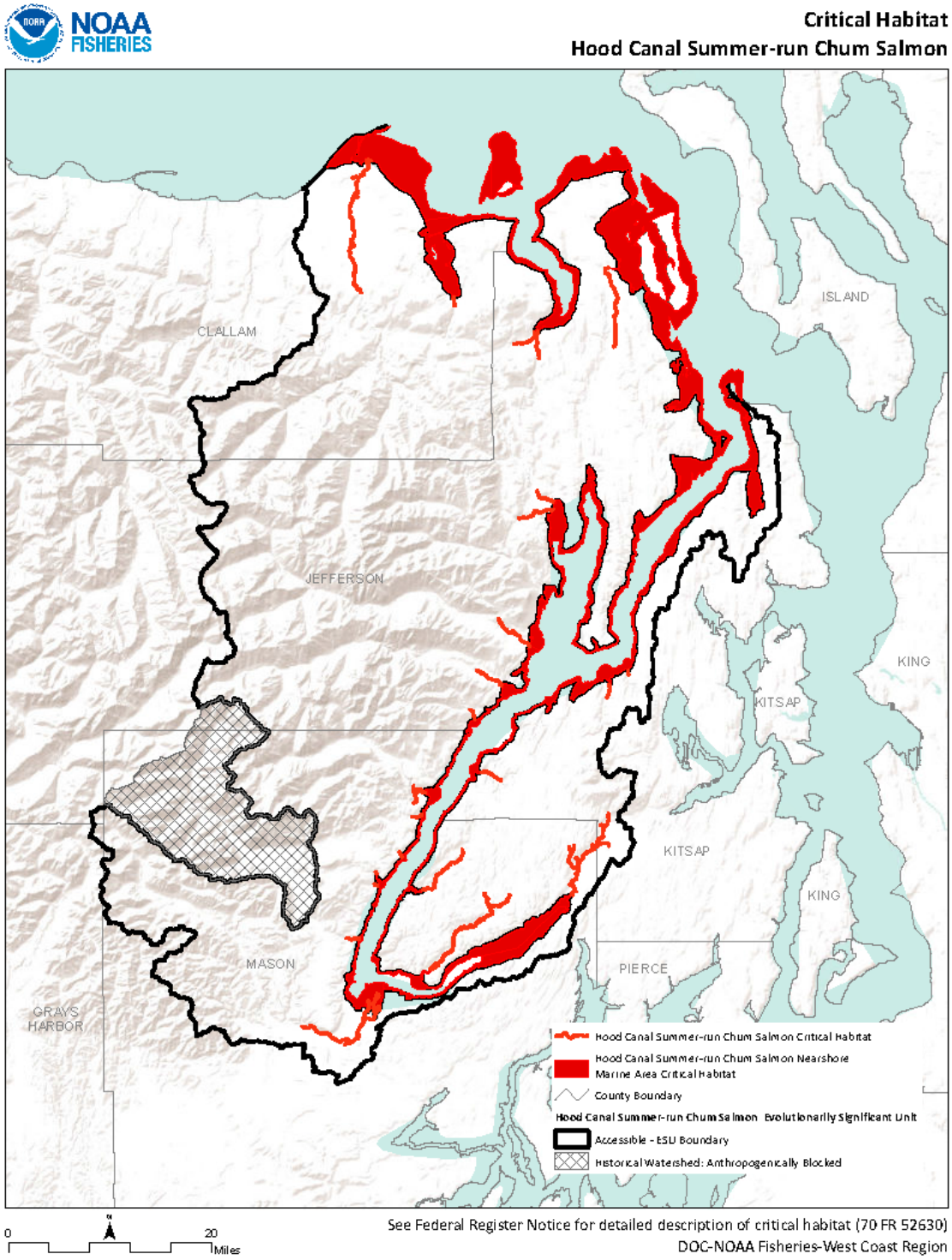

Figure 21. Hood Canal summer run chum salmon critical habitat.

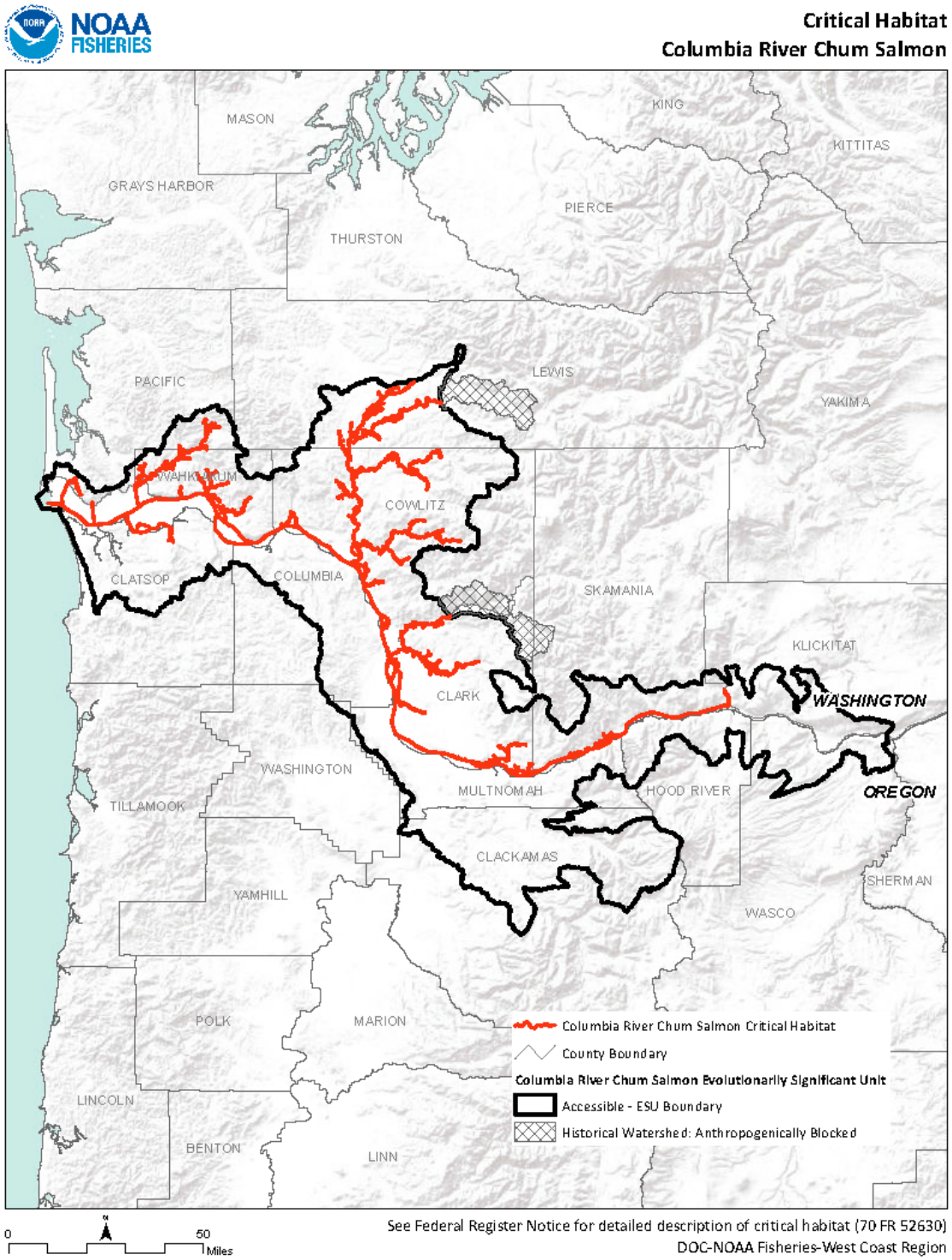

Figure 22. Columbia River chum salmon critical habitat.

3.2.3 Coho Salmon

The proposed action area contains three ESUs of coho salmon – Lower Columbia River coho salmon, Oregon coast coho salmon, and Southern Oregon/Northern California Coast coho salmon.

Listing History

The Lower Columbia River coho salmon ESU was listed as Threatened in 2005 (70 FR 37160) and reaffirmed in 2005 and 2014. The Oregon Coast coho salmon ESU was listed as Threatened in 1998 (63 FR 42587) and reaffirmed in 2005 and 2014. The Southern Oregon/Northern California Coast coho salmon ESU was listed as Threatened in 1997 (62 FR 24588) and reaffirmed in 2005 and 2014.

Life History and Biological Requirements

Coho salmon range from Scott Creek, north of Santa Cruz, California to Kotzebue Sound. Coho tend to spawn in small, moderate-gradient coastal or interior streams. Coho fry may reside in streams for one or two years, or go to sea in first spring. Smolts do not linger in estuary, but migrate directly to the ocean where they reside primarily nearshore. Most coho salmon spend two summers, or one full year at sea (Quinn 2005).

Distribution and Critical Habitat

Critical habitat was designated for the three ESUs as follows.

- Lower Columbia River coho salmon: February 24, 2016
- Oregon coast coho salmon: February 11, 2008
- Southern Oregon/Northern California Coast coho salmon: May 5, 1999

The Lower Columbia River coho salmon ESU includes all naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers and coho salmon originating from the Willamette River and its tributaries below Willamette Falls (Figure 23). Twenty-one artificial propagation programs also contribute to the ESU (NMFS 2016d).

The Oregon Coast coho salmon ESU includes all naturally spawned coho salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco (Figure 24). A single artificial propagation program contributes to the ESU - the Cow Creek Hatchery Program (NMFS 2016f).

The Southern Oregon/Northern California Coast coho salmon ESU includes all coho populations that spawn in coastal rivers from the Elk River (Oregon) in the north to the Mattole River (California) in the south (NMFS 2016g). No distribution map is available for this ESU.

Table 5 presents the physical and biological features (PBF) of anadromous salmonid critical habitat.

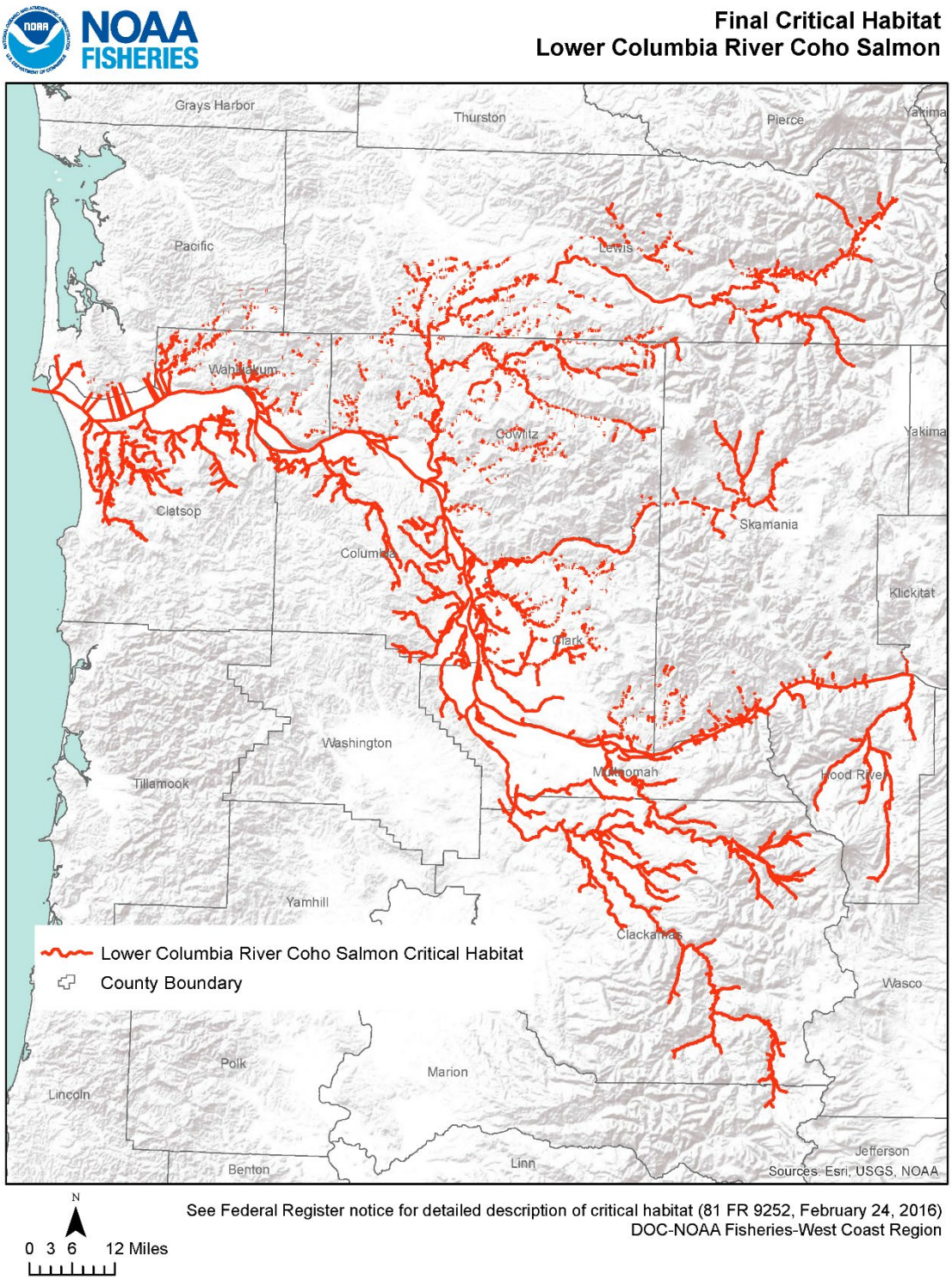

Figure 23. Lower Columbia River coho salmon ciritical habitat.

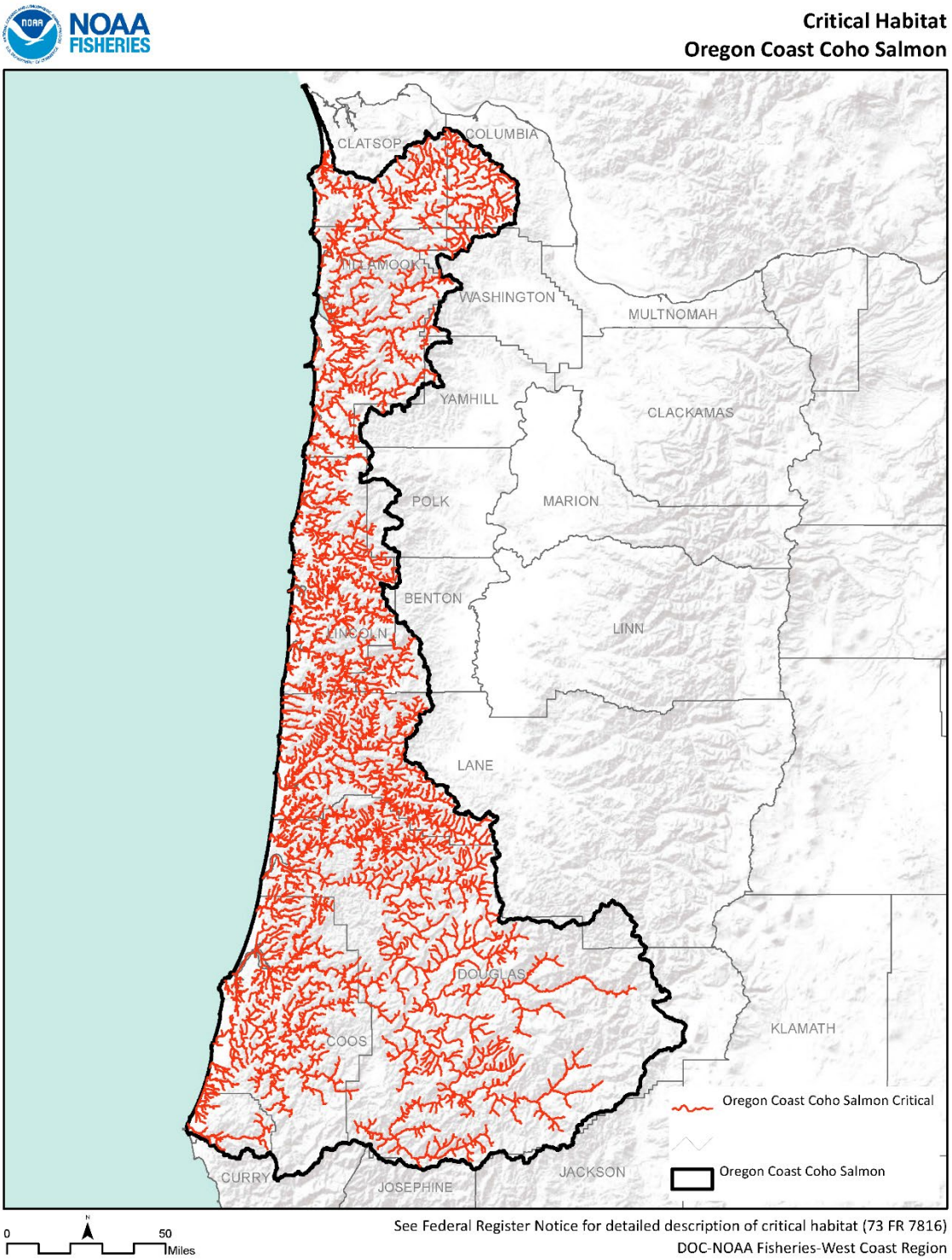

Figure 24. Oregon coast coho salmon critical habitat.

3.2.4 Sockeye Salmon

The proposed action area contains two ESUs of sockeye salmon – Ozette Lake sockeye salmon and Snake River sockeye salmon.

Listing History

The Ozette Lake sockeye salmon ESU was listed as Threatened in 1999 (64 FR 14528) and reaffirmed in 2005 and 2014. The Snake River sockeye salmon ESU was listed as Endangered in 1991 (56 FR 58619) and reaffirmed in 2005 and 2014.

Life History and Biological Requirements

Sockeye salmon historically ranged from the Sacramento River, California to the Kotzebue Sound, but now range from Columbia River to Kuskokwim River. They spawn in coastal systems and inland to Redfish Lake, Idaho, a 994 miles [mi (1600 kilometers (km))] journey. Sockeye deposit eggs into diverse substrates and juveniles typically migrate to lakes immediately after emergence, where they rear for one or two years; although there are ocean- and river-types as well. Most sockeye salmon smolts spend little time in estuaries, but ocean-type juveniles may rear entirely in the estuary zone. All sockeye migrate offshore (as opposed to coastal) and spend two to three years at sea. Sockeye salmon also occur as resident freshwater populations called kokanee. Kokanee populations may be isolated, but also occur sympatricly with anadromous sockeye populations. Both types die after spawning (Quinn 2005).

Distribution and Critical Habitat

Critical Habitat was designated for the two ESUs as follows.

- Snake River sockeye salmon: December 28, 1993
- Ozette Lake sockeye salmon: September 2, 2005

The Ozette Lake sockeye salmon ESU includes naturally spawned sockeye salmon originating from the Ozette River and Ozette Lake and its tributaries (Figure 25). Two artificial propagation programs contribute to the ESU: the Umbrella Creek Hatchery Program; and the Big River Hatchery Program (NMFS 2016h).

The Snake River sockeye salmon ESU includes the Redfish Lake population and sockeye salmon artificially propagated from the Redfish lake Captive Propagation Program [NMFS 2016a (Figure 26)].

Table 5 presents the physical and biological features (PBF) of anadromous salmonid critical habitat.

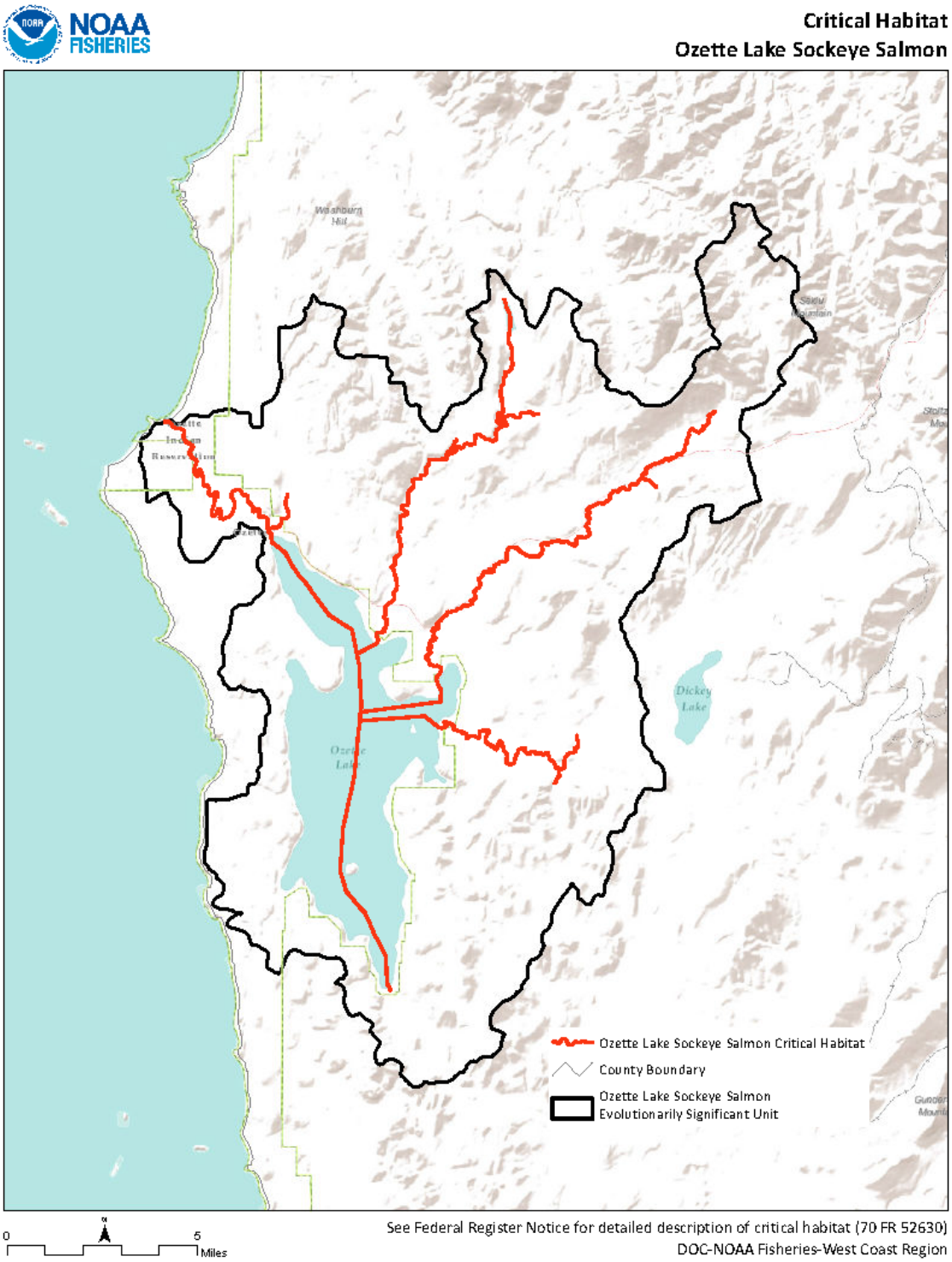

Figure 25. Ozette Lake sockeye salmon critical habitat. There are no proposed sites within the boundaries of this ESU. Plan implementation within this ESU would have coverage under a programmatic framework Opinion and would require additional consultation with NMFS prior to treatment.

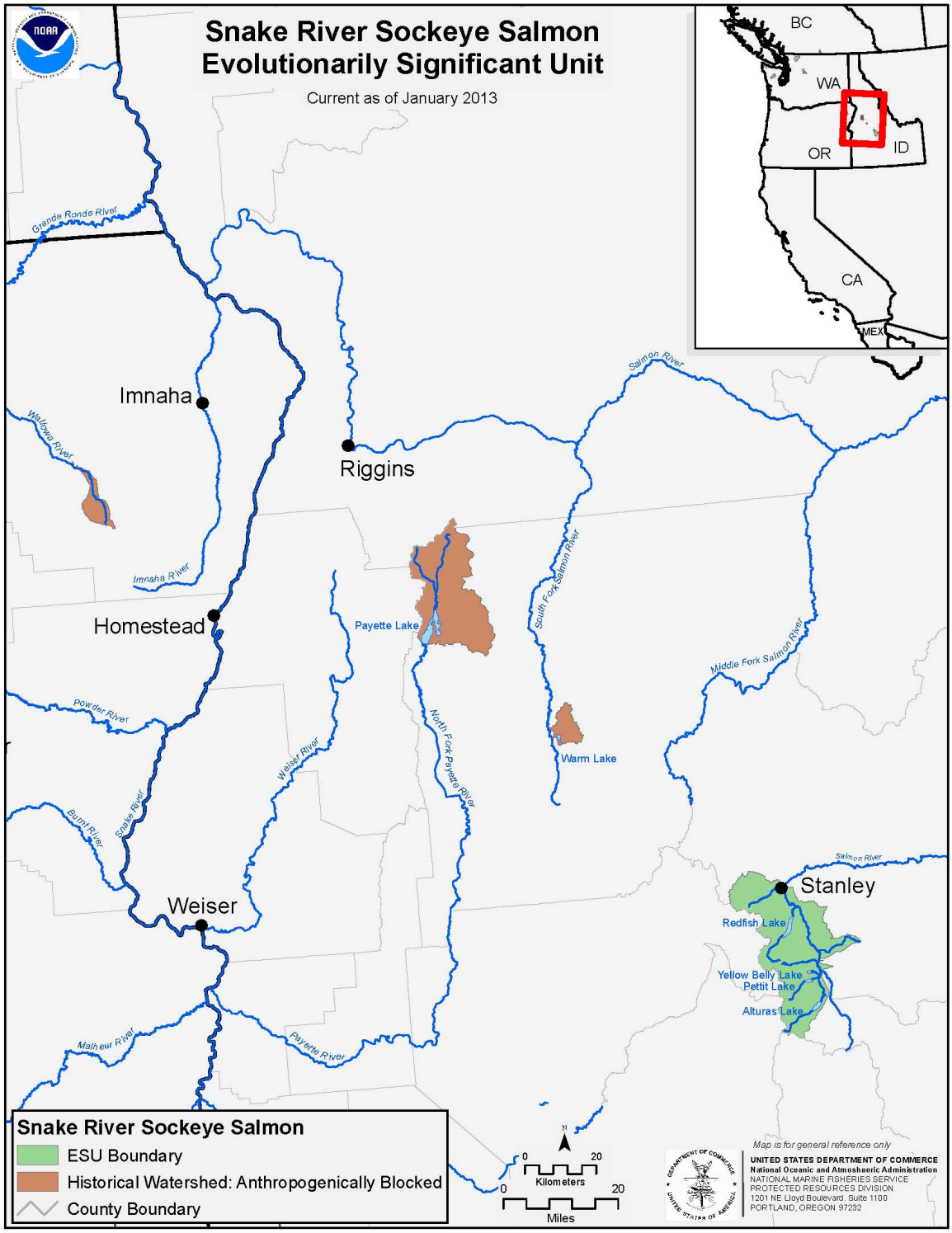

Figure 26. Snake River sockeye salmon ESU. As a conservation measure, EarthTec QZ and Endothall would not be applied as an initial treatment within the boundaries of this ESU. Further consultation with NMFS is required prior to applying these two treatments.

3.2.5 Steelhead

The proposed action area contains six Distinct Population Segments (DPS) of steelhead – Lower Columbia River steelhead, Middle Columbia River steelhead, Snake River steelhead, Upper Columbia River steelhead, Upper Willamette steelhead, and Puget Sound steelhead.

Listing History

The Lower Columbia River steelhead DPS was listed as Threatened in 1998 (63 FR 13347) and reaffirmed in 2006 and 2014. The Middle Columbia River steelhead DPS was listed as Threatened in 1999 (64 FR 14517) and reaffirmed in 2006 and 2014. The Upper Columbia River steelhead DPS was listed as Endangered in 1997 (62 FR 43937), reclassified as Threatened in 2006 (71 FR 834) and this determination was reaffirmed in 2009 and 2014. The Snake River steelhead DPS was listed as Threatened in 1997 (62 FR 43937) and reaffirmed in 2005 and 2014. The Upper Willamette steelhead DPS was listed as Threatened in 1999 (64 FR 14517) and reaffirmed in 2006 and 2014. The Puget Sound steelhead DPS was listed as Threatened in 2007 (72 FR 26722) and reaffirmed in 2014.

Life History and Biological Requirements

Steelhead historically ranged from Malibu Creek, California to the Kuskowim River, Alaska, with non-anadromous populations of rainbow trout as far south as northwestern Mexico. Steelhead spawn in spring unlike other Pacific salmon. Fry emerge in late spring or early summer. Juveniles initially reside in streams and may reside there for one to three years before expressing a fluvial, adfluvial, or anadromous life histories. Adults typically spend one to three years at sea. Steelhead express two different anadromy strategies, ocean-maturing and stream-maturing, or “winter” and “summer” steelhead. Ocean-maturing steelhead enter freshwater in an advanced state of sexual maturity in late winter or early spring, spawning rapidly. Stream-maturing steelhead enter freshwater summer or fall, mature over winter, and spawn in spring. Ocean-maturing steelhead are often found in low elevation and coastal streams with fall-run Chinook, while summer steelhead are typically found in interior systems with spring-run Chinook. Unlike other Pacific salmon, steelhead are iteroparous and may spawn repeatedly, though the proportion of summer steelhead that survive to spawn a second or third time is low (Quinn 2005).

Distribution and Critical Habitat

Critical habitat was designated for the six ESUs as follows.

- Lower Columbia River steelhead: September 2, 2005
- Middle Columbia River steelhead: September 2, 2005
- Snake River steelhead: September 2, 2005
- Upper Columbia River steelhead: September 2, 2005
- Upper Willamette steelhead: September 2, 2005

- Puget Sound steelhead: February 24, 2016

The Lower Columbia River steelhead DPS includes all naturally spawned steelhead originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers and the Willamette and Hood Rivers [NMFS 2016d (Figure 27)].

The Middle Columbia River steelhead DPS includes all naturally spawning populations of steelhead in drainages upstream of the Wind River, Washington, and the Hood River, Oregon, up to, and including, the Yakima River, Washington (Figure 28). Major drainages in this DPS are the Deschutes, John Day, Umatilla, Walla Walla, Yakima, and Klickitat river systems. The Cascade Mountains form the western border of the plateau in both Oregon and Washington, while the Blue Mountains form the eastern edge. The southern border is marked by the divides that separate the upper Deschutes and John Day basins from the Oregon High Desert and drainages to the south. The Wenatchee Mountains and Palouse areas of eastern Washington border the Middle Columbia on the north (NMFS 2016i).

The Snake River steelhead DPS includes all naturally spawned populations of steelhead originating from the Snake River basin six artificial propagation programs are also considered part of the DPS: the Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs [NMFS 2016a (Figure 29)].

The Upper Columbia River steelhead DPS includes naturally spawned steelhead originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border (Figure 30). Six artificial propagation programs contribute to this DPS: the Wenatchee River; Wells Hatchery; Winthrop National Fish Hatchery; Omak Creek; and the Ringold Hatchery Programs (NMFS 2016b).

The Upper Willamette steelhead DPS includes all naturally spawned winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River [NMFS 2016c (Figure 31)].

The Puget Sound steelhead DPS includes all naturally spawned steelhead populations, in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River and to the north by the Nooksack River and Dakota Creek as well as the Green River natural and Hamma Hamma winter-run hatchery stocks [NMFS 2016e (Figure 32)].

Table 5 presents the physical and biological features (PBF) of anadromous salmonid critical habitat.

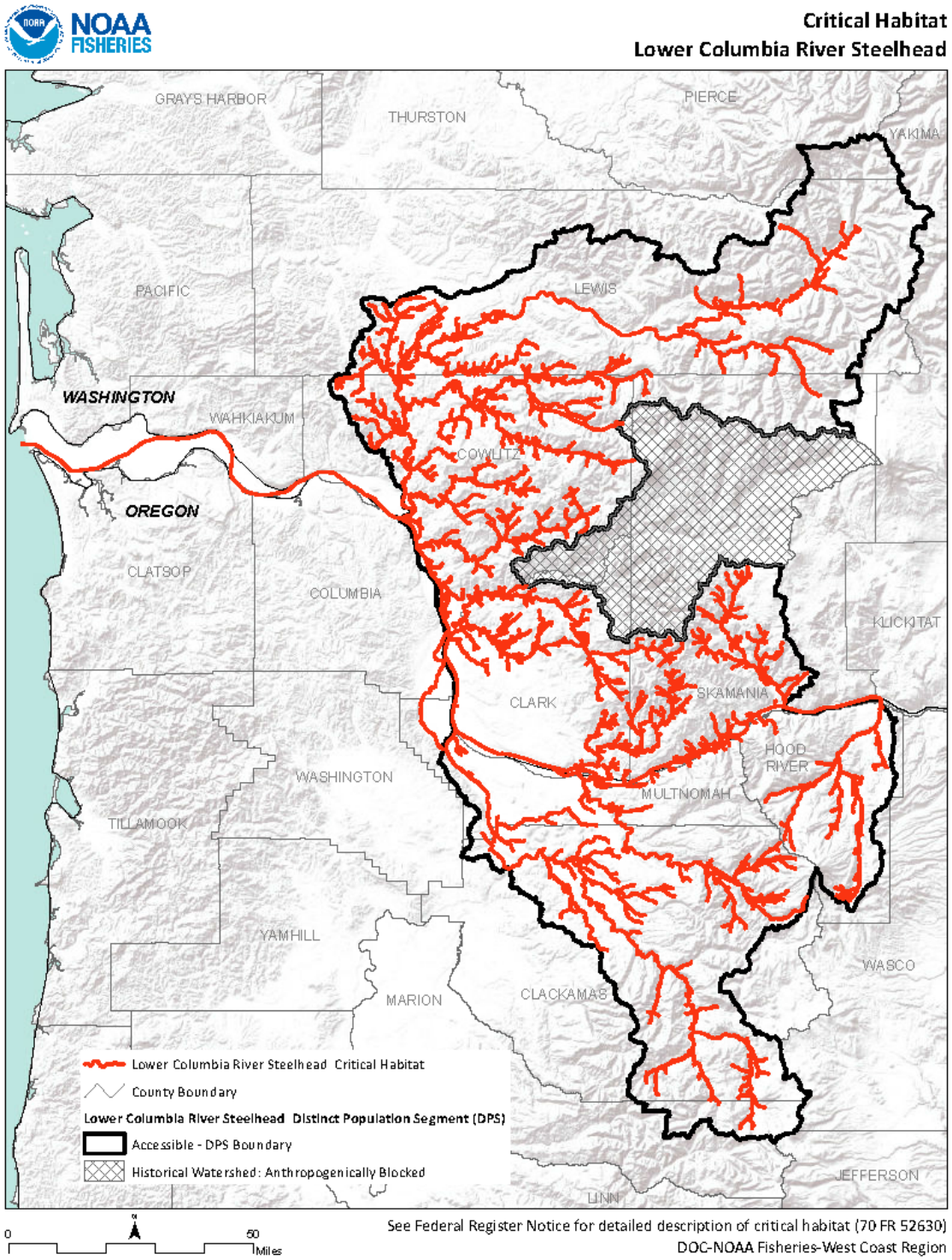

Figure 27. Lower Columbia River steelhead critical habitat.

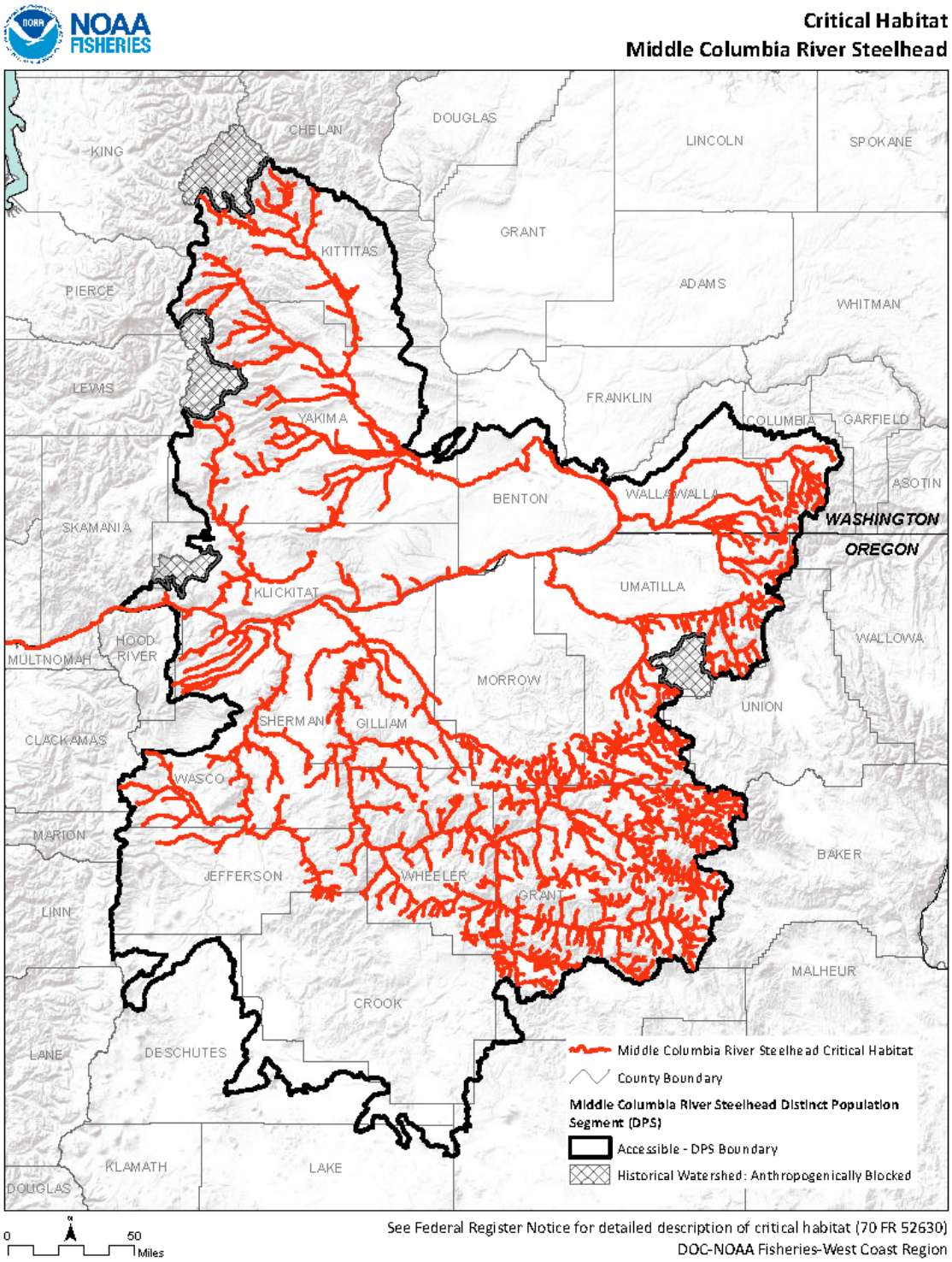

Figure 28. Middle Columbia River steelhead critical habitat.

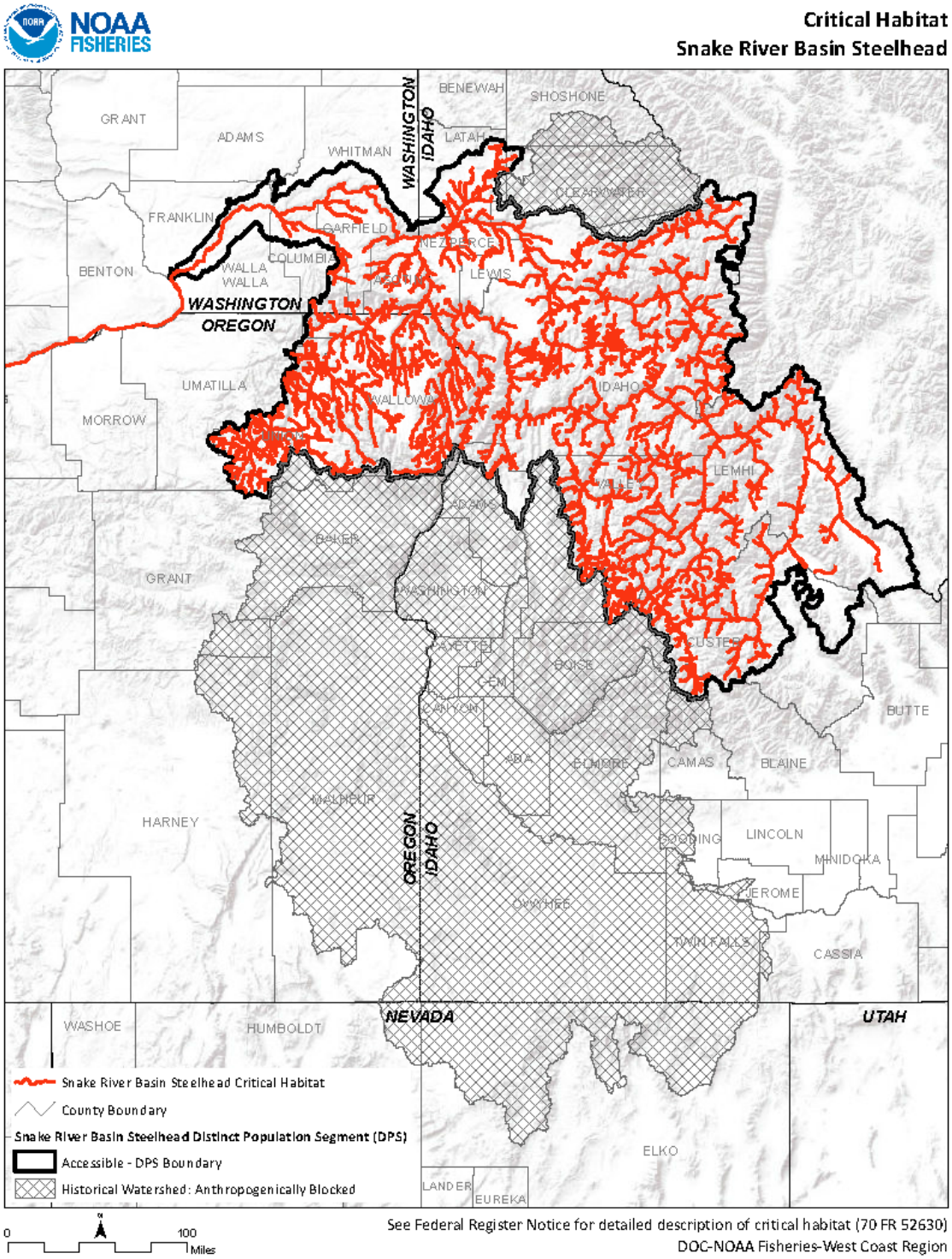

Figure 29. Snake River Basin steelhead critical habitat.

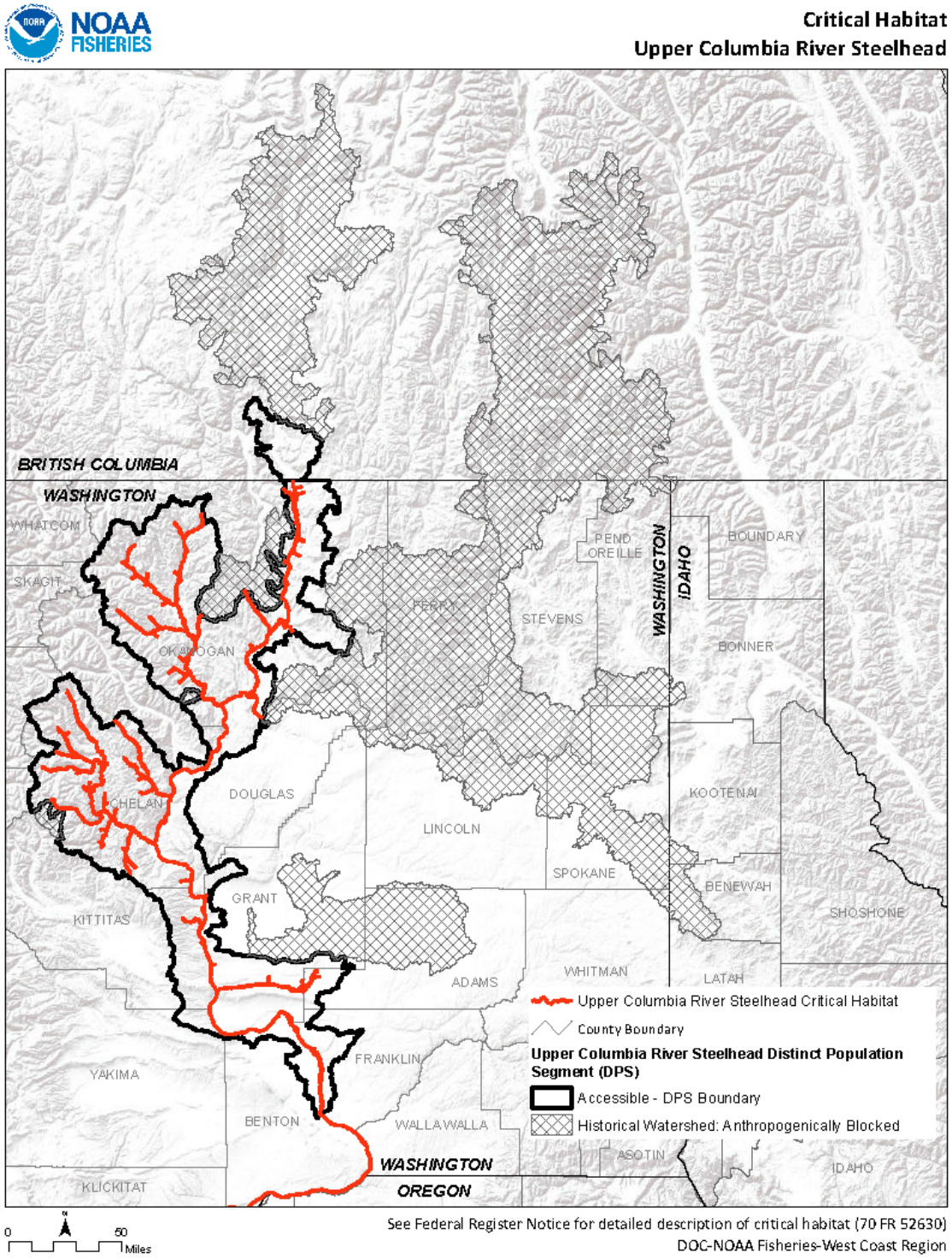

Figure 30. Upper Columbia River steelhead critical habitat.

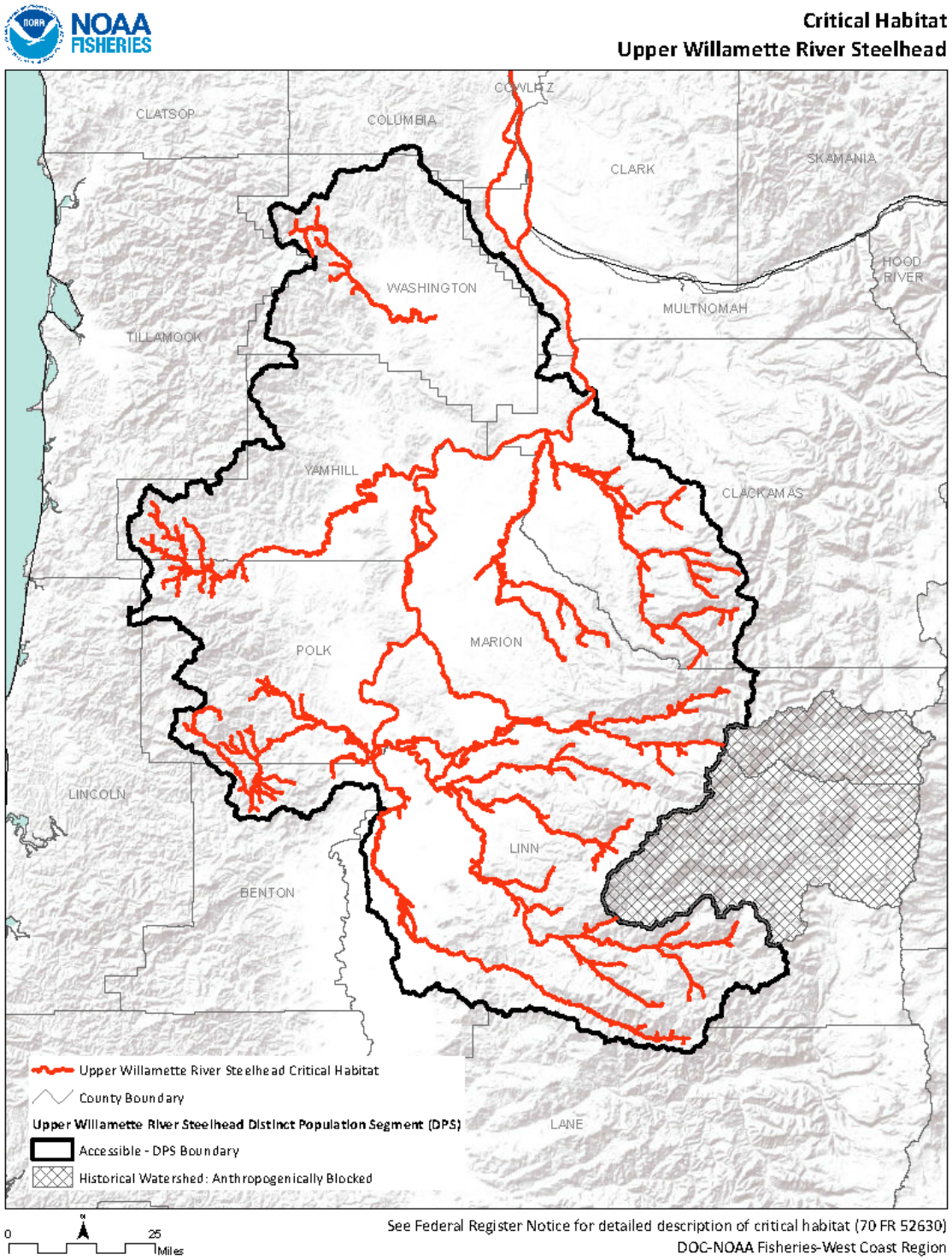

Figure 31. Upper Willamette River steelhead critical habitat.

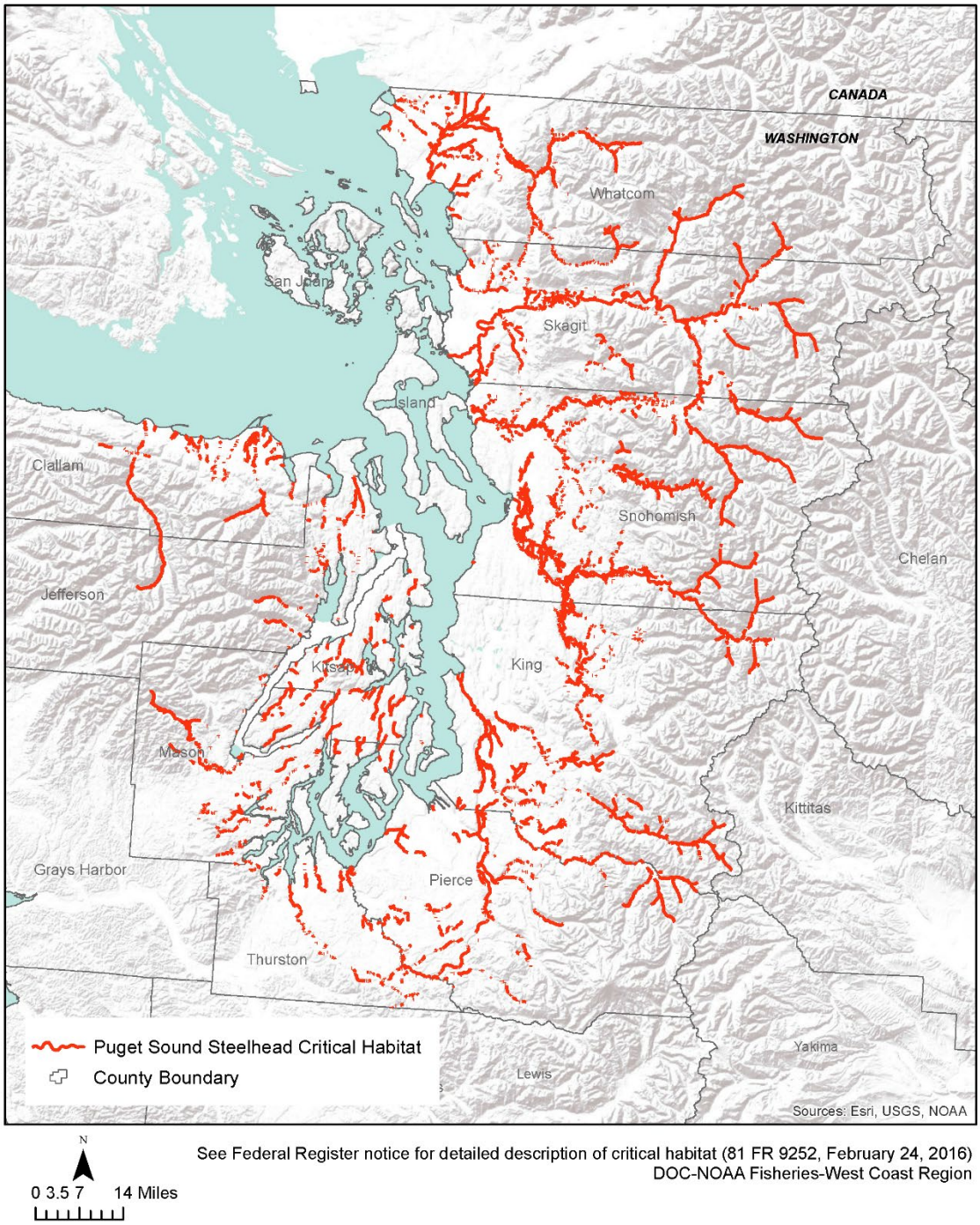

Figure 32. Puget Sound steelhead critical habitat.

Threats to Anadromous Species

Numerous pressures have contributed to the decline and currently impair the recovery of listed pacific salmon. Water withdrawals, diversion, and storage have reduced habitat, impeded passage, and entrained juveniles. Modification of natural hydrographs has elevated stream temperatures, altered trophic structure, and reduced flows needed for migration, spawning, gravel recruitment, and transport of large woody debris. Land use activities associated with urban development, extractive industries, agriculture, and recreation have impaired salmonid habitat quality and reduced the amount of available habitat. Commercial and recreational fisheries have contributed significantly to reductions in salmonid abundance. Establishment of non-native species including smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), and northern pike (*Esox lucius*) has increased predation on juvenile salmonids, while habitat modifications have increased the effectiveness of native predators including piscivorous birds and pinnipeds.

3.2.6 Eulachon

<u>As summarized in NMFS 2017</u>

Listing History

Eulachon was listed as a threatened species under the ESA on March 18, 2010 (75 FR 13012). NMFS 2016 ESA five-year review concluded that the DPS's threatened designation remained appropriate.

Life History/Biological Requirements

Eulachon is an anadromous species that historically migrated in massive schools in the Columbia River and some of its tributaries, the Cowlitz River being the most notable. Eulachon migrate in large schools and are important ecologically, providing a food source for a wide variety of organisms such as birds, marine mammals, and fish in both marine and freshwater environments.

Onset of adult migration appears to be dependent on water temperature; water temperatures colder than 39°F (4°C) slow or stop migration. Adults typically enter the Columbia River system from December to May with peak entry and spawning during February and March. Eulachon spawn in the mainstem of the Columbia River and the two main spawning tributaries of the Columbia are the Cowlitz River in Washington and the Sandy River in Oregon.

The timing and location of spawning may differ from year to year depending on the age structure of returning adults and environmental conditions such as water temperature (ODFW and WDFW 2001). Eulachon broadcast spawn and prefer coarse sandy substrates and small-diameter (pea size and smaller) gravels (Romano et al. 2002). Approximately 7,000 to 31,000 eggs are released depending on the size of the female, and most adults die shortly after spawning (ODFW and WDFW 2006).

Eggs attach to the substrate and hatch within 3-4 weeks, dependent on water temperature (incubation time is less in warmer waters). Larvae drift downriver to the ocean after hatching, and during this time subsist primarily on their yolk sac contents. They drift at various depths within the water column. Studies in the Columbia River shipping channel showed that bottom and mid-water larval densities of eulachon did not differ significantly, but both were significantly greater than surface larval density (Howell et al. 2001). Larval densities in the Columbia River mainstem were significantly greater outside the shipping channel than within.

Eulachon spend most of their lives in nearshore ocean waters, rearing there, and return to spawn typically at three years old. Eulachon larvae become planktivorous, subsisting on phytoplankton, copepods, copepod eggs, mysids, ostracods, worm larvae, and eulachon larvae. Juveniles and adults consume euphausiids, copepods, and other planktonic organisms. Adults only feed at sea (ODFW and WDFW 2006).

Distribution and Critical Habitat

Critical habitat was designated under the ESA for eulachon on October 20, 2011 (76 FR 65324). Eulachon are found from the Klamath River in California north to Bristol Bay, Alaska and the Pribilof Islands (Figures 33 and 34). They spawn mainly in waters fairly close to the ocean. Before construction of Bonneville Dam, there was some evidence of migration of eulachon as far as Hood River (WDFW and ODFW 2001). In a recent study, Howell et al. (2001) found eulachon as far upstream as Bonneville Dam.

There are four subpopulations of the DPS: Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers south of the Nass River.

Threats

Climate change impacts on ocean conditions is the most serious threat to the persistence of eulachon in all four subpopulations. Climate change impacts on freshwater habitat, eulachon bycatch in offshore shrimp fisheries, dams and water diversions in the Klamath and Columbia rivers, and predation in the Fraser and British Columbia coastal rivers round out the top four threats to all subpopulations in the DPS.

Figure 33. Critical habitat for the southern DPS of Eulachon.

Figure 34. Critical habitat for the southern DPS of Eulachon.

3.2.7 Green Sturgeon

As summarized in NMFS 2018

Listing History

The southern DPS of North American green sturgeon was listed as threatened April 7, 2006, and reaffirmed April 14, 2014.

Life History/Biological Requirements

Green sturgeon are long lived (54 years), late maturing (around 15 years of age) and exhibit spawning site fidelity in natal streams. After maturity is reached at approximately 15 years of age and 59 inches (150 cm) total length, the southern DPS typically spawn every three to four years (range two to six years). Adults enter San Francisco Bay in late winter through early spring and spawn in the Sacramento River primarily from April through early July, with peaks of activity likely influenced by factors including water flow and temperature.

Late summer or early fall spawning may also occur given presence of larvae in October 1997, 1999, and 2000 at Glenn Colusa Irrigation District and the fall of 2016 at Red Bluff Diversion Dam. Water flow is an important cue in spawning migration with outmigration related to elevated flows.

Southern DPS spawning primarily occurs in cool sections of the upper mainstem Sacramento River in deep pools [averaging 26 – 30 feet (8-9 m) in depth] containing small to medium sized sand, gravel, cobble, or boulder substrate. Post-spawn fish may hold for several months in the Sacramento River and out-migrate in the fall or winter or move out of the river quickly during the spring and summer months, with the holding behavior most commonly observed. Post-spawn outmigration through the San Francisco Bay Delta Estuary is also variable, with some individuals migrating to the Pacific Ocean rather quickly (2-10 days) and others remaining in the estuary for a number of months after leaving upstream holding habitats.

Green sturgeon larvae disperse at approximately 12 days post hatch in the laboratory. Larval activity is primarily nocturnal, with peaks in migration between dusk and dawn. Larvae utilize benthic structure and seek refuge within crevices but will forage over hard surfaces. Larval abundance and distribution may be influenced by spring and summer outflow and recruitment may be highest in wet years, making water flow an important habitat parameter. Studies suggest optimal temperature for larval growth is 59°F (15°C), with temperatures less than 51.8°F (11°C) or greater than 66.2°F (19°C) reducing growth rates.

Distribution and Critical Habitat

Critical habitat was designated October 9, 2009. Anadromous green sturgeon occurs along the western seaboard of North America (Figure 35). Non-spawning adult and subadult green sturgeon spend much of their lives in marine and estuarine waters from

the Bering Sea, Alaska to El Socorro, Baja California, Mexico. Within the nearshore marine environment, southern DPS green sturgeon most often inhabit marine waters less than 361 ft (110 m) in depth.

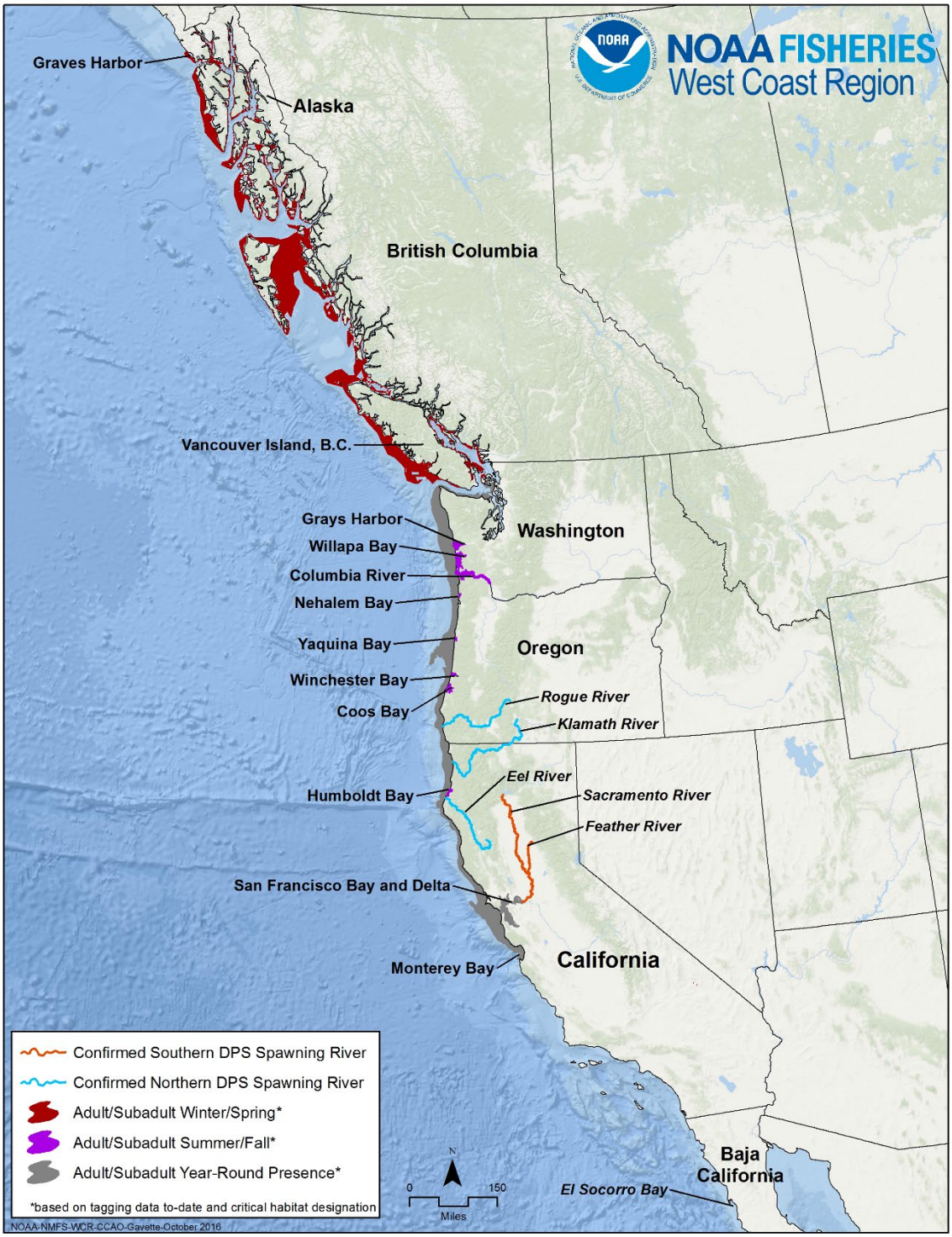

Figure 35. Distribution of the southern DPS of green sturgeon.

Telemetry, genetic, and fisheries data suggest that southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California, and within this range, frequent coastal waters of Washington, Oregon, Vancouver Island, and San Francisco and Monterey bays. Adult and subadult southern DPS green sturgeon occur in relatively large concentrations from late spring to autumn within coastal bays and estuaries including the Columbia River estuary, Willapa Bay, Grays Harbor and the Umpqua River estuary, with peaks in abundance in summer and autumn. Green sturgeon have been detected in acoustic tagging surveys within the Chehalis River (off Grays Harbor; 2004-2005 study), but the detected sturgeon were not assigned to a DPS.

Threats

Habitat destruction has occurred since as early as the 1860s from hydraulic gold mining and continuing up to about 1950 from the development of water pumping plants, dams, and water diversions. Recent analyses indicates that current seasonal and overall flow patterns in the Sacramento River substantially differ from unimpaired flows. Peak fall and winter flows are reduced in both wet and critically dry water year types at Bend Bridge, with the recession limb of the spring snowmelt truncated or absent, and base flows in summer augmented.

The southern DPS of green sturgeon was listed as threatened because of the following factors: 1) the Sacramento River contains the only known spawning population; 2) there has been a substantial loss of spawning habitat in the upper Sacramento and Feather Rivers; 3) the Sacramento River and Delta System face mounting threats to habitat quality and quantity; and 4) fishery-independent data indicated a decrease in observed numbers of juvenile green sturgeon collected.

3.2.8 Southern Resident Killer Whale

<u>As summarized in 70 FR 69903</u>

Listing History

Due to its small population size, the southern resident killer whale segment of the population was listed as endangered under the ESA November 18, 2005.

Life History/Biological Requirements

The species range during the spring, summer, and fall includes the inland waterways of Washington State and the transboundary waters between the United States and Canada. Relatively little is known about the winter movements and range of the southern resident stock. However, in recent years, they have been regularly spotted as far south as central California during the winter months and as far north as Southeast Alaska. Resident killer whale populations in the eastern North Pacific mainly feed on salmonids, showing a strong preference for Chinook salmon.

Killer whales in the Eastern North Pacific region (which includes the Southern Resident killer whales) have been classified into three forms, or ecotypes, termed residents, transients, and offshore whales. Resident whales occur in large, stable pods with membership ranging from 10 to approximately 60 whales. The primary prey of resident whales is fish. The Southern Resident killer whale assemblage contains three pods-- J pod, K pod, and L pod--and is considered a stock under the MMPA.

Significant genetic differences occur among resident, transient, and offshore killer whales. The three forms also vary in morphology, ecology, and behavior. Southern Residents have not been seen to associate with other resident whales, and mitochondrial and nuclear genetic data suggest that Southern Residents interbreed with other killer whale populations rarely if at all. All of these characteristics play an important role in determining whether the monotypic species *O. orca* can be subdivided under the ESA.

Distribution and Critical Habitat

Critical habitat was designated November 29, 2006. Three specific areas are designated, 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca, which comprise approximately 2,560 square miles (6,630 square kilometers) of marine habitat (Figure 36).

Their range during the spring, summer, and fall includes the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. Their occurrence in the coastal waters off Oregon, Washington, Vancouver Island, and more recently off the coast of central California in the south and off the Queen Charlotte Islands to the north has been documented.

Threats

Major threats to the southern resident killer whale population include 1) Uncertain future ocean conditions, 2) the presence of legacy toxins in the marine environment and the likely addition of new toxins, 3) limited prey availability, 4) low numbers of reproductive-aged males and high mortality rates, and 5) small population size.

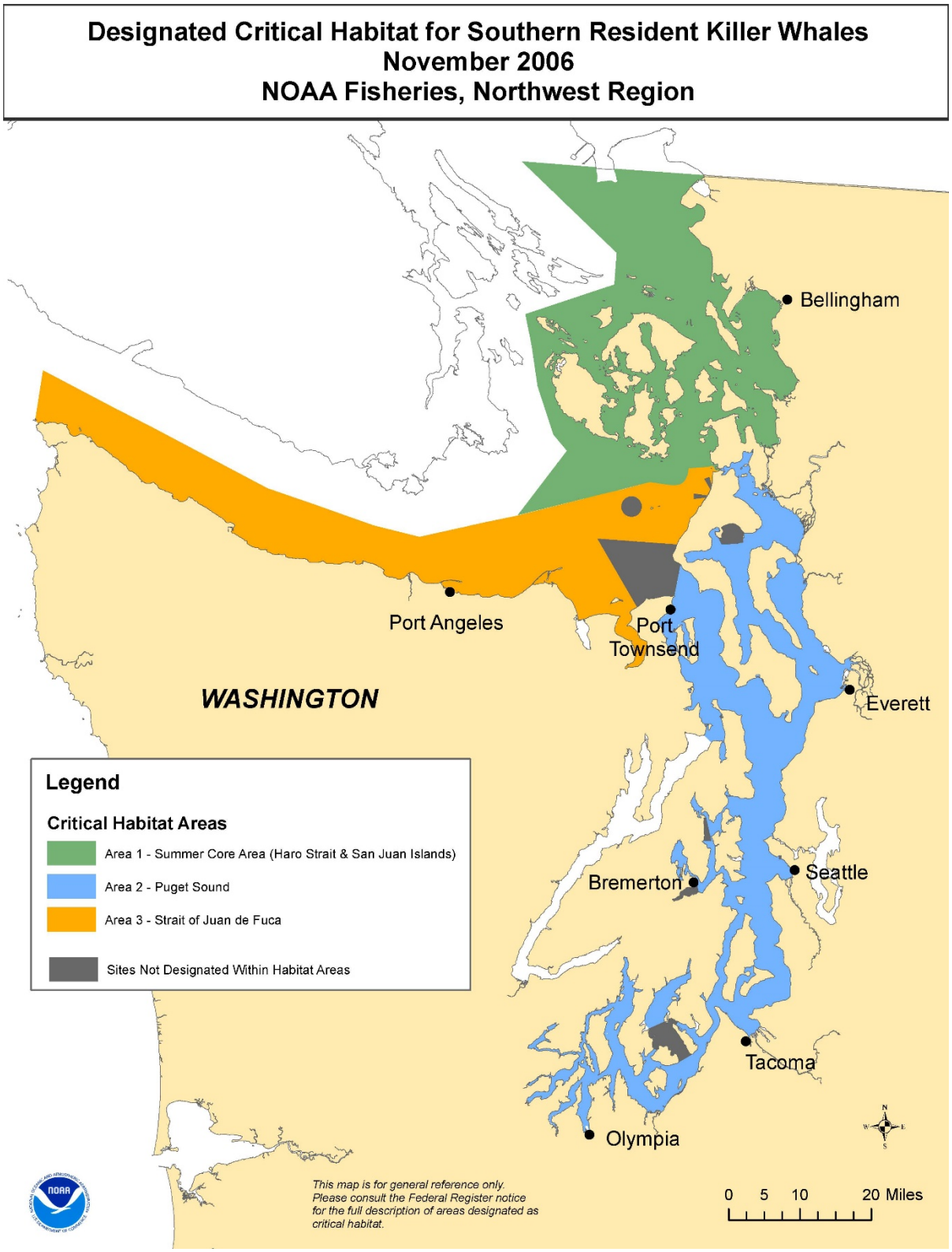

Figure 36. Critical habitat for the southern resident killer whale.

3.3 USWFS Species and Critical Habitat Status

Mammals

3.3.1 Black-footed Ferret

As summarized in USFWS (2013)

Listing History

The black-footed ferret was listed as endangered in 1967 (32 FR 4001, March 11, 1967) and again in 1970 (35 FR 8491, June 2, 1970) under early endangered species legislation and was "grandfathered" into the ESA in 1973.

Life History/Biological Requirements

The black-footed ferret is solitary, except for breeding and the period when mother and young are together. The ferret breeds at approximately one year of age from mid-March through early April. In the wild, kits are born approximately May – June are mobile enough to appear above ground in July and are generally ready to disperse from their mother by September or October.

Dispersal distances up to 30.4 mi (49 km) have been recorded in newly released captive born animals and dispersal of more than 12.4 mi (20 km) in wild-born ferrets. Males tend to disperse more than females.

The black-footed ferret is generally a nocturnal predator, appearing above ground at irregular intervals and for irregular durations. In the post-breeding period ferrets tend to be most active on nights when the moon is above the horizon. The ferret is an extreme specialist that depends on prairie dogs for food and shelter. Ferrets occupy prairie dog burrows and do not dig their own burrows. They will modify burrows, dig out hibernating prairie dogs or remove a soil plug in a behavior called trenching.

Distribution and Critical Habitat

The black-footed ferret is exempt from the requirement to designate critical habitat because they were listed prior to the 1978 amendments requiring critical habitat.

The historical habitat of the black-footed ferret coincided with the ranges of the black-tailed prairie dog, Gunnison's prairie dog, and white-tailed prairie dog. These prairie dog species collectively occupied approximately 100.1 million ac (40.5 million ha) of intermountain and prairie grasslands extending from Canada into Mexico. The habitat occupied by prairie dogs existed within a range of an estimated 563.4 million ac [228 million ha (Figure 37)].

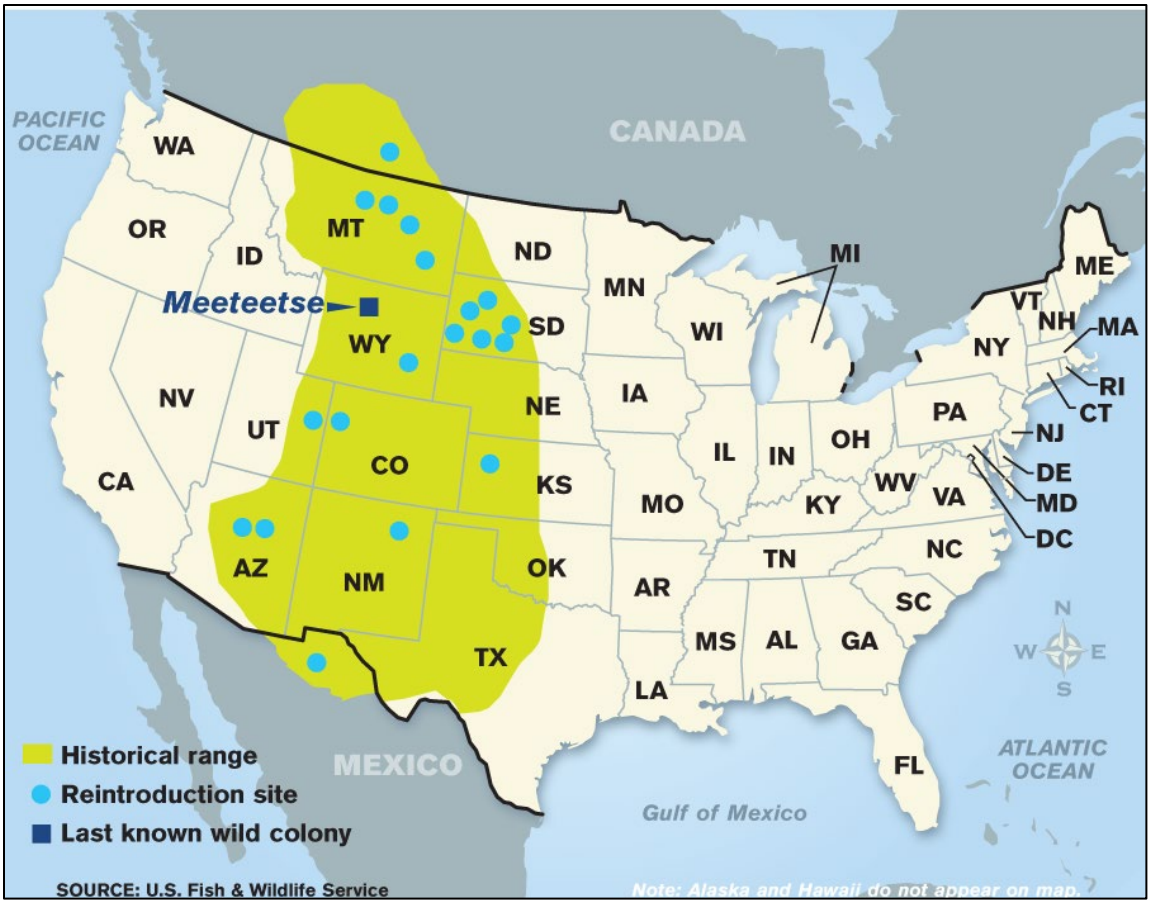

Figure 37. Historic range and present reintroduced populations of black-footed ferret.

Threats

Black-footed ferret populations declined for three principal reasons: 1) A major conversion of native range to cropland, particularly in the eastern portion of the species' range, began in the late 1800s; 2) Poisoning of prairie dogs to reduce competition with domestic livestock for forage began in the early 1900s; and 3) The sylvatic plague first impacted prairie dogs and ferrets in the 1930s. Each of these resulted in a substantial loss of prairie dogs, which in turn led to an even greater decline in ferret populations due to the species' dependency on large expanses of habitat occupied by prairie dogs. Additionally, even a temporal loss of prairie dog habitat can create a population bottleneck for ferrets, despite the subsequent partial recovery of the prairie dog population.

3.3.2 Canada Lynx

<u>As summarized in USFWS (2017a)</u>

Listing History

Canada lynx was listed as Threatened March 24, 2000 due to potential impacts to lynx habitat and the availability of snowshoe hare and other prey populations within the lynx

range. However, on September 12, 2014, the U.S. DPS was revised to include a New Mexico population. The USFWS recommended delisting Canada lynx in their most recent 5-year status review (USFWS 2017a).

Life History/Biological requirements

Canada lynx prefer boreal forest with snowy winters (Aubry et al. 1999; Ruggiero et al. 1999) and a supply of snowshoe hare as a prey base (Apps 1999; Mowat et al. 1999). Lynx survivorship, productivity, and population dynamics are closely related to snowshoe hare density in all parts of its range with high natural mortality and low to no reproduction coinciding with the minimum cyclic hare densities (Mowat et al. 1999). In the U.S., lynx inhabit conifer and mixed conifer-hardwood stands that support snowshoe hare.

Distribution and Critical Habitat

Critical habitat was designated November 9, 2006. However, on September 12, 2014, critical habitat was again revised to include a New Mexico population. Canada lynx in the U.S. are at the southern end of their range which expands across Canada and Alaska, the center of which is north-central Canada. The U.S. populations cover six populations and seven states (Figure 38).

Threats

Habitat loss and destruction that may influence snowshoe hare populations, including climate change.

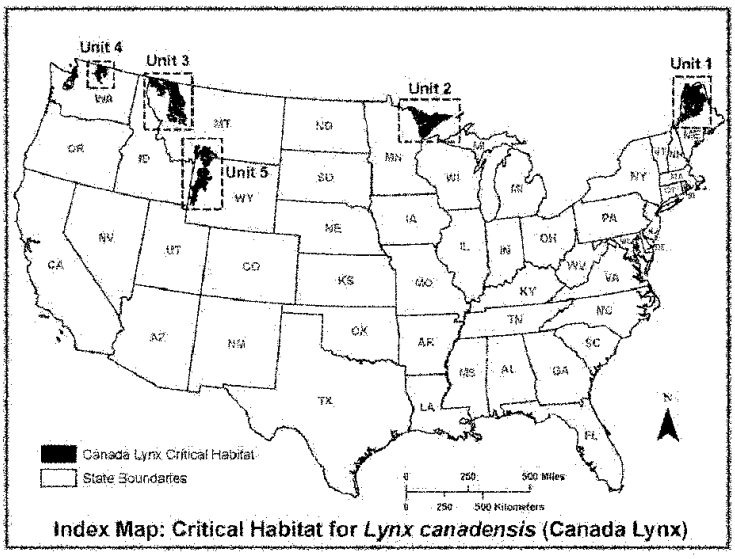

Figure 38. Canada lynx critical habitat in the U.S. New Mexico population not shown.

3.3.3 Columbia Basin Pygmy Rabbit

As summarized in USFWS (2012a).

Listing History

On November 30, 2001, the USFWS, published an emergency rule to federally list the Columbia Basin DPS of the pygmy rabbit as endangered. March 5, 2003, USFWS published a final rule listing the Columbia Basin pygmy rabbit as endangered, without critical habitat designation.

Pygmy rabbits have relatively small home ranges during winter, remaining within roughly 98 ft (30 m) of their burrows, although some snow burrows may extend outward over 328 ft (100 m). Pygmy rabbits have larger home ranges during spring and summer. Home range estimates in Washington are considerably larger than those of pygmy rabbits in other portions of their historical distribution.

Recent records from studies in Idaho indicate that juvenile pygmy rabbits often undertake a single, rapid dispersal movement at 6 to 10 weeks of age, and that some juvenile animals may disperse over 6.2 mi (10 km) during this period. Adult pygmy rabbits may disperse over 7.5 mi (12 km) between their more restricted, seasonal use sites.

Pygmy rabbits breed after their first year and, in Washington, breeding occurs from January through June. Gestation in captive pygmy rabbits is from 22 to 24 days. Females can produce from one to four litters per year.

Life History/Biological requirements

Nearly the entire historical distribution of the Columbia Basin pygmy rabbit lies within the big sagebrush (*Artemisia tridentata*) – bluebunch wheatgrass (*Agropyron spicatum*) zonal habitat type. Pygmy rabbits are typically found in areas that include the tallest [greater than 35.8 in (91 centimeters (cm))] and most dense (greater than 25% cover) stands of sagebrush (*Artemisia* spp.) and are highly dependent on sagebrush to provide both food and shelter throughout the year

Distribution and Critical Habitat

No critical habitat has been designated for the Columbia Basin pygmy rabbit. The historical distribution of the pygmy rabbit included much of the semiarid shrub steppe biome of the Great Basin and adjacent intermountain regions of the western United States and included portions of Montana, Idaho, Wyoming, Utah, Nevada, California, Oregon, and Washington (Figure 39). Pygmy rabbits occur in a variety of semiarid shrub steppe habitat types that are found throughout their historical distribution. The Columbia Basin ecosystem, which extends from northern Oregon through eastern Washington, encompasses the entire Washington State population of the pygmy rabbit, which is the only pygmy rabbit population that occurs within the Columbia Basin.

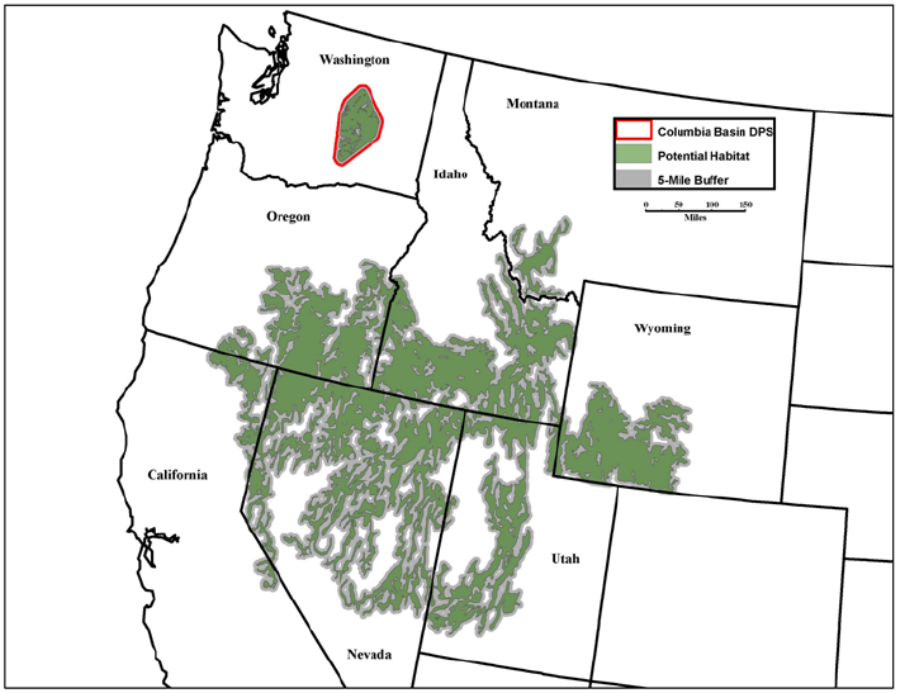

Figure 39. Historic and approximate present distribution and critical habitat for the Columbia Basin pygmy rabbit.

Threats

Large-scale loss and fragmentation of native shrub steppe habitats, primarily for agricultural development, likely played a primary role in the long-term decline of the Columbia Basin pygmy rabbit. However, it is unlikely that these factors alone directly influenced the eventual extirpation of all known subpopulations from the wild. Once a population declines below a certain threshold, it is at risk of extirpation from a number of influences including chance environmental events (*e.g.*, extreme weather), catastrophic habitat loss or resource failure (*e.g.*, from wildfire or insect infestations), predation, disease, demographic limitations, loss of genetic diversity, and inbreeding. At the time of our emergency listing action in 2001, the Columbia Basin pygmy rabbit was imminently threatened by its small population size, loss of genetic diversity, and inbreeding depression, coupled with a lack of suitable, protected habitats in the wild. To varying degrees, all of the above influences continue to impact the Columbia Basin pygmy rabbit and, in combination, have resulted in the population's endangered status.

3.3.4 Columbian White-tailed Deer

<u>As summarized in USFWS (1983).</u>

Listing History

On March 11, 1967, the Secretary of the Interior identified the Columbian white-tailed deer (CWTD) as an endangered species under the authority of the Endangered Species Preservation Act of October 15, 1966. On March 8, 1969, the Secretary of the Interior

again identified the CWTD as an endangered species. On August 25, 1970, the Acting Secretary of the Interior proposed to list the CWTD as an endangered subspecies under the authority of new regulations implementing the Endangered Species Conservation Act of 1969. The CWTD was automatically listed under the ESA when it was enacted in 1973.

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

Life History/Biological requirements

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

Breeding occurs from mid-September through late February, with a peak in November. Does reach sexual maturity by 6 months of age or when their weight reaches approximately 2.2 pounds [lbs (36 kilograms (kg))]. Maturation and fertility depends on the nutritional quality of available forage. Fawns are born in early summer after a 200-day gestation period.

Distribution and Critical Habitat

Although habitat types and locations have been identified for the Columbian white-tailed deer, no critical habitat has been designated. Currently, the Columbia River DPS has a discontinuous range of approximately 149 mi^2 (240 km^2) or about 60,000 ac^2 (24,281 ha^2) in limited areas of Clatsop, Multnomah, and Columbia Counties in Oregon, and Cowlitz, Wahkiakum, Pacific, Skamania, and Clark Counties in Washington. Within that range, CWTD currently occupy an area of approximately 16,000 ac^2 [6,475 ha^2 (Figure 40)].

Threats

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

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

Figure 40. Rough approximation of the range of Columbian white-tailed deer (Suring and Vohs 1979). CWDNR represents the Columbia White-tailed Deer National Wildlife Refuge; now referred to as the Julia Butler Hansen Refuge for the Columbia White-tailed Deer.

3.3.5 Gray Wolf

<u>As summarized in USFWS (2011a).</u>

Listing History

The gray wolf was listed as an endangered species on January 4, 1974. On May 5, 2011, the USFWS announced they were proposing to delist the gray wolf in the Northern Rocky Mountains, in accordance with the April 15, 2011 legislation reinstating the Service's 2009 decision to delist biologically recovered gray wolf populations. Presently, gray wolves outside of the Northern Rocky Mountains DPS remain listed.

Life History/Biological requirements

Wolves are live in groups called packs, which typically include a breeding pair (the alpha pair), their offspring, and non-breeding adults. Wolves are capable of mating by age two or three and occasionally forming lifelong bonds. Lifespan is around 13 years and breed past 10 years of age. On the average, five pups are born in early spring and are cared for by the entire pack.

For the first six weeks, pups are reared in burrows called dens. Dens are often used year after year. Pups depend on their mother's milk for the first month, then are gradually weaned and fed regurgitated meat brought by pack members. By the time pups are seven to eight months old they are almost fully grown and begin traveling with

the adults. After a year or two, young wolves may leave to try to find a mate and form a pack. Lone, dispersing wolves have traveled as far as 594 mi (965.6 km) in search of a mate or territory.

Their territories range in size from 50 mi² (80.5 km²) to more than 1,000 mi² (1,609.3 km²), depending on the available prey and their seasonal movements. Wolves travel over large areas to hunt, as far as 30 mi (48.2 km) in a day (USFWS 2011a).

Distribution and Critical Habitat

Critical habitat has been designated in Michigan and Minnesota March 9, 1978, but not within the Action Area. Gray wolves once ranged from coast to coast and from Alaska to Mexico. They were absent from the Southeast, which was occupied by red wolves (*Canis rufus*), and from the large deserts of the Southwest. Wolves occur presently in the Blue and Cascade Mountain ranges of Washington and Oregon, and throughout the Rocky Mountains in Idaho, Montana, and Wyoming (Figure 41).

Threats

Threats to western gray wolves include the integrity of prey species populations, and their habitats, as well as humans. Controversy over predation on livestock and game animal populations makes illegal hunting an ongoing threat.

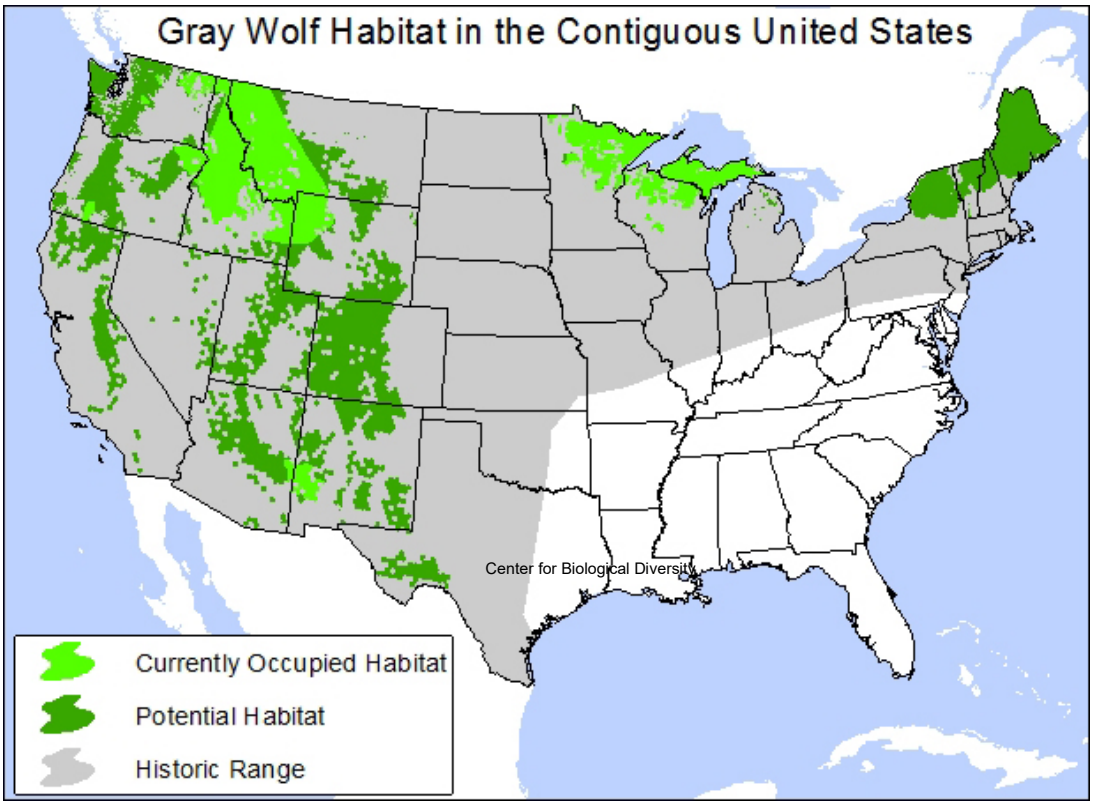

Figure 41. Gray wolf historic and present range.

3.3.6 Grizzly Bear

As summarized in USFWS (1993).

Listing History

Grizzly bear in the lower 48 were listed as threatened July 28, 1975. The Greater Yellowstone ecosystem population has been delisted due to recovery June 30, 2017. An experimental population occurs in the Bitterroot ecosystem of Montana and the North Cascades ecosystem population is currently under review for listing.

Life History/Biological requirements

Grizzlies are omnivorous with a broad adaptability to food sources. Grizzlies are also opportunistic feeders and scavengers that prey on almost any available food. They prefer forest cover with full canopies, but access within 0.6 mi (1 km) to open meadows is also preferable.

Grizzlies den up in winter to hibernate during periods of deep snow, cold temperatures, and low to no food availability. The onset of hibernation appears to correlate with shortening photoperiod and inclement weather.

Age and sex structures are variable, determined mainly by factors such as habitat condition. Mating occurs late May through mid-July, with a peak in mid-June.

Distribution and Critical Habitat

Critical habitat for the grizzly bear was proposed November 5, 1976, but a final rule was never published and the current status of the proposal is unknown.

Historically, grizzlies occupied the mid-west plains west to the California coast, and south into Texas and Mexico; however, through human disturbance and eradication efforts, the grizzly range in lower 48 is confined to large expanses of wilderness in Montana and Idaho, the Northern Cascades, and Yellowstone National Park (Figure 42).

Threats

Human conflict and habitat loss remain the greatest threats to grizzly bears. Through unregulated hunting and habitat destruction, the approximately 50,000 grizzly bears that historically roamed the lower 48 have been reduced to only a few thousand among the various populations.

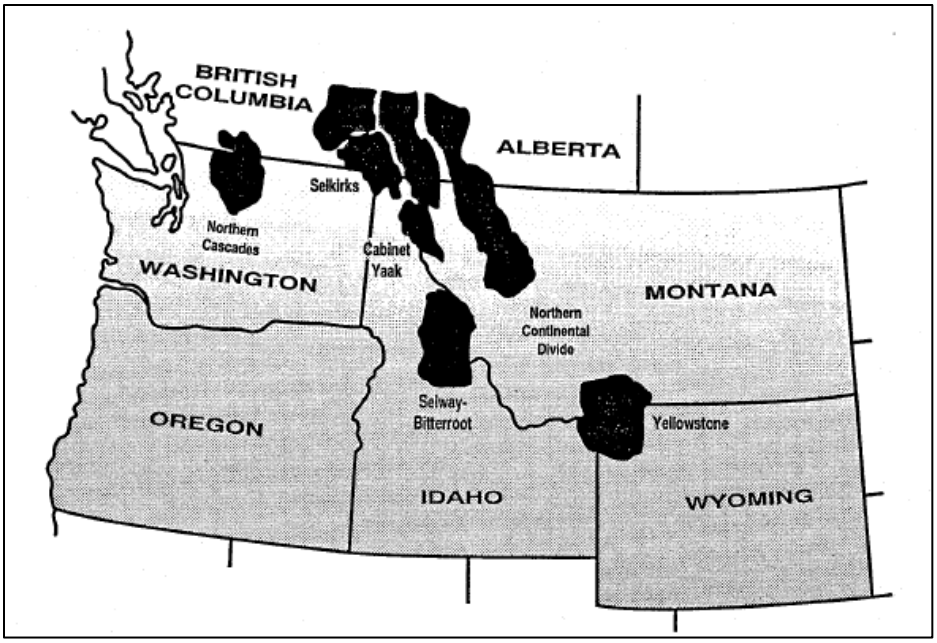

Figure 42. Present grizzly bear range in the U.S. and southern Canada.

3.3.7 North American Wolverine

<u>As summarized in USFWS (2011b).</u>

Listing History

Since 1985, the wolverine has been a candidate species under consideration for listing as threatened.

Life History/Biological requirements

Wolverines occur in a wide variety of alpine, boreal, and arctic habitats including boreal forests, tundra, and western mountains in North America. They do not appear to specialize on specific vegetation or geological habitat aspects, but instead select areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the warm season. The requirement of cold, snowy conditions means that, in the southern portion of the species' range where ambient temperatures are warmest, wolverine distribution is restricted to high elevations, while at more northerly latitudes, wolverines are present at lower elevations and even at sea level in the far north.

Wolverines are opportunistic feeders and consume a variety of foods depending on availability. They primarily scavenge carrion, but also prey on small animals and birds, and eat fruits, berries, and insects. Wolverines have an excellent sense of smell that enables them to find food beneath deep snow.

Breeding generally occurs from late spring to early fall. Females undergo delayed implantation until the following winter to spring, when active gestation lasts from 30 to

40 days. Litters are born from mid-February through March, containing one to five kits, with an average in North America of between 1 and 2 kits. Female wolverines use natal (birthing) dens that are excavated in snow. Persistent, stable snow greater than 5 ft (1.5 m) deep appears to be a requirement for natal denning, because it provides security for offspring and buffers cold winter temperatures.

Distribution and Critical Habitat

Critical habitat has not been designated for the North American wolverine. Currently, wolverines appear to be distributed as functioning populations in two regions in the contiguous United States: the North Cascades in Washington, and the northern Rocky Mountains in Idaho, Montana, and Wyoming (Figure 43). Wolverines were likely extirpated, or nearly so, from the entire contiguous United States in the first half of the 20th Century. The available evidence suggests that, in the second half of the 20th Century and continuing into the present time, wolverine populations have expanded in the North Cascades and the northern Rocky Mountains, but that populations have not been reestablished in the Sierra Nevada Range or the southern Rocky Mountains. We conclude that the current range of the species in the contiguous United States includes the North Cascades Mountains, the northern Rocky Mountains, the southern Rocky Mountains, and the Sierra Nevada Mountains, but that reestablishment of populations in the southern Rocky Mountains and Sierra Nevada has not yet occurred.

Threats

The USFWS has identified the following factors that threaten the wolverine: 1) Climate change, 2) human use and disturbance, 3) dispersed recreational activities, 4) infrastructure development, 5) transportation corridors, and 6) land management. Trapping has been a primary cause of wolverine mortality and unregulated trapping is believed to have played a role in their decline as additive mortality.

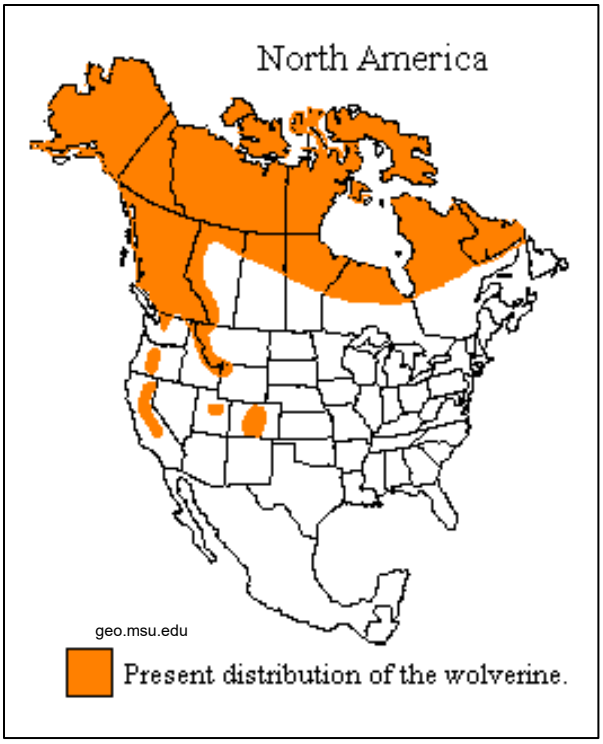

Figure 43. Present wolverine range in North America.

3.3.8 Northern Idaho Ground Squirrel

As summarized in USFWS (2003a).

Listing History

The northern Idaho ground squirrel was listed under the Endangered Species Act of 1973, as amended, as a threatened species on April 5, 2000.

Life History/Biological requirements

Nearly all of the meadow habitats utilized by northern Idaho ground squirrel are bordered by coniferous forests of ponderosa pine (*Pinus ponderosa*) and/or Douglas fir (*Pseudotsuga menziesii*). This ground squirrel is not abundant in meadows that contain high densities of small trees. The northern Idaho ground squirrel consumes at least 45 to 50 plant species. Seeds of forbs, lupines, and composites are important, while roots, bulbs, leaf stems, and flower heads are a minor component of their diet. Grasses and seeds are especially important, and it ingests large amounts of bluegrass (*Poa* sp.) and other grass seeds to store energy for the winter.

The northern Idaho ground squirrel emerges from hibernation in late March or early April and remains active above ground until July or early August. Emergence during this period begins with adult males, followed by adult females, and then yearlings. The northern Idaho ground squirrel becomes reproductively active within the first 2 weeks of

emergence. They produce one litter per year of between two and seven pups, depending on the fitness of the female.

The northern Idaho ground squirrel often digs burrows under logs, rocks, or other objects. Nesting burrows are found in soil pockets that are greater than 0.6 ft (19 cm) deep, but dry vegetation sites with shallow soils of less than 1.6 ft (50 cm) depth above bedrock are used for auxiliary burrow systems.

Distribution and Critical Habitat

Critical habitat has not been designated for the northern Idaho ground squirrel. The distribution of the northern Idaho ground squirrel has become fragmented into what are now very small, isolated populations in Adams and Valley Counties of west-central Idaho (Figure 44). Between about 1980 and 1997, seven populations were known to have become extirpated.

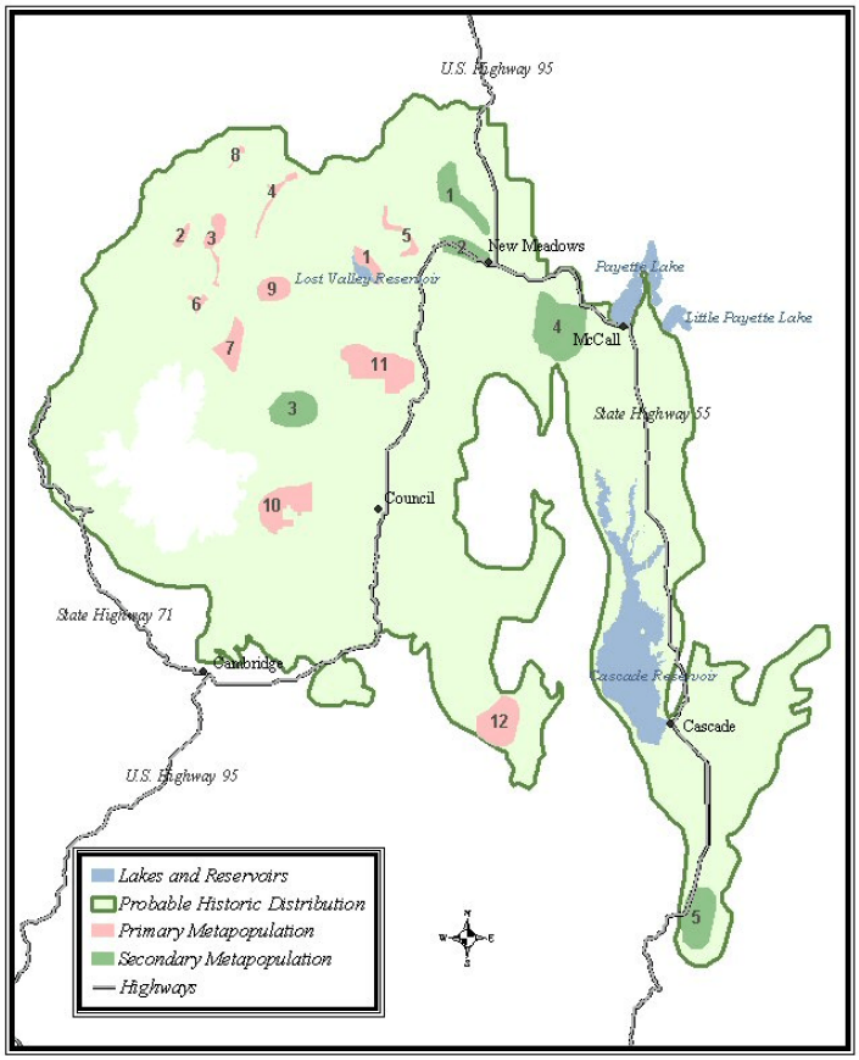

Figure 44. Map of present northern Idaho ground squirrel occupation. Site locations are where ground squirrels were located.

Threats

The primary threat to the northern Idaho ground squirrel is meadow invasion by conifers. Fire exclusion and the dense regrowth of conifers resulting from past logging activities have significantly reduced meadow habitats suitable for these ground squirrels over the past 40 years. As the amount of suitable meadow habitat on public and private lands has been reduced, northern Idaho ground squirrel dispersal corridors have been reduced or eliminated, further constricting the subspecies into smaller isolated areas.

Recreational shooting and natural predation are also thought to be a threat given the small, fragmented populations.

3.3.9 Olympia, Roy Prairie, Tenino, and Yelm Pocket Gopher

As summarized in USFWS (2016a), and at:
https://www.fws.gov/wafwo/articles.cfm?id=149489588.

Listing History

These species of Mazama Pocket gopher were originally considered a candidate for listing October 30, 2001, and a final rule listing the species as threatened was published April 9, 2014, along with a critical habitat designation.

Life History/Biological requirements

Mazama pocket gophers are well adapted for life underground. They have short tubular bodies and strong arms equipped with long pointed claws that allow them to move a tremendous amount of dirt, which brings seeds in the soil to the surface and provides a place for plants to germinate. All of their teeth grow continuously throughout their lives, because they use their teeth along with their long curved claws to sift the roots of plants out of the dirt as they dig their tunnels. Although their vision is poor, their highly sensitive tails may assist in navigation through tunnels. They use their cheek pouches to transport food and nesting material to special caches in their tunnel systems, which are vital to their survival, since they do not hibernate during winter months, but stay active all year long. Pocket gophers even have a special way to deal with waste: they use a tiny den in their tunnel system as a latrine and when the time comes, they block off the tunnel, which in turn enriches the soil with nutrients.

Pocket gophers remain in their home ranges year round. The average home range size likely varies based on factors such as soil type, climate, and density and type of vegetative cover.

Mazama pocket gophers breed from March through July, and young are reared with adults until September. Most young do not survive to breeding age due to high predation rates. Most depredation of subterranean rodents occurs when they are surface feeding, pushing soil out of burrows, or dispersing, especially young of the year that are inexperienced at avoiding predators. Juvenile dispersal occurs each year and in each direction from natal sites (unless there are barriers). Dispersal occurs across

varied cover types. This dispersal pattern allows for colonization of unoccupied sites, increasing density on occupied sites, and a constantly shifting mosaic of occupied sites.

Distribution and Critical Habitat

Critical habitat was designated for Olympia, Roy Prairie, Tenino, and Yelm pocket gophers April 9, 2014; however, no spatial information was published for the Roy Prairie pocket gopher. These species are regionally endemic subspecies of the Mazama pocket gopher found only in the State of Washington. The Olympia, Tenino, and Yelm pocket gophers are only found in Thurston County and the Roy Prairie pocket gopher is only found in Pierce County (Figure 45).

Distribution of these four subspecies of the Mazama pocket gopher in Thurston and Pierce Counties has likely always been somewhat patchy, since these pocket gophers are restricted by the kinds of soils they can use and soil types are naturally patchy in distribution.

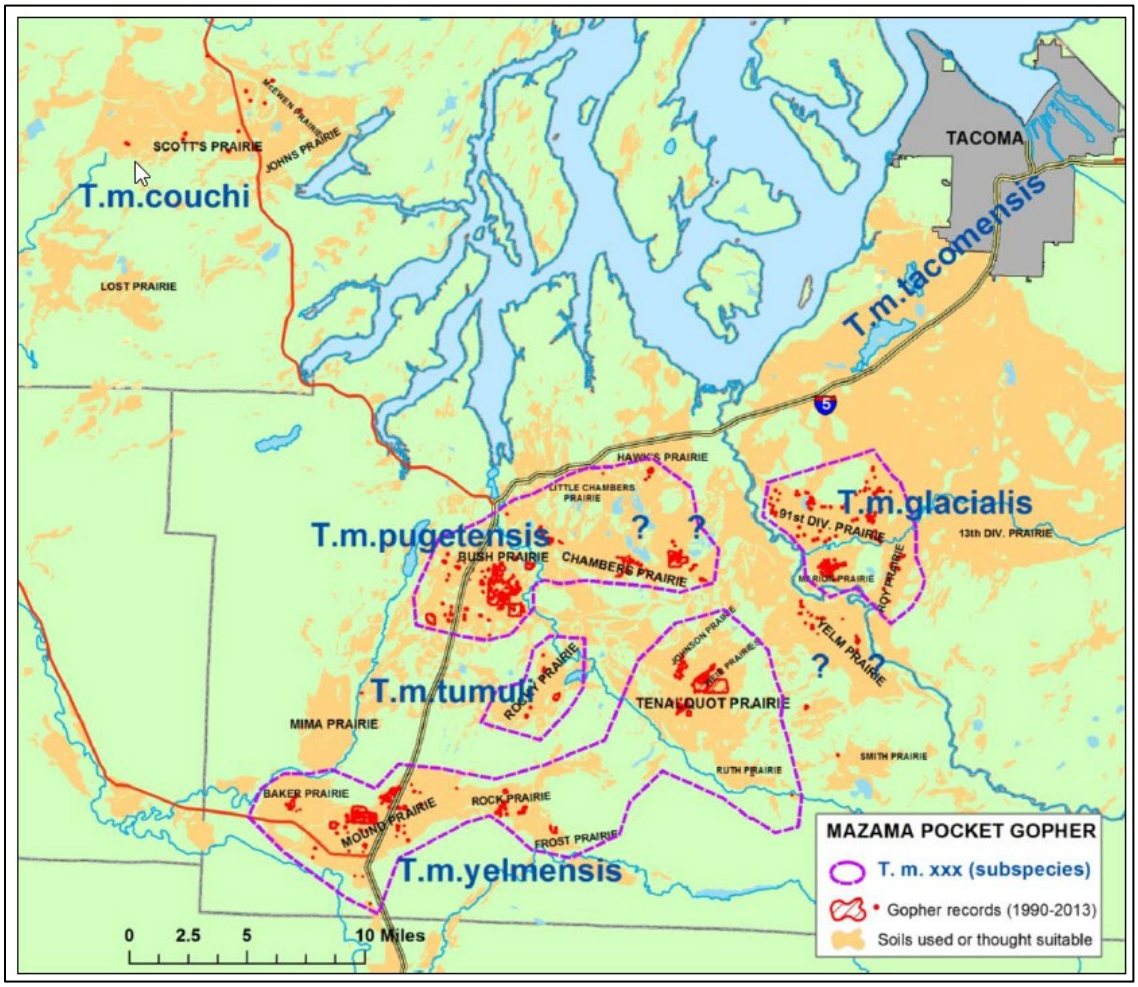

Figure 45. Hypothesized distribution of six subspecies of Mazama pocket gopher in the south Puget Sound region (WDFW 2015).

Threats

The Service has determined that large-scale changes in population and habitat status, including local extirpations and range contraction, threaten the Olympia pocket gopher. Threats to Olympia pocket gopher result from habitat loss and fragmentation (development, succession to unsuitable habitat conditions), loss or curtailment of natural disturbance processes that maintain habitat (e.g. fire), predation, and low genetic diversity. The threats combine to result in the loss of a majority of historical habitat, and the loss of access to suitable habitat.

3.3.10 Red Tree Vole

As summarized in 76 FR 63720.

Listing History

The red tree vole is a candidate for listing and has been considered for listing since November 21, 2012.

Life History/Biological requirements

Red tree voles are found exclusively in conifer forests or in mixed forests of conifers and hardwoods. Throughout most of their range, they are principally associated with Douglas fir for foraging and nesting. However, their nests have also been documented in Sitka spruce (*Picea sitchensis*), grand fir (*Abies grandis*), western hemlock, Pacific yew (*Taxus brevifolia*), and non-conifers such as bigleaf maple (*Acer macrophyllum*) and golden chinquapin. Tree vole nests are located in the forest canopy and are constructed from twigs and resin ducts discarded from feeding, as well as fecal pellets, lichens, dead twigs, and conifer needles.

Where researchers actually measured the canopy cover of stands used by red tree voles indicate the minimum canopy cover requirements of red tree voles are much higher, on the order of 53 to 66%. Tree voles are unique in that they feed exclusively on conifer needles and the tender bark of twigs that they harvest from conifers. In most of their range, they feed primarily on Douglas fir.

Females breed throughout the year, with most reproduction occurring between February and September. Red tree vole litter sizes are among the smallest compared to other rodents of the same subfamily, averaging 2.9 young per litter (range 1 to 4).

Distribution and Critical Habitat

Critical habitat has not been designated for the red tree vole. Tree voles are endemic to the humid, coniferous forests of western Oregon and northwestern California. The red tree vole occurs in western Oregon from below the crest of the Cascade Range to the Pacific coast, with a geographic range covering approximately 16.3 million ac (6.6 million ha) across multiple ownerships (Figure 46). The red tree vole has not been found north of the Columbia River.

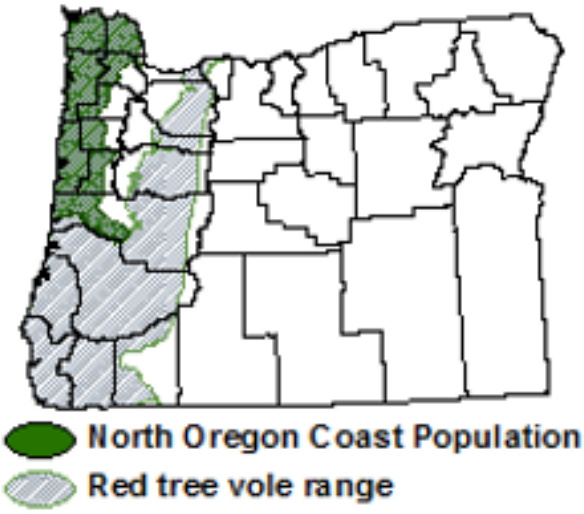

Figure 46. Range of the red tree vole in Oregon (Huff 2016).

Threats

Habitat loss appears to at least partly explain the apparent reduction in tree vole numbers, both range-wide and within the DPS and may be correlated with logging. Private lands comprise more than 60% of the DPS, and most of the projected future timber harvest in the Oregon Coast Range is anticipated to come from these lands. This is particularly problematic because red tree voles are considered habitat specialists and are strongly associated with large, relatively more contiguous areas of conifer forests with late successional characteristics; they are not adapted to fragmented or patchy habitats.

3.3.11 Woodland Caribou

<u>As summarized in USFWS (1994).</u>

Listing History

On January 14, 1983 the Secretary of the Interior listed the Selkirk population as endangered under an emergency rule. The rule expired on September 12, 1983. A second emergency rule was published October 25, 1983 and the final rule published February 29, 1984.

Life History/Biological requirements

Unlike the more familiar barren ground caribou, woodland caribou usually remain in relatively small, in-cohesive groups. In the Selkirks, group size ranges from single females during calving season to groups of approximately 25 during late winter. The largest group sizes are encountered during rut and late winter, whereas spring and summer groups are generally small (2-5 individuals).

The food habits of woodland caribou are unique in the deer family. Although caribou eat a wide range of foods, winter foraging is limited almost exclusively to arboreal lichens (*Alectoria* spp. and *Bryoria* spp.). Selkirk caribou generally depend on arboreal lichens for up to 6 months of the year. During the remainder of the year, Selkirk caribou feed extensively on huckleberry leaves, Sitka valerian (*Valeriana sitchensis*), boxwood (*Pachistima myrsinites*), and smooth woodrush (*Luzula hitchcockii*).

Caribou have a low reproductive rate. Females give birth to their first calf generally at age 3. Gestation is 227-229 days, and calves are born in May or June. Pregnant females seek high elevation ridges to calve, possibly as an anti-predator strategy.

Distribution and Critical Habitat

Critical habitat was designated for the Selkirk Mountain population November 28, 2012. Prior to 1900, woodland caribou were distributed throughout much of Canada, and the northeastern, northcentral, and northwestern conterminous United States. Caribou in Idaho historically occurred as far south as the Salmon River. Since the 1960s the last remaining woodland caribou population in the United States has restricted its range to the Selkirk Mountains of northeastern Washington, northern Idaho, and southeastern British Columbia (Figure 47).

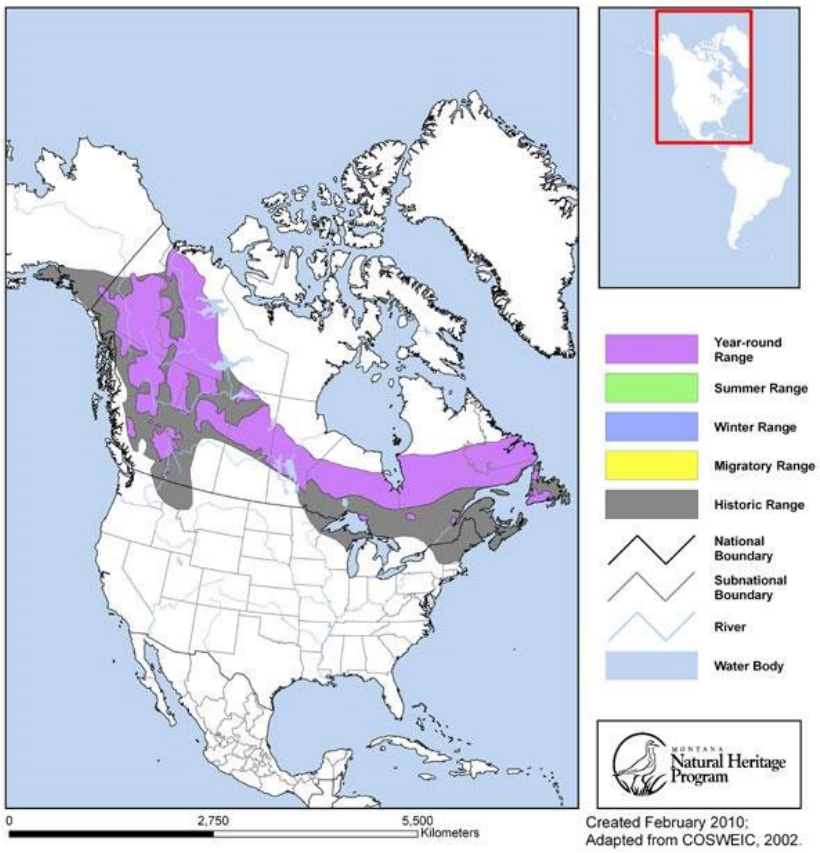

Figure 47. Approximate woodland caribou range in North America.

Threats

Woodland caribou are ranked among the most critically endangered mammals in the U.S. Poaching and accidental killing while hunting poses a threat and research conducted in the 1980s suggests the effects of predation on caribou populations may be more significant than once thought.

Timber harvest alters caribou habitat and creates additional access which increases potential for mortality. Logging can potentially affect caribou habitat by eliminating escape (security) cover, migration corridors, and lichen production. Although food availability is probably not now limiting this caribou population, long-term population survival will partially depend on adequate lichen production and availability. Additionally, timber harvest may alter historic predator and prey densities, thereby exacerbating the predation issue.

Fishes

3.3.12 Borax Lake Chub

As summarized in USFWS (1987).

Listing History

Because of its confined distribution and habitat destruction, the Borax Lake chub was listed as endangered on emergency rule May 28, 1980. The species was proposed for permanent protection October 16, 1980 with a final rule published October 5, 1982 along with critical habitat designation.

Life History/Biological requirements

Although first collected in 1937, the Borax Lake chub was not described as a new species until 1980. The chub descended from the Alvord chub, which originated in Lake Alvord. Over time, lake levels fluctuated, then receded, stranding native fishes in springs, lakes, and creeks. It is thought that due to environmental conditions in the waters of Alvord Lake remnant, Borax Lake that the Borax Lake chub rapidly differentiated into their own species.

Borax Lake is approximately 0.6 ft (19 cm) deep on average and has limited temperature fluctuation. Because of Borax Lake's relatively constant warm environment, chub spawn throughout the year with a peak in March – April. Some evidence exists that a second spawning may occur as well.

Borax Lake chub are opportunistic omnivores feeding on diatoms, chironomids, dipterans, and microcrustaceans in spring. Terrestrial insects are important food sources during summer.

Distribution and Critical Habitat

Critical habitat was designated for the Borax Lake chub October 5, 1982. The Borax Lake chub is endemic to Borax Lake and associated wetlands in the Alvord Basin, Harney County, Oregon (Figure 48).

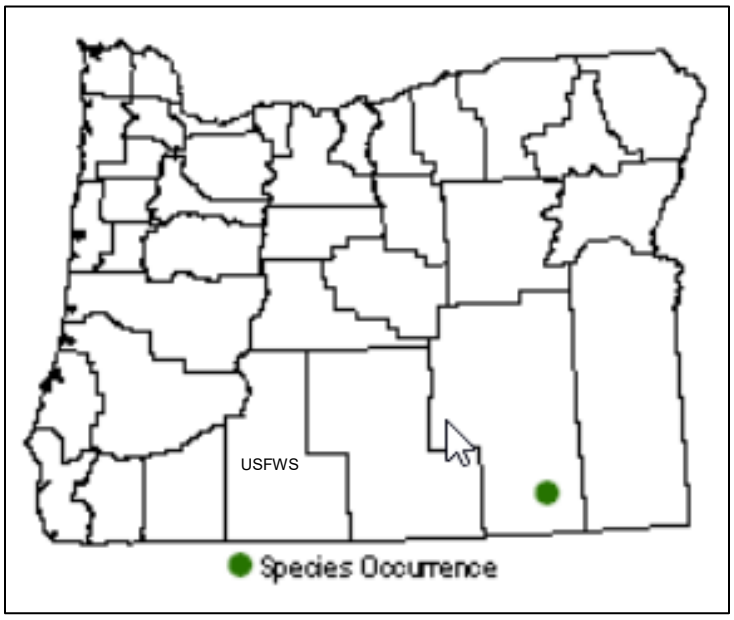

Figure 48. Borax Lake chub occurrence in Oregon.

Threats

Habitat destruction is a critical threat. Mineral and energy exploration on surrounding federal lands threatens to interfere with the flow of springs feeding the lake. Borax Lake sits atop sodium-borate salts deposited by spring flows. The deposit of salts around the shoreline have built up the lake elevation by 32.8 ft (10 m), further isolating the chub from surrounding waters.

3.3.13 Bull Trout

Listing History

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

Life History/Biological requirements

Individual bull trout may exhibit resident or migratory life history strategies. Resident bull trout carry out their entire life cycle in the stream in which they spawn and rear. Migratory bull trout spawn in tributary streams, but eventually travel to larger streams (or lakes) where they mature. Habitat components that appear to influence bull trout

distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates and migratory corridors (with resting habitat). All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders and deep pools (Wydoski and Whitney 2003).

Bull trout normally reach maturity in four to seven years and may live as long as twelve years (Wydoski and Whitney 2003). Migratory bull trout may travel over one hundred miles to their spawning grounds. They generally spawn from August to November during periods of decreasing water temperatures. Egg incubation is normally 100 to 145 days and fry remain in the substrate for several months.

Bull trout are opportunistic feeders. Their diet requirements vary depending on their size and life history strategy. Juvenile bull trout prey on insects, zooplankton and small fish while adults and migratory bull trout are dominantly piscivorous.

Distribution and Critical Habitat

Bull trout critical habitat was designated on October 18, 2010. In the Columbia River Basin, bull trout historically were found in about 60% of the basin. They now occur in less than half of their historic range. Populations remain in portions of Oregon, Washington, Idaho, Montana, and Nevada (Figure 49). Physical and biological features of bull trout critical habitat are listed in Table 6.

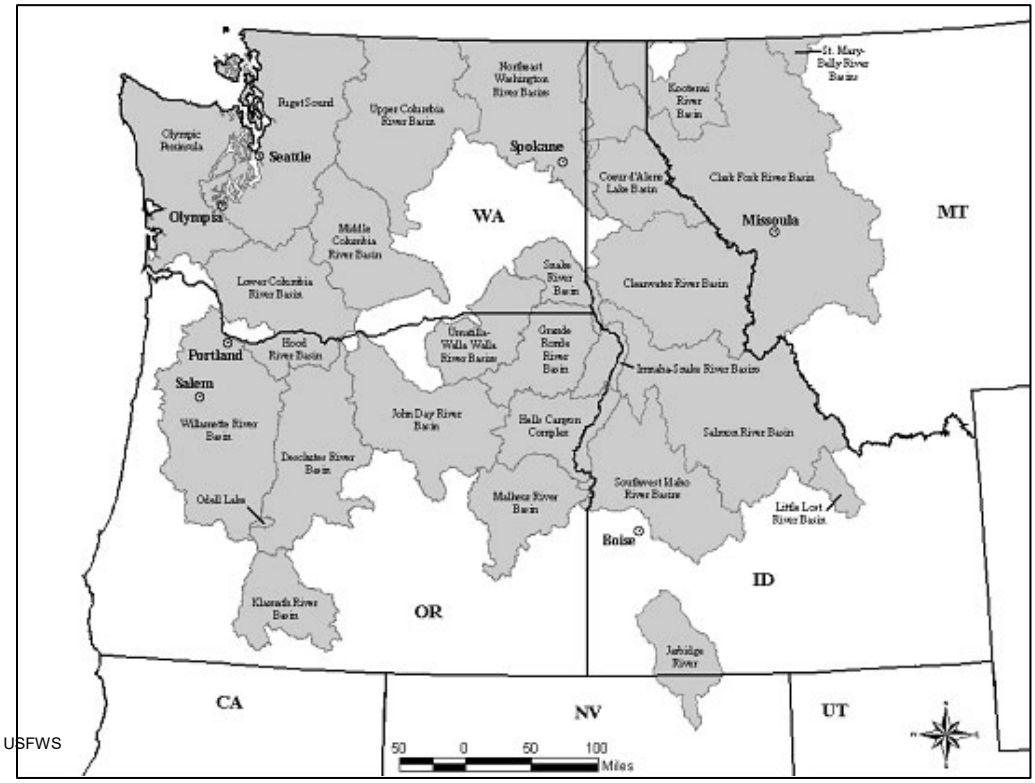

Figure 49. Bull trout distribution and recovery units in the northwest U.S.

Threats

While habitat degradation and loss, connectivity among populations, and nonnative fishes are identified among the primary threats to bull trout.

Table 6. Physical and Biological Features of critical habitat designated for bull trout.

PBFs		
1	Water Quality	Springs, seeps, groundwater sources, and subsurface water connectivity (hyporehic flows) to contribute to water quality and quantity and provide thermal refugia.
2	Migration Habitat	Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
3	Food Availability	An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4	Instream Habitat	Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these environments, with features such as large wood, side channels, pools, undercut banks and clean substrates, to provide a variety of depths, gradients, velocities, and structure.
5	Water Temperature	Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6	Substrate Characteristics	In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 in.) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.
7	Stream Flow	A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8	Water Quantity	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9	Nonnative Species	Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

3.3.14 Dolly Varden

As summarized at https://wdfw.wa.gov/fishing/char/.

Listing History

January 9, 2001, the USFWS proposed to list the Dolly Varden as threatened based on the similarity of appearance to threatened bull trout.

Life History/Biological requirements

Dolly Varden are very similar to bull trout, and some scientists argue that there is no distinction between the two fishes. They prefer deep pools of cold rivers, lakes, and reservoirs. Streams with abundant cover (cut banks, root wads, and other woody debris) and clean gravel and cobble beds provide the best habitat. Their preferred summer water temperature is generally less than 54.8 °F (12.7 °C), while temperatures less than 40 °F (4.4 °C) are tolerated. Spawning during fall usually starts when water temperatures drop between 39.2-44.6 °F (4-7 °C). Cold, clear water is required for successful reproduction.

Dolly Varden have complex, but similar life histories. Anadromous, fluvial, and resident populations often journey long distances in summer and fall, migrating to the small headwater streams where they hatched to spawn. Mature adults with these characteristics are generally four to seven years old and 18-22 in (45.7-55.8 cm) in length when they make their first spawning run.

The adults on their spawning runs can undergo some impressive journeys. Fish in the Skagit River system may travel more than 115 mi (185 km) from the river mouth and ascend to an elevation of more than 3,000 ft (914 m). The spawning area may be upstream of areas used by any other anadromous species.

Newly-hatched fish emerge from the gravel the following spring. Those that migrate down to the main rivers, reservoirs and saltwater normally leave the headwater areas as two year olds. But complicating the picture even more are the resident stream populations that exhibit limited movements, living their entire lives in the same stretch of headwater stream. These fish may not mature until they are seven to eight years old, and rarely reach sizes greater than 14 in (35.5 cm) in length. Biologists have observed these local residents spawning side-by-side with their much larger anadromous kin.

Dolly Varden are opportunistic feeders, eating aquatic insects, shrimp, snails, leeches, fish eggs and fish.

Distribution and Critical Habitat

No critical habitat has been designated for Dolly Varden. Dolly Varden are more abundant in the north Puget Sound area (Figure 50), but statewide their populations are low and in some cases declining.

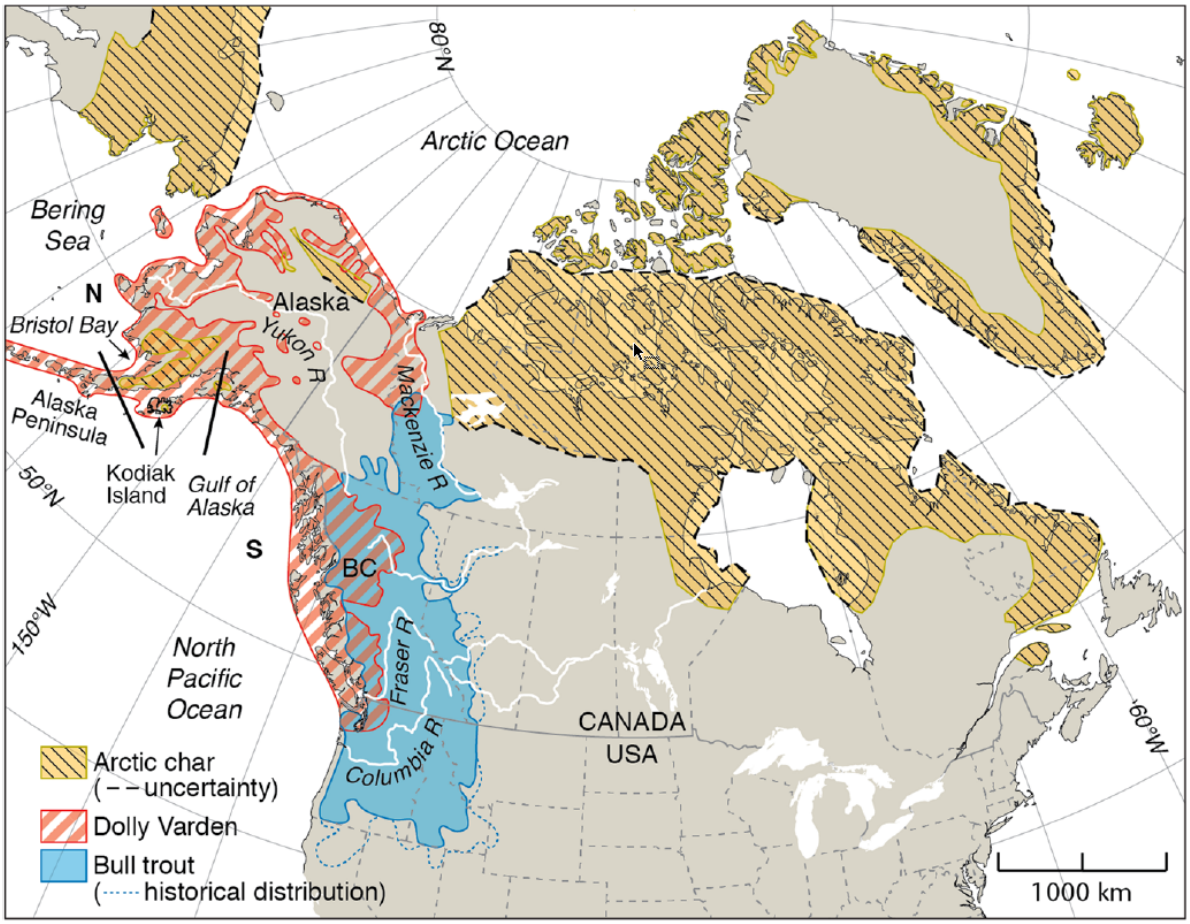

Figure 50. Range of the Dolly Varden, bull trout, and arctic char in the Pacific Northwest (Taylor 2015).

Threats

Habitat loss and over-harvest have both contributed to the decline of bull trout and Dolly Varden in Washington. Protection of spawning and juvenile rearing habitat, regulating harvest, and controlling poaching are required in order to maintain or increase populations. The threat of global warming is especially alarming for Dolly Varden because of limited areas with low enough temperatures for spawning. Non-native fishes such as brook trout also pose a threat through resource competition and potentially genetic dilution through hybridization.

3.3.15 Foskett Speckled Dace

As summarized in USFWS (1998a).

Listing History

Foskett speckled dace was listed as threatened in the Federal Register on March 28, 1985. On January 4, 2018, the Service proposed to delist the Foskett speckled dace

due to recovery. A delisting final rule has not been published as of the drafting of this BA.

Life History/Biological requirements

As of 1997 the USFWS has no information about the biology/ecology of the Foskett speckled dace. The only habitat information available regards plant species found around the springs which include rushes, sedges, Mimulus, Kentucky bluegrass (*Poa pretensis*), thistle, and saltgrass (*Distichlis spicata*). Foskett Spring is a coolwater spring with temperatures recorded at a constant 64.4 °F (18°C) over a 2 year period [A. Munhall, pers. comm., 1997 (as cited in USFWS 1998a)]. No information is available on growth rates, age of reproduction, or behavioral patterns.

Distribution and Critical Habitat

No critical habitat has been designated for Foskett speckled dace. Foskett speckled dace are native to the Alkali subbasin in south-central Oregon and were probably distributed throughout prehistoric (approximately 12,000 years ago) Coleman Lake during times that it held substantial amounts of water. As the lake dried, the salt content of the lake water increased. Suitable habitat would have been reduced from a large lake to any spring systems that provided enough habitat for survival.

Springs that remain within the vicinity of Coleman Lake include Foskett Spring and Dace Spring (Figure 51). Both springs are extremely small and shallow with limited habitat for fish. Foskett Spring has the only known native population of Foskett speckled dace.

Threats

The major threats to the continued existence of the native fishes in the Warner Basin and Alkali Subbasin are 1) human induced stream channel and watershed degradation; 2) irrigation diversion practices; and 3) predation and competition from introduced fishes. These three factors have worked both independently and in unison to threaten the viability of the species discussed in this plan and probably affect other native aquatic and riparian associated species across the interior basins of Oregon.

Site specific and current management of the Foskett speckled dace spring habitat areas appears to be maintaining stable population numbers.

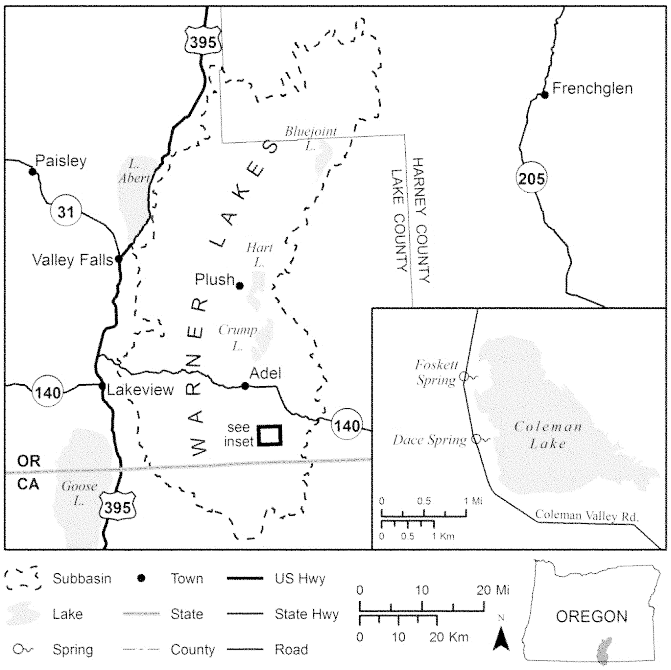

Figure 51. Distribution of Foskett speckled dace in southern Oregon.

3.3.16 Hutton Tui Chub

<u>As summarized in USFWS (1998a)</u>.

Listing History

The Hutton tui chub was listed as threatened in the Federal Register on March 28, 1985.

Life History/Biological requirements

There is very little information regarding the ecology of the Hutton tui chub. Bills (1978) examined gut content and found the Hutton tui chub to be omnivorous with a majority of food eaten being filamentous algae. It appears that dense aquatic algae is needed for spawning and rearing of young [J. Williams pers. comm., 1995 (as cited in USFWS 1998a)]. No information is available on growth rates, age of reproduction or behavioral patterns.

Distribution and Critical Habitat

No critical habitat has been designated for the Hutton tui chub. In 1977 the distribution of the Hutton tui chub included two springs in the Alkali Subbasin, Hutton Spring, and an unnamed spring (Figure 52). Hutton Spring has been diked and has a pool approximately 39 ft (12 m) wide, 14.7 ft (4.5 m) deep and is surrounded by rushes. The unnamed spring is 546.8 yards [yds (500 m)] to the southeast of Hutton Spring.

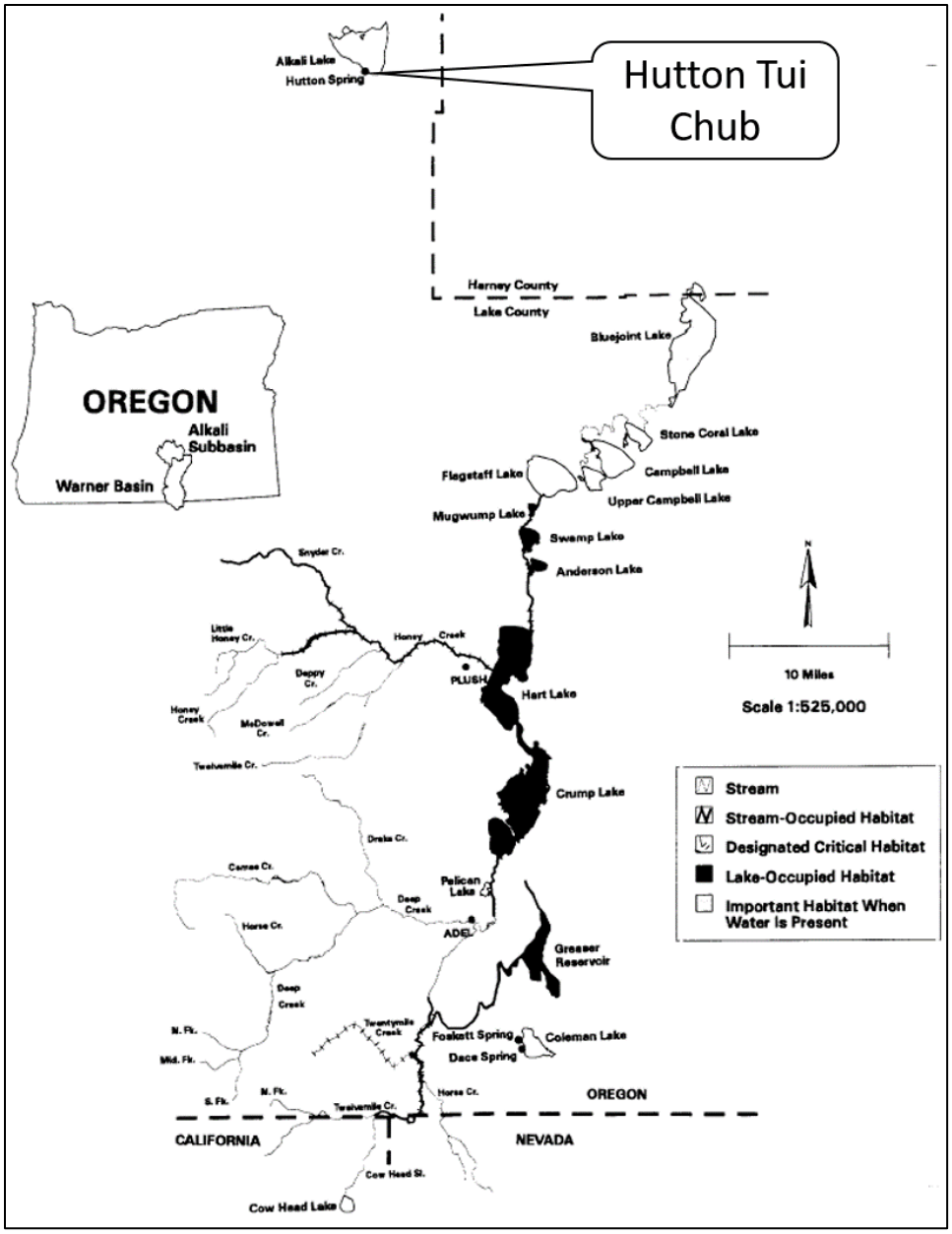

Figure 52. Hutton tui chub distribution within the Warner and Alkali Basins of southern Oregon.

Threats

The major threats to the continued existence of the native fishes in the Warner Basin and Alkali Subbasin are 1) human induced stream channel and watershed degradation; 2) irrigation diversion practices; and 3) predation and competition from introduced fishes. These three factors have worked both independently and in unison to threaten the viability of the species discussed in this plan and probably affect other native aquatic and riparian associated species across the interior basins of Oregon.

Site specific and current management of the Hutton tui chub spring habitat areas appears to be maintaining stable population numbers.

3.3.17 Lahontan Cutthroat

As summarized in USFWS (1995a).

Listing History

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

Life History/Biological requirements

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

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

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

Distribution and Critical Habitat

No critical habitat has been designated for Lahontan cutthroat trout. The Lahontan cutthroat is an inland subspecies of cutthroat trout endemic to the physiographic Lahontan basin of northern Nevada, eastern California, and the Coyote Lake basin in southeast Oregon (Figure 53). Lahontan cutthroat trout currently occupy between 155 and 160 streams; 123 to 129 streams within the Lahontan basin and 32 to 34 streams outside the basin, with approximately 482 mi (775.7 km) of occupied habitat.

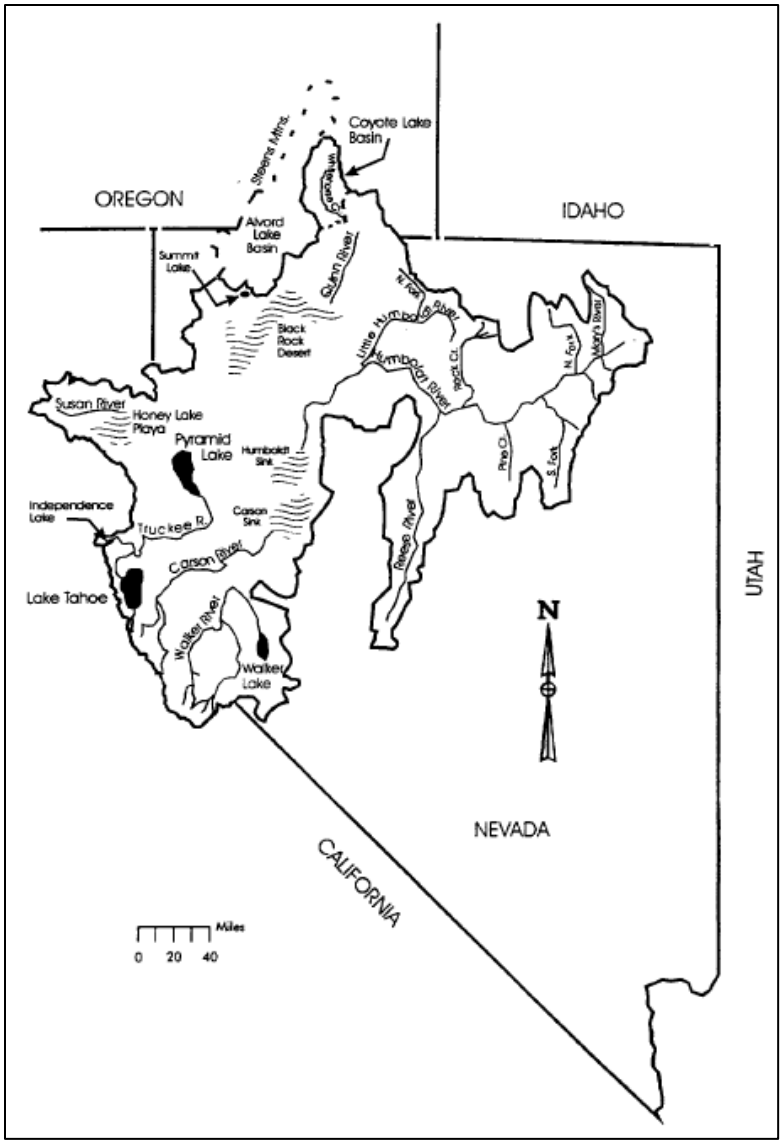

Figure 53. Lahontan cutthroat distribution.

Threats

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

3.3.18 Lost River and Shortnose Sucker

As summarized in USFWS (2012b).

Listing History

The USFWS listed Lost River and shortnose suckers as endangered throughout their entire range on July 18, 1988.

Life History/Biological requirements

Lost River and shortnose suckers have complex life histories that include stream/river, lake, marsh, and shoreline habitats. Both spawn during the spring over gravel substrates in habitats less than 4.3 ft (1.3 m) deep in tributary streams and rivers. A smaller but significant number of Lost River sucker also spawn over gravel substrates at shoreline springs along the margins of Upper Klamath Lake.

Larvae spend relatively little time in rivers or streams before drifting downstream to the lakes by mid-summer. Larval habitat is generally along the relatively shallow shoreline where emergent vegetation provides cover from predators, protection from currents and turbulence, and abundant food (including zooplankton, macroinvertebrates, and periphyton). Juvenile suckers utilize a wide variety of near and off-shore habitat including emergent wetlands and non-vegetated areas. They increasingly move off-shore into the lake as they grow. Adults occupy open water habitats.

Distribution and Critical Habitat

Critical habitat was designated for the Lost River and shortnose sucker on December 11, 2012. Regularly spawning populations now occur only in Upper Klamath Lake, Clear Lake Reservoir, and Gerber Reservoir (Figure 54).

Threats

A main factor cited at the time of listing as contributing to population declines was loss or degradation of spawning, rearing, and adult habitats. Populations declined prior to listing due to habitat loss of approximately 75% of historic range, restricted access to spawning habitat, overharvest, and increased rates of mortality resulting from entrainment in water management structures and severely impaired water quality.

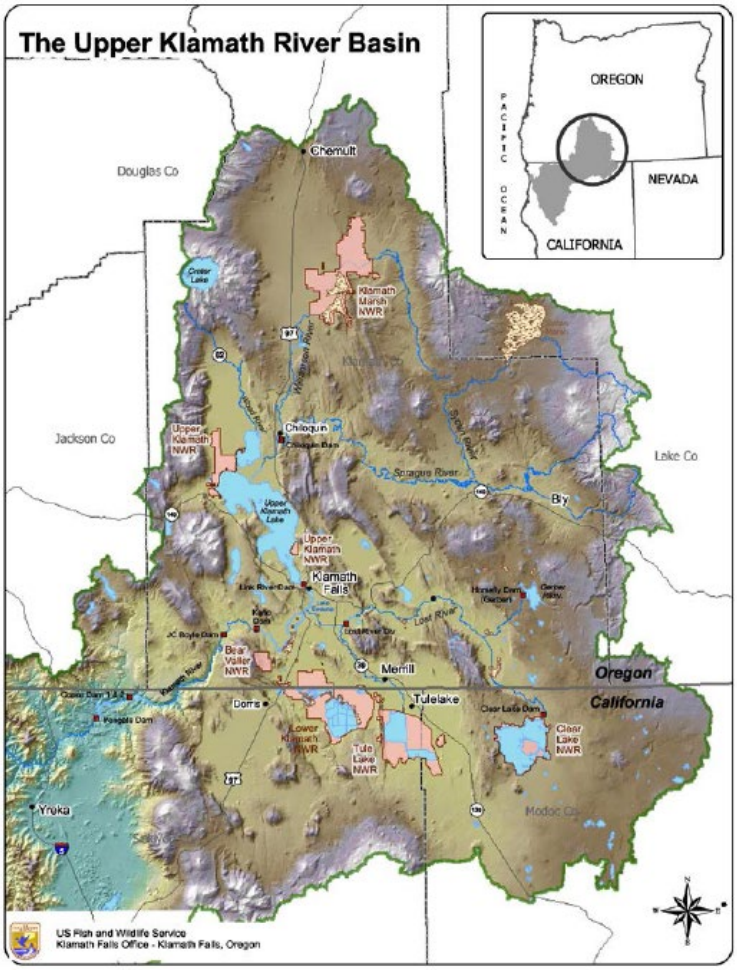

Figure 54. Distribution of the Lost River and shortnose sucker in the Klamath River Basin.

3.3.19 Pallid Sturgeon

<u>As summarized in USFWS (2014).</u>

Listing History

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

Life History/Biological requirements

The Pallid sturgeon is native to the Missouri and Mississippi rivers and adapted to the pre-development habitat conditions that historically existed in these rivers. These conditions generally can be described as large, free-flowing, warm-water, and turbid rivers with a diverse assemblage of dynamic physical habitats. Floodplains, backwaters,

chutes, sloughs, islands, sandbars, and a dynamic main channel formed the large-river ecosystem that met the habitat and life history requirements of Pallid Sturgeon and other native large-river fishes.

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

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

Distribution and Critical Habitat

No critical habitat has been designated for the Pallid sturgeon. Since listing in 1990, wild and hatchery Pallid sturgeon have been documented in the Mississippi and Missouri Rivers (Figure 55).

Threats

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

Figure 55. Distribution of Pallid sturgeon in the Mississippi and Missouri Rivers.

3.3.20 Warner Sucker

<u>As summarized in USFWS (1998a)</u>.

Listing History

The Warner sucker was listed as threatened September 27, 1985 along with designated critical habitat.

Life History/Biological requirements

Lake and stream adaptations of Warner sucker have been documented in the Warner basin. Lake-dwelling fish grow larger than stream-dwelling fish. Lake-dwelling suckers occupy the lakes and, possibly, deep areas in the low elevation creeks, reservoirs, sloughs, and canals. At the time of drafting the recovery plan, only stream-dwelling suckers exhibited frequent recruitment indicated by a high percentage of young of the year (YOY) and juveniles. Lake-dwelling suckers were skewed towards larger, older adults (8 to 12 years old) with no juveniles and few younger adult fish.

Warner suckers prefer pools with undercut banks, large beds of aquatic macrophytes (usually greater than 70% of substrate covered), root wads or boulders, a surface to bottom temperature differential of at least 35.6 °F (2°C) at low flows, a maximum depth greater than 5 ft (1.5 m), and overhanging vegetation.

The feeding habits of the Warner sucker depend to a large degree on habitat and life history stage, with adult suckers becoming more generalized than juveniles and YOY. Young suckers feed on planktonic crustaceans, but as they mature, they develop a subterminal mouth and become primarily benthic feeders eating diatoms, filamentous algae, and detritus.

Spawning usually occurs in April and May in streams, although variations in water temperature and stream flows may result in either earlier or later spawning. Temperature and flow cues appear to trigger spawning, with most spawning taking place at 57-68 °F (14-20°C) when stream flows are relatively high. Suckers spawn in sand or gravel beds in slow pools.

Distribution and Critical Habitat

Critical habitat was designated September 27, 1985. Surveys conducted between 1977 and 1991 have shown that when adequate water is present, Warner suckers may inhabit all the lakes, sloughs, and potholes in the Warner Valley, south-central Oregon (Figure 56). The documented range of the sucker extended as far north into the ephemeral lakes as Flagstaff Lake during high water in the early 1980's, and again in the 1990's. The sucker population of Hart Lake was intensively sampled to salvage individuals before the lake went dry in 1992.

Threats

The major threats to the continued existence of the native fishes in the Warner Basin and Alkali Subbasin are 1) human induced stream channel and watershed degradation; 2) irrigation diversion practices; and 3) predation and competition from introduced fishes. These three factors have worked both independently and in unison to threaten the viability of the species discussed in this plan and probably affect other native aquatic and riparian associated species across the interior basins of Oregon.

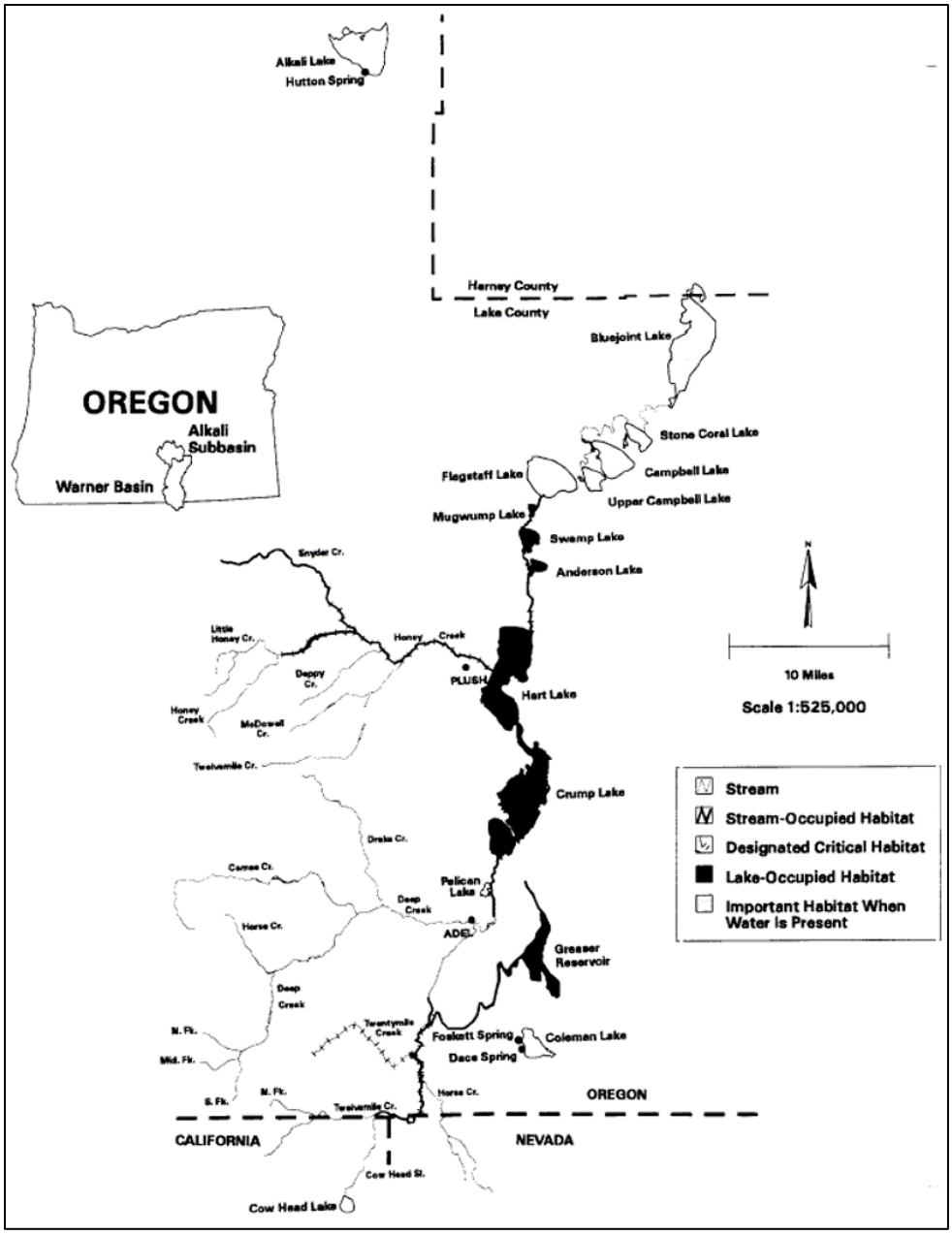

Figure 56. Distribution of the Warner sucker within the Warner and Alkali Basins of southern Oregon.

3.3.21 White Sturgeon

<u>As summarized in USFWS (1999).</u>

Listing History

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

Life History/Biological requirements

The Kootenai River population of white sturgeon became isolated from other white sturgeon in the Columbia River basin during the last glacial age (approximately 10,000 years ago). Once isolated, the population adapted to the predevelopment habitat conditions in the Kootenai River drainage.

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

Distribution and Critical Habitat

Critical habitat was initially designated for white sturgeon September 6, 2001, with a revised designation July 9, 2008. The Kootenai River population is one of several land-locked populations of white sturgeon found in the Pacific Northwest. Although officially termed and listed as the “Kootenai River population of white sturgeon”, this white sturgeon population inhabits and migrates freely in the Kootenai River from Kootenai Falls in Montana downstream into Kootenay Lake, British Columbia, Canada (Figure 57).

Threats

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

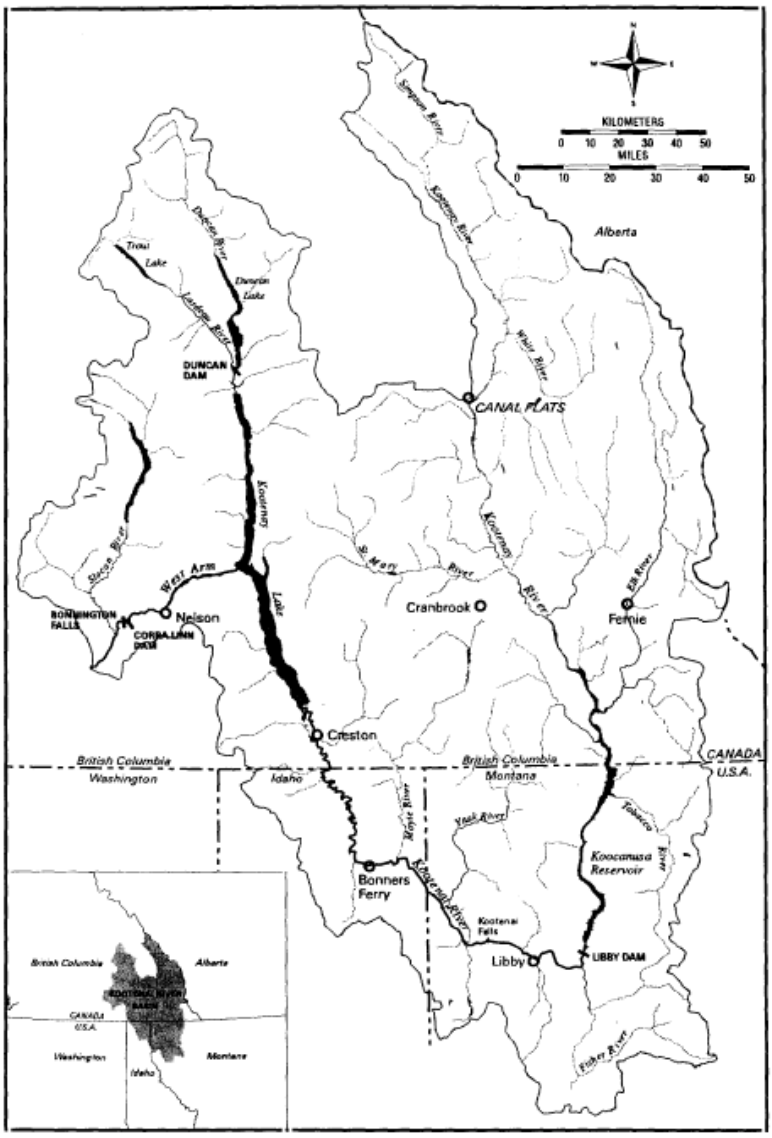

Figure 57. Distribution of Kootenai River white sturgeon.

Birds

3.3.22 Least Tern

<u>As summarized in USFWS (1990).</u>

Listing History

The interior least tern was listed as an endangered species on June 27, 1985 in the States of Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana (Mississippi River and its tributaries north of Baton Rouge), Mississippi (Mississippi River), Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Tennessee, and Texas (except within 80 km of Gulf Coast).

Life History/Biological requirements

Interior least terns spend about 4-5 months at their breeding sites. They arrive at breeding areas from late April to early June. Courtship behavior of least terns is similar throughout North America. Courtship occurs at the nesting site or at some distance from the nest site. Breeding site fidelity is high.

From late April to August they occur primarily on barren to sparsely vegetated riverine sandbars, dike field sandbar islands, sand and gravel pits, and lake and reservoir shorelines. The nest is a shallow and inconspicuous depression in an open, sandy area, gravelly patch, or exposed flat. Small stones, twigs, pieces of wood and debris usually lie near the nest. Least terns nest in colonies or terneries, and nests can be as close as just a few meters apart or widely scattered up to hundreds of meters.

The birds usually lay two or three eggs. The average clutch size for interior least terns nesting on the Mississippi River during 1986-1989 was 2.4 eggs. Egg-laying begins by late May. Both sexes share incubation which generally lasts 20-25 days, but has ranged from 17 to 28 days.

The interior least tern's home range during the breeding season usually is limited to a reach of river near the sandbar nesting site where they feed primarily on fish.

Distribution and Critical Habitat

No critical habitat has been designated for the interior population of the least tern. The interior least tern is migratory and historically bred along the Mississippi, Red and Rio Grande River systems and rivers of central Texas. The breeding range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana. It included the Red, Missouri, Arkansas, Mississippi, Ohio and Rio Grande River systems (Figure 58). Incidental occurrences of least terns in Michigan, Minnesota, Wisconsin, Ohio and Arizona have been reported.

The interior least tern continues to breed in most of the aforementioned river systems, although its distribution generally is restricted to less altered river segments.

Threats

Threats to the survival of the species include the actual and functional loss of riverine sandbar habitat. Channelization and impoundment of rivers have directly eliminated nesting habitat.

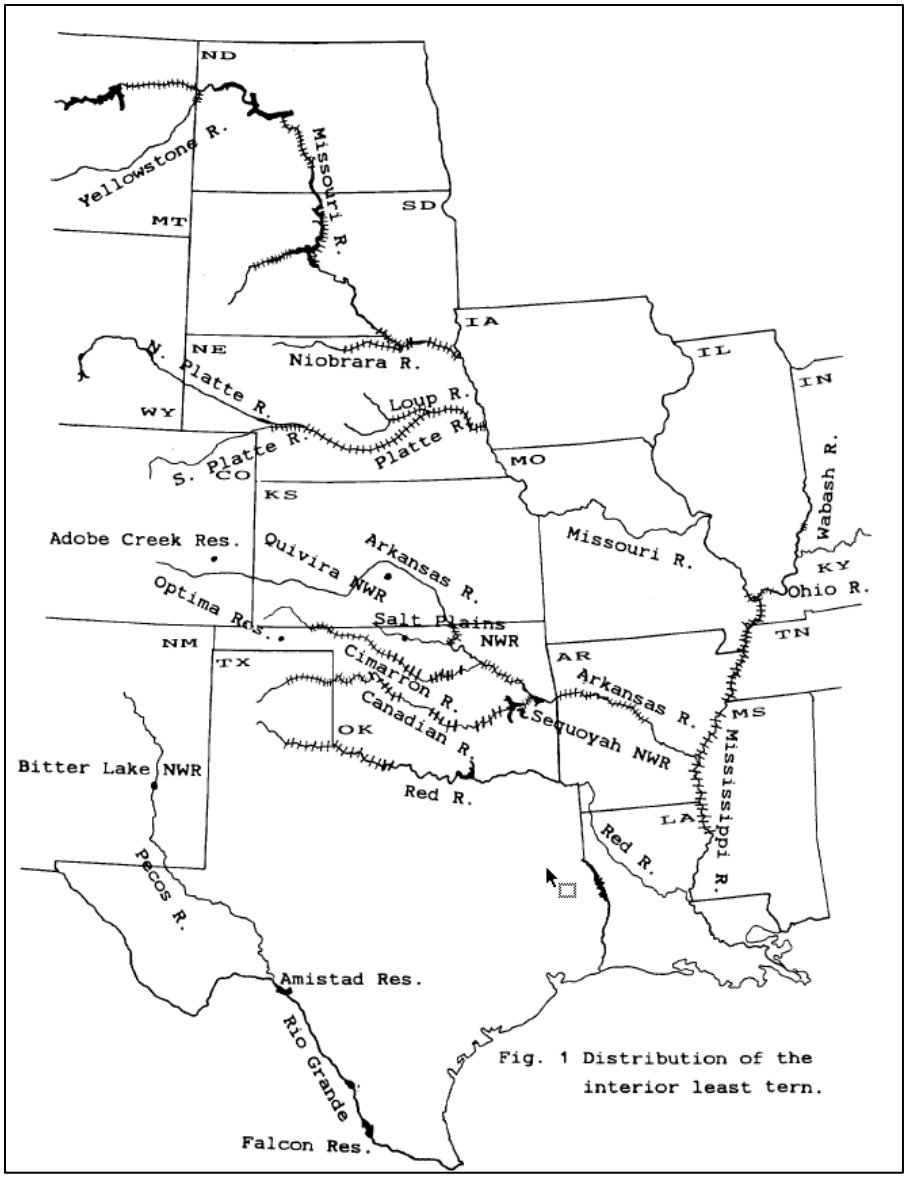

Figure 58. Distribution of interior least tern.

3.3.23 Marbled Murrelet

<u>As summarized in USFWS (1997).</u>

Listing History

Due to the substantial loss and modification of nesting habitat (older forest) and mortality from net fisheries and oil spills, the Washington, Oregon, and California vertebrate population segment of marbled murrelet was federally listed as threatened October 1, 1992.

Life History/Biological requirements

Marbled murrelets use forests that primarily include typical old-growth forests (characterized by large trees, a multistoried stand, and moderate to high canopy closure), but also use mature forests with an old-growth component. Trees must have large branches or deformities for nest platforms, with the occurrence of suitable platforms being more important than tree size alone. Throughout the Pacific Northwest the amount of older forests have decreased substantially due to timber harvest, fires, and wind throw. The earliest possible recovery time for nesting habitat, once lost, is generally 100-200 years.

Specific nesting habitat requirements and life-history strategy, a low reproductive rate, a low current breeding success and recruitment rate (based on juvenile:adult ratios) are likely to yield a decreasing population, which cannot easily recover should numbers be further depleted by additional catastrophic events. Because marbled murrelets feed primarily on fish and invertebrates in nearshore marine waters, they require nearshore marine habitats with sufficient prey resources.

Distribution and Critical Habitat

Critical habitat was designated for the species on May 24, 1996. Marbled murrelets range along the Pacific coast from Alaska to California; the southern end of the breeding range is in central California. Their at-sea distribution becomes more discontinuous in California. Some wintering birds are found in southern California and as far south as northern Baja California, Mexico. Nesting behavior has been documented beyond 50 mi (80 km) inland, though most nesting habitat likely occurs within 50 mi (80 km) of shore throughout the breeding range. Currently, breeding populations are not distributed continuously throughout the forested portion of the Pacific Northwest (Figure 59).

Threats

The principal factor considered to affect the marbled murrelet throughout the southern portion of its range (from British Columbia south to California) is the loss of nesting habitat (older forests). Timber harvest and natural disasters pose the greatest threats as habitat loss is largely permanent.

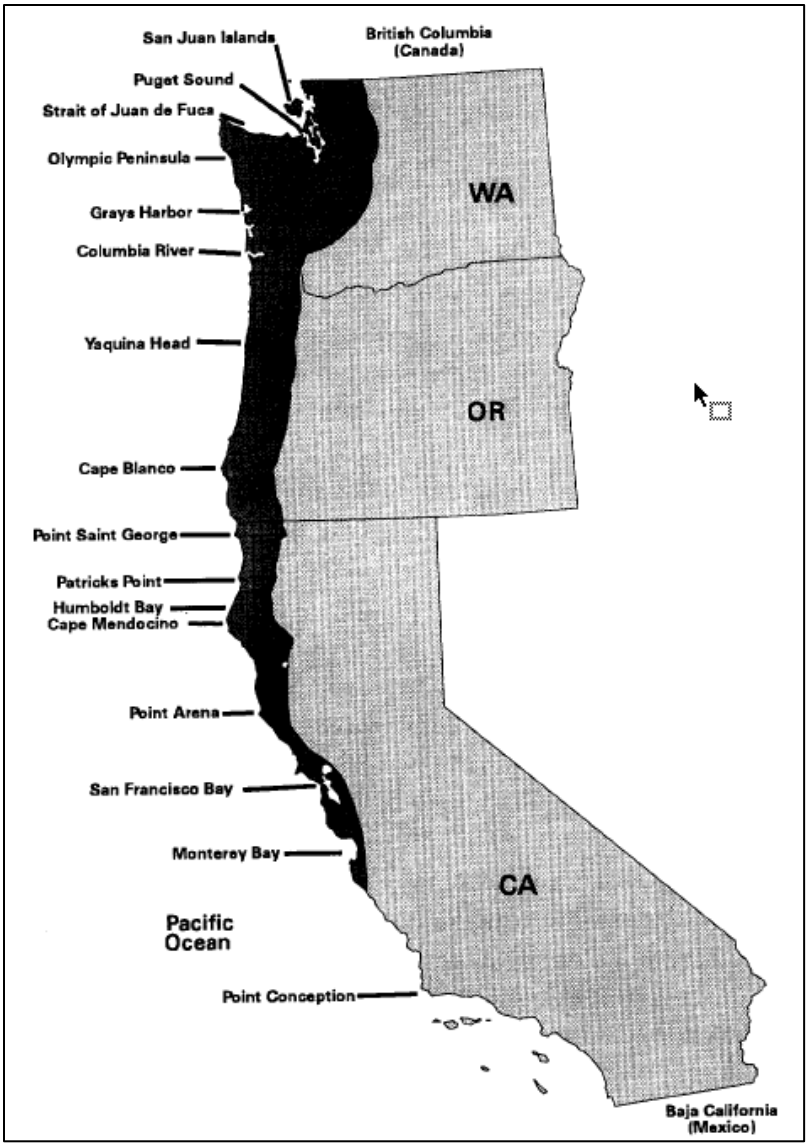

Figure 59. Distribution of marbled murrelet in the Pacific Northwest.

3.3.24 Northern Spotted Owl

<u>As summarized in USFWS (2011c).</u>

Listing History

Northern spotted owl was listed as threatened June 26, 1990.

Life History/Biological requirements

Scientific research and monitoring indicate spotted owls generally rely on mature and old-growth forests because these habitats contain the structures and characteristics required for nesting, roosting, and foraging. Although spotted owls can disperse through

highly fragmented forested areas, the stand-level and landscape-level attributes of forests needed to facilitate successful dispersal have not been thoroughly evaluated or described.

The most important food items for the spotted owl are flying squirrels and woodrats. In areas where woodrats make up the bulk of the diet, the owl has a smaller home range. The spotted owl also eats bats and other owls (Cornell University 2017a).

Distribution and Critical Habitat

Critical habitat was designated January 5, 1992, and most recently revised June 1, 2012. The northern spotted owl ranges from northern California to British Columbia (Figure 60).

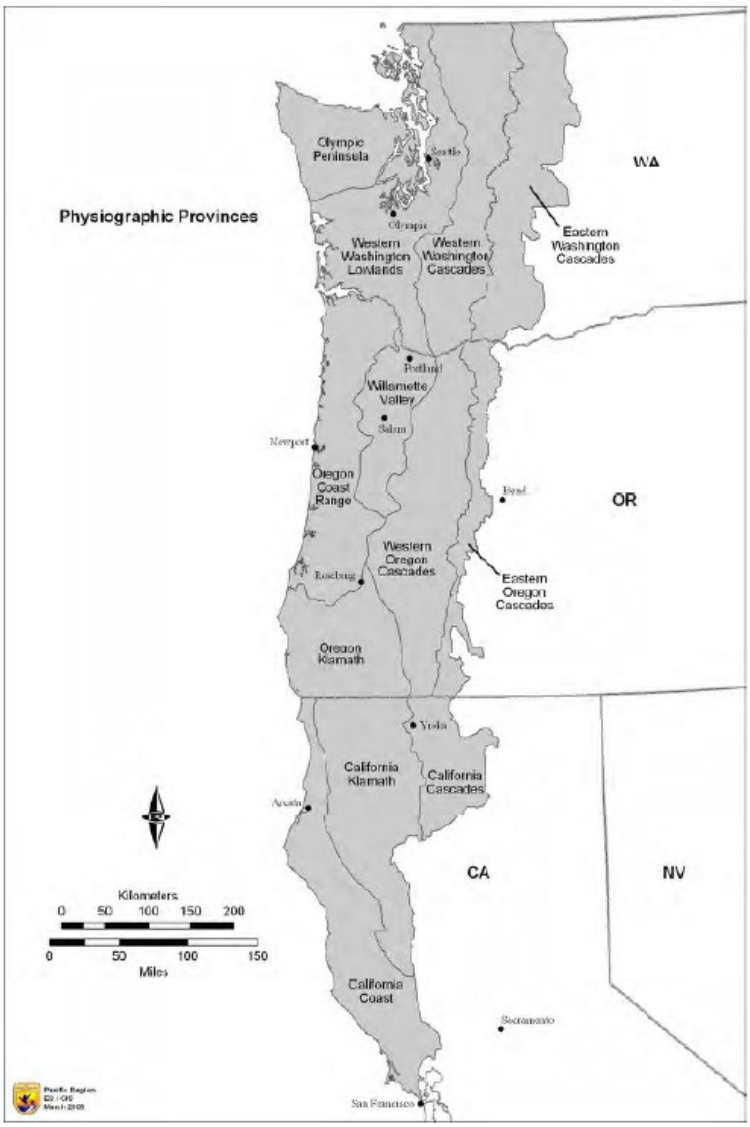

Figure 60. Distribution of the northern spotted owl.

Threats

The spotted owl was listed as threatened throughout its range “due to loss and adverse modification of spotted owl habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms”. More specifically, threats to the spotted owl included low populations, declining populations, limited habitat, declining habitat, inadequate distribution of habitat or populations, isolation of populations within physiographic provinces, predation and competition, lack of coordinated conservation measures, inadequacy of regulatory mechanisms and vulnerability to natural disturbance.

3.3.25 Streaked Horned Lark

<u>As summarized in USFWS (2017b).</u>

Listing History

The streaked horned lark was listed as a threatened species on October 3, 2013.

Life History/Biological requirements

Habitat used by streaked horned larks is generally flat with substantial areas of bare ground and sparse low-stature vegetation primarily composed of grasses and forbs. Suitable habitat is generally 16-17% bare ground and may be even more open at sites selected for nesting. Vegetation height is generally less than 13 in (33 cm). A key attribute of habitat used by larks is open landscape context. Our data indicate that sites used by larks are generally found in open (i.e., flat, treeless) landscapes of 300 ac (121.4 ha) or more.

Horned larks forage on the ground in low vegetation or on bare ground; adults feed on a wide variety of grass and weed seeds, but feed insects to their young. Larks eat a wide variety of seeds and insects and appear to select habitats based on the structure of the vegetation rather than the presence of any specific food plants.

Male streaked horned larks arrive in the Puget lowlands in mid-February, and females arrive by early March. The nesting season for streaked horned larks begins in early April and ends mid- to late August. Clutches range from 1 to 5 eggs, with a mean of 3 eggs. After the first nesting attempt in April, streaked horned larks will often re-nest in late June or early July. Young streaked horned larks leave the nest 8-10 days after hatching, and are cared for by the parents until they are about four weeks old when they become independent.

Horned larks form pairs in the spring and establish territories approximately 2 ac (0.8 ha) in size [range 1.5-2.5 ac (0.6 to 1.0 ha)]. Horned larks create nests in shallow depressions in the ground and line them with soft vegetation. Female horned larks select the nest site and construct the nest without help from the male. Streaked horned larks establish their nests in areas of extensive bare ground, and nests are placed adjacent to clumps of bunchgrass.

Distribution and Critical Habitat

Critical habitat was designated for the streaked horned lark October 3, 2013, for 16 sites; in the Willamette Valley, designated critical habitat is located on the Service's Willamette Valley National Wildlife Refuge Complex at the William R. Finley, Ankeny and Baskett Slough units. The current range and distribution of the streaked horned lark can be divided into three regions: 1) the south Puget Lowlands in Washington; 2) the Washington coast and lower Columbia River islands (including dredge spoil deposition and industrial sites near the Columbia River in Portland, Oregon); and 3) the Willamette Valley in Oregon (Figure 61).

Streaked horned larks currently breed on eight sites in the south Puget Sound. Five of these sites are on Joint Base Lewis McChord: 13th Division Prairie, Gray Army Airfield, McChord Field, and two locations on the 91st Division Prairie – Artillery Impact Area. The largest population of streaked horned larks in Washington breeds at the Olympia Regional Airport.

Most streaked horned larks winter in the Willamette Valley (72%) and on the islands in the lower Columbia River (20%); the rest spend the winter on the Washington coast (8%) or in the south Puget Sound.

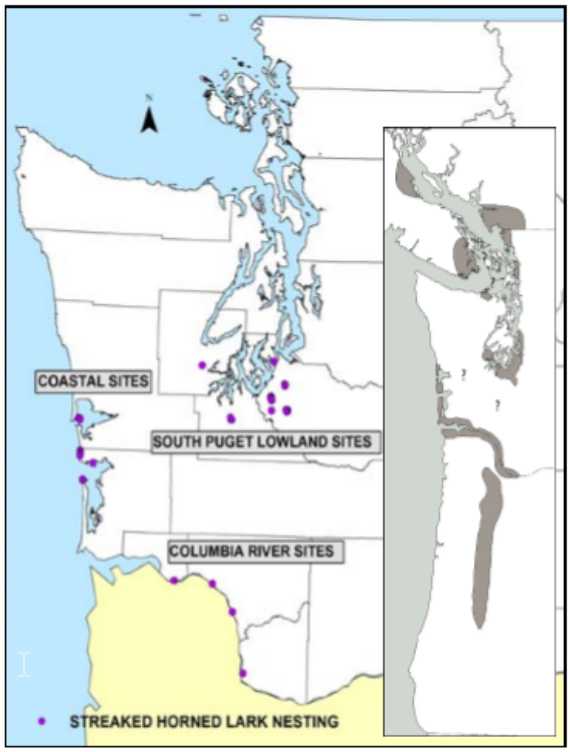

Figure 61. Distribution of the streaked horned lark in Washington (Stinson 2016).

Threats

The streaked horned lark was listed as a threatened species because of the following:

1) The streaked horned lark has disappeared from all formerly documented locations in the northern portion of its range, the Oregon coast, and the southern edge of its range.
2) There are currently estimated to be fewer than 1,600 streaked horned larks range-wide, and population numbers are declining.
3) Their range is small and may be continuing to contract;
4) Their habitat is threatened throughout their entire range from loss of natural disturbance regimes, invasion of unsuitable vegetation that alter habitat structure, and incompatible land management practices.
5) Large winter congregations are limited to one region, Oregon's Willamette Valley, which may put larks at risk from stochastic weather events.
6) Most sites currently used by larks require some level of disturbance or management to maintain the habitat structure they need. The natural processes that previously provided this disturbance no longer operate.

3.3.26 Western Snowy Plover

As summarized in USFWS (2007b).

Listing History

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

Life History/Biological requirements

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

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

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

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

Distribution and Critical Habitat

Critical habitat was designated for the western snowy plover December 7, 1999, again on September 29, 2005, and most recently on June 6, 2012. The current Pacific coast breeding population extends from Damon Point, Washington, south to Bahia Magdalena, Baja California, Mexico [including both Pacific and Gulf of California coasts Figure 62)]. The western snowy plover winters mainly in coastal areas from southern Washington to Central America.

Threats

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

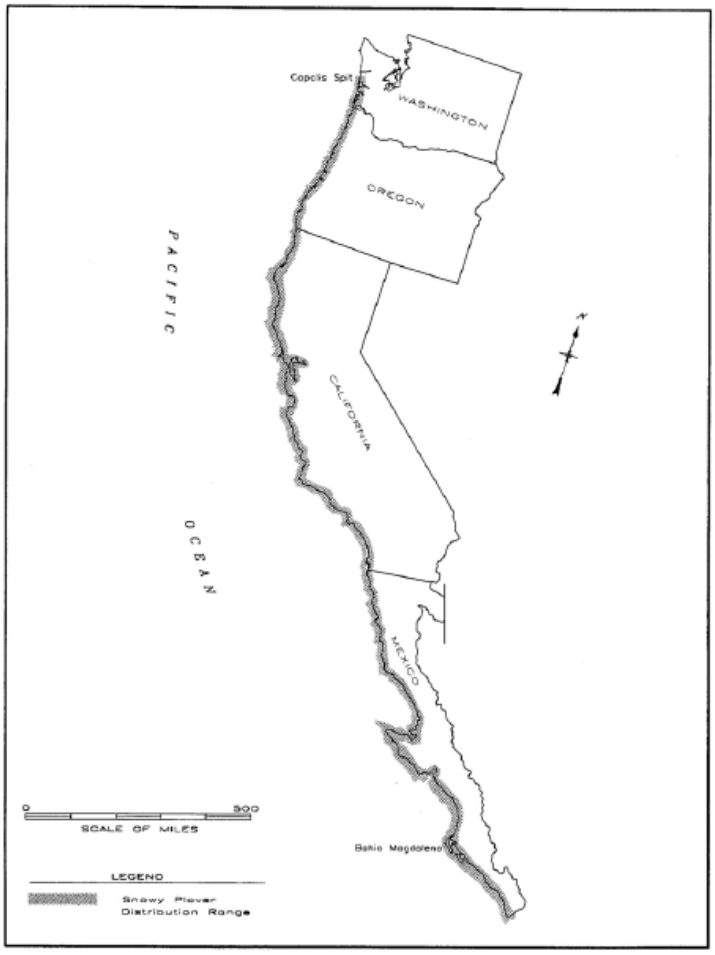

Figure 62. Breeding and wintering distribution of the western snowy plover.

3.3.27 Yellow-billed Cuckoo

Listing History

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

Life History/Biological requirements

As summarized by Cornell University (2017b): Yellow-billed cuckoos use wooded habitat with dense cover and water nearby, including woodlands with low, scrubby, vegetation, overgrown orchards, abandoned farmland, and dense thickets along streams and marshes. In the Midwest, look for cuckoos in shrublands of mixed willow and dogwood, and in dense stands of small trees such as American elm. In the Southwest, yellow-billed cuckoos are rare breeders in riparian woodlands of willows, cottonwoods and dense stands of mesquite to breed.

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

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

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

Distribution and Critical Habitat

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

In recent years, the species' distribution in the west has contracted. The northern limit of breeding in the western coastal States is now in Sacramento Valley, California, and the northern limit of breeding in the western interior States is southern Idaho [AOU 1998; Hughes 1999 (Figure 63)]. The species overwinters from Columbia and Venezuela, south to northern Argentina (Ehrlich et al. 1992; AOU 1998).

Threats

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

Figure 63. Historic and present distribution of western yellow-billed cuckoo (Johnson 2009).

Gastropods

3.3.28 Banbury Springs Limpet, Bliss Rapids Snail, and Snake River Physa Snail

As summarized in USFWS (1995b).

Listing History

Banbury Springs Limpet, Snake River Physa Snail, and Bliss Rapids Snail were listed as Endangered, 14 December 1992.

Life History/Biological requirements

Ecologically, these species share many characteristics, and in some locations two or more can be found sharing the same habitat. Their habitat requirements generally include cold, clean, well-oxygenated flowing water of low turbidity. These snails prefer gravel-to-boulder size substrate.

Despite these affinities, each species has slightly different habitat preferences. The Snake River physa snail is found only in the free-flowing mainstem Snake River. The Bliss Rapids snail occurs in both cold-water springs and mainstem habitats, while the Banbury Springs limpet only occurs in cold-water springs.

Distribution and Critical Habitat

No critical habitat has been designated for these species. At the time of listing, these species were limited geographically and generally intolerant of pollution. The "middle" Snake River is defined as extending from C.J. Strike Reservoir (river mi 910.8) upstream to Milner Dam (river mi 1,124.8) (Figure 64). With few exceptions, extent populations of the five taxa are confined to this reach; although prior to river development and impoundment these and other native goastropods "extended beyond these artificial and manmade boundaries" (Frest et al. 1991).

Threats

Hydroelectric development and agriculture throughout the Snake River has directly impacted these species through inundation of lotic habitats, isolating segmented populations, and impacting suitable shallow water shoreline habitat from project-caused flow fluctuations. Water quality continues to degrade in the middle Snake River from increased water use and withdrawal, aggravated by drought induced low flows. Nutrient loading contributes to dense algal blooms of filamentous algae, which the species cannot utilize. This algae will often cover rock surfaces, effectively displacing suitable snail habitats and food resources.

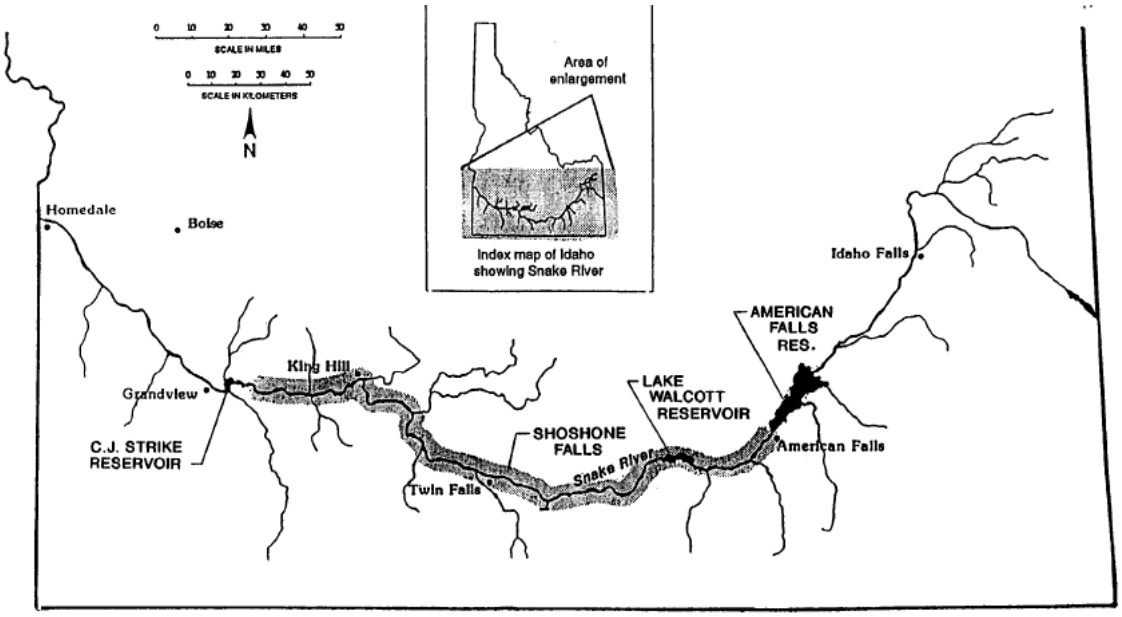

Figure 64. Middle Snake River and distribution of the Banbury Springs Limpet, Bliss Rapids Snail, and Snake River Physa Snail.

3.3.29 Bruneau Hot Springsnail

<u>As summarized in USFWS (2002).</u>

Listing History

The Bruneau hot springsnail was listed as endangered on June 17, 1998.

Life History/Biological requirements

The Bruneau hot springsnail has been found in flowing geothermal springs and seeps with temperatures ranging from 60.3-98.4 °F (15.7-36.9 °C), with the highest densities of springsnails observed at temperatures ranging from 73-98 °F (22.8 to 36.6 °C). Bruneau hot springsnails are found in these habitats on the exposed surfaces of various substrates, including rocks, gravel, sand, mud, and algal film.

The Bruneau hot springsnail appears to be an opportunistic grazer, feeding primarily on algae and diatoms. Springsnail densities are lowest in areas of bright green algal mats, while higher springsnail densities occur where periphyton communities are dominated by diatoms.

Sexual maturity can occur at 2 months, with a sex ratio approximating 1:1. Reproduction occurs throughout the year except when inhibited by high or low temperatures. At sites affected by high ambient temperatures during summer and early fall months, recruitment is seasonal, corresponding with cooler periods. Likewise, sites with cooler

ambient temperatures would likely exhibit recruitment during the summer months. Springsnails use "hard" surfaces such as rock substrates to deposit their eggs.

Distribution and Critical Habitat

No critical habitat has been designated for this species. It currently survives in approximately 89 of 155 small, flowing geothermal springs and seeps along an approximately 5 mi (8 km) reach of the Bruneau River and its tributary Hot Creek in southwestern Idaho (Figure 65).

Threats

The principal threat to this species is the reduction and/or elimination of their geothermal spring habitat as a result of agricultural-related groundwater withdrawal and pumping.

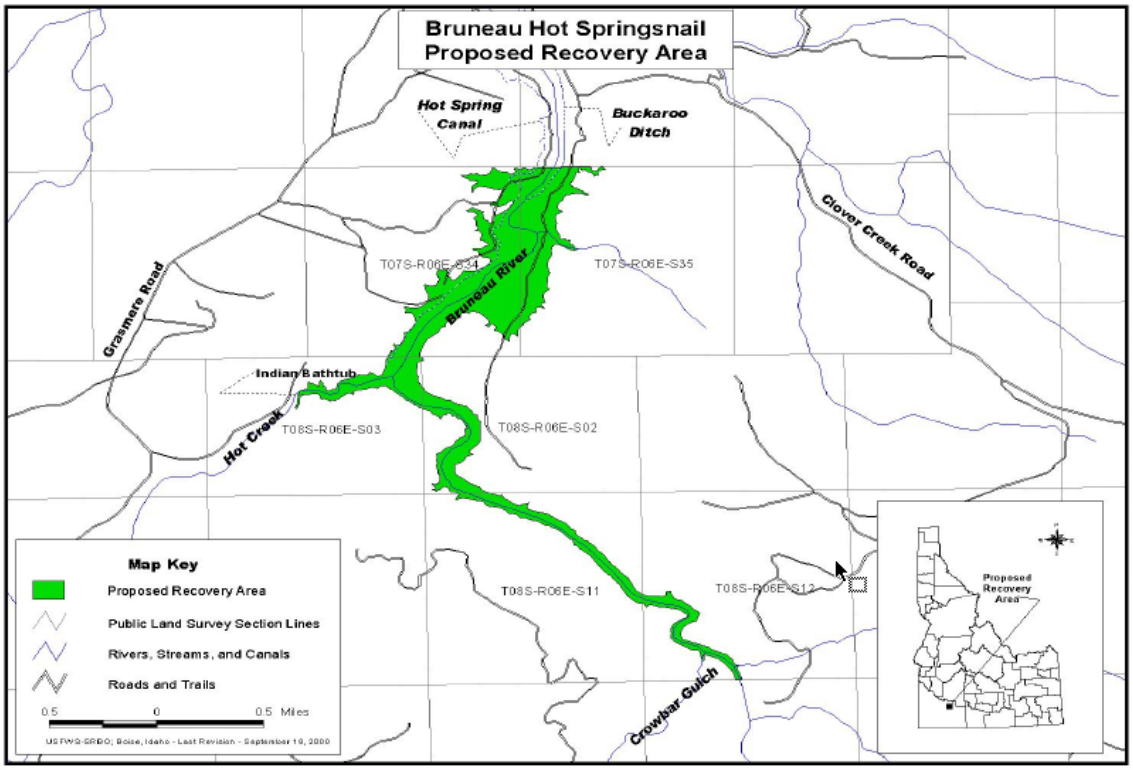

Figure 65. Bruneau hot springsnail distribution and recovery area.

3.3.30 Vernal Pool Fairy Shrimp

<u>As summarized in USFWS (2005).</u>

Listing History

Vernal pool fairy shrimp was listed as endangered September 19, 1994.

Life History/Biological requirements

Vernal pool fairy shrimp are highly adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of the vernal pool fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. Another important adaptation is that the vernal pool fairy shrimp has a relatively short life span, allowing it to hatch, mature to adulthood, and reproduce during the short time period when vernal pools contain water. The vernal pool fairy shrimp can reach sexual maturity in as few as 18 days at optimal conditions of 68 °F (20°C), and can complete its life cycle in as little as 9 weeks.

The vernal pool fairy shrimp occupies a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools. Although the vernal pool fairy shrimp has been collected from large vernal pools, including one exceeding 24.7 ac (10 ha) in area, it tends to occur primarily in smaller pools, and is most frequently found in pools measuring less than 0.05 ac (0.02 ha) in area.

Vernal pool tadpole shrimp are predators of vernal pool fairy shrimp, whereas vernal pool fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. Vernal pool fairy shrimp provide an important food source for a number of species, including the western spadefoot toad. Vernal pool fairy shrimp are also a major prey item for waterfowl, such as ducks. In turn, waterfowl and other migratory birds are important dispersal agents for this and other vernal pool species.

Distribution and Critical Habitat

Critical habitat was designated for the vernal pool fairy shrimp February 10, 2006. It is currently found in 28 counties across the Central Valley and coast ranges of California, and in Jackson County of southern Oregon (Figure 66). The species occupies a variety of vernal pool habitats, and occurs in 11 of the 17 vernal pool regions identified in California. Although the vernal pool fairy shrimp is distributed more widely than most other fairy shrimp species, it is generally uncommon throughout its range, and rarely abundant where it does occur.

Threats

Habitat destruction is the primary threat to the vernal pool fairy shrimp.

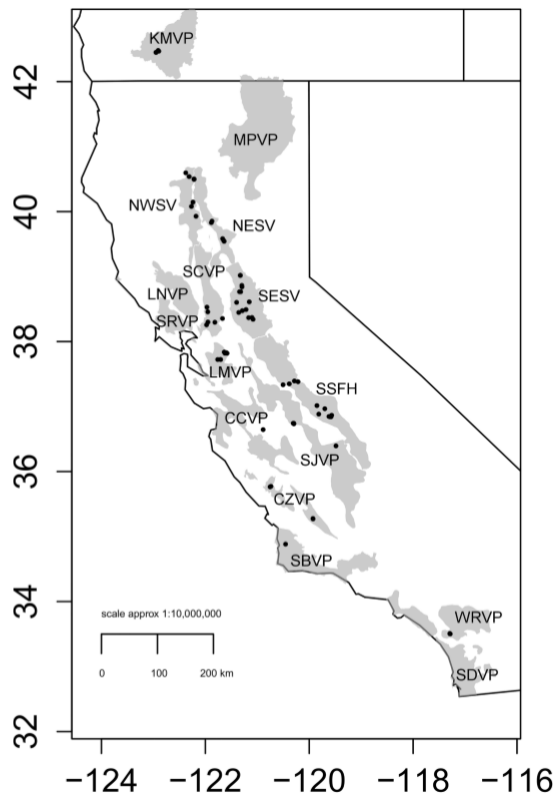

Figure 66. Vernal pool fairy shrimp distribution (Denier et al. 2017). Black dots note where shrimp were collected.

Amphibians

3.3.31 Oregon Spotted Frog

<u>As summarized in 79 FR 51658.</u>

Listing History

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

Life History/Biological requirements

Adult Oregon spotted frogs begin to breed by 1 to 3 years of age, depending on sex, elevation, and latitude. Males may breed at 1 year at lower elevations and latitudes, but generally breed at 2 years of age. Females breed by 2 or 3 years of age, depending on elevation and latitude.

Breeding occurs in February or March at lower elevations and between early April and early June at higher elevations. Males and females separate soon after egg-laying, with females returning to fairly solitary lives. Males often stay at the breeding site, possibly

for several weeks, until egg-laying is completed. Females may deposit their egg masses at the same locations in successive years.

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

Distribution and Critical Habitat

Critical habitat was designated for the Oregon spotted frog May 11, 2016. Historically, the Oregon spotted frog ranged from British Columbia to the Pit River basin in northeastern California. Currently, the Oregon spotted frog is found from extreme southwestern British Columbia south through the Puget Trough and in the Cascades Range from south-central Washington at least to the Klamath Basin in southern Oregon (Figure 67). Oregon spotted frogs occur in lower elevations in British Columbia and Washington and are restricted to high elevations in Oregon.

Threats

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

Figure 67. Present Oregon spotted frog distribution (Hallock 2013).

Insects

3.3.32 Fender's Blue Butterfly

<u>As summarized in USFWS (2010).</u>

Listing History

Fender's blue butterfly was listed as endangered on January 25, 2000.

Life History/Biological requirements

Adult Fender's blue butterflies live approximately 10 to 15 days and apparently rarely travel farther than 1.2 mi (2 km) over their lifespan. The life cycle of Fender's blue butterfly may be completed in one year. An adult Fender's blue butterfly may lay approximately 350 eggs over her lifespan, of which perhaps fewer than two will survive to adulthood.

Lupinus sulphureus ssp. *kincaidii* is the preferred larval host plant at most known Fender's blue butterfly populations. Lupine serves as larval food and oviposition sites and native wildflowers for adult nectar food sources.

Females lay their eggs on perennial lupines (*Lupinus sulphureus* ssp. *kincaidii, L. arbustus*, or occasionally *L. albicaulis*), which are the larval food plants, during May and June. Newly hatched larvae feed for a short time, reaching their second instar in the

early summer, at which point they enter an extended diapause. When the lupine plant senesces, diapausing larvae remain in the leaf litter at or near the base of the host plant through the fall and winter. Larvae become active again in March or April of the following year, although some larvae may be able to extend diapause for more than one season depending upon the individual and environmental conditions.

Distribution and Critical Habitat

Critical habitat was designated for Fender's blue butterfly October 31, 2006, in Benton, Lane, Polk and Yamhill Counties, Oregon. The historic distribution of Fender's blue butterfly is not precisely known due to the limited information collected on this species prior to its description in 1931. Presently, Fender's blue butterfly ranges along the Cascades from Lewis and Pacific Counties in Washington, down through Douglas County in Oregon (Figure 68).

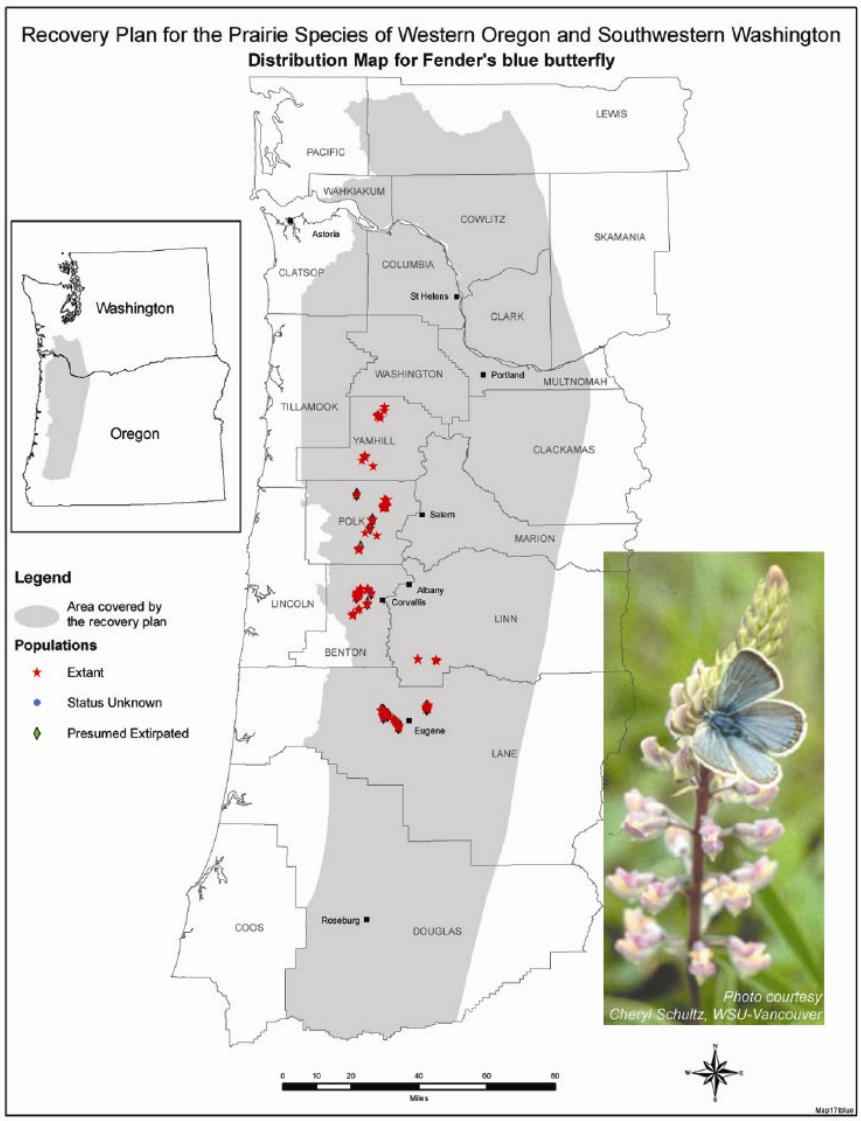

Figure 68. Distribution of Fender's blue butterfly.

Threats

Habitat loss, encroachment into prairie habitats by shrubs and trees due to fire suppression, fragmentation, invasion by non-native plants and elimination of natural disturbance regimes all threaten the survival of Fender's blue butterfly. Few populations occur on protected lands; most occur on private lands which are not managed to maintain native prairie habitats. These populations are at high risk of loss to development or continuing habitat degradation.

3.3.33 Meltwater Lednian Stonefly

As summarized in USFWS (2015a).

Listing History

The meltwater lednian was presented as a candidate species May 22, 1984, and is now a proposed threatened species through the most recent review published in the Federal Register October 31, 2017.

Life History/Biological requirements

Plecopterans (stoneflies) are primarily associated with clean, cool, running waters. Most aquatic invertebrates in stream environments in the northern Rocky Mountains exhibit very strong elevation and temperature gradients in their distribution and the meltwater lednian stonefly exhibits a similar distribution pattern. The meltwater lednian stonefly is restricted to short sections of cold, high-elevation alpine streams directly below glaciers, permanent snowfields, and springs. The species is a cold-water stenotherm (capable of surviving within a limited range of temperatures) because of its absence at sites with mean and maximum temperatures exceeding 50 and 64.4 °F (10 and 18 °C), respectively.

Eggs and larvae of all North American species of stoneflies, including the meltwater lednian stonefly, are aquatic. Nemourid stonefly larvae are typically herbivores or detritivores, and their feeding mode is generally that of a shredder or collector-gatherer. There is no information on the longevity of the meltwater lednian stonefly, but in general stoneflies can complete their life cycles within a single year or in 2 to 3 years. Meltwater lednian stoneflies are thought to emerge from their aquatic environments in August and September to mature to adulthood and breed.

Distribution and Critical Habitat

No critical habitat has been designated for this species. Historically, the meltwater lednian was reported in the Waterton River system in Alberta, Canada, and has been observed in at least 16 streams or hydrological drainages within the boundaries of Glacier National Park, Montana since approximately 1993. The current known distribution and range of the meltwater lednian stonefly is restricted to the 16 streams or hydrological drainages just to the east and west of the Continental Divide within Glacier National Park (Figure 69).

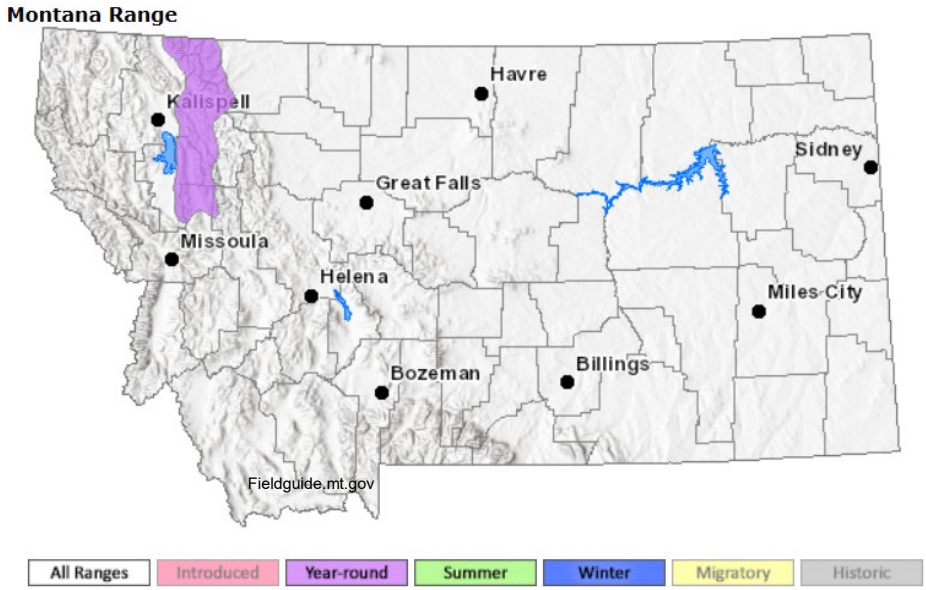

Figure 69. Distribution of the meltwater lednian stonefly.

Threats

The meltwater lednian stonefly is a narrowly distributed endemic insect presently known to occur in a small number of cold, snowmelt- or glacier-fed, high-alpine streams in Glacier National Park, Montana. The melting of glaciers in Glacier National Park is considered a threat to the species, now and within the next 40 years as projected through various global climate models and greenhouse emissions scenarios.

3.3.34 Oregon Silverspot Butterfly

<u>As summarized in USFWS (2001).</u>

Listing History

The Oregon silverspot butterfly was listed as threatened March 26, 1980 along with critical habitat designation.

Life History/Biological requirements

The Oregon silverspot butterfly occupies an early successional, coastally-influenced grassland habitat that contains the caterpillar host plant, early blue violet (*Viola adunca*), adult nectar sources, and adult courtship areas.

The Oregon silverspot butterfly occupies three types of grassland habitats. One type consists of marine terrace and coastal headland “salt spray” meadows as exhibited at Cascade Head, Bray Point, Rock Creek-Big Creek, and portions of the Del Norte site. The second consists of stabilized dunes as found at the Long Beach Peninsula, Clatsop Plains, and the remainder of the Del Norte site. Both of these habitats are strongly influenced by proximity to the ocean, with mild temperatures, high rainfall, and persistent fog. The two habitats differ in topography, soils, and exposure to winds. The

dune habitat has lower relief, highly porous soils, and less exposure to winds. The third habitat type consists of montane grasslands found on Mount Hebo and Fairview Mountain. Conditions at these sites include colder temperatures, frequent orographic cloud cover, significant snow accumulations, less coastal fog, and no salt spray.

Soil and climatic conditions, salt-spray or mist, and disturbance regimes (such as fire) historically contributed to maintaining low, open grasslands within the species' range by suppressing encroaching trees and shrubs. Very little is known about the biology of the caterpillar or pupae.

Distribution and Critical Habitat

Critical habitat was designated for the Oregon silverspot butterfly March 26, 1980. Historically, the Oregon silverspot butterfly was distributed along the Washington and Oregon coasts from Westport in Grays Harbor County south to about Heceta Head in Lane County and was closely associated with the distribution of early blue violet, the primary larval host plant. In addition, there is a disjunct cluster of populations north of Crescent City in Del Norte County, California.

As of 2001, distribution ranges from Long Beach, Washington, south to Rock Creek, south of Yachats, Oregon (Figure 70).

Threats

Invasion by exotic species, natural succession, fire suppression, and land development have resulted in loss and modification of the species' habitat. Land use practices have altered disturbance regimes needed to maintain existing habitats and create new habitats for species expansion. Management is needed to maintain sufficient habitat to sustain the species, curtail vegetative succession, and reduce other threats to the species and/or its habitat. Other threats include off-road vehicles, grazing, erosion, road kill, and pesticides. The Oregon silverspot butterfly is also sought after by butterfly collectors.

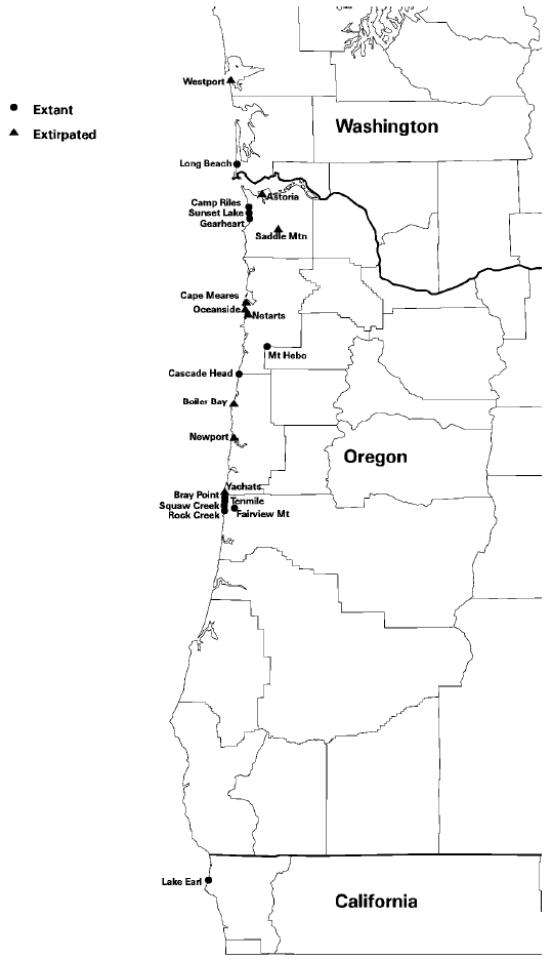

Figure 70. Present distribution of the Oregon silverspot butterfly.

3.3.35 Taylor's (whulge) Checkerspot

As summarized in 78 FR 61452 and at https://www.fws.gov/oregonfwo/articles.cfm?id=149489449

Listing History

Taylor's checkerspot butterfly was listed as endangered with critical habitat designation on October 3, 2013.

Life History/Biological requirements

Taylor's checkerspot butterfly occupies open grassland habitat found on prairies, shallow-soil balds, grassland bluffs, and grassland openings within a forested matrix. Taylor's checkerspot butterflies produce one brood per year. They overwinter (diapause) in the fourth or fifth larval instar (developmental) phase and have a flight period as adults of 10 to 14 days, usually in May, although depending on local site and

climatic conditions, the flight period begins in late April and extends into early July, as in Oregon, where the flight season has been documented as lasting up to 45 days.

Female Taylor's checkerspot butterflies and their larvae utilize plants that contain defensive chemicals known as iridoid glycosides, which have been recognized to influence the selection of oviposition sites by adult nymphalid butterflies (butterflies in the family Nymphalidae). As maturing larvae feed, they accumulate these defensive chemical compounds from their larval host plants into their bodies. According to the work of Bowers (1981), this accumulation appears to deter predation. These larval host plants include members of the Broomrape family (Orobanchaceae) and native and nonnative Plantago species, which are members of the Plantain family (Plantaginaceae).

Distribution and Critical Habitat

Critical habitat was designated for Taylor's checkerspot butterfly October 3, 2013. Historically, the Taylor's checkerspot butterfly was likely distributed throughout grassland habitat in south Vancouver Island, northern Olympic Peninsula, the south Puget Sound, and the Willamette Valley (Figure 71). The current range appears the same; however, the populations have declined significantly.

Threats

The major limiting factors affecting this species are related primarily to the significant loss of suitable habitat that is largely due to agricultural and urban development, encroachment of trees, and spread of invasive plants which threaten the native grasslands in which the species is found. Pesticide use and recreational activities pose a direct threat to the butterflies themselves. The impact of these threats has led to a smaller and smaller number of extant (still existing) populations, with the natural instability of small populations. Most of the remaining checkerspot habitat sites are a considerable distance from one another, likely well beyond dispersal distance. Natural re-colonization is unlikely as populations disappear.

Figure 71. Historic distribution of Taylor's checkerspot butterfly.

3.3.36 Western Glacier Stonefly

<u>As summarized in 76 FR 78601.</u>

Listing History

The western glacier stonefly is proposed threatened. The 90-day finding on a petition to list the western glacier stonefly was published December 19, 2011 with two subsequent 12-month reviews on petitions to list as threatened, the latest being October 31, 2017.

Life History/Biological requirements

There is little information available on the biology of the western glacier stonefly. However, the Service assumes that the western glacier stonefly is likely to be similar to other closely related stoneflies in terms of its habitat needs and life history traits. In general, insects in the order Plecoptera (stoneflies), and the family Nemouridae in particular, are primarily associated with clean, cool or cold, running waters. Depending on the information source, cool or cold waters are defined as those with a mean temperature below 60.8-66.2 °F (16 to 19°C).

Most aquatic invertebrates in stream environments in the northern Rocky Mountains exhibit very strong elevation and temperature gradients in their distribution. There is no information on the longevity of the western glacier stonefly, but in general stoneflies can complete their life cycles within a single year or in 2 to 3 years. Mature stonefly nymphs emerge from the water and complete their development to short-lived adults on and around streamside vegetation or other structures. Either temperature or photoperiod, or a combination of temperature and light, influence the timing of emergence in the Rocky Mountains.

After mating, females deposit a mass of fertilized eggs in water where they are widely dispersed or attached to substrates by sticky coverings or specialized anchoring devices. Eggs may hatch within a few weeks or remain in diapause (dormancy) for much longer periods if environmental conditions, such as temperature, are not conducive to development.

Distribution and Critical Habitat

No critical habitat has been designated for this species. Similar to the meltwater lednian stonefly, the western glacier stonefly has been collected only in the vicinity of five glacier-fed streams east of the Continental Divide in Glacier National Park, Montana (Figure 72).

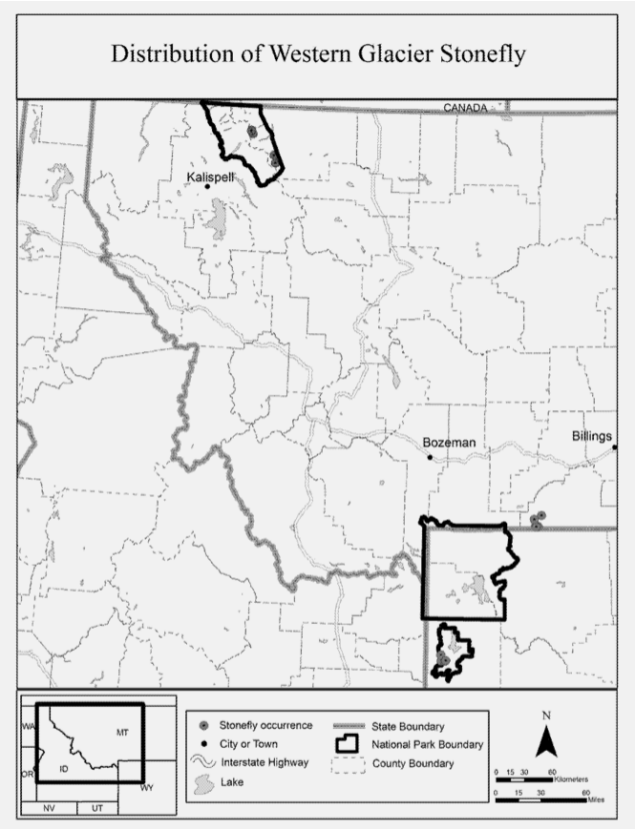

Figure 72. Distribution of the western glacier stonefly.

Threats

Similar to the meltwater lednian stonefly, the western glacier stonefly is a narrowly distributed endemic insect presently known to occur in a small number of cold, snowmelt- or glacier-fed, high-alpine streams in Glacier National Park, Montana. The melting of glaciers in Glacier National Park is considered a threat to the species, now and within the next 40 years as projected through various global climate models and greenhouse emissions scenarios.

Plants

3.3.37 Applegate's Milk-Vetch

As summarized in USFWS (1998b).

Listing History

Applegate's milk-vetch was listed as an endangered species on July 28, 1993.

Life History/Biological requirements

Applegate's milk-vetch is restricted to flat-lying, seasonally moist, strongly alkaline soils. Although currently replete with introduced grasses and other weeds, the species' habitat was historically characterized by sparse, native bunch grasses, and patches of bare soil.

Flowering in Applegate's milk-vetch typically commences in early June and continues to August. Fruits shed their seed shortly after flowering and exhibit no specialized mechanisms for long-distance seed dispersal. Although the species' historical occurrence on patches of bare soil may have allowed for some wind movement of seeds along the soil surface, today's dense coverage of the habitat by introduced grasses and weeds likely eliminates any significant post-dispersal eolian seed movement. Some seed dispersal may take place through ingestion by rodents or jackrabbits, although this has not been documented.

Distribution and Critical Habitat

No critical habitat has been designated for this species. Applegate's milk-vetch is restricted to (endemic to) the Lower Klamath Basin, in Klamath County, Oregon, about fifteen miles north of the Oregon-California border (Figure 73).

Threats

Intensive agricultural and urban development of the Klamath River floodplain has resulted in severe depletion and fragmentation of the species' habitat. Virtually all remaining potential (undeveloped) habitat for the species has been seriously modified by the proliferation of weeds, suppression of floods and fires, and land reclamation projects involving extensive construction of drainage ditches and water retention dikes.

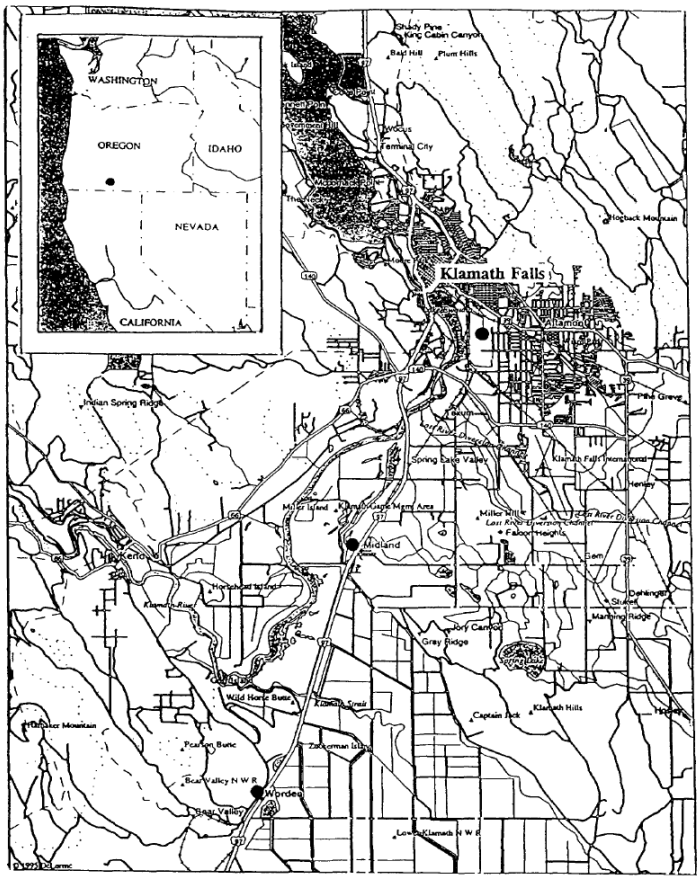

Figure 73. Applegate's milk-vetch distribution.

3.3.38 Gentner's Fritillary

<u>As summarized in USFWS (2003b).</u>

Listing History

Gentner's fritillary was listed as an endangered species on December 10, 1999.

Life History/Biological requirements

Gentner's fritillary occurs within a broad array of plant associations, but often occupies grassland and chaparral habitats within, or on the edges of, dry, open, mixed-species woodlands at elevations below 1,688.5 yds (1,544 m).

The overstory is variably dominated by the following trees: *Quercus garryana* (Oregon white oak), *Quercus keloggii* (California black oak), *Arbutus menziesii* (madrone), *Pseudotsuga menziesii* (Douglas fir), and *Pinus ponderosa* (ponderosa pine).

Commonly associated understory shrubs may include *Arctostaphylos viscida* (white-leaved manzanita), *Ceanothus cuneatus* (buckbrush), *Ceanothus velutinus*

(snowbrush), *Cercocarpus betuloides* (mountain mahogany), and *Toxicodendron diversiloba* (poison oak).

It's a perennial species that reproduces clonally, or asexually, by means of numerous small "rice-grain" bulblets that break off larger bulbs and form new plants. It is common in nature to observe as many as 40 to 60, or more, individuals arising from these bulblets, with their narrow leaves densely clustered around the base of a single mature plant. This species, like most lilies, produces one vegetative leaf in each growing season for several years before storing enough resources to produce a flower.

Distribution and Critical Habitat

No critical habitat has been designated for this species. Gentner's fritillary occurs in the rural foothills of the Rogue and Illinois River valleys in Jackson and Josephine Counties, Oregon (Figure 74). In the early 2000s, a small population was found in northern California, close to the Oregon border

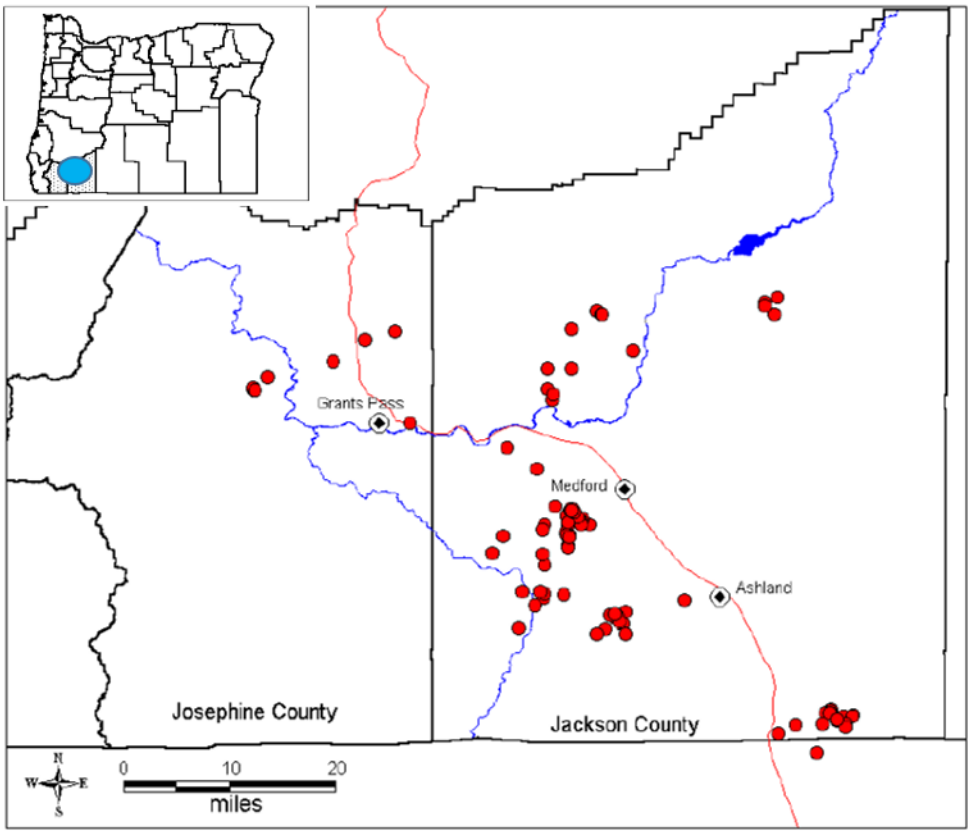

Figure 74. Distribution of Gentner's fritillary in Oregon.

Threats

The species is threatened by a variety of factors including habitat loss associated with rapidly expanding residential and agricultural development, alteration of habitat by invasive weeds and successional encroachment by trees and shrubs, habitat

disturbance from timber harvest and recreational activities, and vulnerability associated with extremely small population sizes. Other potential threats include bulb collecting for gardens and herbivory by deer and livestock.

3.3.39 MacFarlane's Four-o'clock

As summarized in USFWS (2000).

Listing History

MacFarlane's four-o'clock was originally listed as endangered in 1979. Since that time, additional populations have been discovered and some populations on Federal lands are being actively managed and monitored. As a result of ongoing recovery efforts, MacFarlane's four-o'clock was down-listed to threatened in March 1996.

Life History/Biological requirements

MacFarlane's four-o'clock is a long-lived herbaceous perennial with a deep-seated, thickened root. This species typically blooms from May through June. Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring. Seeds apparently fall near the parent plant and are transported by gravity and rain water, although dispersal has not been studied. In addition to reproducing by seed, plants reproduce clonally from a thick woody tuber that sends out many shoots (collectively called a genet). Daughter plants produced in this manner are known as ramets.

MacFarlane's four-o'clock occurs in river canyon grassland habitats that are characterized by regionally warm and dry conditions. Precipitation occurs mostly as rain during winter and spring. Sites are dry and generally open, although scattered shrubs may be present. Plants can be found on all aspects, but often occur on southeast to western exposures. Slopes may be steep or nearly flat. Soils vary from sandy to talus (consisting of gravel and cobbles) substrate. Habitat generally consists of bunchgrass communities.

Distribution and Critical Habitat

No critical habitat has been designated for this species. MacFarlane's four-o'clock is endemic to portions of the Snake, Salmon, and Imnaha River canyons in Wallowa County in northeast Oregon, and adjacent Idaho County in Idaho. It is currently found in 11 populations in Idaho and Oregon (Figure 75).

Threats

Grazing by domestic livestock and the invasion of exotic (non-native) plants are the greatest threats to this species. Other threats include human trampling, off-road vehicle use, construction and maintenance of roads and trails, and herbicide spraying.

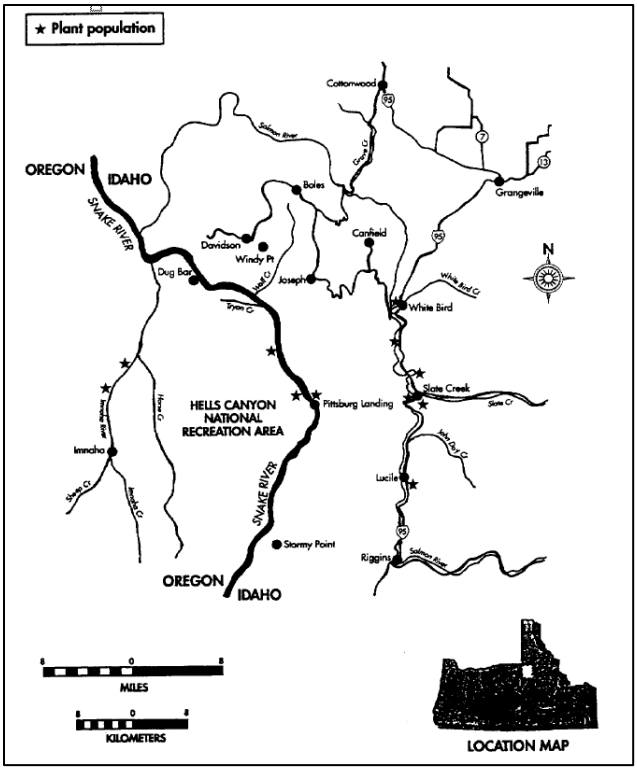

Figure 75. Distribution of MacFarlane's four-o'clock.

3.3.40 Slickspot Peppergrass

As summarized in 81 FR 55058 and at:
https://www.fws.gov/idaho/promo.cfm?id=177175828.

Listing History

Slickspot peppergrass was listed as endangered September 19, 2008, and was reaffirmed three times, the latest being August 17, 2016. This plant is now listed as threatened. Critical habitat was proposed for designation on April 21, 2014.

Life History/Biological requirements

The native plant occurs in specialized habitats known as slickspots, which are mini-playas or natric (high sodium soil) sites with distinct clay layers. Slickspots tend to be highly reflective, are usually relatively light in color and occur dispersed throughout the sagebrush-steppe ecosystem in southwest Idaho. More than 90% of the occupied slickspot peppergrass habitat occurs on federal lands with the remaining occupied habitat owned by the state of Idaho and private land owners.

Slickspot peppergrass displays two different life history strategies, an annual form and a biennial form. The annual form reproduces by flowering and producing seed in its first year, and dies within one growing season. The biennial life form initiates growth in the

first year as a vegetative rosette, but does not flower and produce seed until the second growing season. The proportion of annuals versus biennials in a population can vary greatly.

Distribution and Critical Habitat

Critical habitat has been proposed, but not designated for this species. Presently, slickspot peppergrass occurs in southwest Idaho along the Snake River Plain and Owyhee Plateau (Figure 76).

Critical Habitat for *Lepidium papilliferum* (slickspot peppergrass)

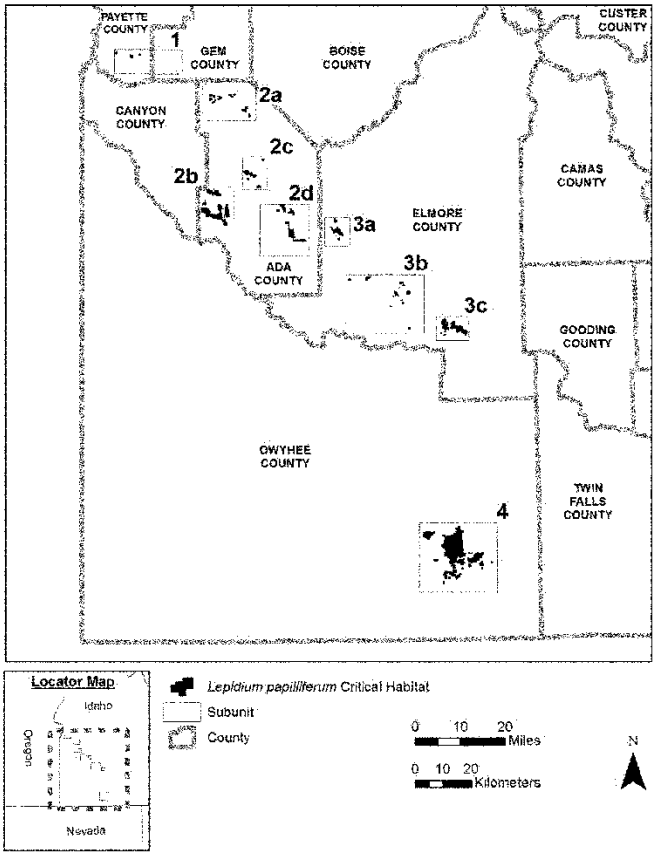

Figure 76. Distribution of slickspot peppergrass in Idaho.

Threats

Altered wildfire regime (increasing frequency, size, and duration of wildfires), and invasive, nonnative plant species (e.g., *Bromus tectorum*) are the two primary threat factors to slickspot peppergrass. Both are further exacerbated by climate change; as well as contributing threat factors of development, habitat fragmentation and isolation, and the emerging threat from seed predation by Owyhee harvester ants (*Pogonomyrmex salinus*).

3.3.41 Spalding's Catchfly

As summarized in USFWS (2007a)

Listing History

Spalding's catchfly was listed as a threatened species under the Endangered Species Act on October 10, 2001.

Life History/Biological requirements

Spalding's catchfly is an herbaceous perennial plant in the pink family (Caryophyllaceae). It is a long-lived species that expresses prolonged dormancy for up to six years without leaves if conditions are unfavorable (Lesica 1997; Lesica and Crone 2007). Lesica and Crone (2007) found that prolonged dormancy may increase plant fitness providing a way to obtain below-ground resources, limiting flower and fruit production.

Little is known about seed productivity, seed bank viability, or dispersal, but it can be assumed that the capsules of Spalding's catchfly serve as an open cup from which seeds are likely carried by the wind, jostled out by passing wildlife, or tossed when plants are knocked over (USFWS 2007a). Seeds are small, flat, and somewhat winged. Plant height and seed characteristics suggest that short-distance wind dispersal may be common.

The plant is found at elevations ranging from 400-1,766.6 yds (365.7-1,615.4 m), usually in deep, productive loess soils (fine, windblown soils). Plants are generally found in swales or on northwest to northeast facing slopes where soil moisture is relatively higher.

Distribution and Critical Habitat

No critical habitat has been designated for this species. In 2007, there were 99 documented populations of Spalding's catchfly (USFWS 2007a). Within the United States, Spalding's catchfly is known from four counties in Idaho (Idaho, Latah, Lewis, and Nez Perce), four counties in Montana (Flathead, Lake, Lincoln, and Sanders), one county in Oregon (Wallowa), and five counties in Washington (Adams, Asotin, Lincoln, Spokane, and Whitman) [Mincemoyer 2005; Oregon Natural Heritage Program 2006; Idaho Conservation Data Center 2007; Montana Natural Heritage Program 2007; Washington Natural Heritage Program 2007; as cited in USFWS 2007a (Figure 77)].

Threats

Spalding's catchfly continues to be impacted by habitat loss due to human development and agriculture, habitat degradation associated with adverse grazing and trampling by domestic livestock, and invasions of aggressive nonnative plants. Other impacts include changes in fire frequency and seasonality, off-road vehicle use, and herbicide spraying and drift.

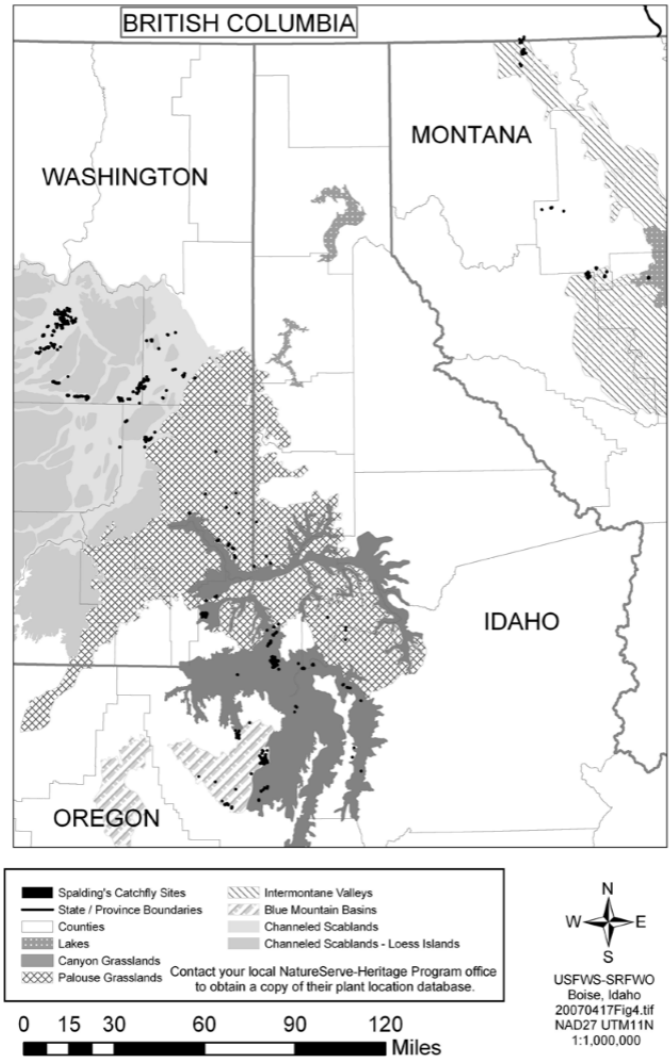

Figure 77. Distribution of Spalding's catchfly.

3.3.42 Ute Ladies'-tresses

<u>As summarized in USFWS (1995c).</u>

Listing History

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

Life History/Biological requirements

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

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

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

Distribution and Critical Habitat

No critical habitat has been designated for this species. Populations of Ute ladies'-tresses orchids are known from three broad general areas of the interior western United States—near the base of the eastern slope of the Rocky Mountains in southeastern Wyoming and adjacent Nebraska and north-central and central Colorado; in the upper Colorado River basin, particularly in the Uinta Basin; and in the Bonneville Basin along the Wasatch Front and westward in the eastern Great Basin, north-central and western Utah, extreme eastern Nevada, and southeastern Idaho. The species is also known to occur in Bonneville, Fremont, Jefferson, and Madison counties along the Snake River, has been discovered in southwestern Montana, and in the Okanogan area and along the Columbia River in North Central Washington (Figure 78).

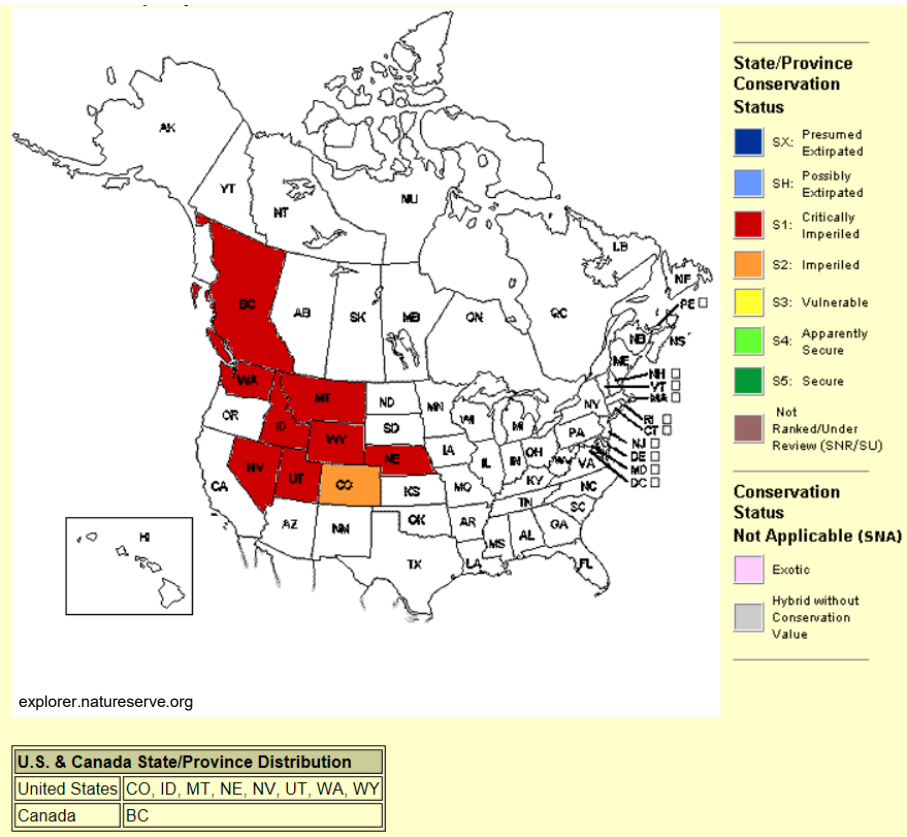

Figure 78. General distribution of Ute ladies'-tresses in North America.

Threats

Alteration of suitable riparian and wetland habitat can affect Ute ladies'-tresses, though after listing, this plant was found in greater numbers than estimated at the time of listing. The overall known population is higher than once thought.

Current threats are drought caused reduction in water table and lake levels, competition from non-native plants, and grazing impacts.

3.3.43 Water Howellia

As summarized in USFWS (1996) and at:
https://www.fws.gov/oregonfwo/articles.cfm?id=149489516.

Listing History

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

Life History/Biological requirements

Water howellia is an annual aquatic species in the bellflower family (Campanulaceae). Individuals are mostly submerged and rooted in bottom sediments. Stems branch near

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

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

Distribution and Critical Habitat

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

As of drafting the recovery plan for this species in 1995, water howellia was known to occur in six location; one in Idaho, three in Washington, and one in Montana, and one in California (Figure 79).

Threats

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

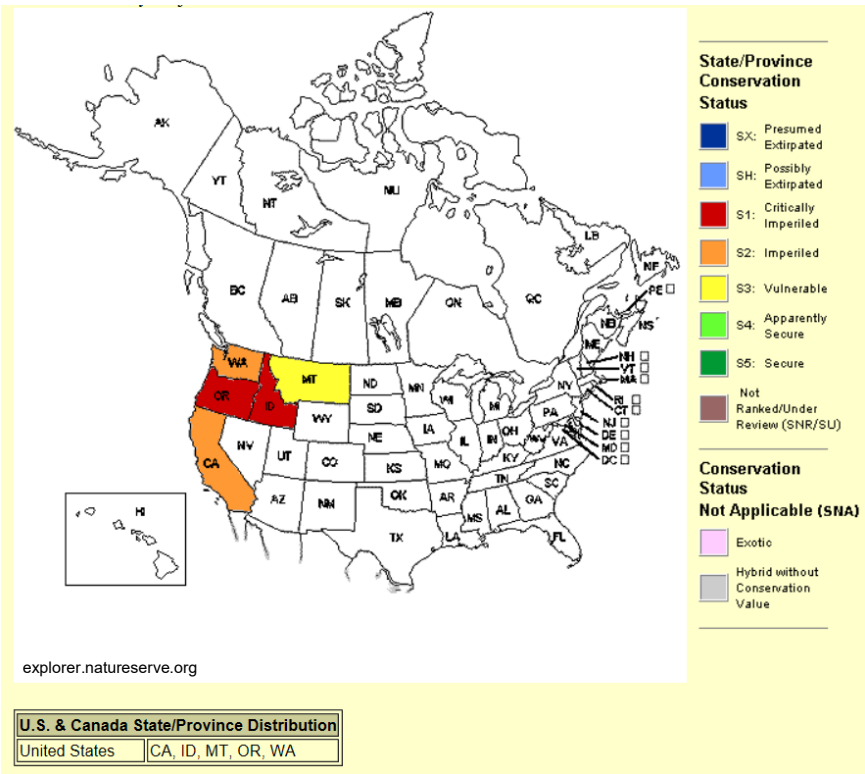

Figure 79. General distribution of water howellia in North America.

3.3.44 Western Lily

<u>As summarized in USFWS (1998c).</u>

Listing History

The western lily was listed as endangered without critical habitat on August 7, 1994.

Life History/Biological requirements

The western lily occurs in early successional bogs or coastal scrub on poorly drained soils, usually those underlain by an iron pan, or poorly permeable clay layer. Populations are found at low elevations, from almost sea level to about 109.4 yds (100 m) in elevation, and from ocean-facing bluffs to about 3.7 mi (6 km) inland. The climate is characterized by cool, wet winters and warm, dry summers. About three-quarters of the rain falls from October to May. Summers are dominated by the North Pacific high pressure zone which generates moderate, but consistent northwest winds. Fog is common in the summer and moisture condensing on trees may increase annual rainfall by as much as a quarter.

The western lily appears to require a habitat that maintains a delicate balance between having some surrounding shrubbery, but not too much. Low [less than 3.3 ft (1 m tall)] vegetation is in most cases beneficial to the lily because it shelters juvenile plants from

large mammal browsing, and provides heat cover in July and August. This protection is perhaps most critical in spring and early summer for seedlings, which seem to tolerate die back in May or June.

Seed germination is hypogeal (the cotyledon or seed leaf stays beneath the surface of the ground). A bulb scale is formed in the fall, and the first true (or epicotylar) leaf emerges the following spring. In cultivation at least, plants may take 4-5 years to flower for the first time, and may live for 25 years or more. Young flowering plants generally produce a single flower in each of the first few years after they begin to flower, and later produce progressively more flowers if they experience favorable environmental conditions. Populations of non-flowering individuals may persist for many years under closed forest canopies

Distribution and Critical Habitat and Critical Habitat

No critical habitat has been designated for this species. The species occurs in a narrow band along 200 mi (320 km) of the Pacific coast from near Coos Bay, Oregon, southward to near Eureka, California (Figure 80). Approximately one third of the historically known populations appear to have been extirpated, and three-quarters of the extant populations consist of 100 or fewer individuals.

Figure 80. Western lily distribution.

Threats

The primary threats to the western lily are: (1) human modification or destruction of habitat; (2) competitive exclusion during natural secondary succession; and (3) grazing by deer, livestock, elk, and small mammals. Secondary threats are: (1) human depredation; (2) insect herbivory; (3) fungal, viral, or bacterial infection; (4) loss of habitat due to ecological succession facilitated by aggressive fire suppression; and potentially (5) random loss of genetic variability in small populations.

3.3.45 Whitebark Pine

As summarized in USFWS (2016b).

Listing History

Whitebark pine was first reviewed as a candidate for listing October 26, 2011, and remains a candidate under review, current as of December 2, 2016.

Life History/Biological requirements

Whitebark pine is a slow-growing, long-lived tree with a life span of up to 500 years and sometimes more than 1,000 years. It's a hardy conifer that tolerates poor soils, steep slopes, and windy exposures and is found at alpine tree line and subalpine elevations throughout its range. It grows typically 16.4-65.6 ft (5 to 20 m) tall with a rounded or irregularly spreading crown shape under a wide range of precipitation amounts, from about 20.1 in (51 cm) to over 100 in (254 cm) per year. Whitebark pine may occur as a climax species, early successional species, or seral (mid-successional stage) co-dominant associated with other tree species. Although it occurs in pure or nearly pure stands at high elevations, it typically occurs in stands of mixed species in a variety of forest community types.

On higher density conifer sites, whitebark pine tends to grow as tall, single-stemmed trees, whereas on open, more exposed sites, it tends to have multiple stems. Above tree line, it grows in a krummholz form, with stunted, shrub-like growth caused by high winds and cold temperatures. This pine species is monoecious (with both male pollen and female seed cones on the same tree). Its characteristic dark brown to purple seed cones are 5 to 8 cm long and grow at the outer ends of upper branches.

Whitebark pine is one of five species of stone pine, so-named for their hard, stone-like seeds, and is the only stone pine that occurs in North America. Stone pines are distinguished from other pines by their five needles per cluster, indehiscent seed cones (scales on the cones remain essentially closed at maturity) that stay on the tree, and wingless seeds that remain fixed to the cone and cannot be dislodged by the wind. Because whitebark pine seeds cannot be wind-disseminated, primary seed dispersal occurs almost exclusively by Clark's nutcrackers (*Nucifraga columbiana*), birds in the taxonomic family Corvidae, which includes include ravens, crows, and jays.

Consequently, Clark's nutcrackers facilitate whitebark pine regeneration and influence its distribution and population structure through their seed caching activities

Distribution and Critical Habitat

No critical habitat has been designated for this species. The historical distribution of whitebark pine is unknown. Presently, whitebark pine occurs in scattered areas of the warm and dry Great Basin but it typically occurs on cold and windy high-elevation or high-latitude sites in western North America. As a result, many stands are geographically isolated. Its range extends longitudinally between 107 and 128 degrees West and latitudinally between 27 and 55 degrees North. The distribution of whitebark pine includes coastal and Rocky Mountain ranges that are connected by scattered populations in northeastern Washington and southeastern British Columbia (Figure 81).

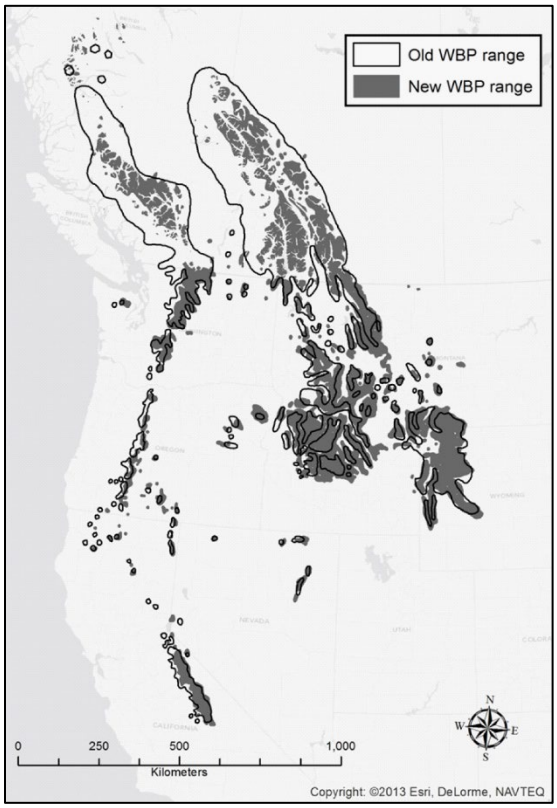

Figure 81. Whitebark pine distribution in North America.

Threats

1) The primary threat to the species is from disease in the form of the nonnative white pine blister rust and its interaction with other threats. 2) Continuing environmental effects resulting from climate change will result in direct habitat loss for whitebark pine, a high-elevation species occurring only in cool mountaintop habitats. 3) Past and ongoing fire suppression is also negatively impacting populations of whitebark pine through direct habitat loss. Many stands of trees once dominated by whitebark pine are now dense stands of shade-tolerant conifers. This change in forest structure and

composition facilitates an increased frequency and intensity of wildfire and an increased susceptibility to predation and disease.

4 Environmental Baseline

The environmental baseline is a “snapshot” of a species’ health at a specified point in time. It does not include the effects of the action under review in the consultation. This section presents an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem within the action area.

The baseline includes State, tribal, local, and private actions already affecting the species or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

4.1 Historic Conditions

Pre-English settlement, the western U.S. largely untouched forest and prairie ecosystems. Natural processes of flood, fire, wind, and wildlife grazing managed the natural ecosystems as they had adapted to over millennia. Species generally inhabited large ranges as habitat was un-fragmented and largely suitable.

4.2 Current Conditions

Presently, a variety of human disturbances such as mineral extraction, energy harnessing (wind and water), timber harvest, livestock grazing, recreation, and human development have and will likely continue to significantly alter the habitats of the 59 ESA-listed species considered in this BA. Human development for consumption and profit, suppressed fire regimes, dammed waterways, harvested timber, mined minerals, and overgrazing has necessitated the creation of the ESA in an attempt to eliminate extirpation and extinction of species and habitats beyond the prior irrevocable damage.

4.3 Matrix of Pathway Indicators

The NMFS uses the "Matrix of Pathways and Indicators" (MPI) to summarize important environmental parameters and conditions for aquatic species (Table 7). USFWS adopted a similar strategy in 1997 based on NMFS’ matrix for aquatic species. The MPI is divided into six overall pathways (major rows in the matrix):

- Water Quality
- Channel Condition and Dynamics
- Habitat Access
- Flow/Hydrology
- Habitat Elements

- Watershed Conditions

Each represents a significant pathway by which actions can have potential effects on anadromous salmonids and their habitats, and is also used herein to analyze habitat for all aquatic species.

It is impossible to conduct an on-site evaluation of current habitat indicators for every proposed site and waterbody for all affected aquatic species; however, applying a higher level understanding of the current conditions of the major basins in the northwest can be applied to review of the description of the proposed action and the matrix to determine potential impacts.

While the USFWS has not developed a MPI for ESA-listed terrestrial species, the Corps developed Table 8, which presents the baseline condition for five factors that are critical for most terrestrial species and can be evaluate at a level appropriate for the size of the action area.

4.4 Baseline Justification

4.4.1 Aquatic Species

Water Quality

The *Temperature* parameter is “at risk”. Water temperature in the action area is at risk due to climate change and habitat disturbance.

The *Sediment* parameter is “at risk”. Human disturbance across the northwest through grazing, timber harvest, and mineral extraction have resulted in increased erosion via precipitation and wind.

The *Chemical Contaminants/Nutrients* parameter is “at risk”. Waterbodies across the northwest originate and flow through watersheds that range from largely undisturbed, to watersheds that are greatly disturbed. Contaminants and nutrient inputs may be at risk from human development and recreation, and these watersheds are most likely to be at risk.

Habitat Access

The *Physical Barriers* parameter is “not properly functioning”. Watersheds in the northwest range from free-flowing to completely (at least effectively) blocked to fish passage.

Habitat Elements

The *Substrate* parameter is “at risk”. Sand and silt may deposit anywhere within the watersheds of the northwest; however, human disturbance and waterbody alteration increases the likelihood of sediment inputs and deposition.

Table 7. Checklist for documenting environmental baseline and effects of proposed actions on salmonid habitat indicators.

Pathways	**Environmental Baseline**		
Indicators	Properly Functioning	At Risk	Not Properly Functioning
Water Quality:			
Temperature		X	
Sediment		X	
Chem. Contam./Nut.		X	
Habitat Access:			
Physical Barriers			X
Habitat Elements:			
Substrate		X	
Large Woody Debris		X	
Pool Frequency		X	
Pool Quality		X	
Off-Channel Habitat			X
Refugia		X	
Channel Cond. and Dynamics:			
Width/Depth Ratio			X
Streambank Condition			X
Floodplain Connectivity			X
Flow/Hydrology:			
Peak/Base Flows			X
Drainage Network Increase		X	
Watershed:			
Road Density and Location		X	
Disturbance History			X
Riparian Reserves		X	

The *Large Woody Debris* parameter is “at risk”. Large woody debris recruitment may be fully functioning, or not at all depending upon watershed.

The *Pool Frequency* parameter is “at risk”. Pool frequency ranges from properly function to not properly functioning depending on watershed.

The *Pool Quality* parameter is “at risk”. Pool quality may range from good to poor across watersheds in the northwest depending on the watershed disturbance history.

The *Off-Channel Habitat* parameter is “not properly functioning”. Off-channel habitat may range from good to poor across watersheds in the northwest depending on the watershed disturbance history.

The *Refugia* parameter is “at risk”. Refugia may range from good to poor across watersheds in the northwest depending on the watershed disturbance history.

Channel Condition and Dynamics

The *Width to Depth Ratio* parameter is “not properly functioning”. Dams have impacted flow, and un-impounded watershed are at risk for development.

The *Streambank Condition* parameter is “not properly functioning”. Streambank condition ranges from good to poor across the northwest depending on watershed disturbance history.

The *Floodplain Connectivity* parameter is “not properly functioning”. Floodplain connectivity may range from good to non-existent in the northwest due to dams, depending on watershed.

Flow and Hydrology

The *Peak/Base Flows* parameter is “not properly functioning”. The peak/base flow parameter may range from properly functioning to improperly functioning across the action area depending on watershed.

The *Drainage Network Increase* parameter is “at risk”. Drainage network increase may range from good to poor across the action area depending on watershed.

Watershed Conditions

The *Road Density and Location* parameter is “at risk”. The road network within the action area may range from good to poor across the action area depending on watershed.

The *Disturbance History* parameter is “not properly functioning”. Large fires have increased in frequency throughout the Pacific Northwest. Runoff after a fire can carry increased amounts of sediment. Landslides due to fires and roads also affect the streams within the watershed.

The *Riparian Reserves* parameter is “at risk”. Riparian reserves may be good to poor quality or non-existent across the action area.

4.4.2 Terrestrial Species

Table 8 provides the five critical terrestrial habitat parameters. Explanations are provided below for each relative to their importance and baseline condition.

Table 8. Corps-developed MPI for evaluating the terrestrial species habitat baseline.

Pathways	**Environmental Baseline**		
Indicators	Properly Functioning	At Risk	Not Properly Functioning
Habitat Connectivity:		X	
Migration Corridors		X	
Cover		X	
Reproduction		X	
Food Sources		X	

The *Habitat Connectivity* parameter is “at risk”. Habitat connectivity is critical for species and populations to seek refugia, food sources, and gene flow. Across the action area, many habitats are fragmented significantly, and some to the point that gene flow and reproduction have been impacted (e.g. Columbian white-tailed deer, Columbia Basin pygmy rabbit). Of course, the smaller the distribution and area of suitable habitat, the greater the risks are for the species or population.

The *Migration Corridors* parameter is “at risk”. Migration corridors are critical for big game animals like woodland caribou, elk, and mule deer, as well as migratory birds. Over time, migration corridors have been encroached upon across the action area by human development in the form of roadways, housing developments, grazing, etc.

The *Cover* parameter is “at risk”. Cover is critical to provide shelter from environmental conditions, support denning or nesting and feeding areas, and largely provide safety from predators across terrestrial species. Cover has been greatly impacted across the action area by human development and actions such as grazing, agriculture, and timber harvest, sometimes to the degree of habitat fragmentation.

The *Reproduction* parameter is “at risk”. Reproductive capability is critical for the persistence of any population. Sage grouse (*Centrocercus urophasianus*) are a prime example of a species with specific reproductive habitat requirements, aside from connectivity and cover. Sage grouse perform mating rituals in a specific area of sagebrush called a lek. The lek is basically an area where males congregate in spring to

entice females with their display. Simply explained, if the sage grouse cannot access the traditional lek, females may not be able to find mates, reducing reproduction potential.

The *Food Sources* parameter is “at risk”. The criticality of food sources goes without saying; however, terrestrial species that rely on specific food sources can be and have been historically displaced or extirpated by habitat disturbance within the action area. An example is the red tree vole (considered in this BA) that associates specifically with Douglas fir for forage and nesting. Another example is Fender’s blue butterfly (also considered in this BA) that relies on lupine species for forage and oviposition. Riparian access development may reduce forage and foraging habitat for species like these, but these sites are unidentified, not certain to occur, and effects would be minimized through sideboards on access areas and conservation measures provided by the USFWS prior to Plan implementation. Therefore, the Plan would have no long-term effects on food sources.

5 Effects of the Action

General effects of treatment area access, isolation, treatment, and restoration include the following.

- Disturbance
- Displacement
- Nesting disruption
- Spawning disruption
- Migration disruption
- Direct injury
- Direct mortality
- Sublethal injury
- Reduced cover
- Reduced nesting habitat
- Reduced spawning habitat suitability
- Reduced dissolved oxygen
- Increased predation
- Elevated turbidity
- Reduced dissolved oxygen
- Reduced food sources
- Habitat fragmentation
- Maintain or improve critical habitat

These effects will be discussed as they pertain to the actions as described. Unavoidable temporary impacts to ESA-listed species and critical habitat are expected; however, implementation of the Plan is a conservation measure within itself. While there would be localized adverse impacts to ESA-listed species and critical habitat via access and treatments, allowing dreissenids to invade waters of the action area without taking

action risks region-wide ecological collapse of keystone endangered species and threatens to endanger populations of other stable aquatic species.

5.1 Effects on Aquatic Species

Aquatic species include all ESA-listed gastropods, amphibians, and water howellia.

5.1.1 Riparian Access Development

Effects to aquatic species from riparian access development may include:

- Disturbance
- Sedimentation
- Reduced shoreline cover

Disturbance would be caused by riparian access development and may require herbaceous vegetation mowing, woody shrub removal, and potentially tree removal at water's edge to facilitate launching boats, staging, treatment area isolation, and other equipment access for fish salvage and treatment. Clean gravel fill may also be required for equipment staging and boat launching, but would not be placed in the water, and would be removed post-treatment. For aquatic species, these actions could reduce available shoreline cover or refugia from water temperature or predators and could reduce insect food sources by removing vegetation in which insects feed or reproduce.

If shoreline vegetation were removed, activity along the shoreline associated with mussel treatment may result in additional suspended sediment in the waterbody. Effects from suspended sediment include 1) possible suffocation of benthic macroinvertebrates (including ESA-listed species) reducing food sources short-term for ESA-listed fishes; 2) potential disorientation of ESA-listed fishes and amphibians reducing predator avoidance abilities; 3) disturbance from occupied habitats; and 4) potential reduction in spawning habitat suitability, however minor or temporary it would be. Effects would be localized to the treatment area, particularly once isolated, and isolation may occur within hours of initial shoreline disturbance. Suspended sediment outside of the treatment area is expected to subside within three hours (based on professional judgement) once the treatment area isolation barrier is deployed. Appropriate BMPs such as silt fence or weed-free straw would be placed to around staging areas to minimize runoff, and native vegetation would be restored at the site post-treatment.

Shoreline vegetation removal at the OWHM would be limited to 60 ft (18 m). This would equate to a total of 720 ft (220 m) of shoreline in a given year if the maximum of 12 treatments were complete. Treatments spatially separated across the action area would not contribute to cumulative impacts, but in the event that a number of treatments occurred in the same watershed, the short-term impacts could exacerbate effects for a given species. ***Therefore, Riparian Access Development may affect, and is likely to adversely affect aquatic ESA-listed species (see Appendix A).***

It should be noted that riparian access development is not certain to occur as these sites are unidentified. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to action.

5.1.2 Treatment Area Isolation

Effects to aquatic species from treatment area isolation may include:

- Disturbance
- Displacement
- Migration disruption
- Reproduction disruption
- Direct injury
- Direct mortality
- Sublethal injury
- Increased predation
- Habitat fragmentation
- Elevated turbidity

Treatment area isolation would cause minor disturbance to sediment within the waterbody. This would be somewhat dependent on the existing substrate. In the event of placing an inflatable bladder dam or dropping a silt curtain and lowering sandbag anchors on a silty substrate, a small plume is expected to erupt and be transported downstream in flowing systems, or settle out near the disturbance site in standing water. The removal of the isolation barrier is expected to result in similar disturbance with effects lasting up to one hour after the barrier is placed or removed.

Isolating habitat would impact adjacent aquatic species making it necessary for species to avoid the isolation barrier while moving within contiguous habitat, whether these are migratory or resident species. The barrier may temporarily fragment habitat which could expose aquatic species to stressors such as increased predation while moving around the barrier. This would be particularly problematic for juvenile fishes and amphibians, as well as crustaceans. Furthermore, isolating suitable spawning habitat could be disruptive to spawning activities.

While a sediment plume is likely to occur from isolation barrier installation and removal, the limited volume and duration of the plume is expected to be minimal, and therefore, insignificant. However, isolating spawning habitat during spawning season or fragmenting habitat such that barrier avoidance would expose migrants and residents to elevated predation potential for an extended period of time would be problematic. It is also possible that a sandbag or inflatable bladder could be laid across gastropods and kill them.

While headwater streams and salmonid spawning areas are not expected to be at high risk of dreissenid invasion, eulachon spawning areas may be isolated and eggs disturbed or killed if treatments occur in April and May.

Therefore, Treatment Area Isolation may affect, and is likely to adversely affect aquatic species (see Appendix A).

5.1.3 Fish Salvage

Effects to aquatic species from fish salvage may include:

- Disturbance
- Displacement
- Migration disruption
- Reproduction disruption
- Direct injury
- Direct mortality
- Sublethal injury
- Increased predation risk
- Indirect loss of food sources (killer whale)

Benefits

Salvaging fish would ensure that a portion of fish (up to 60% estimated best-case) of ESA-listed fishes that may occur within the treatment area would be safely removed. Not salvaging fish would result in certain 100% mortality of individuals isolated within the treatment area.

Effects

The effects of electrofishing have been discussed in detail in a variety of publications and include bruising, petechial hemorrhaging, spinal damage, and mortality. When improperly employed, electrofishing can be quite harmful. As discussed in the Proposed Action section of this document, the guidelines and protocols identified in Reynolds (1996) and NMFS (2000) would be implemented during fish salvage to reduce or eliminate injury and mortality. Aside from the effects of electrofishing, the increased handling required to salvage fish in dreissenid infested waters would cause additional stress.

Given the effects of electrical current are positively correlated with body mass (Reynolds 1996), the stress of disruption or injury to adult fish, particularly anadromous salmonids returning to spawn is of concern. Gravid adult salmonids may release eggs if they encounter an electric field, which could reduce their overall reproduction viability. These fish may also be more susceptible to injury and mortality depending upon their physical condition.

While electrofishing can harm and potentially affect spawning viability of other fishes such as the chub or sucker species of the Warner Basin (USFWS 1998a), resident fish populations are less likely to be affected by localized electrofishing due to their iteroparous life history characteristic. Eulachon may experience spawning disruption,

capture, and egg or juvenile injury if dreissenids were detected within their spawning areas April – June.

Given the known potential for injury and mortality, and the potential to reduce reproduction viability of adult anadromous salmonids, ***Fish Salvage, may affect, and is likely to adversely affect aquatic species (see Appendix A)*** with the exception of green sturgeon and southern resident killer whale***.*** Electrofishing on spawning grounds or encountering adult salmonids during fish salvage is not certain to occur. While the effects of electrical current are positively correlated with body mass, professional judgment and experience suggests that larger fish are more likely to escape or avoid electrical fields, as well as escape the treatment area while setting the isolation barrier. This information, coupled with the employment of electrofishing BMPs (Section 2.1.6) significantly limits the potential harm or encounter with migrating adult salmonids.

The southern DPS of green sturgeon are known only to spawn in the Sacramento River system. Non-spawning adults and subadults are known to spend summer and fall along the Washington and Oregon coast and may enter the Columbia River estuary, but encountering green sturgeon in a treatment site is unlikely. Therefore, ***Fish Salvage, may affect, but is not likely to adversely affect green sturgeon (see Appendix A)***

An indirect effect on the southern resident killer whale may come from potential mortality of juvenile Chinook salmon. Southern resident killer whales prefer large adult Chinook. Any adults taken as a result of treatment would not be available prey for killer whales in fresh water.

Furthermore, mortality of juveniles from treatment may reduce prey availability for killer whales, but the proportion of juveniles that may be affected would need to be significant to result in detectable loss of adult Chinook in the future as a killer whale prey. Therefore, ***Fish Salvage, may affect, but is not likely to adversely affect southern resident killer whales (see Appendix A).***

5.1.4 Treatment

This section focuses on treatment toxicity. Effects to aquatic species from dreissenids treatment may include the following.

- Disturbance
- Direct injury
- Direct mortality
- Sublethal injury
- Reduced dissolved oxygen
- Indirect loss of food sources (killer whale)
- Maintain critical habitat

It should be noted that application BMPs proposed by product labels and post-application water chemistry monitoring (Section 2.1.6) would greatly reduce potential adverse effects to species outside of the treatment area. Chemical levels would need to

be detected at or below the Lowest Observed Effect Concentration (LOEC50) of 0.0008 mg/L for EarthTec QZ [(Copper) Scannell 2009] and 0.038 mg/L for Endothall (CSI 2001) for affected salmonids prior to removing the isolation barrier.

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 a lethal dose of chemical may reach species outside of the treatment area. A breach could conceivably occur from watercraft running across and damaging the barrier or significant wind-driven waves submerging or overtopping the barrier. If a breach were to occur, the exposure time for individuals outside of the treatment area would be low 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. To reduce potential barrier damage or breach, the treatment area could be marked with high visibility buoys.

While impervious isolation barriers are proposed, it should be assumed that some water movement would occur across the barriers into untreated water via seams, around the waters, edge, etc. Impermeable silt curtains have been effective at limiting water movement from the treatment area into untreated water (personal communication, Dr. David Hammond, Earth Science Laboratories, 4 April 2018). The material used to make the proposed barriers is generally HDPE (high-density polyethylene) or PVC (polyvinyl chloride). HDPE is a petroleum-based plastic and PVC is a plastic polymer. Both are highly durable and 100% impervious. Aside from an isolation barrier breach, there is little likelihood that any significant amount of water exchange from the treated area to the untreated would occur at a given time.

Benefits

In the case of all proposed treatments, effects of treatments in the isolated areas would dissipate quickly, posing no long-term or wide-spread contamination (discussed for each treatment). The benefits of mussel eradication include maintaining critical habitat for ESA-listed species and eliminating the potential for system-wide habitat destruction, species displacement, and potential extirpation resulting from the establishment of an aggressive, adaptive, and fiercely competitive invasive species.

Toxicity

The mere presence of a toxin may not result in effects to aquatic species. Rather, the concentration, duration of exposure, species present, life stage of the listed species, and toxicity of the toxin and associated compounds determine the potential for effects to aquatic species. Effects from toxicity are a function of exposure to the toxic substance, at a concentration, and for duration of exposure, sufficient to cause an effect. This is also dependent upon the composition and mode of action of the toxicant, as well as the degradation form and rate. 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.

Toxicology data are presented below for each treatment type to identify the severity of effects that may occur from each treatment. Most data were reviewed from TOXNET. It should be noted that water chemistry (temperature, pH, hardness) can greatly affect toxicity among organisms and data cited may or may not reflect the conditions experienced in the event of rapid response and treatment.

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 such as eulachon egg take.

Endothall would be applied at a rate of 0.3-5 mg/L (Table 2) 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.

Figure 82 provides the effect concentration for 50% of the population (EC50) for aquatic primary productivity (phytoplankton), and lethal concentration for 50% of the population (LC50) for salmonids and prey (*Daphnia*, *Gammarus*, etc.) mortality. The proposed low and high application rates encompass the range of salmonid prey LC50, as well as the salmonid LC50. Given salmonids are typically a more sensitive fish relative to other species, particularly warmer water species, these data are applicable as an assumed conservative estimate of mortality during treatment; however, it is assumed that all aquatic species/individuals not salvaged would be killed during treatment.

There are no long-term effects of Endothall, meaning the degradants 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 (WDNR 2012).

Treatment area isolation would be left in place for up to 45 days for each treatment to ensure Endothall would degrade to 0.1 mg/L (Figure 82) before removing the barrier to avoid effects outside of the treatment area.

Considering the toxicity information presented in Figure 82 and that mussel eradication is the purpose of the proposed treatments, ***Treatment with Endothall may affect, and is likely to adversely affect aquatic species.*** In the case of an invasive aquatic plant

occurring at the same location, this species would be eradicated as well, thus improving critical habitat for native species.

The Aquathol K (Endothall active ingredient) product label is provided in Appendix B for reference.

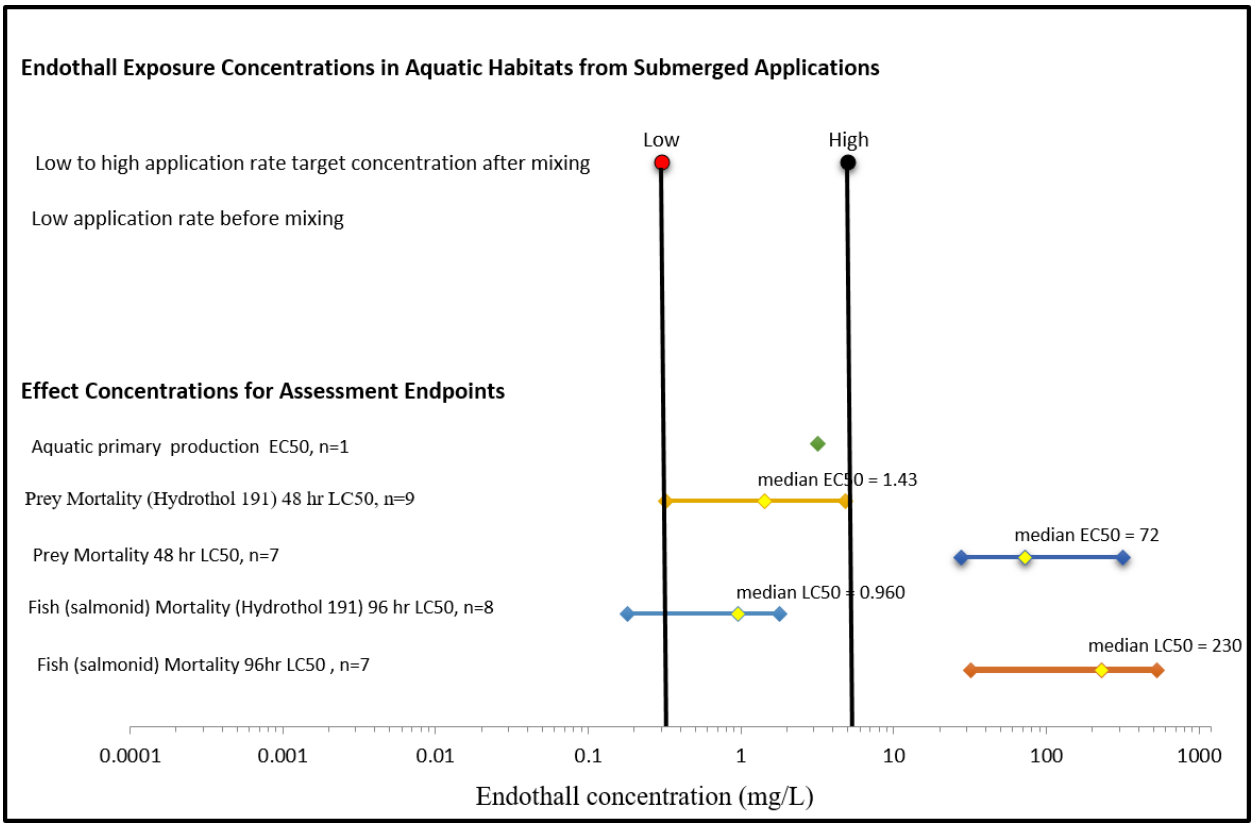

Figure 82. Endothall EC50 and LC50 for phytoplankton and prey (*Daphnia*), and salmonids from toxicity studies. Low and high target application concentrations defined by the red and black dots represent the fully mixed concentrations. Yellow diamonds on LC50 ranges represents the median value among studies.

EarthTec QZ

EarthTec QZ is an aquatic labeled algaecide/bactericide that has been found highly effective on dreissenids, as well as tadpole shrimp species (rice field application). The active ingredient in EarthTec QZ is copper sulfate pentahydrate at 19.8% of the solution per volume. Copper sulfate is a fungicide used to control bacterial and fungal diseases of fruit, vegetable, nut, and field crops. While lethal to aquatic species at proposed doses, 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.

Target application rate would be 0.5 – 2 mg/L (0.06 – 0.1 mg/L as copper) after mixing for up to 30 days for effectiveness. 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.

Figure 83 provides the LC50 for salmonids and *Daphnia* mortality. The proposed low and high application rates are well above the range of salmonids and prey LC50 (96 hour), and the LC50 (96 hour) for pond snails falls at the lowest proposed application rate (TOXNET). Direct bioassay of rainbow trout (assumed adult) subject to EarthTec QZ resulted in a NOEC of 0.240 mg/L copper, and LC50 of 0.294 mg/L copper (Aquatic Bioassay Consulting 2016; Earth Science Laboratories 2016) which are both above the proposed high copper application of 0.1 mg/L (Figure 83).

Given salmonids are typically a more sensitive fish relative to other species, particularly warmer water species, these data are applicable as an assumed conservative estimate of mortality during treatment; however, it is assumed that all aquatic species/individuals not salvaged would be killed during treatment.

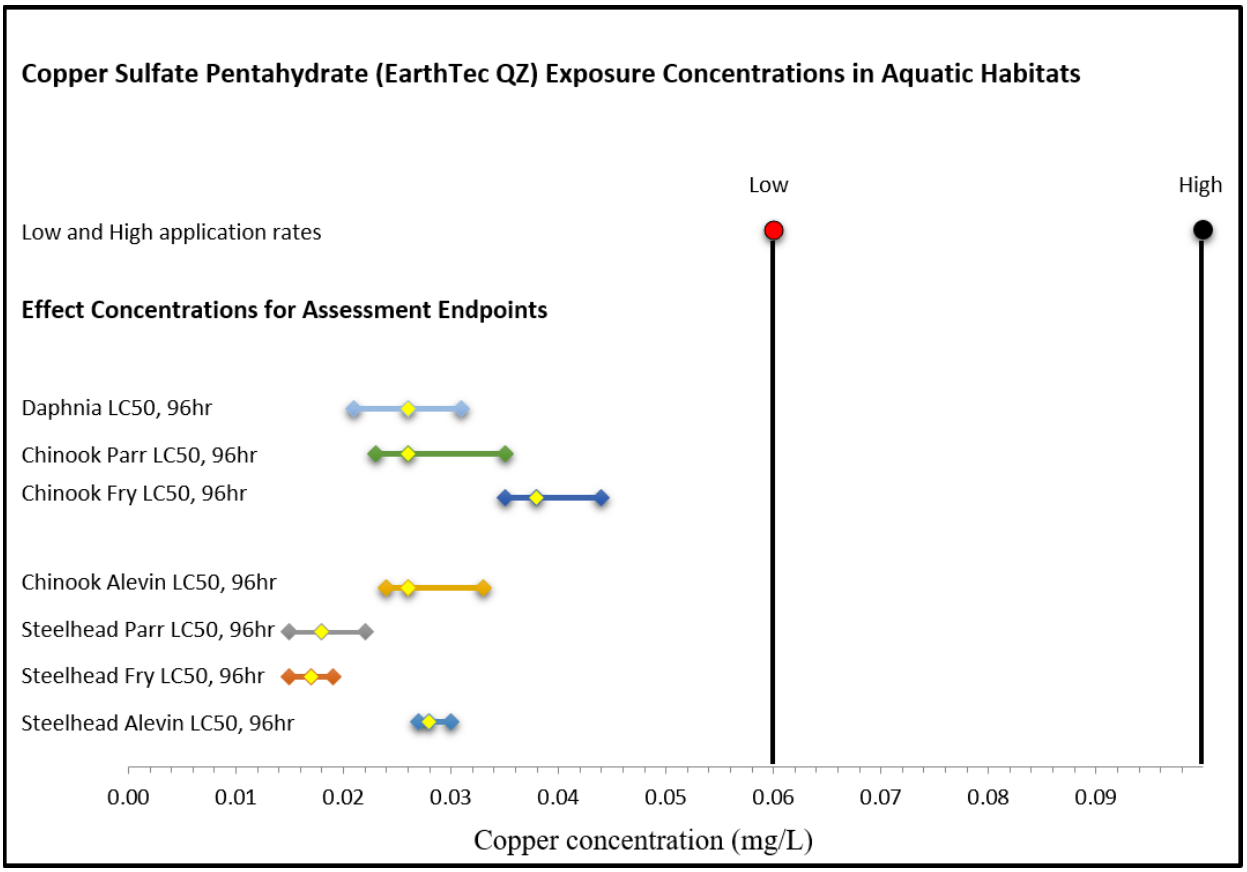

Figure 83. Copper LC50 exposure from copper sulfate pentahydrate for phytoplankton and prey (*Daphnia*), and salmonids from toxicity studies. Low and high target application concentrations defined by the red and black dots represent the fully mixed concentrations. Yellow diamonds on LC50 ranges represents the median value.

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 (Master Label for EarthTec, EPA Reg. No. 64962-1). Dispersion into the waterbody would quickly reduce concentrations to below effect levels outside of the isolated treatment area. The maximum applied copper concentration of 0.1 mg/L, 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 ESA-listed species before being taken up by microorganisms. Treatment area isolation would be left in place up to 45 days for each treatment to ensure effectiveness.

Considering the toxicity information presented in Figure 83 and that mussel eradication is the purpose of the proposed treatments, ***Treatment with EarthTec QZ may affect, and is likely to adversely affect aquatic species.***

The EarthTec QZ product label is provided in Appendix B for reference.

Potash

Potassium is a common plant fertilizer 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 (K2SO4). Target application rates are 95-115 mg/L (KCL), ≤ 10 mg/L (KOH), and 160-640 mg/L (K2SO4) after mixing for up to 21 days for effectiveness. 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.

Figure 84 provides the LC50 for *Daphnia,* Chironomid, rainbow trout parr and fathead minnow for KCL. Figure 85 provides the LC50 for *Daphnia*, *Gambusia*, and fathead minnow for KOH. No data could be found for K2SO4 on TOXNET. The proposed low and high application rates are below the LC50 range for all organisms and both compounds.

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, Figures 84 and 85 support this statement for aquatic species.

Potassium fertilizers used in agriculture have been shown to precipitate out salts when applied in large quantities or over a period of time, which can cause salinity problems in spoils (Magen 1996). There is either a paucity of information on the effects of potassium applied directly to water, or the only actual outcome is increase nutrient loading. Irrigation systems cause compound leaching over time and allow precipitates to build up in soils; however, the volume of water and proposed application concentration of potash would dilute into the water body reducing any likelihood of significant eutrophication or a

salt precipitate to remain in the treatment area. At any rate, our search for more substantial long-term effect potential provided no useful information.

Considering the toxicity information presented in the potash factsheet and Figures 84 and 85 relative to the proposed application rate, toxic effects are not certain to occur and would likely be insignificant. ***Therefore, Treatment with potash compounds may affect, but are not likely to adversely affect aquatic species.***

The material safety data sheets for KCL, KOH, and K2SO4 are provided in Appendix B for reference.

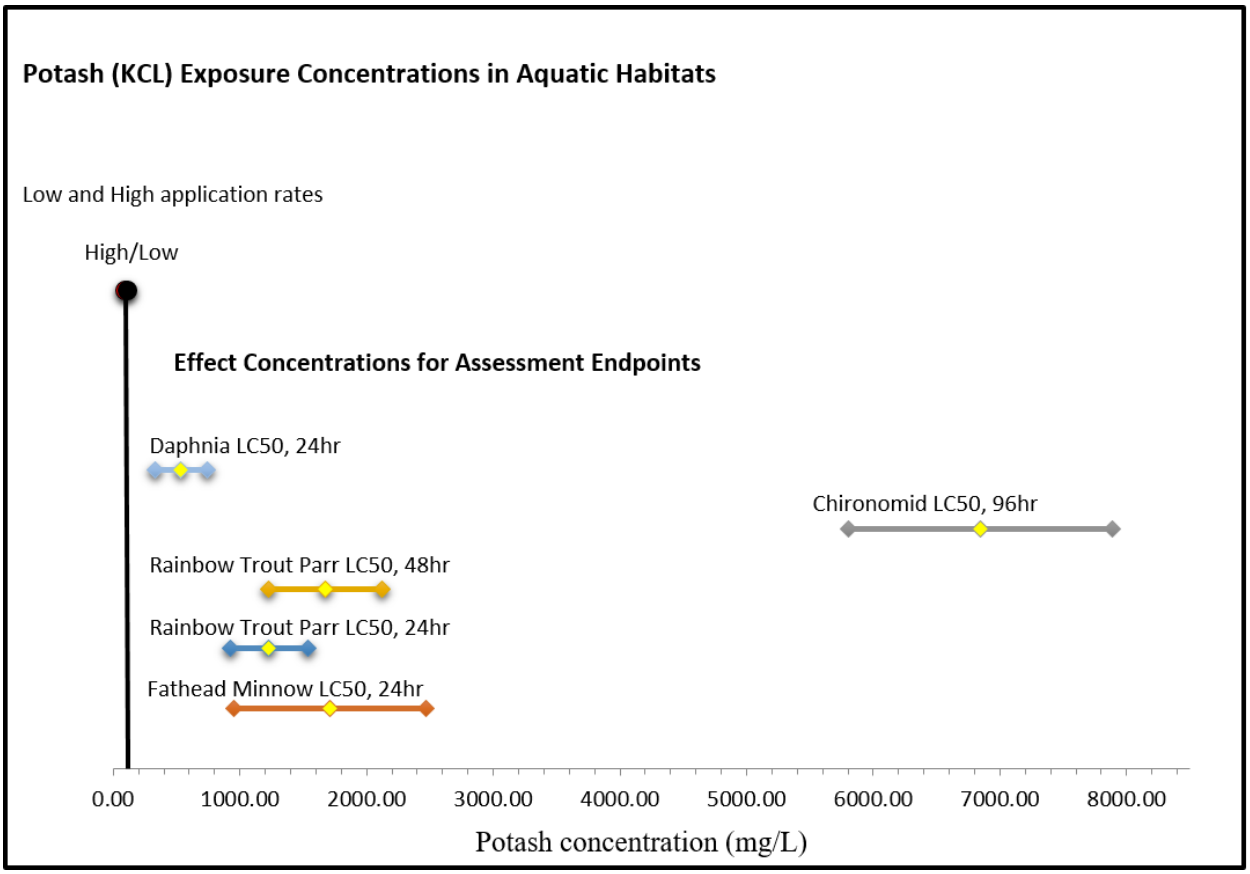

Figure 84. Potash KCL LC50 data for prey (*Daphnia* and Chironomid), warm-water minnow and rainbow trout from toxicity studies. Low and high target application concentrations defined by the red and black dots represent the fully mixed concentrations. Yellow diamonds on LC50 ranges represents the calculated median value.

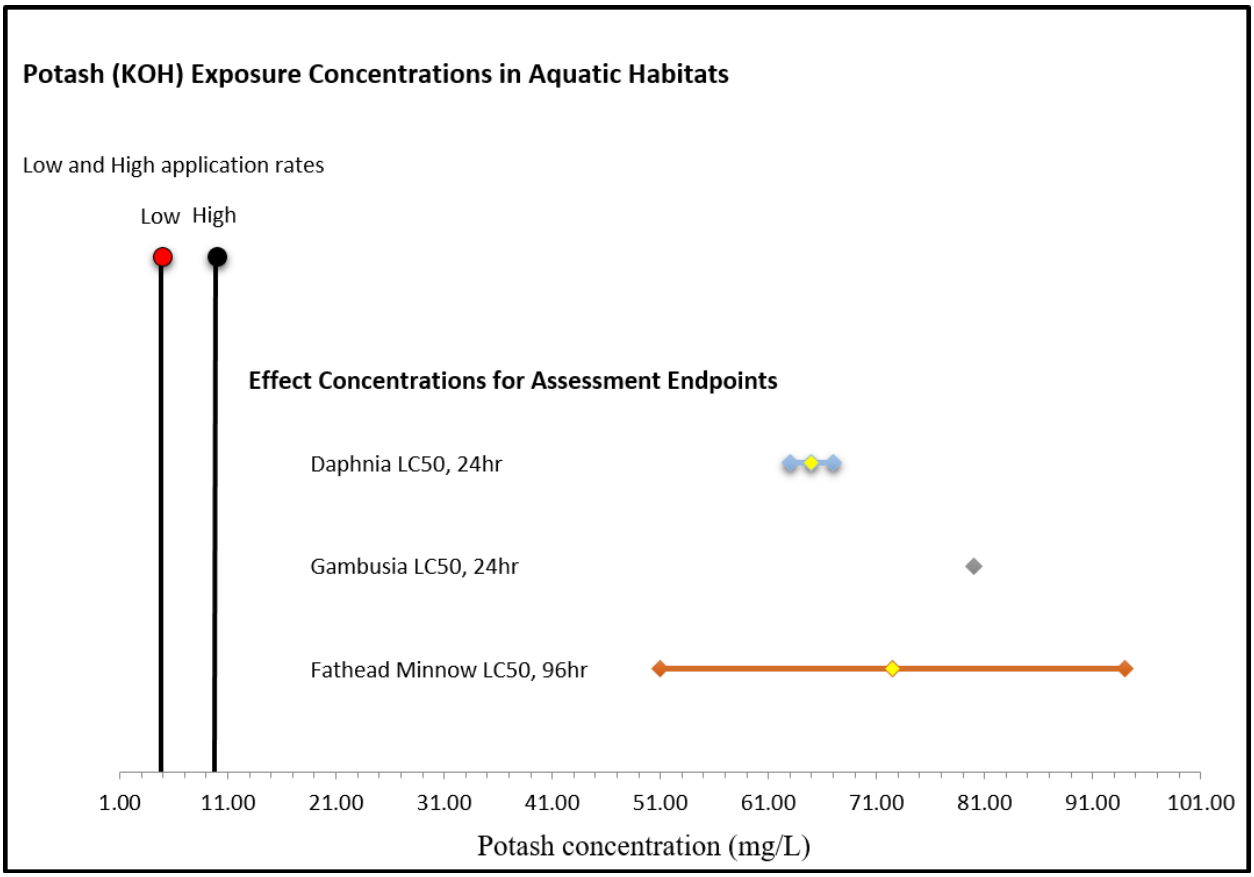

Figure 85. Potash KOH LC50 data for prey (*Daphnia*), and two warm-water minnow species from toxicity studies. Low and high target application concentrations defined by the red and black dots represent the fully mixed concentrations. Yellow diamonds on LC50 ranges represents the calculated median value.

Zequanox

Zequanox is a natural molluscicide comprised of deceased *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 dreissenids as they are filtered from the water column in all life stages. 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.

Prior eco-toxicity studies of Zequanox was limited to macroinvertebrate taxa; However, Waller et al. (2016) studied the effects of exposure at the label-recommended rate and duration on an amphipod *Gammarus lacustris lacustris*, and nymphs of the burrowing mayfly, *Hexagenia* spp. Results indicate that application of Zequanox at the maximum approved concentration and exposure duration did not cause significant mortality or treatment-related histopathological changes to either species. These results compliment

those of previous studies by the Bureau of Reclamation (BOR 2011) and Meehan et al. (2014). Furthermore, BOR (2011) also reported no mortality among six species of Unionoid mussels.

Nicholson (2018) provides a literature review of toxicological literature review identifying studies on warm- and cold-water fish. Luoma et a. (2015) report a rainbow trout LC50 at 19.2 mg/L, far below the label recommendation of 100mg/L at water temperature of 53.6 °F (12 °C). This is the only documentation of adverse effects on aquatic species that were found.

There is a paucity of data currently available on the ecotoxicity of Zequanox, but the evidence presented by Luoma et al. (2015) suggests that ***Treatment with Zequanox may affect, and is likely to adversely affect aquatic species,*** specifically *O. mykiss*. This determination is assumed to be highly conservative. There is no indication of long-term effects and food sources would remain intact. Organisms entering the treatment area post-treatment would not be negatively affected.

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 has been demonstrated as most damaging to amphibians as the UV-B wavelength is readily taken up by organisms and causes cell mutation (Blaustein et al. 2003). Sublethal effects include slowing growth rates and immune dysfunction.

Given the studies that suggest UV-B or C is effective for killing dreissenids (Stewart-Malone et al. 2015; Pucherelli and Claudi 2017), it can be assumed damaging 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. ***Therefore, Treatment with UV-B may affect, and is likely to adversely affect aquatic species.*** 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, for example. 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 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 (Summerfelt 2002; Duran et al. 2010).

Because ozone is used as a wastewater treatment method and is likely 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 tracer for hydrologic studies to characterize water exchange rate, as well as used to successfully simulate aqueous dissipation of herbicides used for aquatic plant control (Getsinger et al. 1997). This dye may be included in treatments at a concentration of 0.01 mg/L to aid in mixing during application, but would also assist with identifying leaks or breaches in the isolation barriers to prevent unintentional effects outside of the treatment area.

Little literature is available on the effects of this dye to aquatic organisms, but several relevant studies were found. Parker (1973) studied the effects of Rhodamine WT at 10 mg/L concentration on juvenile coho salmon over 17.5 hours and found no mortality or respiratory distress. Conversely, Rowiński and Chrzanowski (2011) found a minor toxic effect on aquatic invertebrates, and Behrens et al. (2001) found genotoxicity (effects to cell genetic material DNA or RNA) among various Rhodamine solutions when applied at < 10 mg/L. Effects were only reported for concentration at least 2 orders of magnitude greater than the proposed concentration. The authors cite additional literature on the general safeness of Rhodamine WT.

Getsinger et al. (1997) applied Rhodamine WT to achieve a mixed concertation of 0.01 mg/L and reported a mean half-life of 53.9 hours in a cove application. This concentration (also the proposed application concentration) is three orders of magnitude less than what was tested in the studies above.

Considering the study results and our proposed treatment concentration, adverse effects are not certain to occur from application. ***Therefore, the use of Rhodamine WT would have no effect on aquatic species.***

Summary of Treatment Effects to ESA-listed Anadromous Fishes

Dreissenid treatment would maintain overall critical habitat and protect the ecosystem for ESA-listed aquatic species. Species would experience adverse effects, but long-term effects are not anticipated. In the event of an isolation barrier breach, species outside of the treatment area may be affected temporarily until concentrations diluted to below toxic levels. Dilution is anticipated to occur quickly as the treatment area would most likely be a small fraction of the waterbody, and water exchange would not be equivalent to exposing the entire treatment area volume instantaneously. ***Treatment may affect, and is likely to adversely affect aquatic species (see Appendix A)*** with the exception of green sturgeon and southern resident killer whale.

Chinook salmon (Figures 15 – 20) and steelhead (Figures 27 – 32) populations cover a larger geographic range among at-risk sites than other anadromous ESA-listed fishes, making them more likely to coincide with treatments. Juveniles of both species outmigrate throughout the proposed treatment period of April through October. Outmigration peaks for steelhead and spring Chinook in April – May, and fall Chinook in June – July (based on smolt passage index at McNary Dam). Chinook smolts are

known to seek deeper water as they migrate and mature. This suggests that treatments April – June are most likely to coincide with salmon and steelhead smolts, while treatments July – October are less likely to affect fall Chinook smolts, and not likely to affect spring Chinook or steelhead smolts. Conservation measures to include restricting the use of EarthTec QZ and Endothall within the ESU boundaries of Upper Columbia River spring Chinook and Snake River Basin sockeye greatly reduces risk to these populations, as well as Upper Columbia River Steelhead.

The southern DPS of green sturgeon are known to spawn in the Sacramento River system only. Non-spawning adults and subadults are known to spend summer and fall along the Washington and Oregon coast and may enter the Columbia River estuary, but encountering green sturgeon in a treatment site is unlikely. Therefore, ***Treatment may affect, but is not likely to adversely affect green sturgeon (see Appendix A)***

An indirect effect on the southern resident killer whale may come from potential mortality of juvenile Chinook salmon. Southern resident killer whales prefer large adult Chinook. Any adult Chinook taken as a result of treatment would not be available prey for killer whales in a freshwater treatment site.

Furthermore, mortality of juveniles from treatment may reduce prey availability for killer whales, but the proportion of juveniles that may be affected would need to be significant to result in detectable loss of adult Chinook in the future as a killer whale prey. Therefore, ***Treatment may affect, but is not likely to adversely affect southern resident killer whales (see Appendix A).***

5.1.5 Monitoring

Post-treatment monitoring would consist of occasional SCUBA or snorkeling events to detect adult dreissenids. 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 as species may move to adjacent habitat. Settlement plate checks and boat inspections conducted above water may also minimally disturb aquatic ESA-listed species. These activities are not expected to result in any population level affects to listed species. ***Therefore, Monitoring may affect, but is not likely to adversely affect aquatic species (see Appendix A).***

5.1.6 Restoration

Restoration in itself is a conservation measure defined in Section 2.1.6. Effects to aquatic species from restoration may include:

- Disturbance
- Sedimentation
- Maintain critical habitat

While restoration is proposed as part of the Plan, the actions involved with vegetation replacement may carry affects to ESA-listed species. Specific actions and effects are as follows.

Mowing

Herbaceous vegetation may require mowing prior to planting to make it physically easier to plant, whether by hand or operating machinery, and install appropriate plant protection and weed matting (if applicable). Mowing may also keep noxious weeds from going to seed.

Potential adverse effects on aquatic species may include disturbance; however, no more than 60 ft (18 m) of shoreline would be disturbed for mussel treatment, and mowing would not likely occur down to water's edge. Therefore, the disturbance effects from mowing would be insignificant.

Planting

Planting would involve hand tools, a power auger, or a hydraulic auger or stinger operated by equipment. If willow whips were to be planted along the OHWM, if available, equipment with a hydraulic stinger may be used to stab the whips into the soil. This effectively inserts the whip down to approximately 8.2 ft (2.5 m) deep and leaves virtually no loose soil to erode away. Whips are more likely to survive when planted with this method as well. If an auger were used to plant along the OHWM, loose sediment may potentially enter the waterbody, but appropriate sediment containment measures would be deployed as necessary. The amount of soil typically left bare is approximately 0.5 ft^3 (15.24 cm^3) per hole, based on professional judgement and experience.

Upland planting would not occur right up to water's edge, but typically leaves at least a 3.3 ft (1 m) buffer of herbaceous vegetation between plants and the OHWM. Planting with an auger or hand tools would result in additional ground disturbance relative to the stinger method. Once plants were placed in the holes, the loose soil would be backfilled and packed, and weed matting may be placed around the plants. Considering these methods and the use of appropriate sediment containment measures where appropriate, any effects from planting are expected to be insignificant.

Seeding

Seeding herbaceous vegetation via drill seeding would require seed to be essentially scratched into the ground surface at 0.24 in (0.6 cm) deep and would result in virtually no loose sediment subject to runoff. A drill seeder is an implement that can be towed by a vehicle as small as an all-terrain vehicle, or as large as a bull dozer. Seed mix would be native grasses, forbs, and pollinator species. Therefore, seeding would have insignificant effects on sedimentation and aquatic species.

While the above mowing, planting, and seeding methods may disturb sediment, the sediment containment measures that would be used and minor sediment disturbance are expected to have insignificant effects on aquatic species. Best management practices that would limit effects are presented in Section 2.1.6. ***Therefore, Restoration may affect, but is not likely to adversely affect aquatic species (see Appendix A).*** Furthermore, planting native species may improve riparian habitat over time depending on plant species composition and the proportion of invasive plant species prior to site restoration.

It should be noted that riparian access development and associated restoration is not certain to occur as these sites are unidentified. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to action.

5.1.7 Equipment Sterilization

Equipment sterilization would be required for any equipment in contact with the treatment area. Sterilization is achieved through a high pressure, hot water bath. Waste water would be retained and properly treated to ensure no further contamination of the waterbody. ***Therefore, Equipment Sterilization would have no effect on ESA-listed aquatic species.***

5.1.8 Cumulative Effects on Aquatic ESA-listed Species

A range of potential outcomes may occur at the population level that are captured through ecological risk evaluation. Species considered in this BA 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).

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. 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. Best management practices on chemical applications and riparian vegetation removal (Section 2.1.6) and the low likelihood of riparian access development minimize risk from cumulative effects.

Southern resident killer whales stand to experience effects from a number of treatments occurring within the range of a single Chinook salmon population. If mortality rates increase, mortality of juveniles from treatment may reduce prey availability for killer

whales, but the proportion of juveniles that may be affected would need to be significant to result in detectable loss of adult Chinook in the future as a killer whale prey.

5.2 Effects on Terrestrial Species

5.2.1 Riparian Access Development

Effects to terrestrial species from riparian access development may include:

- Disturbance
- Displacement
- Direct injury
- Direct mortality
- Sublethal injury
- Reproduction disruption
- Reduced food sources
- Reduced cover
- Reduced nesting habitat
- Increased predation
- Habitat fragmentation

Disturbance would be caused by riparian access development and may require herbaceous vegetation mowing, woody shrub removal, and potentially tree removal. Clean gravel fill may also be required for equipment staging and boat launching, but would not be placed in the water, and would be removed post-treatment. For terrestrial species, this could reduce available nesting habitat, food sources, and cover. Vegetation removal at the OHWM would be limited to 60 ft (18 m) of shoreline.

The overarching effect of riparian access development would be disturbance. 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, and trained wildlife biologists would encourage animals to relocate ahead of vegetation removal.

Small mammals such as the red tree vole and subspecies of Mazama pocket gopher 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 pocket gophers poses a risk of collapsing and compacting soils, which may kill gophers, as well as run over amphibians and potentially red tree voles. Vegetation removal from cutting and mowing may harm these species as well, and ESA-listed and candidate plants.

Insect species would be at risk as well. While Fender’s blue butterfly, Taylor’s checkerspot, and the Oregon silverspot butterfly may be able to escape the vegetation removal, food sources and potentially reproductive habitat may be reduced. This risk would be temporary during active treatment and restoration, and would be eliminated post-restoration.

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 restoration, and would be eliminated post-restoration.

A trained wildlife biologist would survey for ESA-listed small mammals and plants prior to vegetation removal. Active pocket gopher habitat, ESA-listed plants, and bird nests would be avoided. Appropriate measures such as silt fence or weed-free straw would be placed around staging areas to minimize runoff, and native vegetation would be restored at the site post-treatment. While these measures would reduce the risk to ESA-listed species, the potential to harm Mazama pocket gophers, listed plants, and food and cover for terrestrial species would remain. ***Therefore, Riparian Access Development may affect, and is likely to adversely affect terrestrial ESA-listed species (see Appendix A).*** Best management practices that would limit effects are presented in Section 2.1.6.

Given the large ranges and mobility of Canada lynx, gray wolf, grizzly bear, wolverine, and woodland caribou, ***potential effects of Riparian Access Development would be insignificant, and therefore may affect, but are not likely to adversely affect these species (see Appendix A).***

It should be noted that riparian access development is not certain to occur as sites requiring access development are unidentified. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to action.

5.2.2 Treatment Area Isolation

Effects to terrestrial species from setting the isolation barrier may include the following.

- Disturbance
- Shoreline vegetation disturbance
- Displacement

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. Trained biologists would ensure that species like amphibians and herpetofauna would be removed from the area prior to action and would avoid bird nests. ***Therefore, Treatment Area Isolation may affect, but is not likely to adversely affect terrestrial ESA-listed species (see Appendix A).***

Given the large ranges and mobility of Canada lynx, gray wolf, grizzly bear, wolverine, and woodland caribou, ***Treatment Area Isolation would have no effect on these species (see Appendix A).***

5.2.3 Fish Salvage

Effects to terrestrial species from fish salvage may include:

- Disturbance
- Displacement

The operation of a boat, backpack, or tow barge electrofishing unit to salvage fish from the treatment area 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. Trained biologists would ensure that bird nests would not be physically disturbed. ***Therefore, Fish Salvage may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants (see Appendix A).***

5.2.4 Treatment

This section focuses on treatment toxicity. Effects to terrestrial species from dreissenid treatment may include:

- Disturbance
- Displacement
- Sublethal injury

The operation of a boat, pressure washer, and other necessary equipment over water to apply treatments would likely cause noise disturbance sufficient that terrestrial ESA-listed species (birds, mammals, insects) would avoid the treatment area. This may pose an inconvenience to terrestrial species, but would not disturb adjacent areas. Trained biologists would ensure that bird nests would not be physically disturbed.

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. There is potential for piscivorous waterfowl to feed on dead aquatic organisms that may be accessible post-treatment while the treatment concentrations are still high enough to kill aquatic species. This is considered for each treatment below.

Endothall

Two studies found on TOXNET suggest that the LC50 for Bob White quail and mallard duck occur at greater than 5,000 mg/L, which would likely never be attained through treatment or bioaccumulation through the food chain as a result of the proposed action. Aquatic food sources would be reduced at a local level. Effects would be insignificant. ***Therefore, treatment with Endothall may affect, but is not likely to adversely affect***

terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants.

EarthTec QZ

A single study found on TOXNET suggests that the LC50 for pheasant ingesting copper was at a concentration of 1,000 mg/L (no observation period listed), which would likely never be attained through treatment or bioaccumulation through the food chain as a result of the proposed action. ***Therefore, treatment with EarthTec QZ would have no effect on any terrestrial ESA-listed species.***

Potash

No studies were found evaluating the toxicity effects of proposed potassium compounds on terrestrial species. Given the low toxicity shown in Figures 84 and 85 above, toxic effects from bioaccumulation are expected to be insignificant to discountable. ***Therefore, treatment with potash may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants.***

Zequanox

BOR (2011) conducted studies and reviewed literature on a number of aquatic and terrestrial species relative to high doses of live and dead *Pseudomonas fluorescens* CL 145A and found no lethality, and determined Zequanox to be “practically non-toxic” to mallard ducks. Effects would be insignificant. ***Therefore, treatment with Zequanox may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants.***

UV-B

The application of UV-B underwater would have indirect effects such as localized reduced food sources, but would have no toxicity effects on terrestrial species (amphibians are addressed under aquatic species). Effects would be discountable. ***Therefore, effects from treatment with UV-B may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants.***

Ozone

The application of ozone underwater would have indirect effects such as localized reduction of food sources, but its quick degradation would have no toxicity effects on terrestrial species (amphibians are addressed under aquatic species). ***Therefore, effects from treatment with ozone would have no effect on any terrestrial ESA-listed species.***

Rhodamine WT Dye

The application of Rhodamine WT dye would have no effect on aquatic species, and ***therefore, would have no effect on any terrestrial ESA-listed species*** (amphibians are addressed under aquatic species).

Summary of Treatment Effects

Given the unlikely bioaccumulation of toxins and lack of substantial evidence suggesting terrestrial species exposed to the proposed treatments and application rates would be negatively impacted, ***Treatment may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants (see Appendix A).***

5.2.5 Monitoring

Post-treatment monitoring would consist of occasional SCUBA or snorkeling events, settlement plate checks, water sampling, and watercraft inspection to detect adult dreissenids. These events, would be 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. ***Therefore, Monitoring may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on terrestrial ESA-listed plants (see Appendix A).***

Given the large ranges and mobility of Canada lynx, gray wolf, grizzly bear, wolverine, and woodland caribou, ***Monitoring would have no effect on these species (see Appendix A).***

5.2.6 Restoration

Effects to terrestrial species from restoration may include:

- Disturbance
- Displacement
- Direct injury
- Direct mortality
- Sublethal injury
- Reproduction disruption
- Improved habitat

Restoration would include the same effects to terrestrial species as riparian access development; however, the benefit of restoration 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 restoration would provide long-term benefits, the temporary adverse effects and potential harm to ESA-listed species cannot be avoided. ***Therefore, Restoration is***

likely to adversely affect terrestrial ESA-listed wildlife species (see Appendix A). Take of ESA-listed terrestrial plants would have occurred under Riparian Access Development; therefore, no further effects would occur for plant species during Restoration.

Given the large ranges and mobility of Canada lynx, gray wolf, grizzly bear, wolverine, and woodland caribou, ***potential effects of Restoration would be insignificant, and therefore may affect, but are not likely to adversely affect these species (see Appendix A).***

5.2.7 Equipment Sterilization

Effects to terrestrial species from equipment sterilization may include:

- Disturbance

Equipment sterilization would be required for any equipment in contact with the treatment area. Sterilization is achieved through a high pressure, hot water bath. Waste water would be retained and properly treated to ensure no further contamination of the waterbody. The operation of a pressure washer or other apparatus during this process would likely produce noise disturbance causing avoidance of the area by terrestrial species. ***Therefore, Equipment Sterilization may affect, but is not likely to adversely affect terrestrial ESA-listed wildlife, and would have no effect on ESA-listed terrestrial plants (see Appendix A).***

5.2.8 Cumulative Effects on Terrestrial ESA-listed Species

Similar to the consideration of cumulative treatment effects on aquatic species, a range of potential outcomes may occur at the population level that are captured through ecological risk evaluation. Species considered in this BA 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. Mazama pocket gopher species and Idaho ground squirrel), while dozens of treatments may not impose ecological risk or destroy critical habitat for species with larger ranges (e.g. gray wolf). Overall, the impacts of cumulative effects would be species- and watershed-specific. Best management practices on chemical applications and riparian vegetation removal (Section 2.1.6), the low likelihood of riparian access development, and proposed restoration minimize risk from cumulative effects.

5.3 Effects on Critical Habitat

Benefits

Unavoidable, temporary impacts to designated critical habitat are expected. While there would be localized adverse impacts to critical habitat via riparian access and restoration (in its rare occurrence), and treatments, the Plan has potential to protect critical habitat overall by delaying, if not eliminating, the region-wide ecological collapse of keystone

endangered species by preventing the physical habitat colonization and redirection of energy sources by dreissenids.

5.3.1 Riparian Access Development

Riparian access development would affect PBFs 1 and 2 for anadromous fishes (Table 7), and PBFs 3 and 6 for bull trout (Table 8). Effects may include:

- Disturbance (aquatic and terrestrial)
    - Mowing
    - Woody vegetation removal
    - Possible gravel fill
- Elevated turbidity (aquatic only)
- Reduced food (aquatic and terrestrial)
- Reduced cover (aquatic and terrestrial)
- Reduced nesting habitat (terrestrial only)
- Habitat Fragmentation (terrestrial only)

Disturbance would be caused by riparian access development and may require herbaceous vegetation mowing, woody shrub removal, and potentially tree removal. Gravel fill may be placed for staging and boat access. Fill would not extend into the water and would be removed prior to site restoration.

The overarching effect of riparian access development would be a reduction in food sources and cover for affected aquatic and terrestrial species. Shoreline vegetation removal at the OWHM would be limited to 60 ft (18 m), which may lead to discountable increases in water temperature and temporary loss of nesting and foraging habitat for ESA-listed birds. Shoreline vegetation would be restored post-treatment and would have no net negative impact to critical habitat.

Ground disturbance may have potential to increase sedimentation along the waterbody, but sediment containment BMPs (see section 2.1.6) would be in place to minimize and sediment inputs. Treatment area isolation would also contain any sediment that did reach the water and allow it to settle out locally. Overall, sedimentation effects on aquatic critical habitat is anticipated to be insignificant.

While a number of adverse effects to critical habitat are expected, these effects would be temporary. However, removing vegetative cover is expected to effectively fragment terrestrial habitat for Mazama pocket gophers, and potentially lead to adverse effects such as increased predation risk for aquatic and terrestrial species. ***Riparian Access Development may affect critical habitat for ESA-listed fishes and Mazama pocket gophers (see Appendix A).*** A suite of BMPs would be implemented to minimize impacts and restoration would restore riparian habitat post-treatment.

It should be noted that riparian access development is not certain to occur as these sites are unidentified. Therefore, ESA consultation would be done on a site-specific

basis and conservation measures would be developed in consultation with the USFWS prior to action.

Given the large ranges and mobility of Canada lynx, gray wolf, grizzly bear, wolverine, and woodland caribou, ***potential effects of Riparian Access Development would be insignificant, and therefore may affect, but are not likely to adversely affect critical habitat for these species (see Appendix A).***

5.3.2 Treatment Area Isolation

Treatment area isolation would affect PBFs 1 and 3 for anadromous fishes (Table 7), and PBFs 2 and 7 for bull trout (Table 8). Effects may include:

- Disturbance (aquatic and terrestrial)
- Elevated turbidity (aquatic only)
- Habitat fragmentation (aquatic only)

Treatment area isolation may cause minor disturbance to riparian and aquatic vegetation and sediments. A minor turbidity plume is expected from both deployment and removal, but is also expected to be insignificant. Some vegetation or shoreline substrate disturbance could occur from securing the ends of the isolation barrier.

Aquatic critical habitat fragmentation is expected to be the significant effect to aquatic critical habitat, making habitat unavailable to aquatic species during treatment. Isolation would effectively subject species to adverse effects by altering food, cover/refugia, migration for resident ESA-listed species, and potentially reproductive habitat elements.

Treatment Area Isolation may affect, and is likely to adversely affect aquatic critical habitat (see Appendix A). Note that headwater streams and salmonid spawning areas are not expected to be at high risk of dreissenid invasion, and therefore, would not be likely treatment areas. Adverse effects would be temporary.

The effects of disturbance from Treatment Area Isolation would be temporary, insignificant, and may affect, but are not likely to adversely affect terrestrial critical habitat for any ESA-listed terrestrial species excluding mammals. Treatment Area Isolation would have no effect on designated critical habitat for ESA-listed mammals (see Appendix A).

5.3.3 Fish Salvage

Fish salvage would affect PBF 1 for anadromous fishes (Table 7), and PBF 6 for bull trout (Table 8). Effects may include:

- Disturbance (aquatic only)

Fish salvage may result in instances of disturbed sediment from netting fish over substrate with fines; however, this turbidity would be temporary, contained within the treatment area where it would resettle, and would be insignificant in the grand scheme of critical habitat. No new sediment would enter the treatment area as a result of this

action. ***Therefore, Fish Salvage may affect, but is not likely to adversely affect aquatic critical habitat (see Appendix A).***

Fish Salvage would have no effect on terrestrial critical habitat.

5.3.4 Treatment

Treatments effects focus on toxicity and physical damage to components of critical habitat. Treatment would affect PBFs 1 and 2 for anadromous fishes (Table 7), and PBFs 2, 3, 6, and 9 for bull trout (Table 8). Beneficial effects would be the end result for the above listed PBFs including PBF 4 for bull trout as the purpose of the Plan is to eradicate invasive dreissenids, thus maintaining aquatic critical habitat. While dreissenids are not predatory or piscivorous (per bull trout PBF 9), their effect on bull trout and critical habitat as an invasive species would be profound. Effects may include:

- Disturbance (aquatic only)
- Reduced cover (aquatic vegetation) (aquatic only)
- Reduced food sources (aquatic only)
- Reduced dissolved oxygen (aquatic only)
- Elevated turbidity (aquatic only)
- Reduced spawning habitat suitability (aquatic only)
- Maintain critical habitat (aquatic only)

Benefits

In the case of all proposed treatments, adverse effects of chemicals in the isolated areas would dissipate quickly, posing no long-term or wide-spread contamination. The benefits of mussel eradication include maintaining critical habitat for ESA-listed species and eliminating the potential for system-wide habitat destruction, species displacement, and potential extirpation resulting from the establishment of an aggressive, adaptive, and fiercely competitive invasive species. In the case of aquatic invasive plant species being present in the treatment area, the application of Endothall, possibly EarthTec QZ, and UV-B would eliminate the invasive vegetation and possibly allow for native species to recolonize the treatment area.

Effects

Dreissenid treatment would introduce toxic chemicals into aquatic critical habitat that would kill aquatic species and vegetation, effectively reducing cover and food sources for ESA-listed aquatic species. Site isolation would allow concentration levels to be maintained sufficient to eradicate dreissenids over a varying timeframe, depending upon which chemical is applied. These effects would be temporary and long-term toxicity of critical habitat is not anticipated. Appropriate BMPs would be implemented to reduce impacts.

If a breach or overtopping of the isolation barrier were to occur when the treatment concentration was thoroughly mixed at the target concentration, it can be assumed that

a lethal dose of chemical may reach organisms and vegetation outside of the treatment area. If a breach were to occur, the exposure time for individuals outside of the treatment area would be low 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.

Endothall

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 (WDNR 2012). Treatment area isolation would be left in place up to 45 days for each treatment to ensure Endothall would degrade to below 0.1 mg/L (Figure 78) before removing the barrier to avoid effects outside of the treatment area.

EarthTec QZ

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 (Master Label for EarthTec, EPA Reg. No. 64962-1). Given the maximum applied copper concentration of 0.1 mg/L, 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 ESA-listed species before being taken up by microorganisms.

Potash

Potassium fertilizers used in agriculture have been shown to precipitate out salts when applied in large quantities or over a period of time, which can cause salinity problems in spoils (Magen 1996). There is either a paucity of information on the effects of potassium applied directly to water, or the only actual outcome is increased nutrient loading. Irrigation systems cause compound leaching over time and allow precipitates to build up in soils; however, the volume of water and proposed application concentration of potash would dilute into the water body reducing any likelihood of significant eutrophication or a salt precipitate to remain in the treatment area.

Zequanox

Zequanox is a natural bacterial strain that occurs in soils and is lethal to dreissenids and algae. There is a paucity of ecotoxicity data for Zequanox, but none of the referenced studies in Section 4.1.4 found any unintentional environmental impacts. The most relevant study would be that of BOR (2011).

UV-B

UV-B would kill aquatic plants and organisms affecting food sources and cover, but effects would be limited to direct application time only, and not persist beyond the treatment period or result in any water quality contamination.

Ozone

Ozone would affect food sources, but would dissipate very quickly making any lasting effects or contamination unlikely. 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 (Summerfelt 2002; Duran et al. 2010).

Rhodamine WT Dye

With a half-life of just over two days (53.9 hours) and insignificant toxicity effects on aquatic organisms, any effects on critical habitat from the application of Rhodamine WT dye would be insignificant. Rhodamine would also assist with identifying leaks or breaches in the isolation barriers.

Summary of Treatment Effects

With the exception of reduced cover, treatment would result in insignificant, temporary effects. Habitat would recover from the identified effects within approximately 24 hours of isolation barrier removal. In the event of application of Endothall, the reduction in cover that may provide refugia would take potentially months to recover. Accumulation of toxins in the substrate sufficient to prohibit aquatic plant regeneration is unexpected. ***Therefore, Treatment may affect, and is likely to adversely affect aquatic critical habitat (see Appendix A), but would have no effect on critical habitat for green sturgeon or southern resident killer whales.*** Treatment effects are specific and temporary, and BMPs (see Section 2.1.6) to reduce impacts would be implemented. The overall benefit of dreissenid treatment is prohibiting the mussels from permanently invading and destroying critical habitat by physically and chemically altering habitat, as well as redirecting the flow of energy sources.

Note that headwater streams and salmonid spawning areas are not expected to be at high risk of dreissenid invasion, and therefore, would not be likely treatment areas.

Because dreissenid treatments would only be applied to aquatic habitat, Treatment would have no effect on terrestrial critical habitat for any ESA-listed species (see Appendix A).

5.3.5 Monitoring

Post-treatment monitoring would consist of occasional SCUBA or snorkeling events, veliger settlement plate checks, water sampling, and watercraft inspection to detect dreissenids. These events, would be short duration, likely on the scale of hours, and

would not physically alter any habitat. ***Therefore, Monitoring would have no effect on aquatic or terrestrial critical habitat.***

5.3.6 Restoration

Restoration would affect PBF 2 for anadromous fishes (Table 7), and PBFs 3 and 4 for bull trout (Table 8). Effects may include:

- Improved habitat

Adverse effects to critical habitat in the form of vegetation removal and gravel placement would occur during riparian access development. These effects would be maintained during active treatment. Restoration would not require additional adverse effects or worsen the condition of affected habitat.

Restoration would restore 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, 80% plant survival standard and native species replanted may improve vegetation composition in the area overall, which would improve habitat function once established. ***Therefore, Restoration may affect, but is not likely to adversely affect designated terrestrial critical habitat for any ESA-listed species (see Appendix A).***

Employment of upland BMPs (see Section 2.1.6) during riparian restoration would reduce any potential sediment inputs from runoff to insignificant levels. No adverse effects to aquatic critical habitat are anticipated, but benefits to PBF 2 for anadromous fishes (Table 7), and PBFs 3 and 4 for bull trout (Table 8) are expected. It is reasonable to assume that benefits to these salmonid PBFs would also benefit other ESA-listed aquatic fish, amphibians, and gastropods. ***Therefore, Restoration may effect, but is not likely to adversely affect designated aquatic critical habitat (see Appendix A).***

It should be noted that riparian access development is not certain to occur as these sites are unidentified. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to action.

5.3.7 Equipment Sterilization

Equipment sterilization would be required for any equipment in contact with the treatment area. Sterilization is achieved through a high pressure, hot water bath. Waste water would be retained and properly treated as discussed in Elwell and Phillips (2016) to ensure no further contamination of the waterbody. Equipment sterilization would not physically alter any habitat. ***Therefore, Equipment Sterilization would have no effect on designated critical habitat for either terrestrial or aquatic ESA-listed species.***

5.3.8 Cumulative Effects on Critical Habitat

Habitat disturbance and loss is a major threat to all 59 ESA-listed species considered in this BA. While there is potential for the cumulative effects of Plan implementation to further degrade aquatic critical habitat when coupled with the ongoing disturbance across the action area. However, treatment effects are anticipated to be localized, sideboards specify the maximum number of treatments and treatment area, and BMPs to minimize impacts to species and habitat greatly reduce the potential for long-term cumulative impacts from the Plan.

Multiple treatments at a given 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 (Sections 2.1.4 and 5.1.4) suggest that multiple treatments would not cumulatively degrade the treatment area/critical habitat condition beyond the effects presented in the BA for a single treatment.

Treatment events would be small-scale relative to the distribution of many of these species (e.g. woodland caribou, Canada lynx, grizzly bear, gray wolf, salmon and steelhead, and bull trout), but the potential for multiple treatment areas to occur within the same relative range (e.g. waterbody, reach, etc.) may tip the scale from “not likely to adversely affect” to “likely to adversely affect” critical habitat, although terrestrial habitat would be restored and likely improved post-treatment. A best management practice (listed on pages 25 and 145) would be to follow chemical label recommendations, which include a maximum treatment level for a waterbody based on proportion of acre-feet treated. Appropriately limiting the number of treatments or proportion of a waterbody that may be treated based on the BMPs would indirectly limit the occurrence and cumulative acreage of riparian disturbance as well, minimizing the overall severity of impacts.

5.4 Ecological Risk Assessment

The NMFS developed an ecological risk assessment (ERA) approach for proposed actions implementing pesticides (Figure 86). The ERA selects critical life history traits for salmonids and evaluates the magnitude of effect that may be realized on each trait relative to the population and species or ESU/DPS level to inform the Service’s jeopardy determinations. The Corps adopted this approach for the Plan to holistically assess the effects of proposed actions as adverse effects are anticipated.

The NMFS ERA was used as developed for pesticide active ingredients, but the “other stressors” considered were modified slightly to capture effects applicable to the proposed action for aquatic species.

The ERA was modified overall to apply to terrestrial species. The original NMFS ERA, as well as the one we used for aquatic species, focused largely on the effects of aquatic

toxins, but dreissenid treatment does not affect terrestrial species as it would aquatic species. Habitat destruction in the event of an access route being developed poses the most significant threat to terrestrial species. Therefore, the ERA was modified to focus on appropriate actions effecting habitat while including toxins in the "other stressors" category.

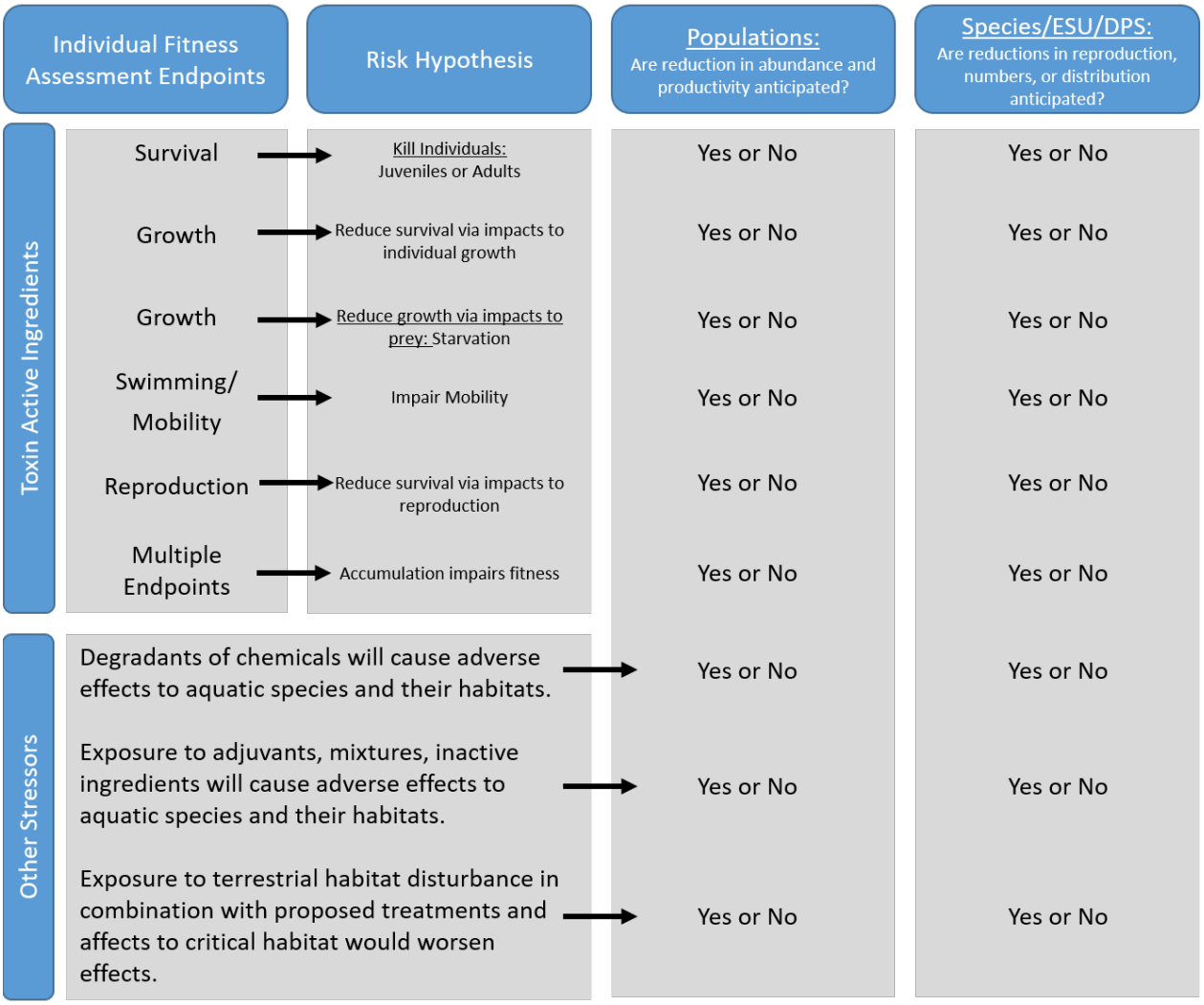

Figure 86. NMFS ERA to evaluate the potential effects of proposed actions involving pesticide applications. The Corps directly adopted this format to evaluate the effects of the proposed Plan on ESA-listed species. The "other stressors" were somewhat modified for aquatic species, and the overall ERA was modified for terrestrial species as stressors of the Plan are different among them.

The direct effects of Plan implementation as described above were evaluated against species populations(s) and distributions relative to the likelihood that a species or its habitat would overlap with at-risk waters as identified by the 4,174 sites. The following sequence of figures (Figures 87-94) details the Corps analysis. The ERAs presented

below cover various groups of aquatic or terrestrial species, but further grouped by species that may experience ecological risk (or not) from Plan implementation.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Toxin Active Ingredients	Survival	Kill Individuals: Juveniles or Adults	Yes	No
	Growth	Reduce survival via impacts to individual growth	No	No
	Growth	Reduce growth via impacts to prey: Starvation	No	No
	Swimming/ Mobility	Impair Mobility	No	No
	Reproduction	Reduce survival via impacts to reproduction	Yes	No
	Multiple Endpoints	Accumulation impairs fitness	No	No
Other Stressors	Degradants of chemicals will cause adverse effects to aquatic species and their habitats.		No	No
	Exposure to adjuvants, mixtures, inactive ingredients will cause adverse effects to aquatic species and their habitats.		No	No
	Exposure to terrestrial habitat disturbance in combination with proposed treatments and affects to critical habitat would worsen effects.		No	No

Figure 87. ERA for aquatic species not considered to be exposed to ecological risk due to spatial separation from the proposed action, large distributions, numbers, and proposed conservation measures. Species include salmonids (excluding Lahontan cutthroat), sturgeon species, Oregon spotted frog, and southern resident killer whales.

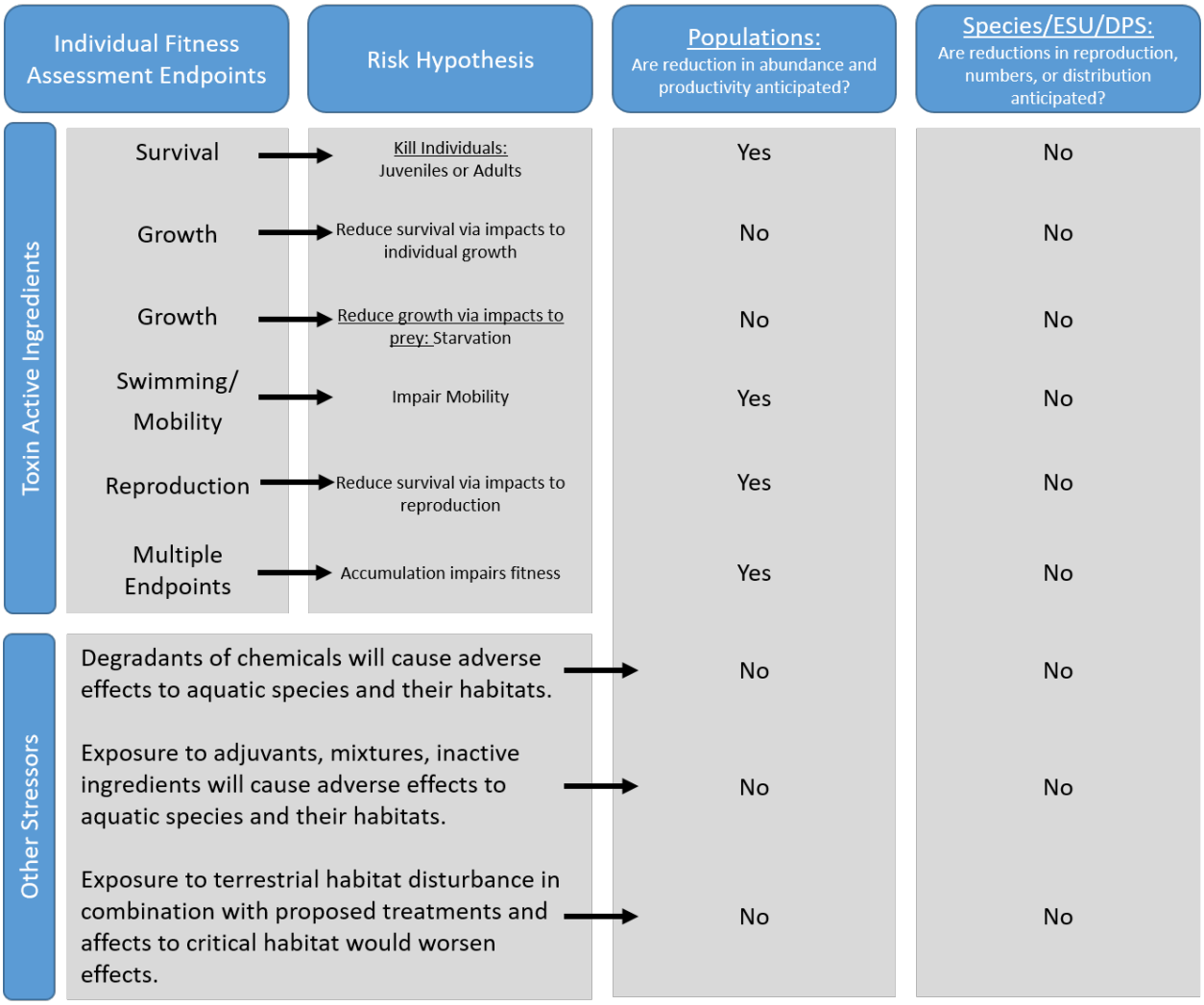

Figure 88. ERA for aquatic species not considered to be exposed to ecological risk due to small distributions or these species occur in habitat that is highly unlikely to be invaded by dreissenids. Species include the Borax Lake chub, Banbury Springs limpet, Bruneau hot springsnail, meltwater lednian and western glacier stoneflies, and vernal pool fairy shrimp.

For example, the Borax Lake chub resides solely in Borax Lake, which is situated atop sodium-borate salts that have been deposited by springs over time. The deposition has created unique water quality and conditions the Borax Lake chub has adapted to. Borax Lake is isolated and the water chemistry makes it an unlikely location for a dreissenid invasion or survival post-invasion. For these reasons, Borax Lake is an unidentified site, considered low risk of dreissenid invasion and subsequent treatment; therefore, the Borax Lake chub is at low ecological risk due to a low risk of exposure to the Plan.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Toxin Active Ingredients	Survival	Kill Individuals: Juveniles or Adults	Yes	Yes
	Growth	Reduce survival via impacts to individual growth	No	No
	Growth	Reduce growth via impacts to prey: Starvation	No	No
	Swimming/ Mobility	Impair Mobility	No	Yes
	Reproduction	Reduce survival via impacts to reproduction	Yes	Yes
	Multiple Endpoints	Accumulation impairs fitness	Yes	Yes
Other Stressors	Degradants of chemicals will cause adverse effects to aquatic species and their habitats.		No	No
	Exposure to adjuvants, mixtures, inactive ingredients will cause adverse effects to aquatic species and their habitats.		No	No
	Exposure to terrestrial habitat disturbance in combination with proposed treatments and affects to critical habitat would worsen effects.		Yes	Yes

Figure 89. ERA for aquatic species that may be exposed to ecological risk due to small populations and distributions, which may coincide with waters that may be at risk of invasion by dreissenids. Species include Eulachon, Hutton tui chub, Foskett's speckled dace, Lahontan cutthroat, Snake River physa snail, Bliss Rapids snail, and shortnose, Lost River, and Warner suckers. Conservation measures exclude Upper Columbia River spring Chinook, Ozette Lake sockeye, and Snake River Basin sockeye.

For example, Foskett's speckled dace occurs in two springs low in the Warner Basin, while Hutton tui chub occurs in two small springs in the Alkali Basin (adjacent to Warner Basin) in Oregon. While these specific springs would be unidentified sites and may be at low risk of dreissenid invasion, the larger Warner and Alkali Basins may be at risk of invasion. Treatment and habitat modification in any of these springs may significantly affect important physical and biological features for these species to the point of no recovery to baseline, even with restoration. Waterbodies and potential treatment areas coinciding with these species are generally unidentified sites. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed by the USFWS prior to treatment to avoid ecological risk.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Habitat Disturbance	Survival	Kill Individuals: Juveniles or Adults	No	No
Habitat Disturbance	Growth	Reduce survival via impacts to individual growth	Yes	No
Habitat Disturbance	Growth	Reduce growth via impacts to food sources: Starvation	No	No
Habitat Disturbance	Mobility	Impair mobility within/among habitat	No	No
Habitat Disturbance	Reproduction	Reduce survival via impacts to reproduction	Yes	No
Habitat Disturbance	Multiple Endpoints	Accumulation impairs fitness	Yes	No
Dreissenid Treatment	Mussel treatments would expose individuals to toxic chemicals.		Yes	No
Dreissenid Treatment	Toxins would result in injury or take.		No	No
Dreissenid Treatment	Actions would fragment habitat sufficient to increase predation and threaten survival.		No	No

Figure 90. ERA for terrestrial species not considered to be exposed to ecological risk due to large distributions, these species occur in habitat that is unlikely to encompass waters at-risk of invasion by dreissenids, or their habitats would be avoidable during Plan implementation. Species include black-footed ferret, Canada lynx, Columbia Basin pygmy rabbit, gray wolf, grizzly bear, North American wolverine, northern Idaho ground squirrel, red tree vole, woodland caribou, least tern, marbled murrelet, northern spotted owl, western snowy plover, yellow-billed cuckoo, Fender's blue butterfly, and Oregon silverspot butterfly.

In general, the distribution, habitat preference, and mobility of the above species puts them at low ecological risk from Plan implementation. For example, the northern Idaho ground squirrel occupies specific, small populations near McCall and New Meadows, Idaho. Only Lost Valley Reservoir has a population on one side of the lake that may be affected by dreissenid treatment, but the lake surroundings make it likely that this population could be completely avoided during Plan implementation.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Habitat Disturbance	Survival	Kill Individuals: Juveniles or Adults	No	No
Habitat Disturbance	Growth	Reduce survival via impacts to individual growth	No	No
Habitat Disturbance	Growth	Reduce growth via impacts to food sources: Starvation	Yes	Yes
Habitat Disturbance	Mobility	Impair mobility within/among habitat	Yes	Yes
Habitat Disturbance	Reproduction	Reduce survival via impacts to reproduction	Yes	Yes
Habitat Disturbance	Multiple Endpoints	Accumulation impairs fitness	Yes	Yes
Dreissenid Treatment	Mussel treatments would expose individuals to toxic chemicals.		No	No
Dreissenid Treatment	Toxins would result in injury or take.		No	No
Dreissenid Treatment	Actions would fragment habitat sufficient to increase predation and threaten survival.		Yes	Yes

Figure 91. ERA for terrestrial species that may be exposed to ecological risk due to small populations and distributions and these species occur in habitat that is likely to encompass waters at-risk of invasion by dreissenids. Species include the streaked horned lark and Taylor's checkerspot butterfly.

Habitat disturbance and fragmentation may greatly affect these species, particularly if multiple treatments requiring riparian access occurred within the habitat ranges in a given year. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to treatment to avoid ecological risk.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Habitat Disturbance	Survival	Kill Individuals: Juveniles or Adults	No/Yes	No/Yes
Habitat Disturbance	Growth	Reduce survival via impacts to individual growth	No	No
Habitat Disturbance	Growth	Reduce growth via impacts to food sources: Starvation	Yes	Yes
Habitat Disturbance	Mobility	Impair mobility within/among habitat	Yes	Yes
Habitat Disturbance	Reproduction	Reduce survival via impacts to reproduction	Yes	Yes
Habitat Disturbance	Multiple Endpoints	Accumulation impairs fitness	Yes	Yes
Dreissenid Treatment	Mussel treatments would expose individuals to toxic chemicals.		No	No
Dreissenid Treatment	Toxins would result in injury or take.		No	No
Dreissenid Treatment	Actions would fragment habitat sufficient to increase predation and threaten survival.		Yes	Yes

Figure 92. ERA for terrestrial species that may be exposed to ecological risk due to small populations and distributions and these species occur in habitat that is likely to encompass waters at-risk of invasion by dreissenids. Species include the Columbian white-tailed deer and the Mazama pocket gophers.

"No" for survival applies to the Columbian white-tail deer. The pocket gophers provide the best example as their populations are very small and they are most likely subject to mortality from the operation of equipment. Waterbodies and potential treatment areas coinciding with these species are generally unidentified sites. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to treatment to avoid ecological risk.

	Individual Fitness Assessment Endpoints	Risk Hypothesis	Populations: Are reduction in abundance and productivity anticipated?	Species/ESU/DPS: Are reductions in reproduction, numbers, or distribution anticipated?
Habitat Disturbance	Survival	Kill Individuals: Juveniles or Adults	Yes	No
	Growth	Cut/Crush Individuals: Reduce survival via impacts to individual growth	Yes	No
	Establishment	Reduce seed or plant rooting and establishment	Yes	No
	Mobility	Impair seed dispersal effectiveness	No	No
	Reproduction	Reduce survival via impacts to reproduction	No	No
	Multiple Endpoints	Accumulation impairs fitness	No	No
Dreissenid Treatment	Mussel treatments would expose individuals to toxic chemicals.		No	No
	Toxins would result in injury or take.		NA	NA
	Actions would fragment habitat sufficient that impacts could not be recovered by mitigation.		No	No

Figure 93. ERA for plant species not considered to be exposed to ecological risk due to large populations and distributions or these species occur in habitat that is unlikely to encompass waters at-risk of invasion by dreissenids. Species include Gentner's fritillary, slickspot peppergrass, Spalding's catchfly, Ute ladies'-tresses, water howellia, western lily, and whitebark pine. NA=not applicable.

These species inhabit coastal waters, and high elevations where waterbodies are isolated (unidentified sites) and appear to be few. These locations are at low risk of dreissenid invasion from either salinity or general access. Furthermore, distributions for most species cover enough geography that if one or two areas were affected, BMPs and restoration are likely to keep adverse effects below the population level.

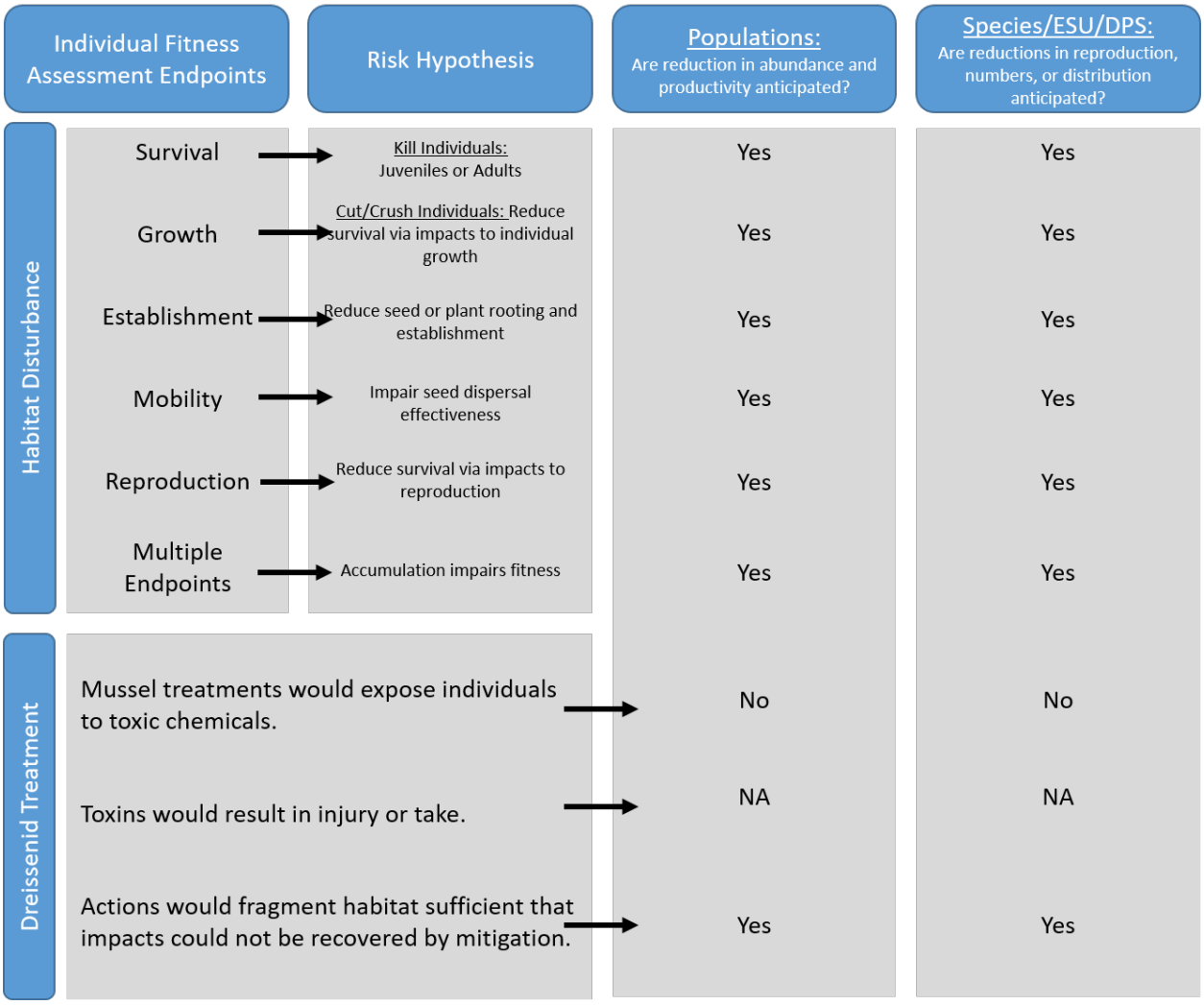

Figure 94. ERA for plant species that may be exposed to ecological risk from Plan implementation due to small populations and distributions, and these species occur in habitat that is likely to encompass waters at-risk of invasion by dreissenids. Species include MacFarlane's four o'clock and Applegate's milk-vetch. NA=not applicable.

Waterbodies and potential treatment areas coinciding with these species are generally unidentified sites. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to treatment to avoid ecological risk.

According to the Corps assessment of distribution, numbers, and location relative to at-risk waters for dreissenids invasion, no anadromous salmonids under NMFS jurisdiction would experience ecological risk from Plan implementation; however, 18 of the 51 species under the jurisdiction of the USFWS may experience ecological risk if dreissenids were identified within habitat occupied by these species (summary provided in Table 9 with effects determinations).

Table 9. Corps ERA summary. Highlighted species may experience ecological risk from Plan implementation without proper conservation measures.

Mammals	
Species	**Ecological Risk**
Black-footed Ferret	Not Likely
Canada Lynx	Not likely
Columbia Basin Pygmy Rabbit	Not likely
Columbian White-tailed Deer	Likely
Gray Wolf	Not likely
Grizzly Bear	Not likely
North American Wolverine	Not likely
Northern Idaho Ground Squirrel	Not likely
Olympia Pocket Gopher	Likely
Red Tree Vole	Not likely
Roy Prairie Pocket Gopher	Likely
Tenino Pocket Gopher	Likely
Woodland Caribou	Not likely
Yelm Pocket Gopher	Likely
Southern Resident Killer Whale	Not Likely

Fish	
Species	**Ecological Risk**
Borax Lake Chub	Not Likely
Bull Trout	Not likely
Chinook Salmon	Not likely
Chum Salmon	Not likely
Coho Salmon	Not likely
Dolly Varden	Not likely
Foskett Speckled Dace	Likely
Eulachon	Likely
Hutton Tui Chub	Likely
Lahontan Cutthroat	Likely
Green Sturgeon	Not Likely
Lost River Sucker	Likely
Palid Sturgeon	Not likely
Shortnose Sucker	Likely
Sockeye Salmon	Not likely
Steelhead	Not likely
Warner Sucker	Likely
White Sturgeon	Not likely

Birds	
Species	**Ecological Risk**
Least Tern	Not Likely
Marbled Murrelet	Not Likely
Northern Spotted Owl	Not Likely
Streak Horned Lark	Likely
Western Snowy Plover	Not Likely
Yellow-billed Cuckoo	Not Likely

Gastropods	
Species	**Ecological Risk**
Banbury Springs Limpet	Not Likely
Bliss Rapids Snail	Likely
Bruneau Hot Springsnail	Not Likely
Snake River Physa Snail	Likely
Vernal Pool Fairy Shrimp	Not Likely

Amphibians	
Species	**Ecological Risk**
Oregon Spotted Frog	Not Likely

Insects	
Species	**Ecological Risk**
Fender's Blue Butterfly	Not Likely
Meltwater Lednian	Not Likely
Oregon Silverspot Butterfly	Not Likely
Taylor's (whulge) Checkerspot	Likely
Western Glacier Stonefly	Not Likely

Plants	
Species	**Ecological Risk**
Applegate's Milk-Vetch	Likely
Gentner's Fritillary	Not Likely
MacFarlane's Four-o'clock	Likely
Slickspot Peppergrass	Not Likely
Spalding's Catchfly	Not Likely
Ute Ladies'-tresses	Not Likely
Water Howellia	Not Likely
Western Lily	Not Likely
Whitebark Pine	Not Likely

Waterbodies and potential treatment areas coinciding with these 18 species are generally unidentified sites. Therefore, ESA consultation would be done on a site-specific basis and conservation measures would be developed in consultation with the USFWS prior to treatment to avoid ecological risk.

5.5 Cumulative Effects

Among the four states covered in the action area, a variety of human disturbances such as mineral extraction, energy harnessing (wind and water), timber harvest, livestock grazing, recreation, and human development have and will likely continue to significantly alter the habitats of the 59 ESA-listed species considered in this BA; hence, the potential spread of dreissenids by humans may devastate critical habitat and species, jeopardize stable species, and has resulted in the Corps developing the Plan to conserve critical habitat.

Habitat restoration programs that may benefit ESA-listed species are somewhat difficult to define as they may occur under many different funding sources and organizations. Other state and Federal protections on species and habitats (e.g. protected areas; state conservation plans) offer to conserve species and populations. In some cases, these programs and protections may offset adverse cumulative effects from the Plan and a variety of actions across entities long enough to allow Plan restoration to recover the impacts.

5.6 Effects on the Environmental Baseline

Following the baseline justification in Section 4.4, The Corps has determined that the proposed action would not restore or degrade the function of habitat indicators of the environmental baseline, but would maintain existing baseline conditions within the action area as a function of eliminating dreissenids from impacting existing critical habitat (Tables 10 and 11). For the purposes of the MPI checklist, "maintain" means that the function of an indicator does not change overall and it applies to all indicators regardless of functional level. The effects of Plan implementation on each indicator is discussed in the following sections.

5.6.1 Aquatic Species

Water Quality

The *Temperature* parameter is “at risk”. While likely minor additional disturbance would occur, through restoration, this Plan would have no net effect on water temperature.

The *Sediment* parameter is “at risk”. Habitat disturbance resulting from the proposed action may cause additional sediment to enter waterbodies where treatment would occur; however, BMPs would be in place to minimize sediment inputs, and treatment area footprints would be relatively small. This Plan would have a minor and temporary effect on sediment.

The *Chemical Contaminants/Nutrients* parameter is “at risk”. Contaminants and nutrient inputs may be at risk from human development and recreation, and these watersheds are most likely to be at risk for dreissenid mussel invasion; hence, the rapid response Plan may involve activities that would impose risk of chemical contaminants and nutrient inputs. The risk would be minimized through BMPs, but toxic chemicals would be directly added to waterbodies. This Plan would temporarily degrade contaminant or nutrient inputs.

Habitat Access

The *Physical Barriers* parameter is “not properly functioning”. While temporary treatment area isolation barriers would segregate areas of habitat, the isolation would be temporary and would not likely block entire passage or migration routes. This Plan would have no effect on physical barriers for any species.

Habitat Elements

The *Substrate* parameter is “at risk”. While small and temporary inputs or disturbances may occur with this Plan, BMPs would greatly reduce the risk or effects. This Plan would have no effect on substrate.

The *Large Woody Debris* parameter is “at risk”. While shoreline vegetation may need to be cleared for access, this may also include woody debris; however, woody debris recruitment would not be affected and submerged woody debris would not be removed. This Plan would have no effect on woody debris.

The *Pool Frequency* parameter is “at risk”. While dams on the mainstem Snake, Columbia, and Missouri Rivers may alter pool frequency, this Plan would have no effect on pool frequency in northwest rivers.

The *Pool Quality* parameter is “at risk”. This Plan would have no adverse effect on pool quality, and may improve pool quality with the incidental removal of invasive plant species.

The *Off-Channel Habitat* parameter is “not properly functioning”. While off-channel habitat may be isolated and treated for dreissenids, no long-term disturbance or degradation is anticipated. This Plan would have no effect on available off-channel habitat.

The *Refugia* parameter is “at risk”. This Plan would have minor, short term impacts to shoreline cover, which would be restored post-treatment. This Plan would have no long-term effect on available refugia.

Channel Condition and Dynamics

The *Width to Depth Ratio* parameter is “not properly functioning”. This Plan would have no effect on the river’s width to depth ratio.

Table 10. Checklist for documenting the effects of Plan implementation on the environmental baseline for ESA-listed fishes.

Pathways	**Effects of the Action**		
Indicators	Restore	Maintain	Degrade
Water Quality:			
Temperature		X	
Sediment		X	
Chem. Contam./Nut.			X
Habitat Access:			
Physical Barriers		X	
Habitat Elements:			
Substrate		X	
Large Woody Debris		X	
Pool Frequency		X	
Pool Quality		X	
Off-Channel Habitat		X	
Refugia		X	
Channel Cond. and Dynamics:			
Width/Depth Ratio		X	
Streambank Condition		X	
Floodplain Connectivity		X	
Flow/Hydrology:			
Peak/Base Flows		X	
Drainage Network Increase		X	
Watershed:			
Road Density and Location		X	
Disturbance History		X	
Riparian Reserves		X	

The *Streambank Condition* parameter is “not properly functioning”. In unidentified sites, up to 60 linear ft (18 m) of shoreline may be disturbed to gain access for dreissenid treatment. Riparian habitat restoration would restore any shoreline conditions that were damaged, and may improve conditions in some cases. This Plan would have no long-term negative effect on streambank condition.

The *Floodplain Connectivity* parameter is “not properly functioning”. This Plan would have no effect on floodplain connectivity.

Flow and Hydrology

The *Peak/Base Flows* parameter is “not properly functioning”. This Plan would have no effect on river flows.

The *Drainage Network Increase* parameter is “at risk”. This Plan would have no effect on the watershed’s drainage network.

Watershed Conditions

The *Road Density and Location* parameter is “at risk”. While riparian access may be required in rare cases, this would include making an access path that could be viewed as a “road”, as well as the potential for clean gravel fill within the staging and boat access areas [upland of the ordinary high water mark (OHWM)]. However, any road or fill that would be placed would also be removed or obliterated during riparian restoration. This Plan would have no net effect on the road density of treated watersheds.

The *Disturbance History* parameter is “not properly functioning”. This Plan would have no effect on the disturbance history of the watershed.

The *Riparian Reserves* parameter is “at risk”. The Plan may require removing riparian habitat to gain water access in the case of remote, isolated waterbody where dreissenids have been identified. Riparian restoration would occur post-treatment and may leave the disturbed area in better condition than existing. This Plan would have no net negative effect on the riparian reserves of the river corridor, and may provide a benefit where invasive plants are replaced with native species during restoration.

5.6.2 Terrestrial Species

Habitat Connectivity: Riparian access development has the potential to fragment habitat for terrestrial species. Fragmentation would be temporary, but restoration measures post-treatment may take two to five years to begin providing usable qualities for terrestrial species. Sites that would require riparian access development are unidentified, not certain to occur, and would also include conservation measures developed by the USFWS prior to implementation to reduce impacts to species. This Plan may have temporary impacts to terrestrial habitat connectivity, but would maintain it long-term.

Migration Corridors: Riparian access development may occur within a migration corridor, but these sites are unidentified, not certain to occur, and effects would be minimized through sideboards on access areas [60 linear ft (18 m) of shoreline and 12 ft wide road) and conservation measures developed in consultation with the USFWS prior to Plan implementation. These measures coupled with site restoration would ensure the Plan would have no long-term effects on migration corridors.

Cover: Riparian access development may reduce cover, but these sites are unidentified, not certain to occur, and effects would be minimized through sideboards on access areas and conservation measures provided by the USFWS prior to Plan implementation. Therefore, the Plan would have no long-term effects on available cover.

Reproduction: Riparian access development may affect important reproduction habitat, but these sites are unidentified, not certain to occur, and effects would be minimized through sideboards on access areas and conservation measures developed in consultation with the USFWS prior to Plan implementation. These measures coupled with site restoration would ensure the Plan would have no long-term effects on migration corridors.

Food Sources: Riparian access development may reduce forage and foraging habitat for species like these, but these sites are unidentified, not certain to occur, and effects would be minimized through sideboards on access areas and conservation measures developed in consultation with the USFWS prior to Plan implementation. Therefore, the Plan would have no long-term effects on food sources.

Table 11. Corps-developed MPI for evaluating the effects of Plan implementation on the environmental baseline for ESA-listed terrestrial species.

Pathways	**Effects of the Action**		
Indicators	Restore	Maintain	Degrade
Habitat Connectivity:		X	
Migration Corridors		X	
Cover		X	
Reproduction		X	
Food Sources		X	

6 Magnuson-Stevens Act

The consultation requirement of section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) directs Federal agencies to consult with NMFS on all actions, or proposed actions that may adversely affect Essential Fish Habitat (EFH). Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

The proposed Plan, specifically riparian access development and dreissenid treatment, would temporarily affect water and substrate, and would result in the temporary loss of benthic organisms, prey species, and their habitat. However, the Plan is proposed to avoid devastating impacts to EFH from an untreated dreissenid invasion. ***As proposed, the Plan may adversely affect EFH*** as described in Section 4.3, Effects to Critical Habitat, and the Corps is requesting review of conservation measures proposed by NMFS.

7 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) protects all marine mammals from take, including cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), sirenians (manatees and dugongs), sea otters, and polar bears within the waters of the United States. Under the MMPA, marine mammals cannot be harassed, fed, hunted, captured, collected, or killed and parts of a marine mammals cannot be possessed without a permit. The Act also formalized the marine mammal health and stranding response program to improve the response of stranding and unusual mortality events. The National Oceanic and Atmospheric Administration web site gives the complete text of the Act.

The proposed Plan would not result in take in any manner as described by the MMPA.

8 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) authorizes the USFWS to evaluate the impacts to fish and wildlife species from proposed Federal water resource development projects that could result in the control or modification of a natural stream or body of water that might have effects on the fish and wildlife resources that depend on that body of water or its associated habitats.

The proposed Plan would not develop or control any water resources, but may temporarily modify a portion of a waterbody through riparian access development, treatment area isolation, and dreissenid treatment. The purpose of the Plan is to maintain aquatic habitat by avoiding devastation from a dreissenid invasion. ***Therefore, the Corps is required to coordinate with USFWS under FWCA on Plan implementation.***

9 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.

The Plan may include riparian habitat disturbance that may disrupt nesting and nesting habitat in unidentified sites. 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 Plan may result in take of migratory birds.*** The Corps would coordinate with the USFWS prior to Plan implementation for unidentified sites. In the event that take may occur, the Corps would apply for a take permit.

10 Bald and Golden Eagle Protection Act

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.

Bald and golden eagles are common throughout much of the action area. Nesting, roosting, or foraging eagles may be present near a treatment site during Plan implementation. In some locations, eagles that may occupy treatment sites frequently are likely accustomed to the daily human activities and related noise levels such as vehicles, equipment, and boat and foot traffic, while in other areas, eagles may rarely have human interaction.

In the case of a treatment site occurring where eagles have relatively little human interaction, eagles are likely to avoid the immediate treatment site. In addition, suitable roosting and foraging habitat is expected to be available adjacent to the treatment site outside of a range of disturbance. The Plan 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.***

11 Effects Determinations

11.1 Listed Species

Toxicology data, habitat occupation, geographic distributions of listed species relative to at-risk waters for dreissenid invasion, and proposed conservation measures all support the following determinations for ESA-listed species (summarized in Table 12). Appendix A, Table 11.1 presents effects determinations and additional considerations for each population of anadromous salmonids under NMFS jurisdiction.

Aquatic Species

Actions that may affect, and are likely to adversely affect are:

- Riparian Access Development
- Treatment Area Isolation
- Fish Salvage
- Treatments

Actions that may affect but are not likely to adversely affect are:

- Monitoring
- Restoration

Actions that would have no effect are:

- Equipment Sterilization

Terrestrial Species

Actions that may affect, and are likely to adversely affect are:

- Riparian Access Development
- Restoration

Actions that may affect but are not likely to adversely affect are:

- Treatment Area Isolation
- Fish Salvage
- Treatments
- Monitoring
- Equipment Sterilization

11.2 Critical Habitat

Toxicology data, habitat occupation, and geographic distributions of listed species relative to at-risk waters for dreissenid invasion all support the following determinations for designated and proposed critical habitat (summarized in Table 12).

Aquatic Critical Habitat

Actions that may affect critical habitat are:

- Riparian Access Development
- Treatment Area Isolation
- Treatments

Actions that may affect, but are not likely to adversely affect are:

- Fish Salvage
- Restoration

Actions that would have no effect are:

- Monitoring
- Equipment Sterilization

Terrestrial Critical Habitat

Actions that may affect critical habitat are:

- Riparian Access Development
- Restoration

Actions that may affect but are not likely to adversely affect are:

- Treatment Area Isolation

Actions that would have no effect are:

- Fish Salvage
- Treatments
- Monitoring
- Equipment Sterilization

Table 12. Effects determination summary for Plan implementation. "LAA" represents likely to adversely affect, "NLAA" represents not likely to adversely affect, and "NA" represents not applicable as no critical habitat is designated or occurs within the action area.

Mammals		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Black-footed Ferret	LAA	NA
Canada Lynx	NLAA	May Affect
Columbia Basin Pygmy Rabbit	LAA	NA
Columbian White-tailed Deer	LAA	NA
Gray Wolf	NLAA	NA
Grizzly Bear	NLAA	May Affect

Mammals Continued		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
North American Wolverine	NLAA	NA
Northern Idaho Ground Squirrel	LAA	NA
Olympia Pocket Gopher	LAA	May Affect
Red Tree Vole	LAA	NA
Roy Prairie Pocket Gopher	LAA	May Affect
Tenino Pocket Gopher	LAA	May Affect
Woodland Caribou	NLAA	May Affect
Yelm Pocket Gopher	LAA	May Affect
Southern Resident Killer Whale	NLAA	No Effect

Fish		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Borax Lake Chub	LAA	May Affect
Bull Trout	LAA	May Affect
Chinook Salmon	LAA	May Affect
Chum Salmon	LAA	May Affect
Coho Salmon	LAA	May Affect
Dolly Varden	LAA	NA
Eulachon	LAA	May Affect
Foskett Speckled Dace	LAA	NA
Green Sturgeon	NLAA	No Effect
Hutton Tui Chub	LAA	NA
Lahontan Cutthroat	LAA	NA
Lost River Sucker	LAA	May Affect
Pallid Sturgeon	LAA	NA
Shortnose Sucker	LAA	May Affect
Sockeye Salmon	LAA	May Affect
Steelhead	LAA	May Affect
Warner Sucker	LAA	May Affect
White Sturgeon	LAA	May Affect

Birds		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Least Tern	LAA	NA
Marbled Murrelet	LAA	May Affect
Northern Spotted owl	LAA	May Affect
Streak Horned Lark	LAA	May Affect
Western Snowy Plover	LAA	May Affect
Yellow-billed Cuckoo	LAA	May Affect

Gastropods		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Banbury Springs Limpet	LAA	NA
Bliss Rapids Snail	LAA	NA
Bruneau Hot Springsnail	LAA	NA
Snake River Physa Snail	LAA	NA
Vernal Pool Fairy Shrimp	LAA	May Affect

Amphibians		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Oregon Spotted Frog	LAA	May Affect

Insects		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Fender's Blue Butterfly	LAA	May Affect
Meltwater Lednian	LAA	NA
Oregon Silverspot Butterfly	LAA	May Affect
Taylor's (whulge) Checkerspot	LAA	May Affect
Western Glacier Stonefly	LAA	NA

Plants		
Species	**Species Effect Determination**	**Critical Habitat Effect Determination**
Applegate's Milk-Vetch	LAA	NA
Gentner's Fritillary	LAA	NA
MacFarlane's Four-o'clock	LAA	NA
Slickspot Peppergrass	LAA	May Affect
Spalding's Catchfly	LAA	NA
Ute Ladies'-tresses	LAA	NA
Water Howellia	LAA	NA
Western Lily	LAA	NA
Whitebark Pine	LAA	NA

MSA
May Adversely Affect
MMPA
No Take
FWCA
Coordination Required
MBTA
Potential for Take
BGEPA
No Take or Disturbance

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Appendix A

Species and Critical Habitat Effects Matrices for the Proposed Action

Table 5.1.1: Effects analysis matrix for aquatic ESA-listed species, Riparian Access Development, BA Section 5.1.1. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect".

Fish and Mammals			
	Potential Effects of Riparian Access Development		
Species	**Disturbance**	**Sedimentation**	**Reduced Shoreline Cover**
Borax Lake Chub	X	X	
Bull Trout	X	X	
Chinook Salmon	X	X	X
Chum Salmon	X	X	X
Coho Salmon	X	X	X
Dolly Varden	X	X	
Eulachon	X	X	X
Foskett Speckled Dace	X	X	
Green Sturgeon	X		
Hutton Tui Chub	X	X	
Lahontan Cutthroat	X	X	X
Lost River Sucker	X	X	X
Pallid Sturgeon	X	X	X
Shortnose Sucker	X	X	X
Sockeye Salmon	X	X	X
Steelhead	X	X	X
Warner Sucker	X	X	
White Sturgeon	X	X	
Southern Resident Killer Whale			

Gastropods			
	Potential Effects of Riparian Access Development		
Species	**Disturbance**	**Sedimentation**	**Reduced Shoreline Cover**
Banbury Springs Limpet	X	X	X
Bliss Rapids Snail	X	X	X
Bruneau Hot Springsnail	X	X	X
Snake River Physa Snail	X	X	X
Vernal Pool Fairy Shrimp	X	X	X

Amphibians			
	Potential Effects of Riparian Access Development		
Species	**Disturbance**	**Sedimentation**	**Reduced Shoreline Cover**
Oregon Spotted Frog	X	X	X

Insects			
	Potential Effects of Riparian Access Development		
Species	**Disturbance**	**Sedimentation**	**Reduced Shoreline Cover**
Meltwater Lednian	X	X	X
Western Glacier Stonefly	X	X	X

Plants			
	Potential Effects of Riparian Access Development		
Species	**Disturbance**	**Sedimentation**	**Reduced Shoreline Cover**
Water Howellia	X	X	

Table 5.1.2: Effects analysis matrix for aquatic ESA-listed species, Treatment Area Isolation, BA Section 5.1.2. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect".

Fish

Species	Disturbance	Displacement	Migration Disruption	Reproduction Disruption	Direct Injury	Direct Mortality	Sublethal Injury	Increase Predation	Habitat Fragmentation	Elevated Turbidity
	Potential Effects of Treatment Area Isolation									
Borax Lake Chub	X	X		X	X	X	X	X	X	X
Bull Trout	X	X	X	X	X	X	X	X	X	X
Chinook Salmon	X	X	X	X	X	X	X	X	X	X
Chum Salmon	X	X	X	X	X	X	X	X	X	X
Coho Salmon	X	X	X	X	X	X	X	X	X	X
Dolly Varden	X	X	X	X	X	X	X	X	X	X
Eulachon	X	X	X	X	X	X	X	X	X	X
Foskett Speckled Dace	X	X		X	X	X	X	X	X	X
Green Sturgeon	X									
Hutton Tui Chub	X	X		X	X	X	X	X	X	X
Lahontan Cutthroat	X	X	X	X	X	X	X	X	X	X
Lost River Sucker	X	X	X	X	X	X	X	X	X	X
Pallid Sturgeon	X	X	X	X	X	X	X	X	X	X
Shortnose Sucker	X	X	X	X	X	X	X	X	X	X
Sockeye Salmon	X	X	X	X	X	X	X	X	X	X
Steelhead	X	X	X	X	X	X	X	X	X	X
Warner Sucker	X	X	X	X	X	X	X	X	X	X
White Sturgeon	X	X	X	X	X	X	X	X	X	X
Southern Resident Killer Whale										

Gastropods

Species	Disturbance	Displacement	Migration Disruption	Reproduction Disruption	Direct Injury	Direct Mortality	Sublethal Injury	Increase Predation	Habitat Fragmentation	Elevated Turbidity
	Potential Effects of Treatment Area Isolation									
Banbury Springs Limpet	X	X	X	X	X	X	X	X	X	X
Bliss Rapids Snail	X	X	X	X	X	X	X	X	X	X
Bruneau Hot Springsnail	X	X	X	X	X	X	X	X	X	X
Snake River Physa Snail	X	X	X	X	X	X	X	X	X	X
Vernal Pool Fairy Shrimp	X	X	X	X	X	X	X	X	X	X

Amphibians

Species	Disturbance	Displacement	Migration Disruption	Reproduction Disruption	Direct Injury	Direct Mortality	Sublethal Injury	Increase Predation	Habitat Fragmentation	Elevated Turbidity
	Potential Effects of Treatment Area Isolation									
Oregon Spotted Frog	X	X	X	X	X	X	X	X	X	X

Insects

Species	Disturbance	Displacement	Migration Disruption	Reproduction Disruption	Direct Injury	Direct Mortality	Sublethal Injury	Increase Predation	Habitat Fragmentation	Elevated Turbidity
	Potential Effects of Treatment Area Isolation									
Meltwater Lednian	X	X	X		X	X	X	X	X	X
Western Glacier Stonefly	X	X	X		X	X	X	X	X	X

Plants

Species	Disturbance	Displacement	Migration Disruption	Reproduction Disruption	Direct Injury	Direct Mortality	Sublethal Injury	Increase Predation	Habitat Fragmentation	Elevated Turbidity
	Potential Effects of Treatment Area Isolation									
Water Howellia	X				X	X			X	X

Table 5.1.3: Effects analysis matrix for aquatic ESA-listed species, Fish Salvage, BA Section 5.1.3. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect".

Fish								
			Potential Effects of Fish Salvage					
Species	**Disturbance**	**Displacement**	**Migration Disruption**	**Reproduction Disruption**	**Direct Injury**	**Direct Mortality**	**Sublethal Injury**	**Increase Predation**
Borax Lake Chub	X	X		X	X	X	X	X
Bull Trout	X	X	X	X	X	X	X	X
Chinook Salmon	X	X	X	X	X	X	X	X
Chum Salmon	X	X	X	X	X	X	X	X
Coho Salmon	X	X	X	X	X	X	X	X
Dolly Varden	X	X	X	X	X	X	X	X
Eulachon	X	X	X	X	X	X	X	X
Foskett Speckled Dace	X	X		X	X	X	X	X
Green Sturgeon	X							
Hutton Tui Chub	X	X		X	X	X	X	X
Lahontan Cutthroat	X	X	X	X	X	X	X	X
Lost River Sucker	X	X	X	X	X	X	X	X
Pallid Sturgeon	X	X	X	X	X	X	X	X
Shortnose Sucker	X	X	X	X	X	X	X	X
Sockeye Salmon	X	X	X	X	X	X	X	X
Steelhead	X	X	X	X	X	X	X	X
Warner Sucker	X	X	X	X	X	X	X	X
White Sturgeon	X	X	X	X	X	X	X	X
Southern Resident Killer Whale							X*	

Mollusks/Crustaceans								
			Potential Effects of Fish Salvage					
Species	**Disturbance**	**Displacement**	**Migration Disruption**	**Reproduction Disruption**	**Direct Injury**	**Direct Mortality**	**Sublethal Injury**	**Increase Predation**
Banbury Springs Limpet	X				X	X	X	
Bliss Rapids Snail	X				X	X	X	
Bruneau Hot Springsnail	X				X	X	X	
Snake River Physa Snail	X				X	X	X	
Vernal Pool Fairy Shrimp	X				X	X	X	

Amphibians								
			Potential Effects of Fish Salvage					
Species	**Disturbance**	**Displacement**	**Migration Disruption**	**Reproduction Disruption**	**Direct Injury**	**Direct Mortality**	**Sublethal Injury**	**Increase Predation**
Oregon Spotted Frog	X	X		X	X	X	X	X

Insects								
			Potential Effects of Fish Salvage					
Species	**Disturbance**	**Displacement**	**Migration Disruption**	**Reproduction Disruption**	**Direct Injury**	**Direct Mortality**	**Sublethal Injury**	**Increase Predation**
Meltwater Lednian	X				X	X	X	X
Western Glacier Stonefly	X				X	X	X	X

Plants								
			Potential Effects of Fish Salvage					
Species	**Disturbance**	**Displacement**	**Migration Disruption**	**Reproduction Disruption**	**Direct Injury**	**Direct Mortality**	**Sublethal Injury**	**Increase Predation**
Water Howellia	X				X	X		

*Could result in take of Chinook salmon as a food source for southern resident killer whales.

Table 5.1.4: Effects analysis matrix for aquatic ESA-listed species, Treatment, BA Section 5.1.4. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not "not likely to adversely affect"; orange shading = "likely to adversely affect".

Fish					
		Potential Effects of Treatment			
Species	Disturbance	Direct Injury	Direct Mortality	Sublethal Injury	Reduced Dissolved Oxygen
Borax Lake Chub	X	X	X	X	X
Bull Trout	X	X	X	X	X
Chinook Salmon	X	X	X	X	X
Chum Salmon	X	X	X	X	X
Coho Salmon	X	X	X	X	X
Dolly Varden	X	X	X	X	X
Eulachon	X	X	X	X	X
Foskett Speckled Dace	X	X	X	X	X
Green Sturgeon	X				
Hutton Tui Chub	X	X	X	X	X
Lahontan Cutthroat	X	X	X	X	X
Lost River Sucker	X	X	X	X	X
Pallid Sturgeon	X	X	X	X	X
Shortnose Sucker	X	X	X	X	X
Sockeye Salmon	X	X	X	X	X
Steelhead	X	X	X	X	X
Warner Sucker	X	X	X	X	X
White Sturgeon	X	X	X	X	X
Southern Resident Killer Whale				X*	

Gastropods					
		Potential Effects of Treatment			
Species	Disturbance	Direct Injury	Direct Mortality	Sublethal Injury	Reduced Dissolved Oxygen
Banbury Springs Limpet	X	X	X	X	X
Bliss Rapids Snail	X	X	X	X	X
Bruneau Hot Springsnail	X	X	X	X	X
Snake River Physa Snail	X	X	X	X	X
Vernal Pool Fairy Shrimp	X	X	X	X	X

Amphibians					
		Potential Effects of Treatment			
Species	Disturbance	Direct Injury	Direct Mortality	Sublethal Injury	Reduced Dissolved Oxygen
Oregon Spotted Frog	X	X	X	X	X

Insects					
		Potential Effects of Treatment			
Species	Disturbance	Direct Injury	Direct Mortality	Sublethal Injury	Reduced Dissolved Oxygen
Meltwater Lednian	X	X	X	X	X
Western Glacier Stonefly	X	X	X	X	X

Plants					
		Potential Effects of Treatment			
Species	Disturbance	Direct Injury	Direct Mortality	Sublethal Injury	Reduced Dissolved Oxygen
Water Howellia	X	X	X		

*Could result in take of Chinook salmon as a food source for southern resident killer whales.

Table 5.1.5: Effects analysis matrix for aquatic ESA-listed species, Monitoring, BA Section 5.1.5. An 'X' represents an effect the species may experience. Blue shading = "not likely to adversely affect".

Fish	
Species	**Potential Effects of Monitoring Disturbance**
Borax Lake Chub	X
Bull Trout	X
Chinook Salmon	X
Chum Salmon	X
Coho Salmon	X
Dolly Varden	X
Eulachon	X
Foskett Speckled Dace	X
Green Sturgeon	X
Hutton Tui Chub	X
Lahontan Cutthroat	X
Lost River Sucker	X
Pallid Sturgeon	X
Shortnose Sucker	X
Sockeye Salmon	X
Steelhead	X
Warner Sucker	X
White Sturgeon	X
Southern Resident Killer Whale	

Gastropods	
Species	**Potential Effects of Monitoring Disturbance**
Banbury Springs Limpet	X
Bliss Rapids Snail	X
Bruneau Hot Springsnail	X
Snake River Physa Snail	X
Vernal Pool Fairy Shrimp	X

Amphibians	
Species	**Potential Effects of Monitoring Disturbance**
Oregon Spotted Frog	X

Insects	
Species	**Potential Effects of Monitoring Disturbance**
Meltwater Lednian	X
Western Glacier Stonefly	X

Plants	
Species	**Potential Effects of Monitoring Disturbance**
Water Howellia	X

Table 5.1.6: Effects analysis matrix for aquatic ESA-listed species, Restoration, BA Section 5.1.6. An 'X' represents an effect the species may experience. Blue shading = "not likely to adversely affect".

Fish		
	Potential Effects of Restoration	
Species	Disturbance	Sedimentation
Borax Lake Chub	X	X
Bull Trout	X	X
Chinook Salmon	X	X
Chum Salmon	X	X
Coho Salmon	X	X
Dolly Varden	X	X
Eulachon	X	X
Foskett Speckled Dace	X	X
Green Sturgeon	X	X
Hutton Tui Chub	X	X
Lahontan Cutthroat	X	X
Lost River Sucker	X	X
Pallid Sturgeon	X	X
Shortnose Sucker	X	X
Sockeye Salmon	X	X
Steelhead	X	X
Warner Sucker	X	X
White Sturgeon	X	X
Southern Resident Killer Whale		

Gastropods		
	Potential Effects of Restoration	
Species	Disturbance	Sedimentation
Banbury Springs Limpet	X	X
Bliss Rapids Snail	X	X
Bruneau Hot Springsnail	X	X
Snake River Physa Snail	X	X
Vernal Pool Fairy Shrimp	X	X

Amphibians		
	Potential Effects of Restoration	
Species	Disturbance	Sedimentation
Oregon Spotted Frog	X	X

Insects		
	Potential Effects of Restoration	
Species	Disturbance	Sedimentation
Meltwater Lednian	X	X
Western Glacier Stonefly	X	X

Plants		
	Potential Effects of Restoration	
Species	Disturbance	Sedimentation
Water Howellia	X	X

Table 5.1.7: Effects analysis matrix for aquatic ESA-listed species, Equipment Sterilization, BA Section 5.1.7. Empty gray cells = "no effect".

Fish	
	Potential Effects of Restoration
Species	**No Effect**
Borax Lake Chub	
Bull Trout	
Chinook Salmon	
Chum Salmon	
Coho Salmon	
Dolly Varden	
Eulachon	
Foskett Speckled Dace	
Green Sturgeon	
Hutton Tui Chub	
Lahontan Cutthroat	
Lost River Sucker	
Pallid Sturgeon	
Shortnose Sucker	
Sockeye Salmon	
Steelhead	
Warner Sucker	
White Sturgeon	
Southern Resident Killer Whale	

Mollusks/Crustaceans	
	Potential Effects of Restoration
Species	**No Effect**
Banbury Springs Limpet	
Bliss Rapids Snail	
Bruneau Hot Springsnail	
Snake River Physa Snail	
Vernal Pool Fairy Shrimp	

Amphibians	
	Potential Effects of Restoration
Species	**No Effect**
Oregon Spotted Frog	

Insects	
	Potential Effects of Restoration
Species	**No Effect**
Meltwater Lednian	
Western Glacier Stonefly	

Plants	
	Potential Effects of Restoration
Species	**No Effect**
Water Howellia	

Table 5.2.1: Effects analysis matrix for terrestrial ESA-listed species, Riparian Access Development, BA Section 5.2.1. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect".

Mammals

Species	Potential Effects of Riparian Access Development										
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption	Reduced Food Sources	Reduced Cover	Reduced Nesting Habitat	Increased Predation	Habitat Fragmentation
Black-footed Ferret	X	X	X	X	X	X	X	X		X	X
Canada Lynx	X	X				X	X	X			
Columbia Basin Pygmy Rabbit	X	X	X	X	X	X	X	X		X	X
Columbian White-tailed Deer	X	X				X	X	X			X
Gray Wolf	X	X				X	X	X			
Grizzly Bear	X	X				X	X	X			
North American Wolverine	X	X				X	X	X			
Northern Idaho Ground Squirrel	X	X	X	X	X	X	X	X		X	X
Olympia Pocket Gopher	X	X	X	X	X	X	X	X		X	X
Red Tree Vole	X	X	X	X	X	X	X	X		X	X
Roy Prairie Pocket Gopher	X	X	X	X	X	X	X	X		X	X
Tenino Pocket Gopher	X	X	X	X	X	X	X	X		X	X
Woodland Caribou	X	X				X	X	X			
Yelm Pocket Gopher	X	X	X	X	X	X	X	X		X	X

Birds

Species	Potential Effects of Riparian Access Development										
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption	Reduced Food Sources	Reduced Cover	Reduced Nesting Habitat	Increased Predation	Habitat Fragmentation
Least Tern	X	X				X	X	X	X	X	X
Marbled Murrelet	X	X				X	X	X	X	X	X
Northern Spotted owl	X	X				X	X	X	X	X	X
Streak Horned Lark	X	X				X	X	X	X	X	X
Western Snowy Plover	X	X				X	X	X	X	X	X
Yellow-billed Cuckoo	X	X				X	X	X	X	X	X

Insects

Species	Potential Effects of Riparian Access Development										
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption	Reduced Food Sources	Reduced Cover	Reduced Nesting Habitat	Increased Predation	Habitat Fragmentation
Fender's Blue Butterfly	X	X	X	X		X	X	X		X	X
Oregon Silverspot Butterfly	X	X	X	X		X	X	X		X	X
Taylor's (whulge) Checkerspot	X	X	X	X		X	X	X		X	X

Plants

Species	Potential Effects of Riparian Access Development										
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption	Reduced Food Sources	Reduced Cover	Reduced Nesting Habitat	Increased Predation	Habitat Fragmentation
Applegate's Milk-Vetch	X		X	X							X
Gentner's Fritillary	X		X	X							X
MacFarlane's Four-o'clock	X		X	X							X
Slickspot Peppergrass	X		X	X							X
Spalding's Catchfly	X		X	X							X
Ute Ladies'-tresses	X		X	X							X
Western Lily	X		X	X							X
Whitebark Pine	X		X	X							X

Table 5.2.2: Effects analysis matrix for terrestrial ESA-listed species, Treatment Area Isolation, BA Section 5.2.2. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect".

Mammals			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Displacement	Shoreline Vegetation Disturbance
Black-footed Ferret	X		
Canada Lynx			
Columbia Basin Pygmy Rabbit	X		
Columbian White-tailed Deer	X		
Gray Wolf			
Grizzly Bear			
North American Wolverine			
Northern Idaho Ground Squirrel	X		
Olympia Pocket Gopher	X		
Red Tree Vole	X		
Roy Prairie Pocket Gopher	X		
Tenino Pocket Gopher	X		
Woodland Caribou			
Yelm Pocket Gopher	X		

Birds			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Displacement	Shoreline Vegetation Disturbance
Least Tern	X	X	
Marbled Murrelet	X	X	X
Northern Spotted owl	X	X	X
Streak Horned Lark	X	X	
Western Snowy Plover	X	X	
Yellow-billed Cuckoo	X	X	X

Insects			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Displacement	Shoreline Vegetation Disturbance
Fender's Blue Butterfly	X	X	X
Oregon Silverspot Butterfly	X	X	X
Taylor's (whulge) Checkerspot	X	X	X

Plants			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Displacement	Shoreline Vegetation Disturbance
Applegate's Milk-Vetch	X		X
Gentner's Fritillary	X		X
MacFarlane's Four-o'clock	X		X
Slickspot Peppergrass	X		X
Spalding's Catchfly	X		X
Ute Ladies'-tresses	X		X
Western Lily	X		X
Whitebark Pine	X		X

Table 5.2.3: Effects analysis matrix for terrestrial ESA-listed species, Fish Salvage, BA Section 5.2.3. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect".

Mammals		
	Potential Effects of Fish Salvage	
Species	Disturbance	Displacement
Black-footed Ferret	X	X
Canada Lynx	X	
Columbia Basin Pygmy Rabbit	X	X
Columbian White-tailed Deer	X	X
Gray Wolf	X	
Grizzly Bear	X	
North American Wolverine	X	
Northern Idaho Ground Squirrel	X	X
Olympia Pocket Gopher	X	X
Red Tree Vole	X	X
Roy Prairie Pocket Gopher	X	X
Tenino Pocket Gopher	X	X
Woodland Caribou	X	
Yelm Pocket Gopher	X	X

Birds		
	Potential Effects of Fish Salvage	
Species	Disturbance	Displacement
Least Tern	X	X
Marbled Murrelet	X	X
Northern Spotted owl	X	X
Streak Horned Lark	X	X
Western Snowy Plover	X	X
Yellow-billed Cuckoo	X	X

Insects		
	Potential Effects of Fish Salvage	
Species	Disturbance	Displacement
Fender's Blue Butterfly	X	
Oregon Silverspot Butterfly	X	
Taylor's (whulge) Checkerspot	X	

Plants		
	Potential Effects of Fish Salvage	
Species	Disturbance	Displacement
Applegate's Milk-Vetch		
Gentner's Fritillary		
MacFarlane's Four-o'clock		
Slickspot Peppergrass		
Spalding's Catchfly		
Ute Ladies'-tresses		
Western Lily		
Whitebark Pine		

Table 5.2.4: Effects analysis matrix for terrestrial ESA-listed species, Treatment, BA Section 5.2.4. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect".

Mammals			
	Potential Effects of Treatment		
Species	Disturbance	Displacement	Sublethal Injury
Black-footed Ferret	X		
Canada Lynx			
Columbia Basin Pygmy Rabbit	X		
Columbian White-tailed Deer	X		
Gray Wolf			
Grizzly Bear			
North American Wolverine			
Northern Idaho Ground Squirrel	X		
Olympia Pocket Gopher	X		
Red Tree Vole	X		
Roy Prairie Pocket Gopher	X		
Tenino Pocket Gopher	X		
Woodland Caribou			
Yelm Pocket Gopher	X		

Birds			
	Potential Effects of Treatment		
Species	Disturbance	Displacement	Sublethal Injury
Least Tern	X	X	X
Marbled Murrelet	X	X	X
Northern Spotted owl	X	X	
Streak Horned Lark	X	X	
Western Snowy Plover	X	X	X
Yellow-billed Cuckoo	X	X	

Insects			
	Potential Effects of Treatment		
Species	Disturbance	Displacement	Sublethal Injury
Fender's Blue Butterfly	X		
Oregon Silverspot Butterfly	X		
Taylor's (whulge) Checkerspot	X		

Plants			
	Potential Effects of Treatment		
Species	Disturbance	Displacement	Sublethal Injury
Applegate's Milk-Vetch			
Gentner's Fritillary			
MacFarlane's Four-o'clock			
Slickspot Peppergrass			
Spalding's Catchfly			
Ute Ladies'-tresses			
Western Lily			
Whitebark Pine			

Table 5.2.5: Effects analysis matrix for terrestrial ESA-listed species, Monitoring, BA Section 5.2.5. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect".

Mammals	
Species	**Potential Effects of Monitoring Disturbance**
Black-footed Ferret	X
Canada Lynx	
Columbia Basin Pygmy Rabbit	X
Columbian White-tailed Deer	X
Gray Wolf	
Grizzly Bear	
North American Wolverine	
Northern Idaho Ground Squirrel	X
Olympia Pocket Gopher	X
Red Tree Vole	X
Roy Prairie Pocket Gopher	X
Tenino Pocket Gopher	X
Woodland Caribou	
Yelm Pocket Gopher	X

Birds	
Species	**Potential Effects of Monitoring Disturbance**
Least Tern	X
Marbled Murrelet	X
Northern Spotted owl	X
Streak Horned Lark	X
Western Snowy Plover	X
Yellow-billed Cuckoo	X

Insects	
Species	**Potential Effects of Monitoring Disturbance**
Fender's Blue Butterfly	X
Oregon Silverspot Butterfly	X
Taylor's (whulge) Checkerspot	X

Plants	
Species	**Potential Effects of Monitoring Disturbance**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	
Spalding's Catchfly	
Ute Ladies'-tresses	
Western Lily	
Whitebark Pine	

Table 5.2.6: Effects analysis matrix for terrestrial ESA-listed species, Restoration, BA Section 5.2.6. An 'X' represents an effect the species may experience. Empty Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect".

Mammals

Species	Potential Effects of Restoration					
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption
Black-footed Ferret	X	X	X	X	X	X
Canada Lynx	X	X				X
Columbia Basin Pygmy Rabbit	X	X	X	X	X	X
Columbian White-tailed Deer	X	X				X
Gray Wolf	X	X				X
Grizzly Bear	X	X				X
North American Wolverine	X	X				X
Northern Idaho Ground Squirrel	X	X	X	X	X	X
Olympia Pocket Gopher	X	X	X	X	X	X
Red Tree Vole	X	X	X	X	X	X
Roy Prairie Pocket Gopher	X	X	X	X	X	X
Tenino Pocket Gopher	X	X	X	X	X	X
Woodland Caribou	X	X				X
Yelm Pocket Gopher	X	X	X	X	X	X

Birds

Species	Potential Effects of Restoration					
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption
Least Tern	X	X				X
Marbled Murrelet	X	X				X
Northern Spotted owl	X	X				X
Streak Horned Lark	X	X				X
Western Snowy Plover	X	X				X
Yellow-billed Cuckoo	X	X				X

Insects

Species	Potential Effects of Restoration					
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption
Fender's Blue Butterfly	X	X	X	X		X
Oregon Silverspot Butterfly	X	X	X	X		X
Taylor's (whulge) Checkerspot	X	X	X	X		X

Plants

Species	Potential Effects of Restoration					
	Disturbance	Displacement	Direct Injury	Direct Mortality	Sublethal Injury	Reproduction Disruption
Applegate's Milk-Vetch						
Gentner's Fritillary						
MacFarlane's Four-o'clock						
Slickspot Peppergrass						
Spalding's Catchfly						
Ute Ladies'-tresses						
Western Lily						
Whitebark Pine						

Table 5.2.7: Effects analysis matrix for terrestrial ESA-listed species, Equipment Sterilization, BA Section 5.2.7. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect".

Mammals	
	Potential Effects of Equipment Sterilization Disturbance
Black-footed Ferret	X
Canada Lynx	X
Columbia Basin Pygmy Rabbit	X
Columbian White-tailed Deer	X
Gray Wolf	X
Grizzly Bear	X
North American Wolverine	X
Northern Idaho Ground Squirrel	X
Olympia Pocket Gopher	X
Red Tree Vole	X
Roy Prairie Pocket Gopher	X
Tenino Pocket Gopher	X
Woodland Caribou	X
Yelm Pocket Gopher	X

Birds	
Species	**Potential Effects of Equipment Sterilization Disturbance**
Least Tern	X
Marbled Murrelet	X
Northern Spotted owl	X
Streak Horned Lark	X
Western Snowy Plover	X
Yellow-billed Cuckoo	X

Insects	
Species	**Potential Effects of Equipment Sterilization Disturbance**
Fender's Blue Butterfly	X
Oregon Silverspot Butterfly	X
Taylor's (whulge) Checkerspot	X

Plants	
Species	**Potential Effects of Equipment Sterilization Disturbance**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	
Spalding's Catchfly	
Ute Ladies'-tresses	
Western Lily	
Whitebark Pine	

Table 5.3.1: Effects analysis matrix for designated critical habitat, Riparian Access Development, BA Section 5.3.1. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect"; black shading = critical habitat not designated.

Mammals						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Black-footed Ferret						
Canada Lynx	X		X	X		X
Columbia Basin Pygmy Rabbit						
Columbian White-tailed Deer						
Gray Wolf	X		X	X		X
Grizzly Bear	X		X	X		X
North American Wolverine						
Northern Idaho Ground Squirrel						
Olympia Pocket Gopher	X		X	X		X
Red Tree Vole						
Roy Prairie Pocket Gopher	X		X	X		X
Tenino Pocket Gopher	X		X	X		X
Woodland Caribou	X		X	X		X
Yelm Pocket Gopher	X		X	X		X
Southern Resident Killer Whale						

Fish						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Borax Lake Chub	X	X	X	X		X
Bull Trout	X	X	X	X		X
Chinook Salmon	X	X	X	X		X
Chum Salmon	X	X	X	X		X
Coho Salmon	X	X	X	X		X
Dolly Varden						
Eulachon	X	X	X	X		X
Foskett Speckled Dace						
Green Sturgeon						
Hutton Tui Chub						
Lahontan Cutthroat						
Lost River Sucker	X	X	X	X		X
Pallid Sturgeon						
Shortnose Sucker	X	X	X	X		X
Sockeye Salmon	X	X	X	X		X
Steelhead	X	X	X	X		X
Warner Sucker	X	X	X	X		X
White Sturgeon	X	X	X	X		X

Birds						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Least Tern						
Marbled Murrelet	X		X	X	X	X
Northern Spotted owl	X		X	X	X	X
Streak Horned Lark	X		X	X	X	X
Western Snowy Plover	X		X	X	X	X
Yellow-billed Cuckoo	X		X	X	X	X

Table 5.3.1 Continued.

Gastropods						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Banbury Springs Limpet						
Bliss Rapids Snail						
Bruneau Hot Springsnail						
Snake River Physa Snail						
Vernal Pool Fairy Shrimp	X	X	X	X		X

Amphibians						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Oregon Spotted Frog	X	X	X	X		X

Insects						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Fender's Blue Butterfly	X		X	X	X	X
Meltwater Lednian						
Oregon Silverspot Butterfly	X		X	X	X	X
Taylor's (whulge) Checkerspot	X		X	X	X	X
Western Glacier Stonefly						

Plants						
	Potential Effects of Riparian Access Development					
Species	**Disturbance**	**Elevated Turbidity**	**Reduced Food**	**Reduced Cover**	**Reduced Nesting Habitat**	**Habitat Fragmentation**
Applegate's Milk-Vetch						
Gentner's Fritillary						
MacFarlane's Four-o'clock						
Slickspot Peppergrass	X					
Spalding's Catchfly						
Ute Ladies'-tresses						
Water Howellia						
Western Lily						
Whitebark Pine						

Table 5.3.2: Effects analysis matrix for designated critical habitat, Treatment Area Isolation, BA Section 5.3.2. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect"; black shading = critical habitat not designated.

Mammals			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Elevated Turbidity	Habitat Fragmentation
Black-footed Ferret			
Canada Lynx			
Columbia Basin Pygmy Rabbit			
Columbian White-tailed Deer			
Gray Wolf			
Grizzly Bear			
North American Wolverine			
Northern Idaho Ground Squirrel			
Olympia Pocket Gopher			
Red Tree Vole			
Roy Prairie Pocket Gopher			
Tenino Pocket Gopher			
Woodland Caribou			
Yelm Pocket Gopher			
Southern Resident Killer Whale			

Fish			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Elevated Turbidity	Habitat Fragmentation
Borax Lake Chub	X	X	X
Bull Trout	X	X	X
Chinook Salmon	X	X	X
Chum Salmon	X	X	X
Coho Salmon	X	X	X
Dolly Varden			
Eulachon	X	X	X
Foskett Speckled Dace			
Green Sturgeon	X	X	
Hutton Tui Chub			
Lahontan Cutthroat			
Lost River Sucker	X	X	X
Pallid Sturgeon			
Shortnose Sucker	X	X	X
Sockeye Salmon	X	X	X
Steelhead	X	X	X
Warner Sucker	X	X	X
White Sturgeon	X	X	X

Birds			
	Potential Effects of Treatment Area Isolation		
Species	Disturbance	Elevated Turbidity	Habitat Fragmentation
Least Tern			
Marbled Murrelet	X		
Northern Spotted owl	X		
Streak Horned Lark	X		
Western Snowy Plover	X		
Yellow-billed Cuckoo	X		

Table 5.3.2 Continued.

Gastropods			
	Potential Effects of Treatment Area		
Species	Disturbance	Isolation Elevated Turbidity	Habitat Fragmentation
Banbury Springs Limpet			
Bliss Rapids Snail			
Bruneau Hot Springsnail			
Snake River Physa Snail			
Vernal Pool Fairy Shrimp	X	X	X

Amphibians			
	Potential Effects of Treatment Area		
Species	Disturbance	Isolation Elevated Turbidity	Habitat Fragmentation
Oregon Spotted Frog	X	X	X

Insects			
	Potential Effects of Treatment Area		
Species	Disturbance	Isolation Elevated Turbidity	Habitat Fragmentation
Fender's Blue Butterfly	X		
Meltwater Lednian			
Oregon Silverspot Butterfly	X		
Taylor's (whulge) Checkerspot	X		
Western Glacier Stonefly			

Plants			
	Potential Effects of Treatment Area		
Species	Disturbance	Isolation Elevated Turbidity	Habitat Fragmentation
Applegate's Milk-Vetch			
Gentner's Fritillary			
MacFarlane's Four-o'clock			
Slickspot Peppergrass	X		
Spalding's Catchfly			
Ute Ladies'-tresses			
Water Howellia			
Western Lily			
Whitebark Pine			

Table 5.3.3: Effects analysis matrix for designated critical habitat, Fish Salvage, BA Section 5.3.3. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; black shading = critical habitat not designated.

Mammals	
Species	**Potential Effects of Fish Salvage Disturbance**
Black-footed Ferret	
Canada Lynx	
Columbia Basin Pygmy Rabbit	
Columbian White-tailed Deer	
Gray Wolf	
Grizzly Bear	
North American Wolverine	
Northern Idaho Ground Squirrel	
Olympia Pocket Gopher	
Red Tree Vole	
Roy Prairie Pocket Gopher	
Tenino Pocket Gopher	
Woodland Caribou	
Yelm Pocket Gopher	
Southern Resident Killer Whale	

Fish	
Species	**Potential Effects of Fish Salvage Disturbance**
Borax Lake Chub	X
Bull Trout	X
Chinook Salmon	X
Chum Salmon	X
Coho Salmon	X
Dolly Varden	
Eulachon	X
Foskett Speckled Dace	
Green Sturgeon	
Hutton Tui Chub	
Lahontan Cutthroat	
Lost River Sucker	X
Pallid Sturgeon	
Shortnose Sucker	X
Sockeye Salmon	X
Steelhead	X
Warner Sucker	X
White Sturgeon	X

Birds	
Species	**Potential Effects of Fish Salvage Disturbance**
Least Tern	
Marbled Murrelet	
Northern Spotted owl	
Streak Horned Lark	
Western Snowy Plover	
Yellow-billed Cuckoo	

Table 5.3.3 Continued.

Gastropods	
Species	**Potential Effects of Fish Salvage Disturbance**
Banbury Springs Limpet	
Bliss Rapids Snail	
Bruneau Hot Springsnail	
Snake River Physa Snail	
Vernal Pool Fairy Shrimp	X

Amphibians	
Species	**Potential Effects of Fish Salvage Disturbance**
Oregon Spotted Frog	X

Insects	
Species	**Potential Effects of Fish Salvage Disturbance**
Fender's Blue Butterfly	
Meltwater Lednian	
Oregon Silverspot Butterfly	
Taylor's (whulge) Checkerspot	
Western Glacier Stonefly	

Plants	
Species	**Potential Effects of Fish Salvage Disturbance**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	
Spalding's Catchfly	
Ute Ladies'-tresses	
Water Howellia	
Western Lily	
Whitebark Pine	

Table 5.3.4: Effects analysis matrix for designated critical habitat, Treatment, BA Section 5.3.4. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; blue shading = "not likely to adversely affect"; orange shading = "likely to adversely affect"; black shading = critical habitat not designated.

Mammals

Species	Potential Effects of Treatment						
	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
Black-footed Ferret							
Canada Lynx							
Columbia Basin Pygmy Rabbit							
Columbian White-tailed Deer							
Gray Wolf							
Grizzly Bear							
North American Wolverine							
Northern Idaho Ground Squirrel							
Olympia Pocket Gopher							
Red Tree Vole							
Roy Prairie Pocket Gopher							
Tenino Pocket Gopher							
Woodland Caribou							
Yelm Pocket Gopher							
Southern Resident Killer Whale							

Fish

Species	Potential Effects of Treatment						
	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
Borax Lake Chub	X	X	X	X	X	X	Benefit
Bull Trout	X	X	X	X	X	X	Benefit
Chinook Salmon	X	X	X	X	X	X	Benefit
Chum Salmon	X	X	X	X	X	X	Benefit
Coho Salmon	X	X	X	X	X	X	Benefit
Dolly Varden							
Eulachon	X	X	X	X	X	X	Benefit
Foskett Speckled Dace							
Green Sturgeon	X		X				Benefit
Hutton Tui Chub							
Lahontan Cutthroat							
Lost River Sucker	X	X	X	X	X	X	Benefit
Pallid Sturgeon							
Shortnose Sucker	X	X	X	X	X	X	Benefit
Sockeye Salmon	X	X	X	X	X	X	Benefit
Steelhead	X	X	X	X	X	X	Benefit
Warner Sucker	X	X	X	X	X	X	Benefit
White Sturgeon	X	X	X	X	X	X	Benefit

Birds

Species	Potential Effects of Treatment						
	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
Least Tern							
Marbled Murrelet							
Northern Spotted owl							
Streak Horned Lark							
Western Snowy Plover							Benefit
Yellow-billed Cuckoo							

Table 5.3.4 Continued.

Gastropods

Species	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
	Potential Effects of Treatment						
Banbury Springs Limpet							
Bliss Rapids Snail							
Bruneau Hot Springsnail							
Snake River Physa Snail							
Vernal Pool Fairy Shrimp	X	X	X	X	X	X	Benefit

Amphibians

Species	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
	Potential Effects of Treatment						
Oregon Spotted Frog	X	X	X	X	X	X	Benefit

Insects

Species	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
	Potential Effects of Treatment						
Fender's Blue Butterfly							
Meltwater Lednian							
Oregon Silverspot Butterfly							
Taylor's (whulge) Checkerspot							
Western Glacier Stonefly							

Plants

Species	Disturbance	Reduced Cover	Reduced Food	Reduced Dissolved Oxygen	Elevated Turbidity	Reduced Spawning Habitat Suitability	Maintain Critical Habitat
	Potential Effects of Treatment						
Applegate's Milk-Vetch							
Gentner's Fritillary							
MacFarlane's Four-o'clock							
Slickspot Peppergrass							
Spalding's Catchfly							
Ute Ladies'-tresses							
Water Howellia							
Western Lily							
Whitebark Pine							

Table 5.3.5: Effects analysis matrix for designated critical habitat, Monitoring, BA Section 5.3.5. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; black shading = critical habitat not designated.

Mammals	
Species	**Potential Effects of Monitoring No Effect**
Black-footed Ferret	
Canada Lynx	
Columbia Basin Pygmy Rabbit	
Columbian White-tailed Deer	
Gray Wolf	
Grizzly Bear	
North American Wolverine	
Northern Idaho Ground Squirrel	
Olympia Pocket Gopher	
Red Tree Vole	
Roy Prairie Pocket Gopher	
Tenino Pocket Gopher	
Woodland Caribou	
Yelm Pocket Gopher	
Southern Resident Killer Whale	

Fish	
Species	**Potential Effects of Monitoring No Effect**
Borax Lake Chub	
Bull Trout	
Chinook Salmon	
Chum Salmon	
Coho Salmon	
Dolly Varden	
Eulachon	
Foskett Speckled Dace	
Green Sturgeon	
Hutton Tui Chub	
Lahontan Cutthroat	
Lost River Sucker	
Pallid Sturgeon	
Shortnose Sucker	
Sockeye Salmon	
Steelhead	
Warner Sucker	
White Sturgeon	

Birds	
Species	**Potential Effects of Monitoring No Effect**
Least Tern	
Marbled Murrelet	
Northern Spotted owl	
Streak Horned Lark	
Western Snowy Plover	
Yellow-billed Cuckoo	

Table 5.3.5 Continued.

Gastropods	
Species	**Potential Effects of Monitoring No Effect**
Banbury Springs Limpet	
Bliss Rapids Snail	
Bruneau Hot Springsnail	
Snake River Physa Snail	
Vernal Pool Fairy Shrimp	

Amphibians	
Species	**Potential Effects of Monitoring No Effect**
Oregon Spotted Frog	

Insects	
Species	**Potential Effects of Monitoring No Effect**
Fender's Blue Butterfly	
Meltwater Lednian	
Oregon Silverspot Butterfly	
Taylor's (whulge) Checkerspot	
Western Glacier Stonefly	

Plants	
Species	**Potential Effects of Monitoring No Effect**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	
Spalding's Catchfly	
Ute Ladies'-tresses	
Water Howellia	
Western Lily	
Whitebark Pine	

Table 5.3.6: Effects analysis matrix for designated critical habitat, Restoration, BA Section 5.3.6. An 'X' represents an effect the species may experience. Blue shading = "not likely to adversely affect"; black shading = critical habitat not designated.

Mammals	
Species	**Potential Effects of Restoration Improved Habitat**
Black-footed Ferret	
Canada Lynx	X
Columbia Basin Pygmy Rabbit	
Columbian White-tailed Deer	
Gray Wolf	X
Grizzly Bear	X
North American Wolverine	
Northern Idaho Ground Squirrel	
Olympia Pocket Gopher	X
Red Tree Vole	
Roy Prairie Pocket Gopher	X
Tenino Pocket Gopher	X
Woodland Caribou	X
Yelm Pocket Gopher	X
Southern Resident Killer Whale	

Fish	
Species	**Potential Effects of Restoration Improved Habitat**
Borax Lake Chub	X
Bull Trout	X
Chinook Salmon	X
Chum Salmon	X
Coho Salmon	X
Dolly Varden	
Eulachon	X
Foskett Speckled Dace	
Green Sturgeon	
Lahontan Cutthroat	
Lost River Sucker	X
Pallid Sturgeon	
Shortnose Sucker	X
Sockeye Salmon	X
Steelhead	X
Warner Sucker	X
White Sturgeon	X

Birds	
Species	**Potential Effects of Restoration Improved Habitat**
Least Tern	
Marbled Murrelet	X
Northern Spotted owl	X
Streak Horned Lark	X
Western Snowy Plover	X
Yellow-billed Cuckoo	X

Table 5.3.6 Continued.

Gastropods	
Species	**Potential Effects of Restoration Improved Habitat**
Banbury Springs Limpet	
Bliss Rapids Snail	
Bruneau Hot Springsnail	
Snake River Physa Snail	
Vernal Pool Fairy Shrimp	X

Amphibians	
Species	**Potential Effects of Restoration Improved Habitat**
Oregon Spotted Frog	X

Insects	
Species	**Potential Effects of Restoration Improved Habitat**
Fender's Blue Butterfly	X
Meltwater Lednian	
Oregon Silverspot Butterfly	X
Taylor's (whulge) Checkerspot	X
Western Glacier Stonefly	

Plants	
Species	**Potential Effects of Restoration Improved Habitat**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	X
Spalding's Catchfly	
Ute Ladies'-tresses	
Water Howellia	
Western Lily	
Whitebark Pine	

Table 5.3.7: Effects analysis matrix for designated critical habitat, Equipment Sterilization, BA Section 5.3.7. An 'X' represents an effect the species may experience. Empty gray cells = "no effect"; black shading = critical habitat not designated.

Mammals	
Species	**Potential Effects of Equipment Sterilization No Effect**
Black-footed Ferret	
Canada Lynx	
Columbia Basin Pygmy Rabbit	
Columbian White-tailed Deer	
Gray Wolf	
Grizzly Bear	
North American Wolverine	
Northern Idaho Ground Squirrel	
Olympia Pocket Gopher	
Red Tree Vole	
Roy Prairie Pocket Gopher	
Tenino Pocket Gopher	
Woodland Caribou	
Yelm Pocket Gopher	
Southern Resident Killer Whale	

Fish	
Species	**Potential Effects of Equipment Sterilization No Effect**
Borax Lake Chub	
Bull Trout	
Chinook Salmon	
Chum Salmon	
Coho Salmon	
Dolly Varden	
Eulachon	
Foskett Speckled Dace	
Green Sturgeon	
Hutton Tui Chub	
Lahontan Cutthroat	
Lost River Sucker	
Pallid Sturgeon	
Shortnose Sucker	
Sockeye Salmon	
Steelhead	
Warner Sucker	
White Sturgeon	

Birds	
Species	**Potential Effects of Equipment Sterilization No Effect**
Least Tern	
Marbled Murrelet	
Northern Spotted owl	
Streak Horned Lark	
Western Snowy Plover	
Yellow-billed Cuckoo	

Table 5.3.7 Continued.

Gastropods	
Species	**Potential Effects of Equipment Sterilization No Effect**
Banbury Springs Limpet	
Bliss Rapids Snail	
Bruneau Hot Springsnail	
Snake River Physa Snail	
Vernal Pool Fairy Shrimp	

Amphibians	
Species	**Potential Effects of Equipment Sterilization No Effect**
Oregon Spotted Frog	

Insects	
Species	**Potential Effects of Equipment Sterilization No Effect**
Fender's Blue Butterfly	
Meltwater Lednian	
Oregon Silverspot Butterfly	
Taylor's (whulge) Checkerspot	
Western Glacier Stonefly	

Plants	
Species	**Potential Effects of Equipment Sterilization No Effect**
Applegate's Milk-Vetch	
Gentner's Fritillary	
MacFarlane's Four-o'clock	
Slickspot Peppergrass	
Spalding's Catchfly	
Ute Ladies'-tresses	
Water Howellia	
Western Lily	
Whitebark Pine	

Table 11.1. Effects determinations and analysis of risk of exposure to treatment for populations of anadromous fish under NMFS jurisdiction.

Eulachon			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Klamath River	NA	NA	Outside of Action Area
Columbia River	LAA	May Affect	Treatment April – June could affect spawning and hatching

Sockeye			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Ozette Lake	LAA	May Affect	No identified sites within this ESU
Redfish Lake	LAA	May Affect	Snake River Basin ESU: proposed conservation measure to exclude EarthTec QZ and Endothall from initial treatments within this ESU.
Pettit Lake	LAA	May Affect	
Alturas Lake	LAA	May Affect	
Stanley Lake	LAA	May Affect	
Yellowbelly Lake	LAA	May Affect	

Chum			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Hood Canal	LAA	May Affect	Low risk of treatment exposure in short, freshwater spawning tribs around Hood Canal.
Youngs Bay (OR)	LAA	May Affect	Columbia River ESU: All coincide with numerous identified boat ramp sites.
Grays/Chinook (WA)	LAA	May Affect	
Big Creek (OR)	LAA	May Affect	
Elochoman/Skamakowa (WA)	LAA	May Affect	
Clatskanie (OR)	LAA	May Affect	
Mill/Abernathy/Germany (WA)	LAA	May Affect	
Scappoose (OR)	LAA	May Affect	
Cowlitz - fall (WA)	LAA	May Affect	
Cowlitz - Summer (WA)	LAA	May Affect	
Kalama (WA)	LAA	May Affect	
Lewis (WA)	LAA	May Affect	
Salmon Creek (WA)	LAA	May Affect	
Clackamas (OR)	LAA	May Affect	
Sandy (OR)	LAA	May Affect	
Washougal (WA)	LAA	May Affect	
Lower Gorge (WA & OR)	LAA	May Affect	
Upper Gorge (WA & OR)	LAA	May Affect	

Chinook

Population	Effect Determination	CH Effect Determination	Comment
Wenatchee	LAA	May Affect	Upper Columbia spring Chinook ESU: proposed conservation measure to exclude EarthTec QZ and Endothall from initial treatments within this ESU.
Entiat	LAA	May Affect	
Methow	LAA	May Affect	
Upper Cowlitz (WA)*	LAA	May Affect	Lower Columbia River ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Cispus (WA)*	LAA	May Affect	
Tilton (WA)	LAA	May Affect	
Toutle (WA)	LAA	May Affect	
Kalama (WA)*	LAA	May Affect	
NF Lewis (WA)	LAA	May Affect	
Sandy (OR)*	LAA	May Affect	
Gorge White Salmon (WA)**	LAA	May Affect	
Hood (OR)*	LAA	May Affect	
Coast Youngs Bay (OR)*	LAA	May Affect	
Grays/Chinook (WA)	LAA	May Affect	
Big Creek (OR)*	LAA	May Affect	
Elochoman/Skamokawa* (WA)	LAA	May Affect	
Clatskanie (OR)*	LAA	May Affect	
Mill/Abernathy/Germany (WA)**	LAA	May Affect	
Scappoose (OR)**	LAA	May Affect	
Cascade Lower Cowlitz (WA)	LAA	May Affect	
Calopooia River**	LAA	May Affect	Upper Willamette River ESU: Calopooia River has no identified boat ramp sites. All other populations coincide with numerous identified sites.
Clackamas River	LAA	May Affect	
McKenzie River	LAA	May Affect	
Middle Fork Willamette River	LAA	May Affect	
Molalla River	LAA	May Affect	
North Santiam River	LAA	May Affect	
South Santiam River	LAA	May Affect	
North Fork Nooksack	LAA	May Affect	Puget Sound ESU:
South Fork Nooksack	LAA	May Affect	
Lower Skagit	LAA	May Affect	
Upper Skagit	LAA	May Affect	

Chinook Continued			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Cascade*	LAA	May Affect	Puget Sound ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. These populations are at low risk of exposure to treatments.
Lower Sauk*	LAA	May Affect	
Upper Sauk*	LAA	May Affect	
Suiattle	LAA	May Affect	
North Fork Stillaguamish	LAA	May Affect	
South Fork Stillaguamish	LAA	May Affect	
Skykomish	LAA	May Affect	
Snoqualmie	LAA	May Affect	
Sammamish	LAA	May Affect	
Cedar	LAA	May Affect	
Duwamish/Green	LAA	May Affect	
White*	LAA	May Affect	
Puyallup	LAA	May Affect	
Nisqually	LAA	May Affect	
Skokomish	LAA	May Affect	
Mid-Hood Canal	LAA	May Affect	
Dungeness	LAA	May Affect	
Elwha	LAA	May Affect	
Wenaha River*	LAA	May Affect	Snake River spring/summer ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Minam River	LAA	May Affect	
Catherine Creek*	LAA	May Affect	
Lookingglass Creek (Extirpated)	LAA	May Affect	
Lostine/Wallowa Rivers	LAA	May Affect	
Up. Grande Ronde River*	LAA	May Affect	
Imnaha River*	LAA	May Affect	
Big Sheep Creek (Extirpated)	--	--	
Tucannon River*	LAA	May Affect	
Asotin Creek (Extirpated)	--	--	
Little Salmon River	LAA	May Affect	
Secesh River**	LAA	May Affect	

Chinook Continued

Population	Effect Determination	CH Effect Determination	Comment
South Fork Salmon River*	LAA	May Affect	Snake River spring/summer ESU Continued: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
EF South Fork Salmon River**	LAA	May Affect	
Chamberlain Creek**	LAA	May Affect	
Big Creek**	LAA	May Affect	
Lower MF Salmon River*	LAA	May Affect	
Camas Creek**	LAA	May Affect	
Loon Creek**	LAA	May Affect	
Upper MF Salmon River*	LAA	May Affect	
Sulphur Creek**	LAA	May Affect	
Bear Valley Creek**	LAA	May Affect	
Marsh Creek**	LAA	May Affect	
North Fork Salmon River**	LAA	May Affect	
Lemhi River	LAA	May Affect	
Upper Salmon River	LAA	May Affect	
Pahsimeroi River*	LAA	May Affect	
East Fork Salmon River*	LAA	May Affect	
Yankee Fork Salmon River**	LAA	May Affect	
Valley Creek	LAA	May Affect	
Upper Salmon River	LAA	May Affect	
Panther Creek (functionally extirpated)	LAA	May Affect	
Snake River fall Chinook	LAA	May Affect	

Coho			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Youngs Bay (OR)	LAA	May Affect	Lower Columbia River ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Grays/Chinook (WA)	LAA	May Affect	
Big Creek (OR)*	LAA	May Affect	
Elochoman/Skamokawa (WA)*	LAA	May Affect	
Clatskanie (OR)*	LAA	May Affect	
Mill/Abernathy/Germany (WA)**	LAA	May Affect	
Scappoose (OR)**	LAA	May Affect	
Cascade Lower Cowlitz (WA)	LAA	May Affect	
Upper Cowlitz (WA)*	LAA	May Affect	
Cispus (WA)*	LAA	May Affect	
Tilton (WA)	LAA	May Affect	
Toutle SF (WA)**	LAA	May Affect	
Toutle NF (WA)**	LAA	May Affect	
Coho Continued			

Population	Effect Determination	CH Effect Determination	Comment
Coweeman (WA)*	LAA	May Affect	Lower Columbia River ESU Continued: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Kalama (WA)*	LAA	May Affect	
NF Lewis (WA)	LAA	May Affect	
EF Lewis (WA)*	LAA	May Affect	
Salmon Creek (WA)	LAA	May Affect	
Clackamas (OR)	LAA	May Affect	
Sandy (OR)*	LAA	May Affect	
Washougal (WA)	LAA	May Affect	
Gorge Lower Gorge (WA & OR)	LAA	May Affect	
Upper Gorge/White Salmon (WA)**	LAA	May Affect	
Upper Gorge/Hood (OR)*	LAA	May Affect	
Elk River**	LAA	May Affect	Southern Oregon/Northern California Coast ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments. Populations with NA for effects determinations occur outside of the action area.
Brush Creek**	LAA	May Affect	
Mussel Creek**	LAA	May Affect	
Lower Rogue River**	LAA	May Affect	
Hunter Creek**	LAA	May Affect	
Pistol Creek**	LAA	May Affect	
Chetco River	LAA	May Affect	
Winchuck River**	LAA	May Affect	
Smith River**	LAA	May Affect	
Elk Creek	NA	NA	
Wilson Creek**	LAA	May Affect	
Lower Klamath River	NA	NA	
Redwood Creek**	LAA	May Affect	
Maple Creek/Big Lagoon	NA	NA	
Little River	LAA	May Affect	
Strawberry Creek	LAA	May Affect	
Norton/Widow White Creek	NA	NA	
Mad River	NA	NA	
Humboldt Bay tributaries	NA	NA	
Lower Eel/Van Duzen Rivers	NA	NA	
Guthrie Creek	NA	NA	
Bear River	LAA	May Affect	
Mattole River	NA	NA	
Illinois River	LAA	May Affect	
Middle Rogue River	LAA	May Affect	
Applegate River*	LAA	May Affect	
Upper Rogue River*	LAA	May Affect	
Middle Klamath River	NA	NA	
Upper Klamath River	LAA	May Affect	
Coho Continued			

Population	Effect Determination	CH Effect Determination	Comment
Shasta River	NA	NA	Southern Oregon/Northern California Coast ESU Continued: Populations with NA for effects determinations occur outside of the action area.
Scott River	NA	NA	
Salmon River	NA	NA	
Lower Trinity River	NA	NA	
South Fork Trinity River	NA	NA	
Upper Trinity River	NA	NA	
Mainstem Eel River	NA	NA	
Middle Mainstem Eel River	NA	NA	
Upper Mainstem Eel River	NA	NA	
Middle Fork Eel River	NA	NA	
South Fork Eel River	NA	NA	
North Fork Eel River	NA	NA	
Necanicum	LAA	May Affect	Oregon Coast ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Ecola**	LAA	May Affect	
Arch Cape**	LAA	May Affect	
Short Sands**	LAA	May Affect	
Nehalem	LAA	May Affect	
Spring	LAA	May Affect	
Watseco	LAA	May Affect	
Tillamook Bay (all tribs)	LAA	May Affect	
Netarts	LAA	May Affect	
Rover	LAA	May Affect	
Sand*	LAA	May Affect	
Nestucca	LAA	May Affect	
Neskowin	LAA	May Affect	
Sutton (Mercer Lake)	LAA	May Affect	
Siltcoos	LAA	May Affect	
Tahkenitch	LAA	May Affect	
Lower Umpqua	LAA	May Affect	
Middle Umpqua	LAA	May Affect	
North Umpqua	LAA	May Affect	
South Umpqua	LAA	May Affect	
Threemile*	LAA	May Affect	
Coos	LAA	May Affect	
Coquille	LAA	May Affect	
Johnson	LAA	May Affect	
Twomile	LAA	May Affect	
Floras/New	LAA	May Affect	
Sixes*	LAA	May Affect	
Salmon*	LAA	May Affect	
Devils Lake	LAA	May Affect	
Siletz	LAA	May Affect	
Coho Continued			

Population	Effect Determination	CH Effect Determination	Comment
Schoolhouse	LAA	May Affect	Oregon Coast ESU Continued: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Fogarty	LAA	May Affect	
Depoe Bay	LAA	May Affect	
Rocky	LAA	May Affect	
Spencer	LAA	May Affect	
Wade	LAA	May Affect	
Coal	LAA	May Affect	
Moolack	LAA	May Affect	
Big (near Yaquina)	LAA	May Affect	
Yaquina	LAA	May Affect	
Theil**	LAA	May Affect	
Beaver*	LAA	May Affect	
Alsea	LAA	May Affect	
Big (near Alsea)	LAA	May Affect	
Vingie	LAA	May Affect	
Yachats	LAA	May Affect	
Cummins	LAA	May Affect	
Bob	LAA	May Affect	
Tenmile	LAA	May Affect	
Rock	LAA	May Affect	
Big (near Siuslaw)	LAA	May Affect	
China	LAA	May Affect	
Cape	LAA	May Affect	
Berry	LAA	May Affect	
Siuslaw	LAA	May Affect	

Steelhead			
Population	**Effect Determination**	**CH Effect Determination**	**Comment**
Wenatchee	LAA	May Affect	Upper Columbia River ESU: proposed conservation measure to exclude EarthTec QZ and Endothall from initial treatments within this ESU.
Entiat	LAA	May Affect	
Methow	LAA	May Affect	
Okanogan	LAA	May Affect	
Kalama (WA)*	LAA	May Affect	Lower Columbia River ESU: Upper and Lower Cowlitz River populations are the only populations in this ESU at higher risk of exposure to treatment due to numerous identified boat ramp sites on this river.
NF Lewis (WA)	LAA	May Affect	
EF Lewis (WA)*	LAA	May Affect	
Washougal (WA)	LAA	May Affect	
Gorge Wind (WA)*	LAA	May Affect	
Hood (OR)*	LAA	May Affect	
Lower Cowlitz (WA)	LAA	May Affect	
Upper Cowlitz (WA)	LAA	May Affect	
Cispus (WA)*	LAA	May Affect	
Steelhead Continued			

Population	Effect Determination	CH Effect Determination	Comment
Tilton (WA)*	LAA	May Affect	
SF Toutle (WA)**	LAA	May Affect	
NF Toutle (WA)**	LAA	May Affect	
Coweeman (WA)*	LAA	May Affect	
Calopooia River**	LAA	May Affect	Upper Willamette River ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Molalla River	LAA	May Affect	
North Santiam River	LAA	May Affect	
South Santiam River	LAA	May Affect	
West Side Tributaries*	LAA	May Affect	
Drayton Harbor Tributaries Winter Run	LAA	May Affect	
Nooksack River Winter Run	LAA	May Affect	
Nooksack River Summer Run	LAA	May Affect	
Samish River and Bellingham Bay Winter Run*	LAA	May Affect	
Skagit River Summer/Winter Run	LAA	May Affect	
Nookachamps Creek Winter Run	LAA	May Affect	
Baker River Summer/Winter Run	LAA	May Affect	
Sauk River Summer/Winter Run	LAA	May Affect	Puget Sound ESU: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Stillaguamish River Winter Run	LAA	May Affect	
Deer Creek Summer Run	LAA	May Affect	
Canyon Creek Summer Run	LAA	May Affect	
Snohomish/Skykomish River Winter Run	LAA	May Affect	
Pilchuck River Winter Run	LAA	May Affect	
NF Skykomish River Summer Run	LAA	May Affect	
Snoqualmie River Winter Run	LAA	May Affect	
Tolt River Summer Run	LAA	May Affect	
North Lake Washington and Lake Sammamish Winter Run	LAA	May Affect	
Cedar River Winter Run	LAA	May Affect	
Green River Winter Run (Summer)	LAA	May Affect	
Puyallup/Carbon River Winter Run*	LAA	May Affect	
White River Winter Run*	LAA	May Affect	
Steelhead Continued			

Population	Effect Determination	Critical Habitat Effect Determination	Comment
Nisqually River Winter Run*	LAA	May Affect	Puget Sound ESU Continued: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
South Sound Tributaries Winter Run	LAA	May Affect	
East Kitsap Winter Run	LAA	May Affect	
East Hood Canal Winter Run*	LAA	May Affect	
South Hood Canal Winter Run*	LAA	May Affect	
Skokomish River Winter Run (Summer)	LAA	May Affect	
West Hood Canal Winter Run*	LAA	May Affect	
Winter Sequim/Discovery Bay Independent Tributaries Winter*	LAA	May Affect	
Dungeness River Winter/Summer Run**	LAA	May Affect	
Strait of Juan de Fuca Independent Tributaries Winter Run**	LAA	May Affect	
Elwha River Winter Run (Summer)*	LAA	May Affect	
Joseph Creek	LAA	May Affect	Snake River Basin ESU Continued: Populations with a single * coincide with one to three identified, isolated boat ramp sites in ponds or lakes, or sites low in the river system. Populations with two ** do not coincide with any of the 4,174 identified sites. These populations are at low risk of exposure to treatments.
Wallowa River	LAA	May Affect	
Upper Grande Ronde River*	LAA	May Affect	
Lower Grande Ronde River	LAA	May Affect	
Imnaha River**	LAA	May Affect	
Tucannon River*	LAA	May Affect	
Asotin Creek	LAA	May Affect	
Lower Main Clearwater River	LAA	May Affect	
Lolo Creek**	LAA	May Affect	
Lochsa River	LAA	May Affect	
Selway River	LAA	May Affect	
South Fork Clearwater River	LAA	May Affect	
Little Salmon River	LAA	May Affect	
South Fork Salmon River*	LAA	May Affect	
Secesh River**	LAA	May Affect	
Chamberlain Creek**	LAA	May Affect	
L. Middle Fork Salmon River*	LAA	May Affect	
U. Middle Fork Salmon River*	LAA	May Affect	
Panther Creek	LAA	May Affect	
North Fork Salmon River**	LAA	May Affect	
Steelhead Continued			

Population	Effect Determination	CH Effect Determination	Comment
Lemhi River	LAA	May Affect	
Pahsimeroi River*	LAA	May Affect	
East Fork Salmon River*	LAA	May Affect	
Upper Salmon River	LAA	May Affect	

Appendix B

Chemical Datasheets and Product Labels for Endothall, EarthTec QZ, and Potash Compounds

AQUATHOL® K

AQUATIC HERBICIDE

For aquatic plant control in quiescent, slow moving, and flowing water aquatic sites.

ACTIVE INGREDIENT:

Dipotassium salt of endothall*	40.3%
OTHER INGREDIENTS:	59.7%
TOTAL	100.0%

Contains 4.23 lbs. dipotassium endothall* per gallon

*7-oxabicyclo [2.2.1]heptane-2,3-dicarboxylic acid equivalent 28.6%

KEEP OUT OF REACH OF CHILDREN

DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

FIRST AID

IF IN EYES:
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.
- Call a poison control center or doctor for treatment advice.

IF SWALLOWED:
- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

IF ON SKIN OR CLOTHING:
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

IF INHALED:
- Move person to fresh air.
- If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call a poison control center or doctor for treatment advice.

HOT LINE NUMBER: Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 866-673-6671 (Rocky Mountain Poison Control Center) for emergency medical treatment information.

See inside for additional precautionary statements.

NOTE TO PHYSICIAN: Measures against circulatory shock, respiratory depression, and convulsion may be needed.

EPA Registration No. 70506-176

Batch/Lot No.: _____

Net Contents: _____

United Phosphorus, Inc.
630 Freedom Business Center, Suite 402
King of Prussia, PA 19406
1-800-438-6071

PRODUCT INFORMATION

Aquathol K is a liquid concentrate soluble in water which is effective against a broad range of aquatic plants. Dosage rates indicated for the application of Aquathol K are measured in parts per million (ppm) of dipotassium endothall.

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

CORROSIVE. CAUSES IRREVERSIBLE EYE DAMAGE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING. AVOID BREATHING VAPORS OR SPRAY MIST. PROLONGED OR FREQUENTLY REPEATED SKIN CONTACT MAY CAUSE ALLERGIC REACTIONS IN SOME INDIVIDUALS.

Personal Protective Equipment (PPE)

Mixers, Loaders, Applicators and other handlers must wear:

- Long-sleeved shirt and long pants,
- Shoes and socks,
- Chemical-resistant gloves made of any waterproof material,
- Protective eyewear,
- NIOSH-approved respirator with a dust/mist filter with MSHA/NIOSH approval number prefix TC-21C or any N, R, P, or HE filter.

  Exception: During application, the respirator need not be worn, provided that the pesticide is applied in a manner (such as direct metering or subsurface application from the rear of a vessel that is moving into the wind) such that the applicator will have no contact with the pesticide.

See Engineering Controls for additional requirements.

User Safety Requirements:

Follow the manufacturers' instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Discard clothing or other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

Engineering Controls:

When mixers and loaders use a closed system designed by the manufacturer to enclose the pesticide to prevent it from contacting handlers or other people AND the system is functioning properly and is used and maintained in accordance with the manufacturers written operating instructions, the handlers need not wear a respirator, provided the required respirator is immediately available for use in an emergency such as a spill or equipment breakdown.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

User should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

This pesticide is toxic to mammals.

Treatment of aquatic plants can result in oxygen loss from decomposition of dead plants. This loss can cause fish suffocation. Water bodies containing very high plant density should be treated in sections to prevent suffocation of fish.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift.

- For quiescent or slow moving water treatments: Waters treated with Aquathol K may be used for swimming, fishing, and irrigating turf, ornamental plants and crops immediately after treatment with the following exceptions: Do not use the Aquathol K treated water to irrigate the following for 7 days after the treatment: annual nursery or greenhouse crops including hydroponics and newly seeded or transplanted annual crops, newly seeded or transplanted ornamentals, and newly sodded or seeded turf. Do not use treated water for animal consumption within the following periods:

  0.5 ppm dipotassium salt – 7 days after application

  4.25 ppm dipotassium salt – 14 days after application

  5.0 ppm dipotassium salt – 25 days after application
- For flowing water treatments: Waters treated with Aquathol K may be used for swimming, fishing, livestock watering, and irrigating turf, ornamental plants and crops immediately after treatment with the following exceptions: Do not use the Aquathol K treated water to irrigate the following: annual nursery or greenhouse crops including hydroponics and newly seeded or transplanted annual crops, newly seeded or transplanted ornamentals, and newly sodded or seeded turf.
- Phytotoxicity is not expected on plants or crops irrigated with Aquathol K treated water, however, all species and cultivars (varieties) have not been tested.
- Undiluted Aquathol K may be injurious to crops, grass, ornamentals, and other foliage.
- Do not use Aquathol K treated water for chemigation as interactions between Aquathol K and other pesticides and fertilizers are not known.
- Do not use Aquathol K in brackish or saltwater.
- Wash out spray equipment with water after each operation.
- Avoid contact of spray concentrate (product) directly or by drift with non-target plants or crops as injury may result.

HOW TO APPLY:

Aquathol K is a contact herbicide; consequently, apply when target plants are present.

Aquathol K should be sprayed on the water or injected below the water surface. It may be applied as a concentrate or diluted with water depending on the equipment.

In instances where the plant(s) to be controlled is an exposed surface problem (i.e., some of the broad-leaved pond weeds) coverage is important. For best results, apply the concentrate with the least amount of water compatible with the application equipment.

Drinking Water (Potable Water)

Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits.

The drinking water (potable water) restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of endothall acid in the water is less than the MCL (Maximum Contamination Level) of 0.1 ppm. Applicators should consider the unique characteristics of the treated waters to assure that endothall acid concentrations in potable drinking water do not exceed 0.1 ppm at the time of consumption.

For Lakes, Ponds, and other Quiescent Water Bodies:

- For Aquathol K applications, the drinking water setback distance from functioning potable water intakes in the treated water body must be greater than or equal to 600 feet.
- Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

For Irrigation Canals and other Flowing Water Bodies:

- Applicator is responsible to assure that treated water does not enter potable water intakes. For Aquathol K applications, potable water intakes must be closed when treated water is present at the intake. In the event the water intake cannot be closed, treatments must only be made downstream from the intake in order to assure Aquathol K treated water does not enter the potable water system.

QUIESCENT OR SLOW MOVING WATER TREATMENTS: SURFACE OR INJECTED APPLICATIONS

For aquatic plant control in quiescent or slow moving water, Aquathol K recommended use rates can be found in the following chart. Since the active ingredient is water soluble and tends to diffuse from the treated area, select the dosage rate applicable to the area to be treated. Marginal treatments of large bodies of water require higher rates as indicated.

Use higher labeled rates of Aquathol K when making treatments to small areas with an increased potential for rapid dilution or when treating narrow areas such as boat lanes or shoreline treatments where dilution may reduce the exposure of plants to Aquathol K.

Use lower labeled rates of Aquathol K for large contiguous treatment blocks or in protected areas such as coves where reduced water movement will not result in rapid dilution of Aquathol K from the target treatment area or when treating entire lakes or ponds.

PLANTS CONTROLLED AND AQUATHOL K DOSAGE RATE CHART

	APPLICATION RATE			
	Entire Pond/Lake or Large Area Treatment		Spot or Lake Margin Treatment	
Aquatic Plant	ppm Dipotassium Endothall	gallons Aquathol K per Acre Ft.	ppm Dipotassium Endothall	gallons Aquathol K per Acre Ft.
Bur Reed, Sparganium spp.	3.0-4.0	1.9-2.6	4.0-5.0	2.6-3.2
Coontail, Ceratophyllum spp.	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Horned Pondweed, Zannichellia palustris	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Sago Pondweed, Stuckenia pectinata	1.0-2.0	0.6-1.3	2.0-5.0	1.3-3.2
Hydrilla, Hydrilla verticillata	1.0-4.0	0.6-2.6	2.0-5.0	1.3-3.2
Hygrophila*, Hygrophila polysperma	4.0-5.0	2.6-3.2	5.0	3.2
Milfoil, Myriophyllum spp.	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Naiad, Najas spp.	2.0-4.0	1.3-2.6	3.0-5.0	1.9-3.2
Pondweed, Potamogeton spp.	0.75-3.0	0.45-1.9	1.5-5.0	1.0-3.2
Including:				
American, P. nodosus	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Largeleaf (Bass Weed), P. amplifolius	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Curlyleaf, P. crispus	0.75-1.5	0.45-1.0	1.5-5.0	1.0-3.2
Flatstem, P. zosteriformis	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Floating-leaf, P. natans	1.0-2.0	0.6-1.3	2.0-5.0	1.3-3.2
Illinois, P. Illinoensis	1.5-2.5	1.0-1.6	2.5-5.0	1.6-3.2
Narrowleaf, P. pusillus	1.0-2.0	0.6-1.3	2.0-5.0	1.3-3.2
Threadleaf, P. filiformis	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Variable Leaf, P. diversifolius	1.0-2.0	0.6-1.3	2.0-5.0	1.3-3.2
Parrotfeather, Myriophyllum aquaticum	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2
Water Stargrass, Heteranthera spp.	2.0-3.0	1.3-1.9	3.0-5.0	1.9-3.2

* Suppression only

The following charts indicate the quantity of Aquathol K to be applied.

Gallons of Aquathol K to Treat One Acre-Foot of Water

	Rate (ppm)						
	0.75	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**
	gallons/A-ft.						
1 acre ft.	0.45	0.6	1.0	1.3	1.9	2.6	3.2

Fluid Ounces of Aquathol K to Treat 1,000 Square-Feet per Foot of Depth

	Rate (ppm)						
	0.75	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**
	fl. oz./1,000 ft.^{2}						
1,000 ft.^{2}	1.4	1.9	2.8	3.8	5.7	7.6	9.4

FLOWING WATER TREATMENTS (WITH THE EXCEPTION OF IRRIGATION CANALS): DRIP OR METERING SYSTEM APPLICATIONS

For aquatic plant control in flowing water, Aquathol K recommended use rates can be found in the following chart. Apply Aquathol K in a manner to achieve the desired rate and adequate mixing so product is distributed throughout the entire water column. Adequate concentration (rate) and exposure time (length of treatment) will impact Aquathol K efficacy on the target plant species. Although Aquathol K is a contact herbicide adequate exposure time is critical. The rates and the length of treatment are guidelines to control the target species. The following rate chart has been developed based on Concentration Exposure Time (CET) data for Aquathol K. The CET concept allows rates and the length of exposure to be adjusted for different treatment scenarios.

AQUATHOL K APPLICATION RATES FOR FLOWING WATER TREATMENTS

	Length of Treatment (hours)							
	6	**8**	**12**	**18**	**24**	**36**	**48**	**72**
Plant Species	Rate (ppm)							
Pondweeds (Potamogeton spp.) Sago Pondweed (Stuckenia pectinata)	4.0-5.0	3.0-4.0	2.0-3.0	1.5-2.5	1.0-2.0	0.75-1.5	0.5-1.0	0.5
Milfoil (Myriophyllum spp.) Parrotfeather (Myriophyllum aquaticum) Coontail (Ceratophyllum spp.) Horned pondweed (Zannichellia spp.) Hydrilla (Hydrilla verticillata) Naiad (Najas spp.) Water Stargrass (Heteranthera spp.)	5.0	4.0-5.0	3.0-4.0	2.0-3.0	1.5-2.5	1.0-2.0	0.75-1.5	0.5-1.0

NOTE: Hygrophila (Hygrophila polysperma) may be suppressed at the higher application rates listed in this table.

Restrictions: Do not apply more than 30 ppm per growing season, not to exceed 5 ppm per application. Do not apply more than a total of 5 ppm within a 7-day interval.

Note: There is no Pre-harvest Interval (PHI) for crops irrigated with treated water.

To calculate the amount of Aquathol K required for a particular treatment use the following formula:

[Cubic Feet per Second (CFS) X Length of Treatment (hrs.) X Rate (ppm)] x 0.052947 = Gallons of Aquathol K Needed for Treatment

To calculate the amount of Aquathol K to be applied per hour use the following formula:

Gallons of Aquathol K per Hour = Total Gallons of Aquathol K / Length of Treatment (hrs.)

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

Pesticide Storage: Store in the original container. Do not store in a manner where cross-contamination with other pesticides, fertilizers, food or feed could occur. Storage at temperatures below 32°F may result in the product freezing or crystallizing. Should this occur the product must be warmed to 50°F or higher and thoroughly agitated. In the event of a spill during handling or storage, absorb with sand or other inert material and dispose of absorbent in accordance with the Pesticide Disposal instructions listed below.

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Container Handling:

(for Nonrefillable containers)

Nonrefillable container. Do not reuse or refill this container. Triple rinse or pressure rinse container (or equivalent) promptly after emptying.

For containers 5 gallons or less:

Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

Or

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

For containers more than 5 gallons:

Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times.

Or

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 PSI for at least 30 seconds. Pour or pump rinsate into application equipment or rinsate collection system. Drain for 10 seconds after the flow begins to drip.

Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

(for Refillable containers)

Refillable container. Refill this container with pesticide only. Do not use this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available or reconditioning if appropriate or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

EMERGENCY TELEPHONE NUMBERS

CHEMTREC: (800) 424-9300

MEDICAL: (866) 673-6671 Rocky Mountain Poison Control Center

IMPORTANT INFORMATION
READ BEFORE USING PRODUCT

CONDITIONS OF SALE AND LIMITATION OF WARRANTY AND LIABILITY

NOTICE: Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

The Directions for Use of this product reflect the opinion of experts based on field use and tests, and must be followed carefully. It is impossible to eliminate all risks associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as manner of use or application, weather or crop conditions, presence of other materials or other influencing factors in the use of the product, which are beyond the control of United Phosphorus, Inc. or Seller. Handling, storage, and use of the product by Buyer or User are beyond the control of United Phosphorus, Inc. and Seller. All such risks shall be assumed by Buyer and User, and Buyer and User agree to hold United Phosphorus, Inc. and Seller harmless for any claims relating to such factors.

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, UNITED PHOSPHORUS, INC. AND SELLER MAKE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ON THIS LABEL.

To the extent consistent with applicable law, United Phosphorus, Inc. or Seller shall not be liable for any incidental, consequential or special damages resulting from the use or handling of this product and **THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF UNITED PHOSPHORUS, INC. AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF UNITED PHOSPHORUS, INC. OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

United Phosphorus, Inc. and Seller offer this product, and Buyer and User accept it, subject to the foregoing conditions of sale and limitations of warranty and of liability, which may not be modified except by written agreement signed by the duly authorized representative of United Phosphorus, Inc.

Aquathol is a registered trademark of United Phosphorus, Inc.

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Made in U.S.A.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

October 20, 2015

John Fournier, Agent for Earth Science Laboratories
c/o Acadia Regulatory Consulting, Inc.
331 W. King Road
Ithaca, NY 14850

Subject: Label Amendment – Deletes "Store EarthTec in its original container only"
Product Name: Earthtec
EPA Registration Number: 64962-1
Application Date: 10/1/2015
Decision Number: 510176

Dear Mr. Fournier:
The amended label referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act, as amended, is acceptable. This approval does not affect any conditions that were previously imposed on this registration. You continue to be subject to existing conditions on your registration and any deadlines connected with them.

A stamped copy of your labeling is enclosed for your records. This labeling supersedes all previously accepted labeling. You must submit one copy of the final printed labeling before you release the product for shipment with the new labeling. In accordance with 40 CFR 152.130(c), you may distribute or sell this product under the previously approved labeling for 18 months from the date of this letter. After 18 months, you may only distribute or sell this product if it bears this new revised labeling or subsequently approved labeling. "To distribute or sell" is defined under FIFRA section 2(gg) and its implementing regulation at 40 CFR 152.3.

Should you wish to add/retain a reference to the company's website on your label, please be aware that the website becomes labeling under the Federal Insecticide Fungicide and Rodenticide Act and is subject to review by the Agency. If the website is false or misleading, the product would be misbranded and unlawful to sell or distribute under FIFRA section 12(a)(1)(E). 40 CFR 156.10(a)(5) list examples of statements EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the Agency find or if it is brought to our attention that a website contains false/misleading statements or claims substantially differing from the EPA approved registration, the website will be referred to EPA's Office of Enforcement and Compliance.

Your release for shipment of the product constitutes acceptance of these conditions. If these conditions are not satisfied, the registration will be subject to cancellation in accordance with FIFRA section 6. If you have questions, contact Lindsay Roe by phone at 703-347-0506, or via email at roe.lindsay@epa.gov.

Sincerely,

Tony Kish

Tony Kish, Fungicide Branch
Registration Division (7505P)
Office of Pesticide Programs

Fast Track Label Acceptable v.20150320

MASTER LABEL FOR EARTHTEC
EPA REG. NO. 64962-1

EARTHTEC

Algaecide/Bactericide*
For Impounded Waters; Lakes; Ponds; Lagoons; Wastewater Lagoons; Reservoirs; Livestock Watering Systems; Potable Water Supplies*; Sedimentation Basins; Ornamental Water Features or Fountains; and Equipment/Structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

Algaecide/Bactericide*
For Irrigation Conveyance Systems, Irrigation Reservoirs, Irrigation Canals, Ditches, and Chemigation Systems

Algaecide/Tadpole Shrimp
For Rice Fields

Algaecide/Bactericide*
For Aquacultural Ponds

Algaecide/ Bactericide*
For Residential Pools, Spas and Hot Tubs

Algaecide/Bactericide*
For Feedlot Run-Off Lagoons, Animal Waste or Confinement Pits and Organic Sludge Pits

Molluscicide For Control of Quagga and Zebra Mussels in Impounded Waters; Lakes; Ponds; Lagoons; Wastewater Lagoons; Reservoirs; Potable Water Supplies*; Canals; Ditches; Aqueducts; and Equipment/Structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

Bactericide* - Nonpublic Health Bacteria
Potable Water Supplies* - Water Destined to Be Used as Drinking Water (this water must receive additional and separate potable water treatment)

ACCEPTED
10/20/2015
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 64962-1

ACTIVE INGREDIENT	
Copper Sulfate Pentahydrate*(CAS No. 7758-99-8).....	19.8%
OTHER INGREDIENTS.....	80.2%
Total.....	100.0%
*Metallic Copper	5%

THIS PRODUCT WEIGHS 9.91 LB. PER GALLON (1.188 kg/L)

AND CONTAINS 0.493 LBS ELEMENTAL COPPER PER GALLON

1

MASTER LABEL FOR EARTHTEC
EPA REG. NO. 64962-1

EARTHTEC

Algaecide/Bactericide*
For Impounded Waters; Lakes; Ponds; Lagoons; Wastewater Lagoons; Reservoirs; Livestock Watering Systems; Potable Water Supplies*; Sedimentation Basins; Ornamental Water Features or Fountains; and Equipment/Structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

Algaecide/Bactericide*
For Irrigation Conveyance Systems, Irrigation Reservoirs, Irrigation Canals, Ditches, and Chemigation Systems

Algaecide/Tadpole Shrimp
For Rice Fields

Algaecide/Bactericide*
For Aquacultural Ponds

Algaecide/ Bactericide*
For Residential Pools, Spas and Hot Tubs

Algaecide/Bactericide*
For Feedlot Run-Off Lagoons, Animal Waste or Confinement Pits and Organic Sludge Pits

Molluscicide For Control of Quagga and Zebra Mussels in Impounded Waters; Lakes; Ponds; Lagoons; Wastewater Lagoons; Reservoirs; Potable Water Supplies*; Canals; Ditches; Aqueducts; and Equipment/Structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

Bactericide* - Nonpublic Health Bacteria
Potable Water Supplies+ - Water Destined to Be Used as Drinking Water (this water must receive additional and separate potable water treatment)

ACCEPTED
10/20/2015
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 64962-1

ACTIVE INGREDIENT	
Copper Sulfate Pentahydrate*(CAS No. 7758-99-8).....	19.8%
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*Metallic Copper	5%

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AND CONTAINS 0.493 LBS ELEMENTAL COPPER PER GALLON

1

NET CONTENTS: EIGHT (8) FLUID OUNCES
THIRTY-TWO (32) FLUID OUNCES
SIXTY-FOUR (64) FLUID OUNCES
ONE (1) U.S. GALLON
TWO AND ONE-HALF (2.5) U.S. GALLONS (Commercial Use Only)
THIRTY (30) U.S. GALLONS
FIFTY-FIVE (55) U.S. GALLONS
TWO HUNDRED SEVENTY-FIVE (275) U.S. GALLONS
TANKER TRUCKS

KEEP OUT OF REACH OF CHILDREN

WARNING
AVISO

If you do not understand this label, find someone to explain it to you in detail.
(Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.)

FIRST AID

IF IN EYES: Hold eye open and rinse slowly and gently with water for 20 minutes. Remove contact lenses, if present, after first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for advice.

IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything to an unconscious person.

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of soap and water for 15 to 20 minutes. Call a poison control center or doctor for treatment.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact INFOTRAC 1-800-535-5053 for emergency medical treatment.

SEE ADDITIONAL PRECAUTIONARY STATEMENTS ON SIDE OR BACK PANEL

MFG. BY:	Earth Science Laboratories, Inc. 113 SE 22nd Street, Suite 1 Bentonville, AR 72712 Phone: 800-257-9283
EPA REGISTRATION NO.:	64962-1
EPA ESTABLISHMENT NO.:	64962-NE-001
BATCH NO.:	

PRECAUTIONARY STATEMENTS
Hazards to Humans and Domestic Animals

WARNING

Causes substantial but temporary eye injury. Harmful if swallowed. Harmful if absorbed through skin. Do not get in eyes or on clothing. Avoid contact with skin. Wear protective eyewear (goggles, face shield or safety glasses), long sleeved shirt, long pants, shoes, socks and chemical-resistant gloves made of any waterproof material. Some materials that are chemical-resistant to this product are polyvinyl chloride, polyethylene and viton. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash clothing before reuse.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and aquatic invertebrates. Waters treated with this product may be hazardous to aquatic organisms. Treatment of aquatic weeds and algae can result in oxygen loss from decomposition of dead algae and weeds. This oxygen loss can cause fish and invertebrate suffocation. To minimize this hazard, do not treat more than ½ of the water body to avoid depletion of oxygen due to decaying vegetation. Wait at least 14 days between treatments. Begin treatment along the shore and proceed outward in bands to allow fish to move into untreated areas. Consult with the state or local agency with primary responsibility for regulating pesticides before applying to public waters to determine if a permit is required.

Certain water conditions including low pH (≤6.5), low dissolved organic carbon (DOC) levels (3.0 mg/L or lower) and "soft" waters (i.e. alkalinity less than 50 mg/L) increases the potential acute toxicity to non-target aquatic organisms. The application rates on this label are appropriate for water with alkalinity greater than 50 mg/L. Do not use these application rates for water with less than 50 ppm alkalinity (e.g., soft or acid waters) because trout and other species of fish may be killed under such conditions.

Consult your local state fish and game agency before applying this product to public waters. Permits may be required before treating such waters.

For applications in waters destined for use as drinking water, those waters must receive additional and separate potable water treatment. Do not apply more than 1.0 ppm as metallic copper in these waters (background + applied copper).

PERSONAL PROTECTIVE EQUIPMENT

USER SAFETY REQUIREMENTS

Mixers, loaders, applicators and other handlers must wear the following:

- Long-sleeved shirt
- Long pants
- Shoes plus socks
- Chemical-resistant gloves made of any waterproof material (Chemical Resistance Category A)
- Protective eyewear

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent material that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

USER SAFETY RECOMMENDATIONS

- Users should wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Users should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.
- Wash the outside of gloves before removing.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirement specific to your state and tribe, consult the agency responsible for pesticide regulation. For use in residential pools, spas and hot tubs, do not apply this product in a way that will contact adults, children or pets.

AGRICULTURAL USE REQUIREMENTS APPLICABLE TO USE ON RICE FIELDS

Use this product only in accordance with its labeling and the Worker Protection Standard, 40 CFR part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, and nurseries, and mixers, loaders, applicators, and other handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on the label about personal protective equipment (PPE), restricted re-entry interval, and notification to workers. Do not enter or allow worker entry into treated areas during the restricted entry interval of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as soil or water. Wear coveralls, protective eyewear, chemical resistant gloves (i.e. gloves made of any waterproof material) and shoes plus socks.

USE INFORMATION

EarthTec is used to control algae and to suppress nonpublic health bacteria and bacteria that cause taste and odor problems in impounded waters; lakes; ponds; lagoons; wastewater lagoons; reservoirs; livestock watering systems; potable water supplies*; sedimentation basins; ornamental water features or fountains; and equipment/structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

EarthTec is used to control algae and to suppress nonpublic health bacteria in irrigation conveyance systems, irrigation reservoirs, irrigation canals, ditches, and chemigation systems.

EarthTec is used to control algae and tadpole shrimp in rice fields.

EarthTec is used to control algae and to suppress nonpublic health bacteria and bacteria that cause odor problems in aquacultural ponds.

EarthTec is used to control algae and to suppress nonpublic health bacteria and bacteria that cause odor problems in residential pools, spas and hot tubs.

EarthTec is used to suppress nonpublic health bacteria and bacteria that cause odors (such as odors from hydrogen sulfide and ammonia gas) in feedlot run-off lagoons, animal waste or confinement pits and organic sludge pits.

EarthTec is used to control quagga and zebra mussels in impounded waters; lakes; ponds; lagoons; wastewater lagoons; reservoirs; potable water supplies*; canals; ditches; aqueducts; and equipment/structures that deliver water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks.

EarthTec is an algaecide/bactericide*/molluscicide consisting of a soluble formulation of copper. EarthTec's proprietary formulation ensures that the active ingredient – metallic copper – is delivered in the form of the biologically available cupric ion, Cu++.

Before treating bodies of water, consult NPDES permitting authorities. **Do not exceed a free metallic copper concentration (background + applied copper) in treated water of 1.0 ppm (mg/L)**, equivalent to 16.7 mg/L of EarthTec.

This product has diffusional properties that move the ions through the water according to physical conditions. The product will stay soluble in the water until the ions are taken up by the algae/bacteria (non-public health) or affected by physical properties.

The product may be applied throughout the year. Apply when algae first appear. Apply based on the volume of water to be treated. The dose rates are variable and depend upon algae species, amount of algae present, water hardness, water temperature, turbidity and flows. Higher doses may be required for lower water temperatures, higher algae concentrations, and for hard waters. See Specific Directions for Use.

For control of planktonic algae, use a dose rate near the lower end of the labeled range. Dose near the higher end of the labeled range for rooted or stemmed species including Chara, Nitella, and filamentous algae. If there is uncertainty about the dosage, begin with the lower dosage and increase until algae control is achieved or until the maximum allowable level has been reached.

When treating flowing waters use a metering pump or similar means to apply a continuous dose so as to achieve a final dilution within the recommended range. See Specific Directions for Use.

USE IN CONTROL OF ALGAE, NONPUBLIC HEALTH BACTERIA, AND BACTERIA THAT CAUSE ODOR PROBLEMS

For algae control, apply in the late spring or early summer when algae first appear. The dosages are variable and depend upon algae species, water hardness, water temperature, amount of algae present, as well as whether water is clear, turbid, flowing or static. Preferably, the water should be clear with temperature above 60 degrees F (15.6 degrees C). Higher dosages are required at lower water temperatures, higher algae concentrations and for hard waters. See Specific Directions for Use. EarthTec is soluble and will quickly disperse. EarthTec application for 3 acres or less may be poured directly into ponds, small lakes and reservoirs. EarthTec application for 3 acres or more should be applied at several points in the ponds, lakes or reservoirs. Larger bodies of water can be treated with EarthTec by dragging a feeder hose behind a boat across the body of water or dispensing via conventional spray equipment mounted to a boat, helicopter or airplane. EarthTec will quickly diffuse throughout the water body in several hours; broad distribution of the product will speed dispersal and provide quicker control of algae. EarthTec may be applied to irrigation systems by a drip system or feeder pump according to the flow volume. Use higher dosages for Chara, Nitella and filamentous algae, and lower dosages for planktonic algae. If there is uncertainty about the dosage begin with the lower dosage and increase until control is achieved or until the maximum allowable level has been reached. See Specific Directions for Use.

Treatment of algae can result in oxygen loss from the decomposition of dead algae. This loss can cause fish suffocation. If the algae cover more than ⅓ of the total water area, treat in sections. Treat ½ of the water area in a single operation and wait for 14 days between treatments. Begin treatment along the shore and proceed outward in bands to allow fish to move into untreated areas. In regions where ponds freeze in winter, treatment should be done 6 to 8 weeks before expected freeze to prevent masses of decaying algae under an ice cover. Before treating bodies of water, consult proper state authorities such as the fisheries commission or conservation department to obtain any necessary permits. For use in controlling algae and cyanobacteria at all aquatic application sites do not exceed a copper concentration in water of 1.0 ppm of metallic copper concentration (background + applied).

For example, if you wish to achieve 1.0 ppm of metallic copper, 1 gallon of EarthTec added to 60,000 gallons of water is equal to 1.0 ppm metallic copper. In order to attain 1.0 ppm of metallic copper in the treated water, the amount of EarthTec added to a water body is equal to the gallons of water being treated divided by 60,000 multiplied by 1 (e.g., see Gallons of EarthTec and Water table below). Use volumetric measurement devices that are calibrated in accordance with manufacturer specifications.

Gallons of EarthTec and Water		
Gallons EarthTec	Gallons Water	Metallic Copper ppm
0.1 (0.4 quarts or 0.8 pints)	6,000	1.0
¼ (1 quart)	15,000	1.0
1	60,000	1.0
1 ⅔	100,000	1.0

Use formula for calculating water volume and flow rates. Calculate the volume of water (multiply the average depth by surface area). To calculate the gallons of water multiply the volume in cubic feet times 7.5. One cubic foot per second of flow equals 27,000 gallons/hour. One acre foot equals 326,000 gallons. See below for additional directions on methods of application to flowing water and aerial spraying on rice fields.

SPECIFIC DIRECTIONS FOR USE

To Control Algae, Nonpublic Health Bacteria, and Bacteria That Cause Odor Problems in Irrigation Reservoirs, Impounded Waters, Lakes, Ponds, Lagoons, Reservoirs, Livestock Watering Systems, Potable Water Supplies+, Sedimentation Basins, and Ornamental Water Features or Fountains: For fish-bearing lakes, ponds, drinking water reservoirs, irrigation canals and other listed applications, it is recommended to apply at the rate of 1 quart of EarthTec per 250,000 gallons of water, or 1 gallon of EarthTec per 1,000,000 gallons of water for preventive treatment of algae and nonpublic health bacteria. This will yield a concentration of 0.06 ppm metallic copper. Increase as necessary to achieve control but do not exceed a resulting copper concentration of 1.0 mg/L of metallic copper (background + applied copper) in the treated water.

If algae are present, treat at the rate of 3 quarts of EarthTec per 250,000 gallons of water, or 3 gallons of EarthTec per 1,000,000 gallons of water. This will yield a concentration of 0.18 ppm metallic copper.

For applications without fish or for wastewater lagoons apply at the rate of up to 1 quart of EarthTec per 15,000 gallons of water, or 1 gallon of EarthTec per 60,000 gallons of water. This will yield a rate of 1.0 ppm metallic copper. Do not exceed a resulting concentration of 1.0 mg/L of metallic copper (background + applied copper) in the treated water.

Do not exceed 1 gallon of EarthTec per 60,000 gallons of water (1.0 ppm metallic copper back ground + applied) under any circumstances for water destined for use as drinking water. EarthTec may be poured into the water manually after calculating the volume of water to be treated and measuring the quantity EarthTec necessary to attain a concentration of 0.06 ppm or by using an automated dispenser calibrated to release the required amount. For best results disperse EarthTec evenly throughout the body of water on a sunny day when algae are near the surface. Do not apply copper sulfate to water with less than 50 ppm alkalinity.

To Control and Suppress Algae, Nonpublic Health Bacteria and Bacteria that Cause Taste and Odor Problems in Potable Water Supplies+; Canals; Aqueducts; and equipment/structures that deliver the treated water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, and penstocks:
For flowing waters use a metering pump to apply a continuous dose so as to achieve a final dilution not to exceed 1.0 mg/L as copper (16.7 ppm as EarthTec). Preferably start with 1 to 4 ppm EarthTec (0.06 to 0.24 mg/L metallic copper) and increase only as necessary. A continuous maintenance dose of 0.6 to 2.0 ppm EarthTec (yielding a metallic copper concentration of 36 to 120 ppb, or micrograms per liter) can be used to prevent further growth. Start treatment at the first sign of algae problems and stop treatment when algae no longer pose a nuisance.

To Control Algae and Tadpole Shrimp in Rice Fields: Apply any time the tadpole shrimp appears from planting time until the seedlings are well rooted and have emerged through the water or at the first sign of algae growth on the surface of the field. Applications are most effective when made prior to algae leaving the soil surface and rising to the water surface and prior to appearance of the tadpole shrimp. Factors such as water depth, temperature, pH and the amount of algae can affect the amount of EarthTec needed to control algae and tadpole shrimp. If the depth of water is 8 inches, apply 9 gallons of EarthTec per acre. If the depth of water is 4 inches, apply 4½ gallons of EarthTec per acre. EarthTec can be metered into the rice field as water is being applied or by aerial application. Do not exceed a copper concentration in water of 2.5 ppm of metallic copper concentration (9 gallons of EarthTec per acre with 8 inch depth of water or 13½ gallons of EarthTec per acre foot of water). If tadpole shrimp are not present, do not exceed 1.0 ppm metallic copper.

To Control Algae or Nonpublic Health Bacteria and Bacteria That Cause Odor Problems in Open Channel Irrigation Conveyance Systems and Chemigation Systems, Ditches, and Canals: To prevent algae growth using a static application method, apply 1 gallon of EarthTec to 1,000,000 gallons of water to yield a rate of 0.06 ppm metallic copper in the water. If algae are present, apply 16.6 gallons of EarthTec to 1,000,000 gallons of water to yield 1.0 ppm metallic copper. To prevent algae growth using continuous flow systems, a metered flow rate of 1 milliliter per minute is added to a pumping flow of 267 gallons per minute to yield a rate of 0.06 ppm metallic copper. If algae are present, do not exceed the total dose of 1 gallon of EarthTec in 60,000 gallons of water (1.0 ppm metallic copper). See Example Calculation table below for continuous flow rates.

To Control Algae or Nonpublic Health Bacteria and Bacteria That Cause Odor Problems in Sprinkler, Drip or Other Types of Irrigation Equipment: Agitation is not required. Do not mix with basic substances. EarthTec must be applied continuously for the duration of the water application. To prevent growth of algae, nonpublic health bacteria, and bacteria that cause odor problems, treat at a rate of 1 gallon EarthTec per 60,000 gallons of water to 1 gallon EarthTec per 1,000,000 gallons of water. This will yield a rate of 1.0 ppm to 0.06 ppm metallic copper (see Example Calculation table below). If algae are visible, start by cleaning the pipes or lines and then applying 1 gallon of EarthTec in 60,000 gallons of water (1.0 ppm metallic copper). See Example Calculation table below for continuous flow rates. Once the lines are cleaned, use the preventive dose described above.

EXAMPLE CALCULATION
CHEMIGATION AND IRRIGATION FLOW RATES
(0.06 ppm Cu)

Water Flow Rate gpm	Water Flow Rate cfm	Dosage Rate ppm Metallic Cu	EarthTec fl oz/min	Feeder Pump Setting EarthTec mL/min
3,000	400	0.06	0.4	11.3
6,000	800	0.06	0.8	22.6
9,000	1,200	0.06	1.1	34.0
12,000	1,600	0.06	1.5	45.3

CHEMIGATION AND IRRIGATION FLOW RATES
(1.0 ppm Cu)

Water Flow Rate gpm	Water Flow Rate cfm	Dosage Rate ppm Metallic Cu	EarthTec fl oz/min	Feeder Pump Setting EarthTec mL/min
3,000	400	1.0	6.4	188.7
6,000	800	1.0	12.8	377.5
9,000	1,200	1.0	19.1	566.2
12,000	1,600	1.0	25.5	755.0

To Control Algae and Nonpublic Health Bacteria and Bacteria That Cause Odor Problems in Aquacultural Ponds: Apply at the rate of ¼ to ½ gallon of EarthTec per acre foot (326,000 gallons) of water to yield concentrations ranging from 0.05 ppm to .09 ppm metallic copper, respectively. Metallic copper concentration is directly proportional to amount of EarthTec added per acre foot. A maintenance dose of 4 to 8 fluid ounces per acre foot may be used every 14 days. The rate is dependent on water temperature, fish density and the degree of suppression targeted.

Computation for Aquacultural Ponds of Amount of EarthTec Applied One Acre Foot (12 Inches Deep)		
Gallons EarthTec	**Gallons Water**	**Copper ppm**
0.25	**326,000**	**0.05**
0.5	**326,000**	**0.09**

To Control Algae and Nonpublic Health Bacteria, and Bacteria That Cause Odor Problems in Residential Swimming Pools, Spas and Hot Tubs:

For pools, apply at the rate of 2 fluid ounces of EarthTec per 1,000 gallons of water (20 fluid ounces per 10,000 gallons).

For spas and hot tubs, apply at the rate of 6 mL of EarthTec per 100 gallons of water using supplied measuring cup.

These dosages will yield a rate of 0.9 ppm metallic copper. Treated pool effluent should not be discharged where it will drain into lakes, streams, ponds or public water. Application should be made before visible algae appear.

Every 14 days, test the copper level using a standard commercial swimming pool copper test kit. Add EarthTec to raise level back to 0.9 ppm (see tables). The amount of EarthTec to be added is proportional to the starting concentration and volume of water. Do not exceed 1.0 ppm metallic copper.

MAINTAINING METALLIC COPPER CONCENTRATION IN POOLS

Pool Volume (gallons)	**7,000**	**8,000**	**9,000**	**10,000**	**11,000**	**12,000**	**13,000**	**14,000**
Measured Metallic Copper Level in Pool	**ADDITIONAL FLUID OUNCES OF EARTHTEC ADDED TO MAINTAIN CONTROL**							
0.9 ppm	0	0	0	0	0	0	0	0
0.8 ppm	1	1	2	2	2	2	2	3
0.7 ppm	3	3	4	4	5	5	5	6
0.6 ppm	4	5	5	6	6	7	8	9
0.5 ppm	6	7	7	8	10	10	11	12
0.4 ppm	8	9	10	11	13	13	14	15
0.3 ppm	9	10	12	13	15	15	16	18
0.2 ppm	11	12	14	15	17	18	20	21
0.1 ppm	12	14	15	17	19	20	22	24

MAINTAINING METALLIC COPPER CONCENTRATION IN SPAS

Spa Volume (gallons)	100	200	300	400	500	700	800	900	1,000
Measured Metallic Copper Level in Spa	ADDITIONAL MILLILITERS OF EARTHTEC ADDED TO MAINTAIN CONTROL								
0.9 ppm	0	0	0	0	0	0	0	0	0
0.8 ppm	1	1	2	3	3	4	5	6	6
0.7 ppm	1	3	4	5	6	9	10	11	13
0.6 ppm	2	4	6	8	9	13	15	17	19
0.5 ppm	3	5	8	10	13	18	20	23	25
0.4 ppm	3	6	9	13	16	22	25	28	32
0.3 ppm	4	8	11	15	19	27	30	34	38
0.2 ppm	4	9	13	18	22	31	35	40	44
0.1 ppm	5	10	15	20	25	35	40	45	51

An alternate method is to apply at the rate of 1 fluid ounce of EarthTec per 1,000 gallons of water. This will yield a rate of 0.45 ppm metallic copper. Repeat a maintenance dosage of 1 fluid ounce of EarthTec per 1,000 gallons of water once a month to maintain control. Application should be made before visible algae appear. Where visible algae are present apply at a rate of 2 fluid ounces of EarthTec per 1,000 gallons of water. This will yield a rate of 0.9 ppm metallic copper.

BACTERIAL ODOR CONTROL

To Control Bacterial Odor in Feedlot Run-Off Lagoons, Animal Waste or Confinement Pits, and Organic Sludge Pits: Apply by pouring product directly from the container into the pit or lagoon. Several application points speed up dispersal. Use 1 gallon of full strength EarthTec in 60,000 gallons (8,000 cubic feet) of sewage. This will yield a rate of 1.0 ppm metallic copper. Bacteria and odors should be noticeably reduced in 1 to 2 weeks. Repeat application when odor reoccurs. Minimum re-treatment interval is 14 days.

Feedlot Run-Off Lagoons: Add a portion of the required dosage of EarthTec at several locations around the lagoon to speed dispersal of the product. A minimum of 2 applications per year (spring and fall) is recommended. Additional applications may be required as needed when the lagoon is pumped.

Animal Waste or Confinement Pits: If pits are located under the confinement buildings, add EarthTec directly to these pits. If the pits are outside, add product to the transfer line to the pit.

MOLLUSCICIDE

OPEN WATERS: To Control Quagga and Zebra Mussels in Lakes, Ponds, Lagoons, Reservoirs, and Potable Water Supplies[+]:
In open or slow-moving, quiescent waters use as a curative measure, i.e., when mussels (veliger, juvenile or adult) have been detected. EarthTec is miscible in water and has ionic diffusion properties that cause it to readily disperse throughout the water column. Apply near the water surface and allow to disperse, or where means exist, deliver via hose and pump to the depths, sites, and surfaces of worst infestation. When applying to large areas, dispense along a route with gaps no greater than 200 feet. When fish are present, do not treat more than one-half of the body of water at a time, starting near one shore and moving outward in bands so as to allow fish to move away. When treating half of a body of water, the second half must not be treated within 14 days from the last treatment.

For effective control of adult and juvenile mussels, apply at the recommended rate of 2 to 16 parts per million EarthTec (i.e., 2 to 16 gallons of EarthTec per million gallons of water) to yield a rate of 0.120 to 0.960 mg/L (ppm) metallic copper. Do not exceed 1.0 mg/L (equivalent to 16.7 ppm EarthTec) metallic copper in any single application or in the treated water (background + applied). Allow at least 4 days for mortality to occur. Colder water temperatures may require longer exposures and doses closer to the high end of the allowable range. Within the half of the water body being treated repeat applications are permissible if needed to maintain lethal concentrations of copper for sufficient time period. When re-applying, do not exceed a resulting concentration of 1.0 mg/L of metallic copper (background + applied copper) in the treated water. Do not treat the second half of the body of water within 14 days of the last treatment of the first half.

Effective control can also be achieved by longer exposures (e.g., 5-30 days) at lower doses (1 to 5 parts per million EarthTec, to yield a rate of 0.06 to 0.30 mg/L (ppm) metallic copper.) Repeat doses are permissible and may be required for severe infestations. When reapplying, do not exceed a resulting concentration of 1.0 mg/L (ppm) metallic copper in the treated water (background + applied).

Dose Rate for Molluscicide EarthTec in Open Waters (LOW DOSES)

Acres	Depth (ft)	Acre-Ft to Treat	Million Gallons to Treat	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Dose Rate (gals)	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Dose Rate (gals)
0.1	3	0.3	0.1	1.0	0.06	0.10	2.0	0.12	0.20
0.5	3	1.5	0.5	1.0	0.06	0.50	2.0	0.12	1
1	3	3.0	1.0	1.0	0.06	1	2.0	0.12	2
1	6	6.0	2.0	1.0	0.06	2	2.0	0.12	4
10	3	30	10	1.0	0.06	10	2.0	0.12	20
10	4.5	45	15	1.0	0.06	15	2.0	0.12	30
10	6	60	20	1.0	0.06	20	2.0	0.12	40
20	3	60	20	1.0	0.06	20	2.0	0.12	40
100	3	300	100	1.0	0.06	100	2.0	0.12	200
1000	3	3,000	1,000	1.0	0.06	1,000	2.0	0.12	2,000

Dose Rate for Molluscicide EarthTec in Open Waters (MEDIUM DOSES)

Acres	Depth (ft)	Acre-Ft to Treat	Million Gallons to Treat	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Dose Rate (gals)	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Dose Rate (gals)
0.1	3	0.3	0.1	4.0	0.240	0.40	10.0	0.600	1.00
0.5	3	1.5	0.5	4.0	0.240	2.00	10.0	0.600	5
1	3	3.0	1.0	4.0	0.240	4	10.0	0.600	10
1	6	6.0	2.0	4.0	0.240	8	10.0	0.600	20
10	3	30	10	4.0	0.240	40	10.0	0.600	100
10	4.5	45	15	4.0	0.240	60	10.0	0.600	150
10	6	60	20	4.0	0.240	80	10.0	0.600	200
20	3	60	20	4.0	0.240	80	10.0	0.600	200
100	3	300	100	4.0	0.240	400	10.0	0.600	1,000
1000	3	3,000	1,000	4.0	0.240	4,000	10.0	0.600	10,000

Dose Rate for Molluscicide EarthTec in Open Waters (MAXIMUM DOSE)

Acres	Depth (ft)	Acre-Ft to Treat	Million Gallons to Treat	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Dose Rate (gals)
0.1	3	0.3	0.1	16.7	1.0	1.7
0.5	3	1.5	0.5	16.7	1.0	8.4
1	3	3.0	1.0	16.7	1.0	16.7
1	6	6.0	2.0	16.7	1.0	33.5
10	3	30	10	16.7	1.0	167
10	4.5	45	15	16.7	1.0	251
10	6	60	20	16.7	1.0	335
20	3	60	20	16.7	1.0	335
100	3	300	100	16.7	1.0	1,673
1000	3	3,000	1,000	16.7	1.0	16,733

For reference:
1 acre-foot = 325,851 gal
1 million gal = 3.07 acre-feet
1 hectare = 2.47 acres
1 meter = 3.28 feet
1 ppm (1 part per million) =1 mg/L and/or 1 gal per million gallons
1 gal = 3.785 mL

When calculating dose rates for a given volume of water, achieve a desired concentration of metallic copper in the water to be treated by using the following general formula:

$$\frac{\text{Gallons of EarthTec Applied}}{\text{Million Gallons to be Treated}} \times 0.06 = \text{parts per million Copper in the Treated Water}$$

For example, treating 3 million gallons with 4.5 gallons of EarthTec (a rate of 1.5 ppm as EarthTec) will yield a final copper dose of:
(4.5 gals / 3 million gallons) x 0.06 = 0.09 mg/L as copper = 90 ppb as copper

Always use volumetric measurement devices that are calibrated in accordance with manufacturer specifications.

FLOWING WATERS: To Control the Mollusk Pests Quagga and Zebra Mussels in flowing potable water supplies+; canals; ditches; aqueducts; and equipment/structures that deliver the treated water directly to publicly owned water treatment facilities to include pipes, intake structures, gatehouses, screens, pumping stations, weirs, penstocks:
In flowing waters, use when mollusks (veliger, juvenile, or adult) have been detected. May be used as a curative measure when adult or juvenile mollusks are present, or as a preventative measure (to inhibit colonization) when adults and/or planktonic larval mollusks have been detected.

EarthTec may be used continuously on flowing waters as a means of preventing further spread and colonization of mollusks. Start the continuous application when mollusks are present and end application when mollusks are no longer present. Use a metering pump to apply a continuous dose so as to achieve a final dilution of 1 to 16 ppm EarthTec (0.06 to 0.96 ppm metallic copper, or mg/L). Do not exceed 1.0 ppm free metallic copper (background + applied) in the flowing water, equivalent to 16.7 ppm as EarthTec. If adult mollusks are already present, allow at least 4 days for mortality to occur, or longer for very well-established populations where adults appear in clumps. For most situations satisfactory control will be obtained at a continuous dose of 1 to 5 ppm EarthTec (i.e., 0.06 to 0.30 mg/L (ppm) metallic copper). Colder water temperatures may require longer exposure and a dose rate closer to the high end of the allowable range.

Once the initial infestation has been cleared from surfaces, a continuous maintenance dose of 0.6 to 2.0 ppm EarthTec (yielding a metallic copper concentration of 36 to 120 ppb) can be used to prevent further colonization.

Example Dose Rates for EarthTec in Flowing Waters (LOW DOSE)

cfs	gal/min	MGD	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Feed Rate (fluid oz/min)	EarthTec Feed Rate (ml/min)	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Feed Rate (fluid oz/min)	EarthTec Feed Rate (ml/min)
1	449	0.65	1.0	0.06	0.06	1.70	2.0	0.12	0.11	3.40
1.55	696	1.0	1.0	0.06	0.09	2.63	2.0	0.12	0.18	5.27
3	1,346	1.9	1.0	0.06	0.17	5.10	2.0	0.12	0.34	10.2
4	1,795	2.6	1.0	0.06	0.23	6.80	2.0	0.12	0.46	13.6
5	2,244	3.2	1.0	0.06	0.29	8.49	2.0	0.12	0.57	17.0
10	4,488	6.5	1.0	0.06	0.57	17.0	2.0	0.12	1.15	34.0
15.47	6,943	10	1.0	0.06	0.89	26.3	2.0	0.12	1.78	52.6
50	22,442	32	1.0	0.06	2.87	84.9	2.0	0.12	5.74	170
100	44,883	65	1.0	0.06	5.74	169.9	2.0	0.12	11.5	340
155	69,429	100	1.0	0.06	8.89	262.8	2.0	0.12	17.8	526
1,000	448,830	646	1.0	0.06	57	1,699	2.0	0.12	115	3,398

Example Dose Rates for EarthTec in Flowing Waters (MEDIUM AND HIGH DOSES)

cfs	gal/min	MGD	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Feed Rate (fluid oz/min)	EarthTec Feed Rate (ml/min)	Desired ppm, EarthTec	Desired ppm, as copper	EarthTec Feed Rate (fluid oz/min)	EarthTec Feed Rate (ml/min)
1	449	0.65	5.0	0.30	0.29	8.49	16.0	0.96	0.92	27.2
1.55	696	1.0	5.0	0.30	0.45	13.2	16.0	0.96	1.42	42.1
3	1,346	1.9	5.0	0.30	0.86	25.5	16.0	0.96	2.76	81.5
4	1,795	2.6	5.0	0.30	1.15	34.0	16.0	0.96	3.68	109
5	2,244	3.2	5.0	0.30	1.44	42.5	16.0	0.96	4.60	136
10	4,488	6.5	5.0	0.30	2.87	84.9	16.0	0.96	9.19	272
15.47	6,943	10	5.0	0.30	4.44	131	16.0	0.96	14.2	420
50	22,442	32	5.0	0.30	14.4	425	16.0	0.96	46.0	1,359
100	44,883	65	5.0	0.30	28.7	849	16.0	0.96	91.9	2,718
155	69,429	100	5.0	0.30	44.4	1,314	16.0	0.96	142	4,205
1,000	448,830	646	5.0	0.30	287	8,494	16.0	0.96	919	27,180

MGD = Million Gallons per Day
cfs = Cubic Feet per Second

AERIAL SPRAY DRIFT MANAGEMENT

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground and aerial) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

Droplet Size

Apply only as a medium or coarser spray (ASAE standard 572) or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

Wind Speed

Do not apply at wind speeds greater than 15 mph. Only apply this product if the wind direction favors on-target deposition (approximately 3 to 10 mph) and there are no sensitive areas within 250 feet downwind.

Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or unstable atmospheric conditions.

Other State and Local Requirements

Applicators must follow all state and local pesticide drift requirements regarding application of copper compounds. Where states have more stringent regulations, they must be observed.

Equipment

All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers or surrogates.

For Aerial Applications

The boom length must not exceed 75% of the wingspan or 90% of the rotor blade diameter.

Release spray at the lowest height consistent with efficacy and flight safety. Do not release spray at a height greater than 10 feet above the water surface unless a greater height is required for aircraft safety.

When applications are made with a crosswind, the swath must be displaced downwind. The applicator must compensate for this displacement at the up and downwind edge of the application area by adjusting the path of the aircraft upwind.

APPLICATION AND HANDLING EQUIPMENT

Application, handling or storage equipment MUST consist of fiberglass, PVC, polypropylene, viton, corrosion resistant plastics or stainless steel. Never use mild steel, nylon, brass or copper around EarthTec. Always rinse and clean equipment thoroughly each night with plenty of fresh, clean water.

PESTICIDE STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

PESTICIDE STORAGE: Store in a safe place away from pets and keep out of the reach of children. Store away from excessive heat. EarthTec will freeze. Always store EarthTec above 32 degrees F (Do Not Freeze). Freezing may cause product separation.

Always keep container closed. Keep away from galvanized pipe, and any nylon storage or handling equipment.

DISPOSAL

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess EarthTec mixture or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your state pesticide or environmental control agency, or the hazardous waste representative at the nearest EPA regional office for guidance. In the event of spill, neutralize with limestone or baking soda before disposal. May deteriorate concrete.

CONTAINER HANDLING:

Containers with capacities less than 5 gallons:
Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure 2 more times. Offer for recycling if available. If recycling is not available, puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Containers with capacities greater than 5 gallons:
Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least 1 complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure 2 more times. Offer for recycling if available. If recycling is not available, puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Containers too large to shake:
Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure 2 more times. Offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Tanker trucks:
Emptied container retains vapor and product residue. Observe all precautions stated on this label until the container is cleaned, reconditioned or destroyed. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, and worn-out threads and closures. Clean thoroughly before reuse for transportation of a material of different composition or before retiring this transport vehicle from service.

NSF®

Certified to NSF/ANSI 60

IMPORTANT
READ BEFORE USING
LIMITED WARRANTY AND LIMITATION OF REMEDIES

Read the entire Directions for Use, Limited Warranty and Limitation of Remedies (including limitations on liability) before using this product. If terms are not acceptable, return the unopened product container at once. By using this product, user or buyer accepts the following conditions, disclaimer of warranties and limitations of liability.

The Directions for Use of this product are believed to be adequate and must be followed carefully. However, it is impossible to eliminate all risks associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Earth Science Laboratories, Inc. To the extent consistent with applicable law, all such risks shall be assumed by the user or buyer.

To the extent consistent with applicable law, seller warrants that the product conforms to the chemical description and is reasonably fit for the purpose stated on the label for use under normal conditions, but makes no other warranties of FITNESS OR MERCHANTABILITY expressed or implied, or any other warranty if the product is used contrary to the label instructions, or under conditions not foreseeable to the seller. To the extent consistent with applicable law, the seller shall not be liable for more than the cost of this product to the buyer and will in no event be liable for any consequential, special or indirect damages connected with the use or handling of this product. This product is offered and the buyer or user accepts it subject to the foregoing terms which may not be varied. Seller makes no warranty for product which has been frozen.

Manufactured by:

Earth Science Laboratories, Inc.
113 SE 22nd Street, Suite 1
Bentonville, AR 72712
Phone: 800-257-9283

CLL 20150724 AMEND

Health	3
Fire	0
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Potassium sulfate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Potassium sulfate

Catalog Codes: SLP5365, SLP1528

CAS#: 7778-80-5

RTECS: TT5900000

TSCA: TSCA 8(b) inventory: Potassium sulfate

CI#: Not available.

Synonym:

Chemical Name: Not available.

Chemical Formula: K2SO4

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Potassium sulfate	7778-80-5	100

Toxicological Data on Ingredients: Potassium sulfate: ORAL (LD50): Acute: 6600 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact:
After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. Cover the irritated skin with an emollient. If irritation persists, seek medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation: Not available.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes

Storage:
No specific storage is required. Use shelves or cabinets sturdy enough to bear the weight of the chemicals. Be sure that it is not necessary to strain to reach materials, and that shelves are not overloaded.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.

Odor: Not available.

Taste: Not available.

Molecular Weight: 174.26 g/mole

Color: Not available.

pH (1% soln/water): Not available.

Boiling Point: 1689°C (3072.2°F)

Melting Point: 1067°C (1952.6°F)

Critical Temperature: Not available.

Specific Gravity: 2.66 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Partially soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Not available.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Eye contact. Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 6600 mg/kg [Rat].

Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes.

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Potassium sulfate

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC): R36/38- Irritating to eyes and skin.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:24 PM

Last Updated: 05/21/2013 12:00 PM

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MATERIAL SAFETY DATA SHEET
Muriate of Potash

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	Muriate of Potash (MOP), all grades
Chemical Name:	Potassium Chloride
Chemical Family:	Inorganic Salt
Synonyms:	Potash; MOP; Potassium Chloride; Potassium Muriate; Potassium Monochloride
Chemical Formula:	KCl
Primary Use:	Crop nutrient; Industrial applications
Responsible Party:	Mosaic USA 100 South Saunders Road, Suite 300 Lake Forest, Illinois 60045
Non-Emergency Technical Contact:	8:00am – 4:00pm Central Time, Mon – Fri: 800-323-5523 or 847-739-1200

EMERGENCY OVERVIEW

24 Hour Emergency Telephone Number:
For Chemical Emergencies:
Spill, Leak, Fire or Accident
Call CHEMTREC
North America: (800)424-9300
Others: (703)527-3887 (collect)

Health Hazards:	Avoid contact with eyes, skin and clothing. Wash thoroughly after handling. Potassium chloride is generally recognized as safe (GRAS) when used in accordance with good manufacturing practice.
Physical Hazards:	None expected
Physical Form:	Solid
Appearance:	White to reddish-brown, crystalline or granular
Odor:	None

NFPA HAZARD CLASS		**HMIS HAZARD CLASS**	
Health:	1 (Slight)	Health:	1 (Slight)
Flammability:	0 (Least)	Flammability:	0 (Least)
Instability:	0 (Least)	Physical Hazard:	0 (Least)
Special Hazard:	None		

Status: Revised MSDS	**Issue Date: November 10, 2004**
Revised Sections: 1	**MSDS Number: MOS002**

2. COMPOSITION/INFORMATION ON INGREDIENTS

Component	% Weight	Exposure Guideline		
		Limits	Agency	Type
Potassium Chloride CAS No. 7447-40-7	95 – 99.5	NE	OSHA ACGIH	All All
Sodium Chloride CAS No. 7647-14-5	0.3 – 3.7	NE	OSHA ACGIH	All All
Calcium and Magnesium Chlorides and Sulfates CAS No. Various	0.2 – 1.3	NE	OSHA ACGIH	All All

NE = Not established, but the following particulate limits apply to all inert inorganic dusts.

Particulates Not Otherwise Classified (PNOC)	10 mg/m^3 3 mg/m^3	ACGIH	TWA – Inhalable TWA - Respirable
Particulates Not Otherwise Regulated (PNOR)	15 mg/m3 5 mg/m3	OSHA	TWA – Total Dust TWA - Respirable

Notes:

State, local or other agencies or advisory groups may have published more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

3. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS	
Eye:	Contact may cause mild eye irritation including stinging, watering and redness.
Skin:	Contact may cause mild irritation including redness and a burning sensation. No information available on skin absorption.
Inhalation (Breathing):	No information available.
Ingestion (Swallowing):	Low to moderate degree of toxicity by ingestion.
Signs and Symptoms:	Effects of overexposure may include irritation of the nose, throat and digestive tract, nausea, vomiting, diarrhea, abdominal cramping, irregular heartbeats (arrhythmias), dehydration, and hypertension. Repeated overexposure to dusts may result in irritation of the respiratory tract, coughing and shortness of breath.
Cancer:	Inadequate data available to evaluate the cancer hazard of this material.
Target Organs:	No data available.
Developmental:	Inadequate data available for this material.
Other Comments:	None
Pre-Existing Medical Conditions:	Conditions aggravated by exposure may include kidney disorders and high blood pressure (hypertension)..

4. FIRST AID MEASURES

Eye:	If irritation or redness develops, move victim away from exposure and into fresh air. Flush eyes with clean water. If symptoms persist, seek medical attention.
Skin:	Clense affected area(s) thoroughly by washing with mild soap and water. If irritation or redness develops and persists, seek medical attention.
Inhalation (Breathing):	If respiratory symptoms develop, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.
Ingestion (Swallowing):	If large amounts are swallowed, seek emergency medical attention. If victim is drowsy or unconscious and vomiting, place on left side with the head down and do not give anything by mouth. If victim is conscious and alert and ingestion occurred within the last hour, vomiting should be induced for ingestion of large amounts (more than 5 ounces or a little more than ½ cup in an adult) preferably under direction from a physician or poison center. If possible, do not leave victim unattended and observe closely for adequacy of breathing.
Note to Physicians:	No information found.

5. FIRE FIGHTING MEASURES

Flammable Properties:	**This product is non-flammable.** Flash Point— Not applicable OSHA Flammability Class— Not applicable LEL/UEL— Not applicable Autoignition Temperature— Not applicable
Unusual Fire & Explosion Hazards:	No unusual fire or explosion hazards are expected. When this material is subjected to high temperatures, it may release small amounts of chloride gas.
Extinguishing Media:	Use extinguishing agent suitable for type of surrounding fire.
Fire Fighting Instructions:	Positive pressure, self-contained breathing apparatus is required for all fire fighting activities involving hazardous materials. Full structural fire fighting (bunker) gear is the minimum acceptable attire. The need for proximity, entry, flashover and/or special chemical protective clothing (see Section 8) needs to be determined for each incident by a competent fire fighting safety professional. Water used for fire suppression and cooling may become contaminated. Discharge to sewer system(s) or the environment may be restricted, requiring containment and proper disposal of water (see Section 6).

6. ACCIDENTAL RELEASE MEASURES

Muriate of Potash is a crop nutrient and plant food, however, large spills can harm or kill vegetation.

- Stay upwind and away from spill (dust hazard).
- Wear appropriate protective equipment including respiratory protection as conditions warrant (see Section 8).
- Prevent spilled material from entering sewers, storm drains, other unauthorized treatment drainage systems, and natural waterways.
- Notify appropriate federal, state, and local agencies as may be required (see Section 13).
- Minimize dust generation.
- Sweep up and package appropriately for disposal.

7. HANDLING AND STORAGE

Handling:	The use of appropriate respiratory protection is advised when concentrations exceed any established exposure limits (see Sections 2 and 8). Wash thoroughly after handling. Wash contaminated clothing. Use good personal hygiene practice.
Storage:	Keep container(s) tightly closed. When possible use and store this material in cool, dry, well ventilated areas. Store only in approved containers. Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:	If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits (see Section 2), additional ventilation or exhaust systems may be required.

Personal Protective Equipment (PPE)	
Respiratory:	A NIOSH approved air purifying respirator with a type 95 (R or P) particulate filter may be used under conditions where airborne concentrations are expected to exceed exposure limits (see Section 2). Protection provided by air purifying respirators is limited (see manufacturer's respirator selection guide). Use a positive pressure air supplied respirator if there is potential for uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection. A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed if workplace conditions warrant a respirator.

Personal Protective Equipment (PPE)	
Skin:	The use of cloth or leather work gloves is advised to prevent skin contact, possible irritation and absorption (see glove manufacturer literature for information on permeability).
Eye/Face:	Approved eye protection to safeguard against potential eye contact, irritation, or injury is recommended. Depending on conditions of use, a face shield may be necessary.
Other PPE:	A source of clean water should be available in the work area for flushing eyes and skin. Impervious clothing should be worn as needed.

9. PHYSICAL AND CHEMICAL PROPERTIES

Note: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1 atm).

Flash Point:	Not applicable
Flammable/ Explosive Limits (%):	LEL/UEL— Not applicable
Autoignition Temperature:	Not applicable
Appearance:	White to reddish-brown, crystalline or granular
Physical State:	Solid
Odor/Taste:	None / Strong saline
Molecular Weight of Pure Material:	KCl – 74.6; NaCl – 58.5
pH:	5.4 – 10.0 in a 5% solution
Vapor Pressure (mm Hg):	Approximately zero
Vapor Density (air=1):	2.57
Boiling Point:	Sublimes at 1,500°C (2,732°F)
Freezing/Melting Point:	772 to 776°C (1423 to 1428°F)
Solubility in Water:	99.5 – 99.999%; 34.2 g/100mL at 20°C
Specific Gravity:	1.986 – 1.990
Volatility:	No data available
Bulk Density:	Loose – 64 to 75 lbs/ft^3 (1025 to 1200 kg/m^3)

10. STABILITY AND REACTIVITY

Chemical Stability:	Stable under normal conditions of storage and handling. Material is hygroscopic (May absorb moisture from air when relative humidity > 72%).
Conditions to Avoid:	None known
Incompatible Materials:	Avoid contact with hot nitric acid, may cause evolution of toxic nitrosyl chloride. Contact with other strong acids may produce irritating hydrogen chloride gas. KCl may react violently with bromine trifluoride and may explode if mixed with potassium permanganate and sulfuric acid. NaCl can react with most noble metals, such as iron or steel, building materials (such as cement), bromine, or trifluoride. A potentially explosive reaction may occur if NaCl is mixed with dichloromaleic anhydride and urea. Electrolysis of mixtures containing NaCl and nitrogen compounds may form explosive nitrogen trichloride.
Corrosivity:	Similar to salt. Mildly corrosive to metals in the presence of moisture.
Hazardous Decomposition Products:	None known
Hazardous Polymerization:	Will not occur

11. TOXICOLOGICAL INFORMATION

Potassium Chloride:	LD50 (rat, oral) = 2.6 g/kg LD50 (mouse, oral) = 1.5 g/kg LC50: no information available Eye (rabbit): 500 mg/24 H, mild irritant Inadequate carcinogenicity, mutagenicity, or developmental toxicity data located for potassium chloride. No target organ data located for potassium chloride
Sodium Chloride:	LD50 (rat, oral) = 3 g/kg; LD50 (mouse, oral) = 4 g/kg LC50 (rat) > 42 g/m^3 / 1hour Eye (rabbit): 100 mg/24 hour, moderate irritant Eye (rabbit): 500 mg/24 hour, mild irritant Inadequate carcinogenicity, mutagenicity, or developmental toxicity data located for sodium chloride. No target organ data located for sodium chloride

12. ECOLOGICAL INFORMATION

Ecotoxicity:	Dissolution of large quantities of potassium chloride and sodium chloride in water may create an elevated level of salinity that may be harmful to fresh water aquatic species and to plants that are not salt-tolerant. **Potassium Chloride:** Lepomis macrochirus LC50 – 2010 mg/l Physa heterostropha LC50 – 940 mg/l Scenedesmus subspicatus EC50 – 2500 mg/l **Sodium Chloride**: Ceriodaphnia dubia LC50 – 280,000 – 3,540,000 ug/l Daphnia magnia LC50 – 3,114,000 – 10,000,000 ug/l Daphnia pulex EC50 – 56.40 mM Pimephales promelas LD50 – 6,020,000 – 10,000,000 ug/l
BOD and COD:	No data found

13. DISPOSAL CONSIDERATIONS

This material, if discarded as produced, is not an RCRA "listed" or "characteristic" hazardous waste. Contamination may subject it to hazardous waste regulations. Properly characterize all waste materials. Consult state and local regulations regarding the proper disposal of this material.

14. TRANSPORT INFORMATION

Hazard Class or Division:	Not listed in the hazardous materials shipping regulations (49 CFR, Table 172.101) by the U.S. Department of Transportation, or in the Transport of Dangerous Goods (TDG) regulations in Canada.

15. REGULATORY INFORMATION

FDA:	1. Potassium Chloride used as a dietary supplement in food for human consumption is generally recognized as safe (GRAS) when used in accordance with good manufacturing practice [21 CFR 182.5622]. 2. Substance added directly to human food affirmed as GRAS [21 CFR 184.1622].
CERCLA:	Not listed
RCRA 261.33:	Not listed
SARA Title III:	**SARA 302:** RQ: No; TPQ: No
	SARA 311/312: Acute: No; Chronic: No; Fire: No; Pressure: No; Reactivity: No – Exemptions at 40 CFR, Part 370 may apply for agricultural use, or quantities of less than 10,000 pounds on-site.
	SARA 313 List: No
TSCA:	8(b) Chemical Inventory: Yes; TSCA 8(d): No
Proposition 65: (CA Health & Safety Code Section 25249.5)	Warning: This product contains substances that are known to the State of California to cause cancer and/or reproductive harm.
NTP, IARC, OSHA:	This material has not been identified as a carcinogen by NTP, IARC, or OSHA.
Canada DSL:	Yes
Canada NDSL:	No
WHMIS:	Not controlled

16. OTHER INFORMATION

The information in this document is believed to be correct as of the date issued. **HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY IS EXPRESSED OR IS TO BE IMPLIED REGARDING THE ACCURACY OR COMPLETENESS OF THIS INFORMATION, THE RESULTS TO BE OBTAINED FROM THE USE OF THIS INFORMATION OR THE PRODUCT, THE SAFETY OF THIS PRODUCT, OR THE HAZARDS RELATED TO ITS USE.** This information and product are furnished on the condition that the person receiving them shall make his own determination as to suitability of the product for his particular purpose and on the condition that he assume the risk of his use thereof.

Status: Revised MSDS	**Issue Date: November 10, 2004**
Revised Sections: 1	**MSDS Number: MOS002**

Material Safety Data Sheet
Potassium Hydroxide

ACC# 19431

Section 1 - Chemical Product and Company Identification

MSDS Name: Potassium Hydroxide
Catalog Numbers: S71978, S71979, S71979-1, S71979-2, P246-3, P250-1, P250-10, P250-3, P250-50, P250-500, P250-50LC, P251-3, P251-50, P251-500, P251-50KG, P25812, P258212, P25850, P25850LC, PFP25050LC, S71977, S72221D
Synonyms: Caustic potash, Lye, Potassium hydrate
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
1310-58-3	Potassium hydroxide (KOH)	100.0	215-181-3

Hazard Symbols: C
Risk Phrases: 22 35

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: white or yellow. **Danger!** Corrosive. Water-Reactive. Harmful if swallowed. Causes severe eye and skin burns. Causes severe digestive and respiratory tract burns.
Target Organs: None.

Potential Health Effects
Eye: Causes severe eye burns. May cause irreversible eye injury. Contact may cause ulceration of the conjunctiva and cornea. Eye damage may be delayed.
Skin: Causes skin burns. May cause deep, penetrating ulcers of the skin.
Ingestion: Harmful if swallowed. May cause circulatory system failure. May cause perforation of the digestive tract. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.
Inhalation: Harmful if inhaled. Irritation may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.

Chronic: Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately.
Skin: Get medical aid immediately. Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Discard contaminated clothing in a manner which limits further exposure.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure to fresh air immediately. If breathing is difficult, give oxygen. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Use water with caution and in flooding amounts. Contact with moisture or water may generate sufficient heat to ignite nearby combustible materials.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam.

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Use with adequate ventilation. Do not allow water to get into the container because of violent reaction. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale.
Storage: Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids. Keep away from water. Keep away from metals. Keep away from flammable liquids. Keep away from organic halogens.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate general or local exhaust ventilation to keep airborne

concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Potassium hydroxide (KOH)	C 2 mg/m3	none listed	none listed

OSHA Vacated PELs: Potassium hydroxide (KOH): C 2 mg/m3
Personal Protective Equipment
Eyes: Wear safety glasses and chemical goggles or face shield if handling liquids.
Skin: Wear appropriate gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance: white or yellow
Odor: odorless
pH: 13.5 (0.1M solution)
Vapor Pressure: Not available.
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 2408 deg F
Freezing/Melting Point:680 deg F
Autoignition Temperature: Not applicable.
Flash Point: Not applicable.
Decomposition Temperature: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 0; Reactivity: 1
Explosion Limits, Lower: Not available.
Upper: Not available.
Solubility: Soluble in water
Specific Gravity/Density:2.04
Molecular Formula:KOH
Molecular Weight:56.1047

Section 10 - Stability and Reactivity

Chemical Stability: Stable. Readily absorbs carbon dioxide and moisture from the air and deliquesces.
Conditions to Avoid: Incompatible materials, moisture, contact with water, acids, metals.
Incompatibilities with Other Materials: Generates large amounts of heat when in contact with water and may steam and splatter. Reacts with chlorine dioxide, nitrobenzene, nitromethane, nitrogen trichloride, peroxidized tetrahydrofuran, 2,4,6-trinitrotoluene, bromoform+ crown ethers, acids alcohols, sugars, germanium cyclopentadiene, maleic dicarbide. Corrosive to metals such as aluminum, tin, and zinc to cause formation of flammable hydrogen gas.
Hazardous Decomposition Products: Oxides of potassium.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 1310-58-3: TT2100000
LD50/LC50:
CAS# 1310-58-3:
Draize test, rabbit, skin: 50 mg/24H Severe;
Oral, rat: LD50 = 273 mg/kg;
Carcinogenicity:
CAS# 1310-58-3: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: No data available.
Teratogenicity: No information reported.
Reproductive Effects: No data available.
Neurotoxicity: No data available.
Mutagenicity: No data available.
Other Studies: No data available.

Section 12 - Ecological Information

Ecotoxicity: Fish: Mosquito Fish: LC50 = 80.0 mg/L; 24 Hr.; Unspecified No data available.
Environmental: No information found.
Physical: No information found.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	POTASSIUM HYDROXIDE, SOLID				POTASSIUM HYDROXIDE
Hazard Class:	8				8(9.2)
UN Number:	UN1813				UN1813
Packing Group:	II				II

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 1310-58-3 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA

Section 302 (RQ)
CAS# 1310-58-3: final RQ = 1000 pounds (454 kg)
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 1310-58-3: acute, reactive.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants. This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 1310-58-3 is listed as a Hazardous Substance under the CWA. None of the chemicals in this product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 1310-58-3 can be found on the following state right to know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
C
Risk Phrases:
R 22 Harmful if swallowed.
R 35 Causes severe burns.

Safety Phrases:
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)
CAS# 1310-58-3: 1
Canada
CAS# 1310-58-3 is listed on Canada's DSL List. CAS# 1310-58-3 is listed on Canada's DSL List.
This product has a WHMIS classification of D1B, E.

CAS# 1310-58-3 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

CAS# 1310-58-3: OEL-AUSTRALIA:TWA 2 mg/m3 OEL-BELGIUM:STEL 2 mg/m3 OEL-DENMARK:TWA 2 mg/m3 OEL-FINLAND:TWA 2 mg/m3 OEL-FRANCE:STEL 2 mg/m3 OEL-JAPAN:STEL 2 mg/m3 OEL-THE NETHERLANDS:TWA 2 mg/m3 OEL-SWITZERLAND:TWA 2 mg/m3 OEL-UNITED KINGDOM:TWA 2 mg/m3;STEL 2 mg/m3 OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

Section 16 - Additional Information

MSDS Creation Date: 6/21/1999

Revision #3 Date: 10/06/2000

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

Appendix C

Corps Proposed Draft Site-Specific Request for Incidental Take