United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon Fish and Wildlife Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266
Phone: (503) 231-6179 FAX: (503) 231-6195

Reply To: 8330.F0047(09)
File Name: CREP BO 2009_final.doc
TS Number: 09-314
TAILS: 13420-2009-F-0047
Doc Type: Final

Don Howard, Acting State Executive Director
U.S. Department of Agriculture
Farm Service Agency, Oregon State Office
7620 SW Mohawk St.
Tualatin, OR 97062-8121

Dear Mr. Howard,

This letter transmits the U.S. Fish and Wildlife Service's (Service) Biological and Conference Opinion (BO) and includes our written concurrence based on our review of the proposed Oregon Conservation Reserve Enhancement Program (CREP) to be administered by the Farm Service Agency (FSA) throughout the State of Oregon, and its effects on Federally-listed species in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your November 24, 2008 request for informal and formal consultation with the Service, and associated Program Biological Assessment for the Oregon Conservation Reserve Enhancement Program (BA), were received on November 24, 2008. We received your letter providing a 90-day extension on March 26, 2009 based on the scope and complexity of the program and the related species that are covered, which we appreciated. This Concurrence and BO covers a period of approximately 10 years, from the date of issuance through December 31, 2019. The BA also includes species that fall within the jurisdiction of the National Oceanic and Atmospheric Administration's Fisheries Service (NOAA Fisheries Service). FSA is consulting separately with the NOAA Fisheries Service concerning listed anadromous fish species and their designated critical habitats.

FSA has requested informal consultation with the Service on Columbian white-tailed deer (*Odocoileus virginianus leucurus*), Applegate's milk-vetch (*Astragalus applegatei*), Gentner mission-bells (*Fritillaria gentneri*), Howellia *(Howellia aquatilis*), Western lily (*Lilium occidentale*), Large-flowered wooly meadowfoam (*Limnanthes floccosa* ssp. *grandiflora*), Cook's lomatium (*Lomatium cookie*), MacFarlane's four o'clock (*Mirabilis macfarlanei*), Rough popcorn flower (*Plagiobothrys hirtus*), Spalding's campion (*Silene spaldingii*), Howell's spectacular thelypody (*Thelypodium howellii* ssp. *spectabilis*) and vernal pool fairy shrimp (*Branchinecta lynchi*) and its designated critical habitat. Formal consultation with the Service has been requested on Fender's blue butterfly (*Icaricia icarioides fenderi*), Golden Indian paintbrush (*Castilleja levisecta*), Bradshaw's lomatium (*Lomatium bradshawii*), Nelson's checker-mallow (*Sidalcea nelsoniana*), Willamette daisy (*Erigeron decumbens* var. *decumbens*), Kincaid's lupine (*Lupinus sulphureus* var. *kincaidii*), Warner sucker (*Catostomus warnerensis*), bull trout, Columbia River and Klamath River Basins (*Salvelinus confluentus*), Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), Oregon chub (*Oregonichthys crameri*), shortnose sucker (*Chasmistes brevirostris*), Lost River sucker (*Deltistes luxatus*), Modoc sucker (*Catostomus microps*) and designated critical habitat for the Fender's blue butterfly, Willamette daisy, Kincaid's lupine, Warner sucker and bull trout. Conferencing has been requested for proposed critical habitat for the shortnose and Lost River suckers, and is included for Oregon chub proposed critical habitat which became available in March 2009.

Our concurrence and BO are based on (1) information provided in the BA; (2) technical assistance and informational meetings between the Service, FSA, Oregon Department of Agriculture, Natural Resource Conservation Service and NOAA Fisheries Service regarding the CREP program and consultation issues; (3) Federal Register notices of proposed and final listing rules for species covered in this opinion and relevant approved recovery plans; (4) recent consultations completed by the Service that address similar actions and one or more of the same species (*e.g.,* Invasive Plant Project with Umatilla and Wallowa-Whitman National Forests, 2009; Fender's Blue Butterfly Programmatic Safe Harbor Agreement, 2009; Western Oregon Prairie Restoration Activities, 2008; Continued Operation and Maintenance of the Willamette River Basin Project, 2008; Programmatic Aquatic Habitat Restoration Activities in Oregon and Washington, 2007; Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, 2005; Warner Basin Environmental Quality Incentives and Conservation Security programs for irrigation system projects, 2007; (5) file materials and other sources of information. A complete administrative record of this consultation is on file at the Oregon Fish and Wildlife Office.

CONSULTATION HISTORY

On December 22, 1998, FSA submitted a Biological Assessment to initiate a programmatic-level consultation with the Service and the NOAA Fisheries Service on the Oregon CREP program. The initial Biological Assessment submitted by FSA was modified by a letter dated March 25, 1999. A BO was jointly issued by the Service and NOAA Fisheries Service on June 2, 1999 (references: NMFS Log #6112, USFWS Log #1-7-99-F-117). The Service determined that the implementation of the Oregon CREP was not likely to jeopardize any of the species nor adversely modify designated critical habitats addressed within the Service's jurisdiction in the 1999 opinion, which are shown in Table 1.

Provisions of the Oregon CREP are set forth by an agreement between the Governor of Oregon and the Secretary of Agriculture. The previous agreement, which was signed in 1998, was modified in November 2004 to expand the CREP program service area to virtually include the entire state of Oregon and to add two new practices to the program. Consequently, since the 1999 BO was issued, the programmatic changes within the CREP program, geographical program boundary changes, new species listings, species delistings, and additional critical habitat designations prompted FSA to reinitate consultation.

Table 1. Species addressed by the Service in the 1999 CREP consultation.

GROUP	SPECIES	STATUS
Fishes	Bull trout (*Salvelinus confluentus*)	T
	Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	T
	Oregon chub (*Oregonichthys crameri*)	E
	Lost River sucker (*Deltistes luxatus*)	E, PCH
	Shortnose sucker (*Chasmistes brevirostris*)	E, PCH
Birds	Aleutian Canada goose (*Branta canadensis leucopareia*)	T
	Bald eagle (*Haliaeetus leucocephalus*)	T
Mammals	Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	E
Plants	Nelson's checkermallow (*Sidalcea nelsoniana*)	T
	Bradshaw's lomatium (*Lomatium bradshawi*)	E
	Howell's spectacular thelopody (*Thelypodium howellii* ssp. *spectabilis*)	PT
	Rough popcornflower (*Plagiobothrys hirtus*)	PE
	Willamette daisy (*Erigeron decumbens* var. *decumbens*)	PE

E = Endangered, T = Threatened, PE = Proposed Endangered, PT = Proposed Threatened, PCH = Proposed Critical Habitat

FSA began discussions with the Service and NOAA Fisheries Service about the changes to the CREP program and their consultation reinitiation needs in 2004. The Service participated in on-going discussions with FSA and the other involved agencies, and both the Service and NOAA Fisheries Service assisted with the development of the current BA until it was submitted in November 2008. Activity-based and listed species-specific best management practices (BMPs) designed to reduce and minimize the potential for adverse affects on listed species and habitats were jointly developed and are included as part of the proposed action. The Service greatly appreciates the work of FSA and its partnering agencies to carry out actions that will benefit listed species, and to incorporate BMPs that will avoid or reduce unintended impacts.

CONCURRENCE

The primary purpose of the Oregon CREP is to restore agriculture lands that contain streams to improve fish and wildlife habitat and water quality. Restoration activities designed to achieve desired habitat conditions can involve unintended and sometimes unavoidable adverse effects, especially over the short-term as project activities are taking place and after construction as sites are stabilizing. Activity-based and listed species-specific BMPs have been developed as part of the action to avoid and greatly reduce the potential for adverse affects on listed species and their habitats.

Based on the proposed action and with consideration of the BMPs, as described in the BA, the Service concurs with your determination that the proposed action may affect, but is not likely to adversely affect, the following listed species and designated critical habitat: Columbian white-tailed deer (*Odocoileus virginianus leucurus*), Applegate's milk-vetch (*Astragalus applegatei*), Gentner mission-bells (*Fritillaria gentneri*), Howellia *(Howellia aquatilis*), Western lily (*Lilium occidentale*), Large-flowered wooly meadowfoam (*Limnanthes floccosa* ssp. *grandiflora*), Cook's lomatium (*Lomatium cookie*), MacFarlane's four o'clock (*Mirabilis macfarlanei*), Rough popcorn flower (*Plagiobothrys hirtus*), Spalding's campion (*Silene spaldingii*), Howell's spectacular thelypody (*Thelypodium howellii* ssp. *spectabilis*) and vernal pool fairy shrimp (*Branchinecta lynchi*) and its designated critical habitat.

Our concurrence is based upon: (1) the processes, guidance and specifications used in administering the Oregon CREP program to ensure that activities are carried out in accordance with program directives, including environmental considerations and determining if listed species may be present on CREP project sites (see sections 2.1 and 2.2 of the BA), (2) the limited scope of the proposed action, which involves the implementation of five CREP practices (*i.e.,* filter strip, riparian forest buffer, wetland restoration, marginal pastureland wildlife habitat buffer, and marginal pastureland wetland buffer) that are specifically designed to improve fish and wildlife habitat and water quality on agricultural lands that have been impacted by past land uses, and (3) the activity-based and species-specific BMPs included in the proposed action, described in more detail below for the species addressed in this section, that are specifically designed to avoid and minimize potential adverse affects to listed species and habitats.

Columbian white-tailed deer

It is unlikely that CREP project activities will exceed current noise and activity levels on CREP project areas that may support Columbian white-tailed deer, and a BMP is in place to ensure that noise and activity levels do not rise above ambient conditions in fawning areas from June 1 to July 15. Project personnel will be instructed to reduce vehicle speed around project sites where deer occur, especially during times of limited visibility (*e.g.,* sunset to sunrise) to avoid vehicle-deer collisions. They will also be instructed not to approach adults or fawns at any time in order to avoid disturbance to the deer.

Vegetation that could be used for cover and forage by deer may be temporarily reduced as invasive species are removed, but less desirable species that are removed will be replaced by native grasses, forbs, shrubs and trees, which are expected to provide more valuable habitat for the deer. Any fencing that is installed in Columbian white-tailed deer habitat will meet a height restriction so deer will be able to move throughout the area. The use of manual and mechanical methods to control competitive vegetation around newly planted trees is encouraged to reduce the need for herbicides. Any herbicide that is used in deer habitat is restricted to certain herbicides and application rates that were found in the herbicide analyses to be below both the acute and chronic “No Observable Adverse Effect Levels” for large herbivorous mammals (see section 4.3.1.1 in the BA for a full discussion of the effects of herbicide applications to terrestrial wildlife).

We concur that CREP activities that occur in Columbian white-tailed deer habitat are likely to benefit the deer over time by restoring native vegetation and increasing the quality and quantity of available forage and cover.

Listed plants
BMPs have been developed to avoid and minimize the risk of disturbing areas where listed plants may occur. Disking, tillage, fence building, and construction of livestock watering facilities, will not take place in locations that could cause physical harm to listed plants. In addition, areas with the listed plant species included in this section will not be mowed, and vehicles and machinery will not be driven on areas where the plants occur. To avoid shading out shade-intolerant listed species, technical staff will recommend species for planting that will maintain or restore habitat conditions needed to support listed plants that occur on the project sites. Plants used in revegetation efforts will be selected based on soil type and plant community type and will not grow tall enough to shade out listed shade-intolerant species that occur on site. Therefore, shading is not likely to adversely affect listed plants.

BMPs have been developed that avoid and minimize the risks to listed plants that are associated with herbicide use. The BMPs specify and limit the types of herbicides that can be used, application methods, weather conditions required when spraying occurs, and distances that must be maintained between herbicide use and listed plants. Limitations on the herbicide use areas and application methods were developed with consideration of the potential for herbicide movement, mode of uptake by plants, herbicide half-lives, and the types of plants affected by each herbicide to prevent listed plants from being exposed to herbicides that would put them at risk. In addition, the BMPs require that listed plants be physically shielded or that application buffers be maintained between sprayed areas and listed plants to greatly minimize the potential for listed plants to come into contact with herbicides that could harm them. See the "Herbicide-related BMPs for Listed Plants" in section 2.5.6 of the BA for a complete listing of relevant BMPs.

All applicable project BMPs listed in section 2.4 of the BA will be followed, as well as those listed in section 2.5.6 of the BA that are specifically related to plants. Some CREP projects may be specifically designed to benefit threatened and endangered plants over the long-term.

Vernal pool fairy shrimp
Several BMPs have been developed to prevent or minimize potential impacts to the vernal pool fairy shrimp and its critical habitat, and most potentially disturbing activities will be avoided altogether. CREP actions will not occur directly within the vernal pool habitats themselves where vernal pool fairy shrimp may occur. Herbicides will not be applied on project areas that may support the vernal pool fairy shrimp. Activities that could cause the excess movement of soils that could be deposited into vernal pools, disturbances from vehicular or foot traffic or disruption of the impermeable subsurface soil layer needed to maintain vernal pool habitats that support the fairy shrimp are not allowed per the BMPs.

The BMPs listed in section 2.4 of the BA will be followed, as well as those listed in section 2.5.4 that are specifically related to vernal pool fairy shrimp. CREP projects may benefit the shrimp in the long-term. For instance, installing fencing to eliminate livestock traffic in vernal pools could improve water quality in vernal pools, potentially benefiting the shrimp and its critical habitat. In addition, vernal pools created through wetland restoration projects may create additional habitat for the fairy shrimp, thus benefiting the species.

CONCLUSION

In closing, we again want to express our appreciation for the efforts of FSA and its CREP partners to improve fish and wildlife habitat and support recovery actions for listed and at-risk species throughout the State of Oregon. Please do not hesitate to contact Jennifer Thompson of my staff at (503) 231-6179 if you have any questions or concerns about this consultation.

Sincerely,

Paul Henson, Ph.D.
State Supervisor

Enclosure

PROGRAMMATIC
BIOLOGICAL AND CONFERENCE OPINIONS
on the
OREGON CONSERVATION RESERVE ENHANCEMENT PROGRAM

U.S. Department of Agriculture
Farm Service Agency
Oregon State Office

8330.F0047(09)
TS Number: 09-314
TAILS Number: 13420-2009-F-0047

Prepared by:
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Portland, Oregon

Approved by: ___________________________________
Paul Henson, Ph.D.
State Supervisor

Date: ___________________________

BIOLOGICAL AND CONFERENCE OPINIONS

TABLE OF CONTENTS

FIGURES

TABLES

1. DESCRIPTION OF THE PROPOSED ACTION

1.1. Action Area

CREP projects may take place on up to 100,000 acres of private agricultural lands (*i.e.,* pastureland and cropland) throughout Oregon during the life of the agreement between the State of Oregon and U.S. Department of Agriculture, which does not have a specified duration. To date, approximately 35,000 acres have been enrolled, leaving 65,000 acres that can be enrolled over time before the CREP cap of 100,000 acres is reached (L. Loop, pers. comm. 2009). This BO covers a period of approximately 10 years, from the date of issuance through December 31, 2019.

CREP projects will primarily occur in riparian areas, along with some wetlands and upland habitats. Wetlands and uplands enrolled in CREP will generally be associated with streams and rivers. Some supporting actions, such as spring developments, may take place in upland areas or springs. In general, habitats eligible to be enrolled in CREP have been significantly modified so they are no longer providing all of the functions that benefit fish and wildlife and water quality. Eligible lands are as follows:

- Land must have been cropped two of the last five years or be pasture that can be planted to a riparian buffer.
- Land must be along a stream where threatened or endangered salmonids, sucker, chub, or dace are present or were historically present (excludes lands above permanent barriers to fish passage); be along a stream within an area with an Agricultural Water Quality Management Area Plans; or be along a stream on reservation or tribal trust land (combined, these criteria virtually account for all of Oregon).
- The riparian area must be in poor condition. For example, the riparian area could be cropped to the water's edge, or could have small patches of vegetation interspersed with bare, heavily grazed ground.
- To receive the irrigated rental rate, land must have been irrigated for two of the last five years, and landowners must lease their water right to the Oregon Water Resources Department for the length of their CREP contract (generally 10 to 15 years).

On grazed lands, impacts from livestock use are often concentrated in riparian areas, since animals are drawn to these areas for forage and water. Concentrated livestock use of riparian areas, if improperly managed, eliminates riparian vegetation, prevents vegetation from reestablishing, and causes streambank erosion. Bank trampling and livestock activity in streams have increased sediment and manure runoff to streams, impacting aquatic life. On cropland, removal of riparian vegetation and cropping in the riparian area has reduced shade, prevented streamside vegetation from reestablishing, and caused streambank erosion. In addition, cleaning out or straightening streams along cropland or pastureland has reduced the amount and quality of instream and riparian habitat available for fish and wildlife.

The average size of a riparian buffer contract in Oregon is 28 acres. Assuming that the average width of these buffers is 100 feet, each contract provides stream buffering along 2.31 stream miles. The Oregon CREP includes incentives that encourage more projects to be concentrated together, rather than having scattered participation by individual landowners, in order to increase program effectiveness in achieving the desired water quality and habitat benefits. This is done by offering cumulative impact incentive payments to landowners in any case where a total of at least 50% of the streambank within a 5-mile stream segment is enrolled.

Listed species that occur within the action area and that are included in this programmatic consultation are shown in Table 1.

Table 1. **Species addressed by the Service in the current programmatic CREP consultation.**

GROUP	SPECIES	STATUS
Inland Fish	Bull trout (*Salvelinus confluentus*)	T, CH
	Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	T
	Lost River sucker (*Deltistes luxatus*)	E, PCH
	Modoc sucker (*Catostomus microps*)	E, CH
	Oregon chub (*Oregonichthys crameri*)	E, PCH
	Shortnose sucker (*Chasmistes brevirostris*)	E, PCH
	Warner sucker (*Catostomus warnerensis*)	T, CH
Plants	Bradshaw's lomatium (*Lomatium bradshawi*)	E
	Golden Indian paintbrush (*Castilleja levisecta*)	T
	Kincaid's lupine (*Lupinus sulphureus* var. *kincaidii*)	T, CH
	Nelson's checkermallow (*Sidalcea nelsoniana*)	T
	Willamette daisy (*Erigeron decumbens* var. *decumbens*)	E, CH
Invertebrates	Fender's blue butterfly (*Icaricia icarioides fenderi*)	E, CH

E = Endangered, T = Threatened, CH = Critical Habitat, PCH = Proposed Critical Habitat

The following are the annual enrollment targets for the various geographic regions within Oregon:

Coastal Basins

- 1,250 acres of riparian forest buffer
- 1,000 acres of restored wetland
- 2,250 total acres (180 total stream miles) of riparian forest, wetland, and wildlife buffers.

Columbia Basin

- 8,000 acres of riparian forest buffer and filter strips
- 1,000 acres of restored wetland
- 9,000 total acres (700 stream miles) of riparian forest, wetland, and wildlife buffers.

Interior Drainages

- 3,500 acres of riparian forest buffer and filter strips
- 1,000 acres of restored wetland
- 4,500 total acres (375 stream miles) of riparian forest, wetland, and wildlife buffers

The above figures are CREP program goals set by FSA and the Oregon Watershed Enhancement Board rather than mandated minimums, maximums, or relative proportions of projects by geographic region (L. Loop, pers. comm. 2009). From the time the CREP program became available in 1999 through January 2008, 32,650 acres have been enrolled in Oregon. CREP plantings have restored riparian vegetation along over 1,150 miles of stream. Based on the average enrollment during the first 9 years of CREP, FSA anticipates 704 more projects covering 18,000 additional acres throughout Oregon during the next five years (FSA 2008). Recent enrollments have averaged approximately 3,600 acres a year, ranging from around 3,000 to 5,000 acres per year (L. Loop, pers. comm. 2009). The actual number will depend on landowner interest and the availability of funding and technical staff to work with landowners to enroll in the project and complete practices. Landowner interest and enrollment in Oregon continues to increase (FSA 2008).

1.2. Oregon CREP Conservation Practices

The purpose of the Oregon CREP is to enroll and restore agricultural lands along streams, rivers and other waterbodies to improve fish and wildlife habitat and water quality. Participants may enroll land to be restored under one of the following Conservation Practices (CPs) eligible through the Oregon CREP: filter strips (CP21), riparian forest buffer (CP22), wetland restoration (CP23), marginal pastureland wildlife habitat buffer (CP29), and marginal pastureland wetland buffer (CP30). To complete any of the CPs, a landowner and his or her contractor(s) must complete practice **components**, which involve one or more of the following: tree and shrub planting, invasive species removal (including manual, mechanical or chemical treatments), seeding, fence installation, the installation of livestock and wildlife watering facilities, wetland restoration, livestock crossings and upland wildlife habitat management. More detailed descriptions are provided below. Some additional activities were mentioned in Appendix A of the BA (*e.g.,* breaching dikes/levies, dike setbacks, animal trapping and animal removal of invasive species), but are not typically funded through the CREP and are not included according to the BA. Therefore, unless activities were specifically discussed in the main body of the BA as part of the action, they have not been included in this BO and will need to be addressed through separate consultations as appropriate if activities arise that have not been covered.

1.2.1. Tree and Shrub Planting

Both the riparian forest buffer and wetland restoration practice may involve tree and shrub establishment. The Natural Resource Conservation Service (NRCS) Field Office Technical Guide (FOTG) has three sets of standards and specifications that apply to this component (Practice code 391A, Riparian Forest Buffer; Practice code 612; Tree and Shrub Establishment; Practice code 490, Forest Site Preparation). The ODF either prepares or reviews site preparation and tree planting plans. NRCS and SWCD technical staff recommend shrub, grass and forb species.

The landowner or contractor may complete several site preparation activities prior to planting, depending on the condition of the site. These activities include the following.

- Disking – using a tractor and disk attachment to eliminate competing vegetation in the planting area.

- Ripping – using a tractor and attachment with 3 to 4-foot deep shanks to break up compacted soil layers, increase infiltration of water, and allow tree roots to grow deeper into the soil.
- Herbicide application – applying herbicide to reduce competition with new plantings (this activity is described in more detail in section 1.2.2).
- Mechanical and manual clearing – using equipment or hand tools to clear a field of heavy weeds or to clear circles around spots where trees will be planted. Depending on the site conditions, heavy equipment, small mechanical equipment, or hand tools may be used.

Once the site is prepared for planting, the landowner or contractor will either hand-plant or machine-plant trees and shrubs. For a bare-root seedling, the tree planter or planting machine create a hole for the plant, spread out the roots and fill in the hole. Stakes are usually pounded or shoved into the ground without digging. However, if the planting occurs in a very rocky site, the tree planter may use other equipment to dig holes for bareroot seedlings or stakes.

After the planting, the landowner or contractor may reduce competing vegetation to increase planting survival by manually, mechanically or chemically treating vegetation around the plantings. This activity may be done anytime during the life of the CREP contract. Landowners may also irrigate the plantings for the first three years of establishment if they have valid water rights. Pipelines may be installed using mechanical equipment or manual methods (*i.e.,* a shovel or pick) to dig trenches for the placement of pipes. Water may be delivered from a bucket, hose, water truck, handlines, pipes, sprinkler heads, spray guns or microsprinklers. The water source may be a stream, well, or water truck.

Moisture conservation measures, such as placing geo-textile fabric or mulch around plants, may be used to help ensure survival of plantings. Temporary animal control measures are sometimes used to protect the plants in areas where they may be damaged due to browsing or grazing. Tree protection may involve putting cages, netting or tubes around the plants. Repellents such as bloodmeal and human hair may also be used to keep target animals away from plants while they are becoming established.

Oregon Department of Forestry or other technical staff conduct annual site reviews, and certify the tree and shrub establishment as complete when the plants are in a "free to grow" condition. In other words, they are no longer in danger of dying because of competing vegetation.

1.2.2. Herbicide Applications

Herbicides may be used for site preparation, short-term management during the period when revegetated areas are becoming established, and site maintenance as needed during the life of the CREP contract to control invasive plants. A variety of chemicals, application equipment and application methods are proposed for addressing CREP program needs to control various invasive species of concern, with consideration of site-specific situations and factors. Herbicides proposed for use in CREP activities covered under this programmatic consultation are limited to aminopyralid, chlorsulfuron, clopyralid, dicamba, glyphosate, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, triclopyr and 2,4-D. Application equipment to be used includes hand pump sprayers, hand pump backpack sprayers, boom or boomless sprayers, and wick or wipe equipment for applications that will include basal bark treatment, patch spray, spot spray, cut surface treatment, hack and squirt, herbicide injection, ground broadcast spray, spot application with dry granule, and wick or wipe applications.

Section 2.3.2.1of the BA (incorporated by reference) includes general descriptions of each herbicide that may be used, the formulations to be used on CREP projects, and the proposed application methods and equipment. Application methods and equipment are described for use within various zones along streams, lakes and ponds. Additional BMPs and application zones that will be used to further minimize effects to listed species and their critical habitats are discussed in sections 1.3.3 and 1.4 below (based on sections 2.4.3 and 2.5 of the BA).

1.2.3. Seeding

Seeding may occur on any of the CREP conservation practices to establish wildlife habitat and provide for filtration of pollutants from runoff. Two NRCS practice codes may apply (Filter Strip; Riparian Herbaceous Cover). NRCS or SWCD staff will prepare seeding recommendations for landowners to implement this component. Seeding activities may include plowing or disking the riparian area, rolling or packing the soil, and mechanically seeding the area or hand-broadcasting seed. A no-till drill may also be used to plant the seed and lessen soil disturbance. Plugs may also be planted. Competing vegetation, including weeds, may be chemically treated before or after the seeding. The landowner must continue to control weeds on the seeding throughout the life of the CREP contract.

1.2.4. Fence Installation

Fencing may be built on any CREP practice except for wetland restoration. NRCS practice code 382 (Fence) applies to this activity. CREP participants may build either a 4-strand barbed wire or smooth-wire fence. If they wish to construct a woven-wire or other fence, they may receive cost-share only up to the cost of the 4-strand wire fence. To install the fence, participants must either hand-dig post holes or use equipment such as an auger, then string the wire. The fence must be maintained to exclude livestock from the CREP area for the life of the contract.

1.2.5 Livestock and Wildlife Watering Facilities

Livestock watering facilities may be built on any CREP practice except for wetland restoration. Wildlife watering facilities may be built on any CREP practice. Several NRCS practice codes may apply to the livestock and wildlife watering facility components (Practice Code 574, Spring Development; Practice Code 614, Trough or Tank; Practice Code 614, Watering Facility; Practice Code 648, Wildlife Watering Facility; Practice Code 441, Pipeline; Practice Code 776, Aluminum Pipe).

To construct a spring development, the landowner or contractor would manually or mechanically excavate into the spring, level the area, install a spring box, and install a pipe that feeds from the spring box to the livestock trough or tank. Vegetation may need to be cleared from around the spring. A trench is dug from the spring box to the trough and a pipe is installed in the trench to feed the trough. A fence is also constructed around the spring development to protect it from livestock trampling. Alternatively, the trough or tank may be fed from a stream or river. The landowner installs a pump with a fish screen into the stream, withdrawing water to feed the trough or tank. In some cases, machinery is used to shape a section of the bank (*i.e.,* less than 30 linear feet) as needed to install the pump and piping.

Livestock troughs are usually installed above-ground and are equipped with a float valve. Manual labor or a tractor is used to excavate and level the site. A concrete pad is then poured into a form created on-site, and the trough or tank and pump are bolted onto the concrete pad. Facilities include escape ramps to prevent wildlife from being trapped in the troughs. To prevent mud from accumulating around the trough, it is surrounded with a concrete pad, gravel, and/or geotextile fabric. No portion of these watering facilities will be constructed within any portion of the active stream channel, with the exception of pumps and pipes that may be installed to withdraw water to feed the trough or tank, as discussed above (L. Loop, pers. comm. 2009).

1.2.6. Wetland Restoration

A wetland restoration component is only conducted on the wetland restoration practice (CP 23). NRCS practice code 657 (Wetland Development or Restoration) applies to this component. The only wetland restoration projects included in this programmatic consultation are those that involve breaking drain tiles, excavating to create new shallow vernal pools, and reestablishing native wetland vegetation. To break drainage tile, small holes will be dug along drain tile pathways to break the tile, and holes will then be filled in with soil. New vernal pools may be constructed, typically in disturbed areas dominated by non-native species. To construct vernal pools, the existing vegetation would be scraped away and shallow, small pools will be constructed no more than a few inches deep. Generally, natural topography will be restored. Native vegetation would be established through tree and shrub planting or seeding.

1.2.7. Livestock Crossings

Livestock crossings may be installed on all CREP practices except wetland restorations. The NRCS practice standard for Animal Trails and Walkways (575) applies to this component. Some livestock crossings involve minimal bank shaping (*i.e.,* less than 30 linear feet), vegetation clearing, and installing rock and/or geotextile on the bank and in the stream channel to minimize erosion at the crossing site. Fencing is installed, and may be placed across the creek to keep livestock within the crossing area. These livestock crossings are included as part of the action in this consultation.

Crossings that involve culvert installation within habitat for fish species under NOAA Fisheries Service jurisdiction and that meet the NOAA Fisheries Service criteria outlined in the Standard Localized Operating Procedures for Endangered Species (SLOPES) BiOp are also included in the CREP BA. However, crossings that involve culvert or bridge installation that are outside the terms and conditions of the SLOPES BiOp, or that may affect the fish species included in this BO (*i.e.,* that fall within the Service's jurisdiction) are not included as part of the action and will require individual consultations.

1.2.8. Upland Wildlife Habitat Management

Revegetation of native plant communities may occur to enhance upland wildlife habitat. In addition, structures such as nesting platforms, snags and bird and bat boxes may be installed to benefit local wildlife. Mechanical augers may be used to dig holes to install structures, and blasting charges or chain saws may be used to create snags. In some cases, hand tools may be used to prune trees. Meadows may be maintained, created or improved by clearing or thinning trees or other vegetation using hand saws, chain saws or machetes. Light disking may be used as a strategy to promote plant species desirable to upland wildlife or promote plant species of concern. Projects involving disking in areas where listed plants or their designated critical habitats occur are not included in this consultation, and will be addressed as needed through separate consultations.

1.3. Activity-Based Best Management Practices

Activity-based and listed species-specific BMPs are included as part of the action, as described in the BA (see sections 2.4 and 2.5). The activity-based BMPs are listed below, organized by type of action. They are designed to help avoid adverse impacts to multiple taxa. Additional BMPs for specific listed species that may occur within the vicinity of CREP projects are discussed in section 1.4. In areas where BMPs may conflict, the more restrictive BMP applies.

1.3.1. General BMPs

- Technical staff will determine which listed species may occur in the area prior to completing the CREP conservation plan for a site. Surveys for listed species that may occur within the area to be affected will be conducted whenever possible; if information is not available about potential location(s) of listed species and surveys cannot be conducted for species that may occur, it will be assumed that species that may occur are present.
- Technical staff will work with landowners to plan construction and other activities to minimize or eliminate adverse effects to listed species and to follow all applicable BMPs.
- Exploring opportunities to benefit listed species and support their recovery is encouraged on CREP project sites that may provide potentially suitable habitat.
- Sediments will be removed from behind work isolation structures or stabilized before structures or erosion controls are removed.
- Existing roads or travel paths will be used to access project sites whenever possible; vehicular access ways to project sites will be planned ahead of time and will provide for minimizing impacts on riparian corridors and areas where listed species or their critical habitats may occur.
- Vehicle use and human activities, including walking in areas occupied by listed species, will be minimized to reduce damage or mortality to listed species.
- Vehicles will not enter or cross streams except in cases where no alternative exists. Where stream crossings are required, the number of crossings will be minimized. Vehicles and machinery will cross streams at right angles to the main channel whenever possible. The use of equipment in or adjacent to a stream channel will be minimized to reduce sedimentation rates and channel instability.
- Removal of native vegetation will be limited to the amount that is absolutely necessary to complete a construction activity.
- Slash materials will be gathered by hand or with light machinery to reduce soil disturbance and compaction. Avoid accumulating or spreading slash in upland draws, streams, and springs. Slash control and disposal activities must be conducted in a manner that reduces the occurrence of debris in aquatic habitats.
- Disturbed areas will be reseeded or planted with apropriate vegetation.

1.3.2. BMPs for Planting

- Vegetative planting techniques must not cause major disturbances to soils or slopes.
- Hand planting is the preferred technique for all plantings, except for filter strips.
- Planting will occur during the appropriate seasonal period for the respective plant species involved.
- Only native species will be used for CREP projects whenever feasible. Where use of native vegetation is not feasible, similar species which are functional equivalents and are known not to be aggressive colonizers may be substituted.
- All materials must be from an appropriate seed zone and certified as disease-free.
- Seeding to establish riparian buffers will use seed that is certified weed-free.

1.3.3. BMPs for Herbicide Applications

The following BMPs are in addition to the measures discussed under "Use Zones, Application Equipment, and Application Methods" for each specific herbicide in section 2.3.2. of the BA, which is hereby incorporated by reference Additional BMPs may be required where certain listed species occur, as discussed in section 1.4. In areas where BMPs may conflict, the more restrictive BMP applies.

BMPs for all herbicide applications

- All herbicide label requirements will be followed.
- Herbicides will not be applied if precipitation is likely within 24 hours unless using soil-activated herbicides, which can be applied as long as label is followed.
- When consistent with label instructions, water will be used when diluting herbicides prior to application. When oil carriers are needed, only crop oils will be used. Use of diesel oil is prohibited.
- A spill cleanup kit will be available whenever herbicides are used, transported, or stored. The cleanup kit will include, at a minimum, the herbicide Material Safety Data Sheet, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain the spill.
- Anyone that applies herbicides on a CREP project is required to provide FSA with a written herbicide application summary. The summary will indicate who applied the herbicide, what was applied, how it was applied, when it was applied, the location of the application on the project map, and the rate of application.
- All herbicide applications will be reported to the Oregon Department of Agriculture (PURS) as required by state law.
- When adjuvants are added to a herbicide formulation, Agri-dex and LI-700 will be the only adjuvants used within 200 feet of the high-water mark.

BMPs for herbicide applications along streams, lakes, and ponds

BMPs for Basal Bark herbicide applications from HWM to outer edge of project

- Dilute herbicide with a crop oil (vegetable oil). (Use of diesel oil is prohibited).
- Avoid unnecessary run off when applying herbicide to stems of undesirable vegetation.
- Apply using lowest nozzle pressure that will allow adequate stem coverage.

- Apply spray from the stream bank into the project area (applicator should have back to the stream).
- Do not apply during periods of rain, snow, or melting snow.

<u>BMPs for spot spraying or patch spraying herbicide within 15 feet of HWM:</u>

- If possible, spraying is to take place only during calm periods (no breeze), except when a temperature inversion exists. Temperature inversions may increase the likelihood of off-target drift. Read and follow all product label requirements related to temperature inversions.
- Spraying may take place <u>IF</u> there is a breeze of 6 mph or less <u>AND</u> the direction of the breeze is away from the creek or other sensitive resources.
- Allow post-application rain free period according to herbicide label requirements.
- Herbicide will be applied such that the spray is directed towards the project area away from the creek [person applying the spray will generally have their back to the creek or other sensitive resource.]
- Nozzles will be adjusted [to minimize fine particle size] such that spray does not drift off of the project site or away from the target vegetation.
- The spray nozzle will be kept within four feet of the ground when herbicide is being applied.
- To the extent possible, the spray will be directed away from all desirable vegetation.

<u>BMPs for spot spraying or patch spraying herbicide from 15 feet to outer edge of project</u>:

Same as requirements as "within 15 feet of HWM" except that herbicide can be applied with nozzle that is held up to six feet above the ground if needed to treat taller clumps of competing vegetation.

<u>BMPs for ground broadcast spraying herbicide from 15 feet out from HWM to outer limit of project boundary</u>.

- If possible, spraying is to take place only during calm periods (no breeze).
- Spraying may take place <u>IF</u> there is a breeze of 6 mph or less <u>AND</u> the breeze is blowing away from the creek or other sensitive resource.
- Allow post-application rain free period according to herbicide label requirements
- Spray will be applied in swaths <u>parallel</u> to the creek.
- Spray boom will be mounted such that nozzles are no more than four feet above the ground.
- Nozzles will be adjusted to minimize fine particle size such that spray does not drift off of project site.
- Nozzle pressure will be the adjusted to the lowest practical level (psi) while still providing for reasonable spray converge.
- Drift control agents will be used if necessary to prevent any spray from drifting off of the project site.

<u>BMPs for Cut Surface application from HWM to outer edge of project boundary.</u>

- Applications will be made in a manner that prevents herbicide runoff onto the ground.
- Do not apply herbicide during periods of rain, snow, or melting snow.

<u>BMPs for Hack & Squirt / Injection application from HWM to outer edge of project boundary.</u>

- Applications will be made in a manner that prevents herbicide runoff onto the ground.
- Do not apply herbicide during periods of heavy rainfall.

BMPs for spot application of dry granule [Pronone].
Same as "BMPs for spot or patch spraying herbicide from 15 feet to outer edge of project" with the following exception:

- Applications can be accomplished during a breeze of up to 10 mph IF the direction of the breeze is away from the creek or other sensitive resources.

1.3.4. BMPs for Chemical Effects

Please refer to section 1.3.3. for BMPs specifically related to herbicide use. Other chemicals that may be used on CREP projects are associated with mechanical equipment, vehicle or pump use. These chemicals include fuels and other fluids normally needed to operate farm equipment or other vehicles. To minimize potential impacts from these pollutants, the following BMPs will be used:

- Appropriate materials and supplies (*e.g.,* shovels, disposal containers, absorbent materials, first aid supplies, and clean water) will be available on-site to cleanup any small accidental spills in accordance with product Material Safety Data Sheets and labels. Significant hazardous spills will be reported to the Oregon Emergency Response System at 1-800-452-0311 (system available 24 hours a day). (Also see ODEQ emergency response web site at http://www.deq.state.or.us/wmc/cleanup/spl0.htm for more information.) The Oregon Poison Control Center will be contacted at 1-800-222-1222 (24 hours) for assistance in responding to emergency exposures. Project managers will ensure that each applicator is familiar with spill response procedures before commencing herbicide application operations.
- Locate staging and refueling areas at least 150 feet from any stream or other waterbody.
- Limit the size of staging and refueling areas and only store enough supplies, materials, and equipment onsite to complete the project.
- All equipment must be cleaned to remove external oil, grease, dirt, and mud before beginning operations below the high water mark of a stream.
- All equipment operated within 150 feet of an aquatic habitat must be inspected daily for fuel leaks before leaving the equipment staging area. All detected leaks must be repaired in the staging area before the equipment resumes operation.
- All stationary power equipment (*e.g.,* generators) operated within 150 feet of any aquatic habitat must be diapered to prevent leaks and/or enclosed in a containment device (*e.g.,* non permeable drip plan) of adequate capacity to retain equipment fluids (*e.g.,* gasoline, diesel fuel, and oil) if a leak occurs.

1.3.5. BMPs for Fence Installation

- Where wildlife movement is a concern, maximum fence height is 42 inches.

1.3.6. BMPs for Riparian, Instream and Streambank Work

To prevent disturbances to fish and wildlife and their habitats from riparian, instream and streambank work, the following BMPs will be used:

- Whenever possible, livestock will be excluded from streams and riparian areas altogether.

- There will be no instream work except for installation of livestock crossings and the installation of pumps and pipes for off-stream livestock watering facilities.[1]
- Oregon guidelines for the timing of in-water work will be followed for each affected stream reach, unless the Oregon Department of Fish and Wildlife (ODFW) approves an extension based on current year site-specific conditions. In reaches where the current ODFW timing restrictions for instream construction activities conflicts with the needs for resident listed fish, ODFW should be contacted for a waiver to the timing restrictions to avoid impacts to listed fish.
- Streambank shaping may be implemented where streambank stability is extremely poor or where necessary to restore riparian functions. Streambank modification for planting purposes will be thoroughly documented.
- On each CREP contract where more than 30 linear feet of streambank is shaped by mechanical equipment, USDA will consult with the Services (this consultation only covers projects that involve shaping of up to 30 linear feet of streambank).
- Bank shaping will be done from the top of bank.
- Design of all streambank modification projects will recognize the important wildlife values provided along naturally eroding outside meander curves.
- Any soil control structures will be bio-engineered to the extent possible.
- No riprap will be used under this program for streambank stabilization.
- No streambank stabilization activity will reduce natural stream functions or floodplain connection.
- Sedimentation and erosion controls will be implemented on all project sites where the implementation of restoration activities has the potential to deposit sediment into a stream or waterbody. Structures/techniques must be placed and/or anchored appropriately to prevent adverse impacts to down slope habitats. Control structures/techniques may include, but are not limited to, silt fences, straw bale structures, seeding by hand and hydro-seeding, jutte mats, and coconut logs. Grading and shaping will generally restore natural topography and hydrology.

1.3.7. BMPs for Mechanical Activities

To minimize potential impacts of mechanical activities on sensitive species and habitats, the BMPs below will be followed.

- The project boundary must be flagged to prevent soil disturbance to areas outside the site.
- Construction impacts will be confined to the minimum area necessary to complete the project.
- Filter strips will be left between disturbed areas and streams.
- To prevent the spread of noxious weeds and non-native plants, all vehicles and heavy construction equipment will be cleaned to remove mud, debris, and vegetation prior to entering the project area; all equipment must be cleaned to remove external oil, grease, dirt, and mud before beginning operations below the high water mark elevation of a stream.
- All equipment operated within 150 feet of an aquatic habitat must be inspected daily for fuel leaks before leaving the equipment staging area. All detected leaks must be repaired in the staging area before the equipment resumes operation.

[1] The BMP in the BA reads, "There will be no instream work except for installation of livestock crossings and installation of offstream livestock watering facilities." This BMP was rewritten to clarify that the only instream work associated with watering facilities involves the installation of pumps and pipes.

(See BMPs for Chemical Effects in section 1.3.4 for additional measures that apply to mechanical activities.)

1.3.8. BMPs for Livestock Watering Facilities and Spring Developments

- Whenever possible, livestock will be excluded from streams and riparian areas altogether.
- Springs will always be fenced when spring developments are constructed to provide off-stream watering for livestock.
- Watering facilities will be equipped with float valves, and protection will be used around troughs and other watering sources as needed to prevent mud and sediment delivery to streams.
- Pumps must be screened to meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.,* regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning). On CREP projects where listed suckers or Oregon chub may be affected, pumps may be installed under this BA if water delivery is under 0.5 cfs (minor volume diversions).
- All pumps must be sized to only use water amounts that fall within the allowances of the landowner's documented or estimated historic water use and legal water right(s).
- Water withdrawals for watering facilities or irrigation must not dewater habitats, or cause or exacerbate low stream flow conditions that could impact listed fish.
- Escape ramps will be installed on all livestock and wildlife watering facilities.
- Off-channel livestock watering facilities will not be located in areas where compaction and/or damage could occur to sensitive soils, slopes, or vegetation due to congregating livestock.
- Livestock stream crossings will only be constructed on the smallest streams, generally 10 feet or less in width at mean high water level. Crossings will not be placed on the mid- to downstream end of gravel point bars. Crossings will generally be 30 feet or less in width.
- Livestock stream crossings will be appropriately rocked to stabilize soils/slopes and prevent erosion. Fords will be placed on bedrock or stable substrates whenever possible.
- Crossings that involve culvert or bridge installation within habitat for listed fish under NOAA Fisheries' jurisdiction must meet the criteria outlined in the SLOPES BiOp. Crossings that involve culvert or bridge installation that are outside the terms and conditions of the SLOPES BiOp, or that are within habitat for fish species under the jurisdiction of the U.S. Fish and Wildlife Service require individual consultations.

1.4. Listed Species-Specific Best Management Practices

Activity-based and listed species-specific BMPs are included as part of the action, as described in the BA. The species-specific BMPs for the species covered in this consultation are listed below. For projects that involve sites where listed species may be affected by CREP activities, the pertinent species-specific BMPs will be followed in addition to all other BMPs that may apply to the project activities or area. In areas where BMPs may conflict, the more restrictive BMP applies. Some of the BMPs below are repeated because they apply to more than one listed species category.

1.4.1. BMPs for Listed Inland Fish

The BMPs below will be followed to avoid or minimize effects on listed inland fish (see list of inland fish species in Table 1).

General BMPs for Listed Inland Fish

- Oregon guidelines for the timing of in-water work will be followed for each affected stream reach, unless the Oregon Department of Fish and Wildlife approves an extension based on current year site-specific conditions. In reaches where the ODFW in-water work period conflicts with the needs for resident listed fish, ODFW should be contacted for a waiver to the timing restrictions.
- Stream crossings involving culverts or bridges within habitat for listed fish under the jurisdiction of the U.S. Fish and Wildlife Service require individual section 7 consultations.
- Potential spawning habitat will be surveyed for listed species within 300 feet downstream of a proposed stream crossing. Stream crossing will not be constructed at known or suspected spawning areas, or within 300 feet upstream of such areas if spawning areas may be affected.
- Spring development projects will not occur from springs where listed species occur, and water will not be redirected from habitat where listed species occur.
- On CREP projects where listed anadromous species, bull trout or Lahontan cutthroat trout may be affected, pumps must be screened to meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.,* regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning).
- On CREP projects where listed suckers or Oregon chub may be affected, pumps may be installed under this BA if water delivery is under 0.5 cfs (minor volume diversions). Pumps must be screened to meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.,* regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning).
- Water withdrawals for watering facilities or irrigation must not dewater habitats, or cause or exacerbate low stream flow conditions that could impact listed fish.
- CREP project sites with spring habitats that may support the Hutton tui chub or Foskett speckled dace within Lake County, Oregon will be surveyed for these species if the springs may be affected. An individual ESA section 7 consultation should be initiated if needed *(these species are not included in this programmatic consultation)*. If springs will not be affected but there is potential for either of these species to occur on CREP project sites, the Oregon Department of Fish and Wildlife and/or U.S. Fish and Wildlife Service may be contacted to investigate the possibility that unknown populations exist if landowners are agreeable.

Herbicide BMP for Bull trout

- The herbicide-related BMPs listed in section 1.3.3 and the measures discussed under "Use Zones, Application Equipment, and Application Methods" for each specific herbicide in section 2.3.2 of the BA (incorporated by reference) will be followed on CREP project sites with bull trout.

Herbicide BMPs for listed suckers, Oregon chub and Lahontan cutthroat trout

Shortnose, Lost River, Warner and Modoc suckers, Oregon chub and Lahontan cutthroat trout all have relatively limited distributions in Oregon compared with anadromous salmonids and bull trout, and all but the Warner sucker and Lahontan cutthroat trout are listed as endangered. To reduce the risk of potential adverse affects to these species and their proposed and designated critical habitats, the added precautions below will be taken when applying herbicides on or near habitats where they may occur. The allowable herbicide use covers a wide range of noxious weed treatment needs that may be encountered, while reducing risks to listed species and their critical habitats.

- Herbicides used along streams and ponds is limited to the following chemicals, as proposed in the BA with the restrictions in parenthesis:
  - Aminopyralid
  - Clopyralid
  - Dicamba (beyond 25' of the HWM only at no more than the typical rate of 0.3 lbs/acre)
  - Glyphosate (at no more than the typical application rate of 2 lbs/acre)
  - Imazapic (beyond 50' of the HWM only)
  - Imazapyr (beyond 25' of the HWM only at no more than the typical rate of 0.45 lbs/acre)
  - Picloram (at no more than the typical application rate of 0.35 lbs/acre in areas with annual rainfall levels below 50" only)
- Only aminopyralid may be used in ditches and intermittent channels, and only in segments of ditches and channels where listed species do not occur.
- Only glyphosate may be used in perennial channel instream areas (*i.e.,* dry areas within channel and emergent knotweed) using spray, wick or wipe application methods at a rate of no more than 0.5 lbs/acre or using the injection method in accordance with label requirements.
- Applicable application methods, use zones and BMPs described in sections 1.2.2 and 1.3.3 above, and in sections 2.3.2 and 2.4.3 of the BA (incorporated by reference), shall be followed. In the event that measures conflict, the more restrictive measure shall be followed.

These BMPs were developed based on the combined results of all of the related analyses for the various scenarios discussed in section 4.3.1 and Appendix E of the BA (incorporated by reference). The specific herbicides, application rates, rainfall levels and distances from aquatic resources described in the BMPs are below threshold risk levels (*i.e.,* HQ values and NOEC levels) found in the analyses for fish as well as aquatic invertebrates, algae, and aquatic macrophytes, which are related to the PCEs for designated and proposed critical habitats and food and cover resources for listed fish.

1.4.2. BMPs for Fender's blue butterfly

The BMPs below will be used to avoid or minimize effects on Fender's blue butterfly.

General BMPs for Fender's blue butterfly

- If possible, CREP sites with potential Fender's blue butterfly habitat will be surveyed for Fender's blue butterfly host plants (*i.e., Lupinus sulphureus* spp. *kincaidii, L. arbustus, L. albicaulis)* during the optimal survey period (May and June, or otherwise when in bloom between late April and July). If suitable lupine habitat is present, Fender's blue butterfly surveys will be conducted during the mid-May to early July flight period. Surveys will be conducted by a qualified biologist or individual trained to conduct surveys for this species, and may include observations for presence of the species and non-destructive egg or larvae counts. If it is not possible to conduct surveys or otherwise document that Fender's blue butterfly is absent from the site, it will be assumed that the site is occupied.

- Soil disturbing activities, such as disking, tillage and fence building, will not take place in locations that could cause physical harm to the Fender's blue butterfly or listed plants.
- With the exception of mowers used for mowing in accordance with the BMPs below, vehicles and machinery will not be driven where Fender's blue butterfly or listed plants could be impacted.
- Invasive plants may be removed using a variety of manual methods and hand tools, including hoeing, grubbing, pulling, clipping, digging or cutting. Tools that may be used include shovels, hoes, weed wrenches, lopping shears, trowels, machetes, weed wackers, hand saws and chain saws. Removal using these methods may occur year-round, as long as precautions are taken to prevent negative effects to listed species.
- Trees and shrubs will only be planted outside of habitats where the Fender's blue butterfly or listed prairie plants may occur, and outside of their critical habitats.
- CREP projects may include actions designed to benefit the butterfly, such as planting native nectar and host plants on sites that may support Fender's blue butterfly if food sources or host species are lacking and could be added to enhance habitat.
- If there are opportunities to support Fender's blue butterfly recovery efforts on CREP project sites where landowners may be interested, partners such as the U.S. Fish and Wildlife Service may be invited to provide additional technical and possible financial assistance.

Mowing BMPs for Fender's Blue Butterfly Habitats

- Mowing may be conducted throughout sites with Fender's blue butterflies when lupine and nectar plants have completed seed production, lupine have not yet re-emerged and the butterflies are in diapause (i.e. generally August 15 to February 28).
- Mowing at any time of year, including early spring mowing (i.e. March 1 to May 15), may be used for management purposes in unoccupied Fender's blue butterfly habitat; note that BMPs in section 1.4.3 for sites with Kincaid's lupine or other listed plants may be applicable.
- After the butterfly flight season but before lupine senescence (generally June 30 through August 15), tractor mowing may occur no closer than 2 meters (m) (6 feet) from the nearest lupine host plants.
- Mowing with hand-held mowers may be implemented during the Fender's blue butterfly flight season (generally May 1 to June 30), as long as a buffer of at least 8 m (25 feet) is maintained between the mower and any individual of a lupine host plant. Spring tractor mowing will not occur at sites with Fender's blue butterflies.
- Rubber-tracked mowers vs. wheeled mowers will be encouraged whenever possible/practical and the mowing deck should be set sufficiently high to avoid soil gouging and impacting listed plants and butterfly larvae, but low enough to remove weed flowers (generally at least 15 centimeters [cm]) (6 inches).[2]

Herbicide-related BMPs for Fender's Blue Butterfly

[2] This BMP was changed from "Mowers will be rubber-tracked and the mowing deck will be set sufficiently high to avoid soil gouging (generally at least 15 centimeters) (6 inches) to reduce potential impacts to butterfly larvae and low-stature native plants," as written in the BA, for consistency with related BMPs and to allow for greater flexibility.

- Only the following herbicides may be applied on sites with Fender's blue butterfly: glyphosate, imazapyr, clopyralid, triclopyr BEE, and triclopypr TEA; no more than one type of herbicide will be used at a time (*i.e.,* herbicides will not be mixed).
- On sites where Fender's blue butterfly may occur, herbicide spraying will only occur while larvae are in diapause (*i.e.,* generally August 15 through February 28).
- Host plants (*i.e.,* Kincaid's, sickle-keeled, and spur lupine) will be covered during spraying, even if they have senesced, to protect butterfly larvae that may be on the plant or on the ground in the immediate vicinity; plants will be uncovered immediately after spraying has been completed.

1.4.3. BMPs for Listed Plants

The BMPs below will be used to avoid or minimize effects on listed plants.

General BMPs for Listed Plants

- All CREP sites will be surveyed for any listed plants that may occur in the project area; surveys will be conducted by a botanist or otherwise qualified individual following a standardized or otherwise appropriate protocol during the known flowering period for the specific plant.
- Soil disturbing activities, such as disking, tillage and fence building, will not take place in locations that could cause physical harm to the Fender's blue butterfly or listed plants.
- With the exception of mowers used for mowing in accordance with the BMPs below, vehicles and machinery will not be driven where Fender's blue butterfly or listed plants could be impacted.
- Trees and shrubs will only be planted outside of habitats where the Fender's blue butterfly or listed prairie plants may occur, and outside of their critical habitats.

Mowing BMPs for Listed Plants

Project sites occupied by listed native prairie plants species in the Willamette Valley may be mowed to control or remove woody vegetation or invasive non-native vegetation, as follows:

- Mowing may occur when listed plants are dormant and seeds have been dispersed (generally August 15 through February 28).
- Spring mowing with tractor or hand-held mowers may occur where necessary to control overwhelming weed infestations, except at sites with Fender's blue butterflies. Spring mowing at sites with listed plants will maintain a buffer of 2 m (6 feet) from nearest listed plants. However, if needed to control serious infestations of weeds that mainly reproduce by seed (*e.g.,* meadow knapweed [*Centaurea x pratensis*]), up to one half of the listed plant population at a site may be mowed in an effort to reduce seed set by non-native weeds.
- Rubber-tracked mowers vs. wheeled mowers will be encouraged whenever possible/practical and the mowing deck should be set sufficiently high to avoid soil gouging and impacting listed plants and butterfly larvae, but low enough to remove weed flowers (generally at least 15 centimeters [cm]) (6 inches).
- All mowing equipment will be cleaned of invasive and non-native plant materials before entering an occupied site to prevent the dispersal of unwanted seeds or other reproductive plant parts.

Herbicide-related BMPs for Listed Plants

Only the following herbicides will be applied on listed plant sites: glyphosate, imazapyr, clopyralid, triclopyr BEE, triclopypr TEA, Pronone (granular form of hexazinone), sethoxydim and 2,4-D. FSA selected this subset of herbicides will provide effective control of weeds while minimizing impacts to sensitive plants. Application will occur in accordance with the BMPs below.

BMPs for Wick/Wipe herbicide applications from edge of listed plant site to outer edge of project

- Glyphosate and clopyralid may be hand-applied up to or within the plant patch to control competing vegetation.
- A 10-foot buffer will be maintained between the plant patch and the hand-application area for imazapyr, 2,4-D, and the triclopyrs to reduce the risk of herbicide movement through the soil and uptake by the roots of listed plants.

BMPs for Basal Bark herbicide applications from edge of listed plant site to outer edge of project

- Dilute herbicide with a crop oil (vegetable oil). (Use of diesel oil is prohibited).
- Avoid unnecessary run off when applying herbicide to stems of undesirable vegetation.
- Apply using lowest nozzle pressure that will allow adequate stem coverage.
- Applicator should apply facing away from plant site.
- Do not apply during periods of rain, snow, or melting snow.
- A 10-foot buffer will be maintained between the plant patch and the hand-application area for imazapyr, 2,4-D, and the triclopyrs to reduce the risk of herbicide movement through the soil and uptake by the roots of listed plants.
- Listed plants will be physically shielded (*e.g.,* covered with buckets or some other barrier that will not harm the plants) as needed to protect them from drift, unless they are dormant; plants will be uncovered immediately after spraying has been completed.

BMPs for spot spraying or patch spraying herbicide from edge of listed plant site out 50 feet

- If possible, spraying is to take place only during calm periods (no breeze).
- Spraying may take place IF there is a breeze of 3 mph or less AND the direction of the breeze is away from the sensitive resource.
- Allow post-application rain free period according to herbicide label requirements.
- Herbicide will be applied such that the spray is directed towards the project area away from the sensitive resource [person applying the spray will generally have their back to the plant site or other sensitive resource.]
- Nozzles will be adjusted to minimize fine particle size such that spray does not drift off of the project site or away from the target vegetation.
- The spray nozzle will be kept within four feet of the ground when herbicide is being applied within 50 feet of listed plants; beyond 50 feet, the nozzle may be held up to six feet above ground if needed to treat taller clumps of competing vegetation.
- To the extent possible, the spray will be directed away from all desirable vegetation.
- A 10-foot buffer will be maintained between the plant patch and the spray application area for imazapyr, 2,4-D and the triclopyrs to reduce the risk of herbicide movement through the soil and uptake by the roots of listed plants.

- Listed plants will be physically shielded (*e.g.,* covered with buckets or some other barrier that will not harm the plants) as needed to protect them from spray or drift, unless they are dormant; plants will be uncovered immediately after spraying has been completed.

BMPs for ground broadcast spraying herbicide

- Broadcast sprays will only occur at a distance from listed plants where the hazard quotient identified from SERA risk assessment worksheets is below 1 (*i.e.,* adverse effects are not likely to occur according to the analyses). Specific application buffers are as follows: 900 feet for clopyralid and imazapyr; 300 feet for triclopyr acid (TEA) and BEE, and 50 feet for glyphosate.
- If possible, spraying is to take place only during calm periods (no breeze).
- Spraying may take place IF there is a breeze of 3 mph or less AND the breeze is blowing away from the sensitive resource.
- Allow post-application rain free period according to herbicide label requirements
- Spray boom will be mounted such that nozzles are no more than four feet above the ground.
- Nozzles will be adjusted to minimize fine particle size such that spray does not drift off of project site.
- Nozzle pressure will be the adjusted to the lowest practical level (psi) while still providing for reasonable spray converge.
- Drift control agents will be used if necessary to prevent any spray from drifting off of the project site.

BMPs for Cut Surface application from edge of listed plant site to outer edge of project

- Applications will be made in a manner that prevents herbicide runoff onto the ground.
- Do not apply herbicide during periods of rain, snow, or melting snow.

BMPs for Hack & Squirt / Injection application from edge of listed plant site to outer edge of project

- Applications will be made in a manner that prevents herbicide runoff onto the ground.
- Do not apply during herbicide during periods of heavy rainfall.

BMPs for spot application of dry granule [Pronone]

- A 10-foot buffer will be maintained between the plant patch and the application area to prevent exposure by listed plants.
- If possible, application is to take place only during calm periods (no breeze).
- Applications may take place IF there is a breeze of 10 mph or less AND the direction of the breeze is away from the sensitive resource.

2. ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

2.1 Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this BO relies on four components: (1) the *Status of the Species*, which evaluates the range-wide condition, the factors responsible for that condition, and the survival and recovery needs for the species covered in the

BO; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species covered in the BO; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species covered in the BO; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species covered in the BO.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of each species addressed in the BO, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of any of the covered species in the wild.

The jeopardy analysis in this BO places an emphasis on consideration of the range-wide survival and recovery needs of the species addressed in this BO and the role of the action area in the survival and recovery of the species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

2.2 Adverse Modification Determination

This BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this BO relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitats for the species addressed in this BO in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on designated critical habitats for species addressed in this BO are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the species.

The analysis in this BO places an emphasis on using the intended range-wide recovery function of critical habitats for the species addressed in this BO and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

3. STATUS OF THE SPECIES AND DESIGNATED CRITICAL HABITAT

3.1. Bull trout, *Salvelinus confluentus*

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (USFWS 1999a,b). A 5-year review was conducted in 2008 and reaffirmed the species status as threatened (USFWS 2008a). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978, Bond 1992, Brewin *et al.* 1997, Leary and Allendorf 1997).

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (USFWS 1998a and 1999a). The Columbia and Klamath DPSs were consolidated into one listed taxon (USFWS 1999a). Based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process (USFWS 2005b).

At the time of publication of the Draft Bull Trout Recovery Plan (USFWS 2002b), there were 27 recovery units described. Almost immediately upon publication, the FWS recognized that these units may not meet the FWS standard for “recovery units” and decided to call them “management units.” In addition, the DPSs described in the June 10, 1998 listing of bull trout (USFWS 1998a) were subsequently recognized as “interim recovery units” in the November 1, 1999, final listing rule for bull trout (USFWS 1999a). In summary, until the Draft Bull Trout Recovery Plan is finalized, the FWS has adopted the use of local population, core area, management unit, and interim recovery unit for purposes of consultation and recovery.

Critical Habitat

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on September 26, 2005 (USFWS 2005b); the rule became effective on October 26, 2005. Approximately 3,828 miles of streams and 143,218 acres of lakes and reservoirs in Oregon, Washington, Idaho and Montana were designated. The scope of the designation involves the Klamath River, Columbia River, Coastal-Puget Sound, and St. Mary-Belly River DPSs. No critical habitat was designated for the Jarbidge River population of bull trout in Nevada and southern Idaho. The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 2005a). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses.

Critical habitat units generally encompass one or more core areas and may include foraging, migration and overwintering areas outside of core areas that are important to the survival and recovery of bull trout. Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support core areas which (1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993); (2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993, MBTSG 1998); (3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993, Hard 1995, Healey and Prince 1995, MBTSG 1998); and (4) are distributed throughout the historical range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993, Hard 1995, MBTSG 1998, Rieman and Allendorf 2001).

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, and sheltering. The PCEs are as follows:

1. Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 0 to 22 ºC (32 to 72 ºF) but are found more frequently in temperatures ranging from 2 to 15 ºC (36 to 59 ºF). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation;

2. Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures;

3. Substrates 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. This should include a minimal amount of fine substrate less than 0.63 centimeters (0.25 inches) in diameter;

4. A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a BO that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation. This rule finds that reservoirs currently operating under a BO that addresses bull trout provides management for PCEs as currently operated;

5. Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source;

6. Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows;

7. An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish; and

8. Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five interim recovery units of the coterminous United States population of the bull trout are considered essential to the survival and recovery of the species: Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and St. Mary-Belly River. Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

Jarbidge River

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawners, are estimated to occur within the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004c). The draft bull trout recovery plan (USFWS 2004c) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout within the core area; maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area; restore and maintain suitable habitat conditions for all life history stages and forms; and conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning fish per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004c).

Klamath River

This interim recovery unit currently contains three core areas and 12 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002b). Bull trout populations in this unit face a high risk of extirpation (USFWS 2002b). The draft bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and strategies; conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to fifteen new local populations and an increase in population size from about 3,250 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002b).

Columbia River

This interim recovery unit currently contains about 90 core areas and 500 local populations. About 62 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good but generally all have been subject to the combined effects of habitat degradation, fragmentation, fisheries management, and alterations associated with one or more of the following activities: dewatering; road construction and maintenance; mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; poaching and incidental mortality from other targeted fisheries; entrainment into diversion channels; and introduced non-native species. The draft bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this unit: maintain or expand the current distribution of the bull trout within core areas; maintain stable or increasing trends in bull trout abundance; maintain/restore suitable habitat conditions for all bull trout life history stages and strategies; and conserve genetic diversity and provide opportunities for genetic exchange.

Coastal-Puget Sound

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this unit. This interim recovery unit currently contains fourteen core areas and 67 local populations (USFWS 2004a,b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this unit. With only a few exceptions, bull trout continue to be present in nearly all major watersheds where they likely occurred historically within this unit. Generally, bull trout distribution has contracted and abundance has declined especially in the southeastern part of the unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (*e.g.,* timber harvest and associated road building activities), agricultural practices (*e.g.,* diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching and incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft bull trout recovery plan (USFWS 2004a,b) identifies the following conservation needs for this unit: maintain or expand the current distribution of bull trout within existing core areas; increase bull trout abundance to about 16,500 adults across all core areas; and maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002b). Currently, the bull trout is widely distributed in the St. Mary River drainage and occurs in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002b). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002b). The draft bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and forms; conserve genetic diversity and provide the opportunity for genetic exchange; and establish good working relations with Canadian interests because local bull trout populations in this unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Species Description

Bull trout, a char in the salmonid family, were commonly known as Dolly Varden until recognized as a separate species by the American Fisheries Society in 1980. Char are distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots, small scales, and differences in the structure of their skeleton. Their spotting pattern is easily recognizable, showing pale yellow spots on the back, and pale yellow and orange or red spots on the sides. Bull trout fins are tinged with yellow or orange, while the pelvic, pectoral, and anal fins have white margins. Bull trout have no black or dark markings on the fins. They have an elongated body covered with cycloid scales, somewhat rounded and slightly compressed laterally. Unlike Dolly Varden, the head of a bull trout is more broad and flat on top, and hard to the touch. The bull trout was first described by Girard in 1856 from a specimen collected in the lower Columbia River.

Life History

Bull trout exhibit resident and migratory life-history strategies through much of the current range (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear from one to four years before migrating to either a lake (adfluvial), a river (fluvial), or in certain coastal areas to salt water (anadromous) where they grow to maturity (Fraley and Shepard 1989, Goetz 1989). Growth of resident fish is generally slower than migratory fish; resident fish tend to be smaller at maturity and less fecund (Fraley and Shepard 1989, Goetz 1989). The size and age of maturity for bull trout is variable depending upon life-history strategy, but they typically reach sexual maturity in 4 to 7 years. Bull trout can live as long as 12 years.

Preferred bull trout spawning habitat consists of low gradient streams with loose, clean gravel (Fraley and Shepard 1989) and water temperatures 5 to 9 ^{o}C (41 to 48 ^{o}F) (Goetz 1989). Spawning occurs late summer to early fall in the upper reaches of clear streams in areas of flat gradient, uniform flow, and uniform gravel or small cobble. Bull trout typically spawn from August to November during periods of decreasing water temperatures. However, migratory bull trout frequently begin spawning migrations as early as April, and move upstream as far as 250 kilometers (km) (155 miles (mi)) to spawning grounds (Fraley and Shepard 1989). Temperatures during spawning generally range from 4 to 10 ^oC (39 to 51 ^oF), with redds often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, Pratt 1992, Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and juveniles remain in the substrate after hatching. Time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing stream flows (Howell and Buchanan 1992, Pratt 1992, Ratliff and Howell 1992). Fry and juvenile fish are strongly associated with the stream bottom and are often found at or near it.

Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, amphipods, mysids, crayfish, and small fish (Wyman 1975, Rieman and Lukens 1979, Boag 1987, Goetz 1989, Donald and Alger 1992). Adult migratory bull trout are an apex predator that is primarily piscivorous, known to feed on various trout (*Salmo* spp.) and salmon (*Onchorynchus* spp.), whitefish (*Prosopium* spp.), yellow perch (*Perca flavescens*), and sculpin (*Cottus* spp.) (Fraley and Shepard 1989, Donald and Alger 1992). Growth varies depending upon life-history strategy. Resident adults range from 150 to 300 millimeters (mm) or (6 to 12 inches (in.)) total length, and migratory adults commonly reach 600 mm (24 in) or more (Pratt 1985, Goetz 1989).

Older individuals are found in deeper and faster water compared to juveniles. Adults are often found in pools sheltered by large, organic debris or "clean" cobble substrate (McPahil and Murray 1979). Migratory bull trout may use a wide range of habitats ranging from first-to-sixth order streams and varying by season and life stage. In intermountain areas, lower-elevation lakes and rivers constitute important habitats for maturing and overwintering fluvial and adfluvial bull trout. Resident populations are generally found in small headwater streams where they spend their entire lives. Stream resident bull trout occupy small, high-elevation streams.

Where suitable migratory corridors exist, extensive migrations are characteristic of this species. Retention and recovery of migratory life history forms and maintenance or re-establishment of stream migration corridors is considered crucial to the persistence of bull trout throughout their geographic range. Migratory bull trout facilitate the interchange of genetic material between local subpopulations and are necessary for recolonizing habitat where subpopulations are or become extirpated by natural or human-caused events.

Habitat Needs

Bull trout have habitat requirements that are more specific than those for many other salmonids (Rieman and McIntyre 1993). Four elements relate to suitable bull trout habitat, known as the "Four C's": (1) CLEAN substrate composition that includes free interstitial spaces, (2) COMPLEX cover including large woody debris, undercut banks, boulders, shade, pools or deep water, (3) COLD water temperatures, and (4) CONNECTED habitats through migratory corridors. Stream temperatures and substrate types are especially important to bull trout, with water temperature representing a critical habitat characteristic for bull trout. Temperatures above 15 ^oC (59 ^oF) are thought to limit bull trout distribution (Rieman and McIntyre 1993). Spawning bull trout require hiding cover such as logs and undercut banks. Strict habitat requirements make spawning and incubation habitat for bull trout limited and valuable (Fraley and Shepard 1989).

Strong populations require high stream channel complexity, and are likely to be found in areas with low road densities, on forested lands, and in mid-size streams at relatively high elevations (> 5000 feet) (Quigley and Arbelbide 1997). However, because bull trout exhibit a patchy distribution, even in undisturbed habitats (Rieman and McIntyre 1993), fish are not likely to simultaneously occupy all available habitats (Rieman *et al.* 1997).

Reasons for Listing and Threats

Bull trout are vulnerable to many of the same threats that have reduced salmon populations in the Columbia River Basin. They are more sensitive to increased water temperatures, poor water quality, and low flow conditions than many other salmonids. Past and continuing land management activities such as timber harvest, livestock grazing, road construction, and mining have degraded stream habitat, especially those along larger river systems and stream areas located in valley bottoms, to the point where bull trout can no longer survive or successfully reproduce. Cumulative impacts of these activities are increased stream temperatures, more fine sediment in spawning gravels, loss of stream channel stability, and the creation of migration barriers. Road construction and maintenance account for a majority of man-induced sediment loads to streams in forested areas (Shepard *et al.* 1984b; Cederholm and Reid 1987; Furniss *et al.* 1991). Sedimentation affects streams by reducing pool depth, altering substrate composition, reducing interstitial space, and causing braiding of channels (Rieman and McIntyre 1993), which reduce carrying capacity. Sedimentation negatively affects bull trout embryo survival and juvenile bull trout rearing densities (Shepard *et al.* 1984b; Pratt 1992).

Large dams built for flood control and power production have eliminated riverine habitat and restricted bull trout movement. Culverts installed at road crossings may also act as barriers to bull trout movement. Additionally, irrigation withdrawls including diversions can dewater spawning and rearing streams, impede fish passage and migration, and cause entrainment. Discharging pollutants such as nutrients, agricultural chemicals, animal waste, and sediment into spawning and rearing waters is also detrimental. The loss and degradation of habitat has isolated many populations, increasing the risk of extinction due to demographic, genetic, and environmental stochasticity, and other natural catastrophic events. In many watersheds, remaining bull trout are small, resident fish isolated in headwater streams.

Historically, both intentional reductions and liberal harvest regulations posed a threat to some bull trout populations. Bull trout can no longer be legally harvested in Idaho, but misidentification of bull trout as brook trout or lake trout is resulting in some fish being killed accidentally. Illegal poaching of spawning adults is a problem in some areas.

Hybridization, competition, and predation from non-native species has also been detrimental to bull trout. Brook trout readily spawn with bull trout creating a hybrid that is often sterile. Lake trout have out-competed and replaced adfluvial populations of bull trout in some lakes. Overall, interspecific interactions, including predation, with non-native species may exacerbate stresses on bull trout from habitat degradation, fragmentation, isolation, and species interactions (Rieman and McIntyre 1993).

Warmer temperature regimes associated with global climate change represent another risk factor for bull trout. Increased stream temperature is a recognized effect of a warming climate (ISAB 2007). Species at the southern margin of their range that are associated with colder water temperatures, such as the bull trout, are likely to become restricted to smaller more disjunct habitat patches or become extirpated as the climate warms (Rieman *et al.* 2007). Climate warming is projected to result in the loss of 22 to 92 percent of suitable bull trout habitat in the Columbia River basin (ISAB 2007). Habitat conservation and restoration will be needed to mitigate these habitat losses.

3.2. Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*

Listing Status

Lahontan cutthroat trout is an inland subspecies of cutthroat trout endemic to the physiographic Lahontan basin of northern Nevada, eastern California, and southern Oregon (USFWS 1995). It was initially listed as endangered under the Endangered Species Conservation Act of 1969 based on evidence of destruction and drastic modification of their habitat and hybridization with introduced species (USFWS 1970). The species was reclassified as threatened in 1975 to facilitate management and allow regulated angling (USFWS 1975). Critical habitat has not been designated for Lahontan cutthroat trout. A final recovery plan for Lahontan cutthroat trout was published by the Service in January 1995 (USFWS 1995). The species has been introduced into habitat outside of its native range, primarily for recreational fishing purposes.

Species Description

The Lahontan cutthroat trout is an inland subspecies of cutthroat trout belonging to the Salmonidae family. This trout is one of 14 recognized subspecies of cutthroat trout in the western United States. Stream-dwellers generally live less than 5 years, and lake-dwellers live between 5 and 9 years. Lahontan cutthroat trout range between 10 and 15 inches in length, and feed on terrestrial and aquatic insects.

Cutthroat trout have the most extensive range of any inland trout species of western North America, and occur in anadromous, non-anadromous, fluvial, and lacustrine populations (Behnke 1979). Many of the basins in which cutthroat trout occur contain remnants of much more extensive bodies of water which were present during the wetter period of the late Pleistocene epoch (Smith 1978).

Differentiation of the species into 14 recognized subspecies occurred during subsequent general desiccation of the Great Basin and Inter-mountain Region since the end of the Pleistocene, and indicates presence of cutthroat trout in most of their historic range prior to the last major Pleistocene glacial advance (Behnke 1981, Loudenslager and Gall 1980). Ancestral Lahontan cutthroat trout probably invaded the pluvial Lake Lahontan system over 35,000 years ago (Gerstung 1986, Coffin 1982), although the precise events of entry and origin of original stock are unclear (Behnke 1979, Loudenslager and Gall 1980).

Life History and Habitat Needs

Lahontan cutthroat trout evolved in a range of habitat types, from cold-water, high elevation streams to warmer, more alkaline lake environments. It is likely that localized, natural events historically caused the local extirpation of small populations of Lahontan cutthroat trout. Those events included landslides and rock fall, fires, drought, and debris flows that restricted movement. Lahontan cutthroat trout population persistence is associated with the ability to maintain connectivity among populations, (*i.e.,* networked populations). A networked system is defined as an interconnected, stream and/or stream lake system in which individuals can migrate from or disperse into areas from which fish have been extirpated. This ability to disperse and repopulate habitats allows populations to persist (Neville-Arsenault 2003, Rieman and Dunham 2000, Dunham *et al.* 1997). Periodic repopulation by upstream or downstream sources enabled Lahontan cutthroat trout to survive extreme circumstances and provided for genetic exchange (Neville-Arsenault 2003).

Lahontan cutthroat trout historically occurred in most cold waters of the Lahontan Basin of Nevada and California, including the Humboldt, Truckee, Carson, Walker, and Summit Lake/Quinn River drainages. Large alkaline lakes, small mountain streams and lakes, small tributary streams, and major rivers were inhabited, resulting in the present highly variable subspecies. The fish occurred in Tahoe, Pyramid, Winnemucca, Summit, Donner, Walker, and Independence Lakes, but disappeared from the type locality, Lake Tahoe, about 1940 due primarily to blockage of spawning tributaries, and subsequently from Pyramid and Walker Lakes (Behnke 1979). The subspecies has been extirpated from most of the western portion of its range in the Truckee, Carson and Walker River Basins, and from much of its historic range in the Humboldt Basin. Only remnant populations remain in a few streams in the Truckee, Carson, and Walker Basins out of an estimated 1,020 miles of historic habitat (Gerstung 1986). Coffin (1988) estimated that only 85 stream populations existed in the Humboldt Basin in a total of 270 miles of habitat compared with an estimated historic occurrence in 2,210 stream miles.

Lahontan cutthroat trout, like other trout species, are found in a wide variety of cold-water habitats including large terminal alkaline lakes (*e.g.,* Pyramid and Walker lakes); oligotrophic alpine lakes (*e.g.,* Lake Tahoe and Independence Lake); slow meandering low-gradient river (*e.g.,* Humboldt River); moderate gradient montane rivers (*e.g.,* Carson, Truckee, Walker, and Marys Rivers); and small headwater tributary stream (*e.g.,* Donner and Prosser Creeks). Generally, Lahontan cutthroat trout occur in cool flowing water with available cover, velocity breaks, well-vegetated and stable stream banks, and relatively silt free, rocky substrate in riffle-run areas.

Lacustrine Lahontan cutthroat trout populations have adapted to a wide variety of lake habitats from small alpine lakes to large desert waters. Unlike most freshwater fish species, some Lahontan cutthroat trout tolerate alkalinity and total dissolved solid levels as high as 3,000 mg/L and 10,000 mg/L, respectively (Koch *et al.* 1979). Galat *et al.* (1983) indicated that Lahontan cutthroat trout will develop slight to moderate hyaline degeneration in kidney tubules in lakes where total dissolved solids and sulfates equal or exceed 5,000mg/L and 2,000 mg/L, respectively. This ability to tolerate high alkalinity prompted introductions of Lahontan cutthroat trout into saline-alkaline lakes in Nevada, Oregon, and Washington for recreational purposes (Trotter 1987). Walker Lake, Nevada is the most saline-alkaline water maintaining a Lahontan cutthroat trout sport fishery. In Walker Lake, total alkalinity exceeded 2,800 mg/L HCO 3 in 1975 and total dissolved solids exceeded 11,000 mg/L in 1982 (Sevon 1988).

Like other cutthroat trout subspecies, Lahontan cutthroat trout is an obligatory stream spawner that spawns between April and July. Spawning depends upon stream flow, elevation, and water temperature. Female sexual maturity is reached between the ages of 3 and 4, while males mature at 2 to 3 years of age. Over 60 percent of male and female Lahontan cutthroat die after their first time spawning, and those that remain usually spawn again two or more years later. Consecutive repeat spawning is very rare.

Reasons for Listing and Threats

The severe decline in range and numbers of Lahontan cutthroat trout is attributed to a number of factors, including hybridization and competition with introduced trout species; loss of spawning habitat due to pollution from logging, mining, and urbanization; blockage of streams by dams; channelization; de-watering from irrigation and urban water withdrawal; and watershed degradation due to overgrazing of domestic livestock (Gerstung 1986, Coffin 1988, Wydoski 1978). Minshall *et al.* (1989) state that the major human impacts on Great Basin streams are due to irrigated farming and livestock grazing. In the Humboldt Basin in Nevada, Coffin (1981, 1982, 1988) and Behnke (1979) attribute the poor condition of most stream habitats primarily to effects of extensive long-term livestock grazing. However, in the Truckee, Carson, and Walker Basins, Gerstung (1986) does not include effects of livestock grazing as a factor in the decline of Lahontan cutthroat trout, but includes pollution, over fishing, construction of dams and diversions, and competition and hybridization with non-native trout species.

3.3. Warner sucker, *Catostomus warnerensis*

Listing Status and Critical Habitat

The Service listed the Warner sucker as a threatened species and designated critical habitat on September 27, 1985 (USFWS 1985b). A final recovery plan for the Warner sucker was published in the Federal Register on April, 27, 1998 (USFWS 1998c).

Warner sucker critical habitat includes the following streams in Lake County, Oregon and 50 feet on either side of the stream banks: Twelvemile Creek from the confluence of Twelvemile and Twentymile Creeks upstream for about six stream kilometers (four stream miles); Twentymile Creek starting about 14 kilometers (nine miles) upstream of the junction of Twelvemile and Twentymile Creeks and extending downstream for about 14 kilometers (nine miles); Spillway Canal north of Hart Lake and continuing about three kilometers (two miles) downstream; Snyder Creek, from the confluence of Snyder and Honey Creeks upstream for about five kilometers (three miles); Honey Creek from the confluence of Hart Lake upstream for about 25 kilometers (16 miles). Constituent elements of the critical habitat include streams 15 feet to 60 feet wide with gravel-bottom shoal and riffle areas with intervening pools. Streams should have clean, unpolluted flowing water and a stable riparian zone. The streams should support a variety of aquatic insects, crustaceans, and other small invertebrates for food (USFWS 1985b).

Species Description

The Warner sucker is a member of the Catostomidea family. It is a slender-bodied species that attains a maximum recorded fork length (the measurement on a fish from the tip of the nose to the middle of the tail where a V is formed) of 456 millimeters (17.9 inches). Pigmentation of sexually mature adults can be striking. The dorsal two-thirds of the head and body are blanketed with dark pigment, which borders creamy white lower sides and belly. During the spawning season, males have a brilliant red (or, rarely, bronze) lateral band along the midline of the body, female coloration is lighter. Breeding tubercles (small bumps usually found on the anal, caudal and pelvic fins during spawning season) are present along the anal and caudal fins of mature males and smaller tubercles occasionally occur on females (Coombs *et al.* 1979).

Sexes can be distinguished by fin shape, particularly the anal fin, among sexually mature adults (Coombs *et al.* 1979). The anal fin of males is broad and rounded distally, whereas the female anal fin is narrower in appearance and nearly pointed or angular. Bond and Coombs (1985) listed the following characteristics of the Warner sucker that differentiate it from other western species of Catostomus: dorsal fin base short, its length typically less than, or equal to, the depth of the head; dorsal fin and pelvic fins with 9 to 11 rays; lateral line (microscopic canal along the body, located roughly at midside) with 73-83 scales, and greater than 25 scales around the caudal peduncle (rear, usually slender part of the body between the base of the last anal fin ray and the caudal fin base); eye small, 0.035 millimeter (0.0013 inch) Standard Length (straight-line distance from the tip of the snout to the rear end of the vertebral column) or less in adults; dark pigmentation absent from lower 1/3 of body; in adults, pigmented area extends around snout above upper lip; the membrane-covered opening between bones of the skull (fontanelle) is unusually large, its width more than one half the eye diameter in adults.

Life History and Habitat Needs

Much of the information on the life history of Warner sucker is taken from the species' recovery plan (USFWS 1998c). Information from research and observations since completion of the recovery plan has been added.

The probable historic range of the Warner sucker includes the main Warner Lakes (Pelican, Crump, and Hart), and other accessible standing or flowing water in the Warner Valley, as well as the low to moderate gradient reaches of the tributaries which drain into the Warner Valley. Warner sucker historic distribution in tributaries includes Deep Creek (up to the falls west of Adel), the Honey Creek drainage, and the Twentymile Creek drainage. In Twelvemile Creek, a tributary to Twentymile Creek, the historic range of Warner sucker extended through Nevada and back into Oregon.

Early collection records document the occurrence of Warner sucker from Deep Creek up to the falls about 5 kilometers (3.1 miles) west of Adel, the sloughs south of Deep Creek, and Honey Creek (Snyder 1908). Andreasen (1975) reported that long-time residents of the Warner Valley described large runs of suckers in the Honey Creek drainage, even far up into the canyon area.

Between 1977 and 1991, eight studies examined the range and distribution of the Warner sucker throughout the Warner Valley (Kobetich 1977, Swenson 1978, Coombs *et al.* 1979, Coombs and Bond 1980, Hayes 1980, White *et al.* 1990, Williams *et al.* 1990, White *et al.* 1991). These surveys have shown that when adequate water is present, Warner sucker may inhabit all the lakes, sloughs, and potholes in the Warner Valley. 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 (Allen *et al.* 1996). The Warner sucker population of Hart Lake was intensively sampled to salvage individuals before the lake went dry in 1992.

Stream resident populations of Warner sucker are found in Honey Creek, Snyder Creek, Twentymile Creek and Twelvemile Creek. Intermittent streams in the drainages may support small numbers of migratory suckers in high water years. No stream resident Warner sucker have been found in Deep Creek since 1983 (Smith *et al.* 1984, Allen *et al.* 1994), although a lake resident female apparently trying to migrate to stream spawning habitat was captured and released in 1990 (White *et al.* 1990). The known upstream limit of the Warner sucker in Twelvemile Creek is through the Nevada reach and back into Oregon (Allen *et al.* 1994). However, the distribution appears to be discontinuous and centered around low gradient areas that form deep pools with protective cover. In the lower Twentymile Slough area on the east side of the Warner Valley, White *et al.* (1990) collected adult and young suckers throughout the slough and Greaser Reservoir. This area dried up in 1991, but because of its marshy character, may be important sucker habitat during high flows. Larval, young-of-year, juvenile and adult Warner sucker captured immediately below Greaser Dam suggest either a slough resident population, or lake resident suckers migrating up the Twentymile Slough channel from Crump Lake to spawn (White *et al.* 1990, Allen *et al.* 1996).

While investigating the distribution of Cowhead Lake tui chub, Scoppettone and Rissler (2001) discovered a single juvenile Warner sucker in West Barrel Creek. West Barrel Creek is a tributary to Cow Head Slough that eventually enters Twelvemile Creek at the known upper extension of suckers in the Twelvemile drainage. This discovery of a Warner sucker in the Cowhead Lake drainage is a significant range extension for Warner sucker.

Kennedy and Vinyard (1997) made observations of the success of survivorship of sucker larvae during 1992 and 1993. In 1992, all lakes were dry by July and refilled in 1993 due to higher spring run-off. Estimated survivorship of sucker larvae were not significantly different and showed low recruitment to the juvenile size class both years (<10% in 1992 and <3% in 1993). Evidence of similar survivorship despite lake level, may indicate that the sucker's survivorship is independent of its ability to occupy and use lake type habitat.

The distribution of Warner sucker is well known, but limited information is available on stream habitat requirements and spawning habits. Relatively little is known about feeding, fecundity, recruitment, age at sexual maturity, natural mortality, and interactions with introduced game fishes. In this account, "larvae" refers to the young from the time of hatching to transformation into juvenile (several weeks or months), and "juvenile" refers to young that are similar in appearance to adults. Young of year refers to members of age-group 0, including transformation into juvenile until January 1 of the following year.

A common phenomenon among fishes is phenotypic plasticity (the ability of different individuals of the same species to have different appearances despite identical genotypes) induced by changes in environmental factors (Wooton 1990, Barlow 1995). This is most easily seen by a difference in the size of the same species living in different but contiguous, and at times sympatric (occurring in the same area) habitats for a portion of their lives (Healey and Prince 1995, Wood 1995). The Warner Basin provides two generally continuous aquatic habitat types; a temporally more stable stream environment and a temporally less stable lake environment (*e.g.,* lakes dried in 1992 and in the early 1930's).

Observations indicate that Warner sucker grow larger in the lakes than they do in streams (White *et al.* 1990). The smaller stream morph (development form) and the larger lake morph are examples of phenotypic plasticity within metapopulations of the Warner sucker. Expressions of these two morphs in Warner sucker might be as simple as the species being opportunistic. When lake habitat is available, the stream morph migrates downstream and grows to become a lake morph. These lake morphs can migrate upstream to spawn or become resident populations while the lake habitat is available. Presumably, when the lake habitat dries up the lake morph is lost but the stream morph persists. When the lakes refill, the stream morph can reinvade the lakes to again become lake morphs. The lake habitat represents a less stable but more productive environment than the metapopulations of Warner sucker use on an opportunistic basis. The exact nature of the relationship between lake and stream morphs remains poorly understood and not well studied.

The lake and stream morphs of the Warner sucker probably evolved with frequent migration and gene exchange between them. The larger, presumably longer-lived, lake morphs are capable of surviving through several continuous years of isolation (*e.g.,* drought or other factors) from stream spawning habitats. Similarly, stream morphs probably serve as sources for recolonization of lake habitats in wet years following droughts, such as the refilling of the Warner Lakes in 1993 following their desiccation in 1992. The loss of either lake or stream morphs to drought, winter kill, excessive flows and a flushing of the fish in a stream, in conjunction with the lack of safe migration routes and the presence of predaceous exotic fishes, may strain the ability of the species to rebound (White *et al.* 1990, Berg 1991).

Lake morph Warner sucker occupy the lakes and, possibly, deep areas in the low elevation creeks, reservoirs, sloughs and canals. Recently, only stream morph suckers have exhibited frequent recruitment, indicated by a high percentage of young of year and juveniles in Twelvemile and Honey Creeks (Tait and Mulkey 1993a,b). Lake morph suckers, on the other hand, were skewed towards larger, older adults (8-12 years old) with no juveniles and few younger adult fish (White *et al.* 1991) before the lakes dried up in 1992. Since the lakes refilled, the larger lake morph suckers have reappeared. Captured lake suckers averaged 267 millimeters (10.5 inches) SL in 1996 (Allen 1996), 244 millimeters (9.6 inches) SL in 1995 (Allen *et al.* 1995a) and 198 millimeters (7.8 inches) SL in 1994 (Allen *et al.* 1995b). Stream caught fish averaged 138 millimeters (5.4 inches) SL in 1993 (Tait and Mulkey 1993b).

Warner sucker recovered from an ice induced kill in Crump Lake were aged to 17 years old and had a maximum fork length of 456 millimeters (17.9 inches) (White *et al.* 1991). Lake resident suckers are generally much larger than stream residents, but growth rates for adults are not known for either form. Sexual maturity occurs at an age of three to four years (Coombs *et al.* 1979), although in 1993, captive fish at Summer Lake Wildlife Management Area, Oregon, successfully spawned at the age of two years (White *et al.* 1991).

Coombs *et al.* (1979) measured Warner sucker larval growth and found a growth rate of approximately 10 millimeters (0.39 inch) per month during the summer (*i.e.,* when the larvae were 1-4 months old). Sucker larvae at Summer Lake Wildlife Management Area grew as large as 85 millimeters (3.3 inches) in three months during the summer of 1991, but this was in an artificial environment (earth ponds) and may not reflect natural growth patterns.

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 young of year. Larvae have terminal mouths and short digestive tracts, enabling them to feed selectively in midwater or on the surface. Invertebrates, particularly planktonic (having weak powers of locomotion) crustaceans, make up most of their diet. As the suckers grow, they develop subterminal mouths, longer digestive tracts, and gradually become generalized benthic (living on the bottom) feeders on diatoms (small, usually microscopic, plants), filamentous (having a fine string-like appearance) algae, and detritus (decomposed plant and animal remains). Adult stream morph suckers forage nocturnally over a wide variety of substrates such as boulders, gravel, and silt. Adult lake morph suckers are thought to have a similar diet, though caught over predominantly muddy substrates (Tait and Mulkey 1993a,b).

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 14-20 degrees Celsius (57-68 degrees Fahrenheit) when stream flows are relatively high. Warner sucker spawn in sand or gravel beds in slow pools (White *et al.* 1990, White *et al.* 1991, Kennedy and North 1993). Allen *et al.* (1996) surmise that spawning aggregations in Hart Lake are triggered more by rising stream temperatures than by peak discharge events in Honey Creek.

Tait and Mulkey (1993b) found young of year were abundant in the upper Honey Creek drainage, suggesting this area may be important spawning habitat and a source of recruitment for lake recolonization. The warm, constant temperatures of Source Springs at the headwaters of Snyder Creek (a tributary of Honey Creek) may provide an especially important rearing or spawning site for Warner sucker (Coombs and Bond 1980).

Warner sucker may attempt to spawn on gravel beds along the lake shorelines during years when access to stream spawning areas is limited by low flow or by physical in-stream blockages (such as beaver dams or irrigation diversion structures). In 1990, Warner sucker were observed digging nests in 40+ centimeters (16+ inches) of water on the east shore of Hart Lake at a time when access to Honey Creek was blocked by extremely low flows (White *et al.* 1990).

Warner sucker larvae are found in shallow backwater pools or on stream margins where there is no current, often among or near macrophytes. Young of year Warner sucker are often found over deep, still water (from midwater to the surface) but also move into faster flowing areas near the heads of pools (Coombs *et al.* 1979).

Warner sucker larvae venture near higher velocities during the daytime to feed on planktonic organisms but avoid the mid-channel water current at night. This aversion to downstream drift may indicate that spawning habitats are also used as rearing grounds during the first few months of life (Kennedy and North 1993). None of the studies conducted thus far have succeeded in capturing Warner sucker younger than two years old in the Warner lakes, and it has been suggested that Warner sucker do not migrate down from the streams for two to three years (Coombs *et al.* 1979). The absence of young Warner sucker in the Warner lakes, even in years following spawning in the lakes, could be due to predation by introduced game fishes (White *et al.* 1991).

Juvenile suckers (one to two years old) are usually found at the bottom of deep pools or in other habitats that are relatively cool and permanent, such as near springs. As with adults, juvenile Warner sucker prefer areas of the streams that are protected from the higher velocities of the main stream flow (Coombs *et al.* 1979). Larval and juvenile mortality over a two month period during the summer has been estimated at 98 percent and 89 percent, respectively, although accurate larval Warner sucker counts were hampered by dense macrophyte cover (Tait and Mulkey 1993b).

White *et al.* (1991) found in qualitative surveys that, in general, adult suckers used stretches of stream where the gradient was sufficiently low to allow the formation of long (50 meters [166.6 feet] or longer pools. These pools tended to have undercut banks, large beds of aquatic macrophytes (usually greater than 70 percent of substrate covered), root wads or boulders, a surface to bottom temperature differential of at least two degrees Celsius (at low flows), a maximum depth greater than 1.5 meters (5 feet), and overhanging vegetation (often *Salix spp*.). About 45 percent of these pools were beaver ponds, although there were many beaver ponds in which Warner sucker were not observed. Warner sucker were also found in smaller or shallower pools or pools without some of the above mentioned features. However, they were only found in such places when a larger pool was within approximately 0.4 kilometer (0.25 mile) upstream or downstream of the site.

Submersed and floating vascular macrophytes are often a major component of Warner sucker-inhabited pools, providing cover and harboring planktonic crustaceans which make up most of the young of year Warner sucker diet. Rock substrates such as large gravel and boulders are important in providing surfaces for epilithic (living on the surface of stones, rocks, or pebbles) organisms upon which adult stream resident Warner sucker feed, and finer gravels or sand are used for spawning. Siltation of Warner sucker stream habitat increases the area of soft stream bed necessary for macrophyte growth, but embeds the rock substrates utilized by adult Warner sucker for foraging and spawning. Embeddedness, or the degree to which hard substrates are covered with silt, has been negatively correlated with total Warner sucker density (Tait and Mulkey 1993a).

Habitat use by lake resident Warner sucker appears to be similar to that of stream resident Warner sucker in that adult Warner sucker are generally found in the deepest available water where food is plentiful. Not surprisingly, this describes much of the habitat available in Hart, Crump, and Pelican Lakes, as well as the ephemeral lakes north of Hart Lake. Most of these lakes are shallow and of uniform depth (the deepest is Hart Lake at 3.4 meters (11.3 feet) maximum depth), and all have mud bottoms that provide the Warner sucker with abundant food in the form of invertebrates, algae, and organic matter.

Population Dynamics

A population estimate of Warner sucker in streams was conducted in 1993 on the Honey Creek and Twentymile Creek drainages (Tait and Mulkey 1993b). Approximately 20 percent of available stream habitat in the Honey Creek drainage was sampled. The population within the area sampled was estimated at 77 adults, 172 juveniles, and 4,616 young of year. Approximately 60 percent of the available stream habitat in the Twentymile Creek drainage was also sampled. The population estimates within this area sampled was 2,563 adults, 2,794 juveniles, and 4,435 young of year.

As of 1996, the Hart Lake Warner sucker population was estimated at 493 spawning individuals (95 percent confidence intervals of 439-563) (Allen *et al.* 1996). Although this is the only quantified population estimate of Warner sucker ever made for Hart Lake, it is likely well below the abundances found in Hart Lake prior to the drought.

In 1997, Bosse *et al.* (1997) documented the continued existence, but reduced numbers, of Warner sucker in the Warner Lakes. The number of Warner sucker, as measured by catch per unit effort, had declined 75 percent over the 1996 results. The reduction in sucker numbers was offset by a sharp increase in the percentage composition of introduced game fish, especially white crappie and brown bullhead.

Hartzell and Popper (2002) indicated a continued reduction of Warner sucker numbers and an increase of introduced fish in Warner Lakes. The greatest number of Warner sucker captured was in Hart Lake (96% of total Warner sucker catch) with only a few Warner sucker captured in the other Warner Lakes, including Crump Lake. Suckers represented a greater percentage of the catch in relation to introduced and other native fish compared to the efforts of 1997, although a smaller total number of sucker were captured than in 1997. This was the first year since 1991 that native fish made up a smaller percentage of the catch than introduced fish.

Reasons for Listing and Threats

Warner suckers were once common throughout the Warner basin but gradually declined from about the 1900 to the early 1970's. Historical accounts tell of impressive runs of fish in the Warner Valley. Long-time residents recall during the 1930's large numbers of spawning Warner suckers ascend Honey Creek into upstream canyon areas. The combination of restricted distribution, semi-permanent nature of the lakes, degradation of existing stream habitat, blockage of migration corridors, introduction of piscivorus exotic fishes into the lakes and water usage have impacted the existing populations of Warner sucker.

Warner sucker were listed due to reductions in the range and numbers, reduced survival due to predation by introduced game fishes in lake habitats, and habitat fragmentation and migration corridor blockage due to stream diversion structures and agricultural practices. Since the time of listing, it has been recognized that habitat modification, due to both stream channel degradation and overall reduced watershed function has worsened and the status and viability of the Warner sucker has declined. Signs of stream channel and watershed degradation are common in the Warner Valley, and include fences hanging in mid-air because stream banks have collapsed beneath them, high cut banks on streams, damaged riparian zones, bare banks, and large sagebrush flats where there were once wet meadows (White *et al.* 1991).

With few exceptions, designated Warner sucker critical habitat is excluded from grazing and other land use authorizations by the BLM. The one exception is on the Deppy Creek/ Honey Creek confluence where a water gap allows stock access. The other exception is in the 0207 allotment on Twentymile Creek. This area is not occupied by Warner sucker and is an intermittent, rock-armored channel.

The first large scale human impact to migration of the Warner sucker within the Warner Basin was the construction of irrigation diversion structures in the late 1930s (Hunt 1964). These structures hamper or block both upstream and downstream migrations of various life stages of Warner sucker. Few irrigation diversions have upstream fish passage. Adult suckers that have spawned and are moving downstream can be diverted from the main channel to become lethally trapped in unscreened irrigation canals. Larval, post larval, young of year, and juvenile suckers are probably also lethally diverted into unscreened irrigation canals.

In high water years, the amount of water diverted from Warner Valley streams may be only a small portion of the total flow, but in drought years, total stream flows often do not meet existing water rights, and so entire streams may be diverted. Over a series of drought years, reduced flows can cause drops in lake levels and sometimes, especially in conjunction with lake pumping for irrigation, cause complete dry-ups, as was the case with Hart Lake in 1992.

Although the native species composition in the Warner basin included some piscivorus fishes like the Warner Valley redband trout (*Oncorhynchus mykiss* sp.), the introduction of exotic game fish disrupted this balance and the native ichthyofauna has suffered. In the early 1970s, ODFW stocked white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus*), and largemouth bass (*Micropterus salmoides*), in Crump and Hart Lakes. Prior to this, brown bullhead (*Ameiurus nebulosus*) and non-native rainbow trout were introduced into the Warner Valley. The adults of all five piscivorous fish species feed on Warner sucker to varying degrees.

The presence of the introduced game fishes may also threaten Warner sucker through competitive interactions. Brown bullhead is a bottom oriented omnivore (Moyle 1976) that may compete directly with Warner sucker for the same food sources. Bullhead may also prey on sucker eggs in the lower creek or lake spawning areas, as well as on sucker larvae and juveniles. Young crappies probably eat many of the same zooplankton and other small invertebrates that young suckers depend on. Habitat use by young Warner sucker remains poorly understood, but there may be competition between suckers and other fishes for what scarce cover resources are available.

3.4. Lost River sucker, *Deltistes luxatus* and Shortnose sucker, *Chasmistes brevirostris*

Listing Status and Proposed Critical Habitat

The Lost River and shortnose suckers were listed as endangered in 1988 (USFWS 1988a). A recovery plan for both species was published in April 1993 (USFWS 1993d). Critical habitat for the suckers was proposed in 1994, but has not been finalized (USFWS 1994). The PCEs identified in the critical habitat proposal are: (1) water of sufficient quantity and suitable quality; (2) sufficient physical habitat, including water quality refuge areas, and habitat for spawning, feeding, rearing, and travel corridors; and (3) a sufficient biological environment, including adequate food levels, and patterns of predation, parasitism, and competition that are compatible with recovery. A five-year status review was conducted in 2007. A recommendation was made to down-list the Lost River sucker. No status change was recommended for the shortnose sucker (USFWS 2008c).

Life History

Lost River suckers are large fish (up to 1 meter long and 4.5 kg in weight) that are distinguished by their elongate body and sub-terminal mouth with a deeply notched lower lip. They have dark brown to black backs and brassy sides that fade to yellow or white on the belly (Moyle 2002). Lost River suckers have been recorded to live up to 43 years (Scoppettone 1988).

Shortnose suckers are distinguished by their large heads with oblique, terminal mouths with thin but fleshy lips. The lower lips are deeply notched. Adults are dark on their back and sides and silvery or white on the belly. They can grow to about 50 cm in length, but growth is variable among individuals (Moyle 2002). Shortnose suckers have been recorded to live as long as 33 years (Buettner and Scoppettone 1990).

Lost River and shortnose suckers are native to the Lost River and upper Klamath River systems in Oregon and California where they have adapted to lake living (Moyle 2002). Adult and juvenile Lost River and shortnose suckers feed on benthic and planktonic organisms, primarily midge larvae and *Daphnia*. While adult fish can be found throughout the reservoirs they inhabit at depths of 6 feet or more, larvae prefer shorelines with emergent vegetation that can provide cover from predators and invertebrate food (Moyle 2002); juveniles occur over various substrates. Little is known about sub-adults but it is believed they occupy habitats similar to the adults.

Lost River and shortnose suckers grow rapidly in their first five to six years. Shortnose suckers reach sexual maturity sometime between years four and six, whereas Lost River suckers reach sexual maturity between five and 14 years of age, with most maturing at 9 years (Buettner and Scoppettone 1990). Spawning of Lost River and shortnose suckers occurs from February to May in the larger tributaries of inhabited lakes. River spawning habitat is riffles or runs with gravel or cobble substrate, moderate flows, and depths less than 130 cm. Lost River suckers and a few shortnose suckers spawn in Upper Klamath Lake near springs and seeps occurring along the shorelines (Moyle 2002). Females of both species are highly fecund, producing tens of thousands of eggs during each spawning event and spawn with numerous males (Perkins *et al.* 2000). Adults of both species can spawn multiple times during their life, but it is unknown if an individual fish will spawn every year (NRC 2004).

Sucker eggs incubate in the gravels for approximately two to three weeks, depending on the water temperature. Sucker larvae are small being only 11 mm upon hatching. They emerge sometime in late March to early June and most immediately move downstream to lakes where they rear (Cooperman and Markle 2003); however, some rearing occurs in tributaries especially in years when backwater areas are created by high flows. Larval suckers prefer to rear in shallow, nearshore and vegetated habitat in both lakes and rivers (Cooperman and Markle 2004), but in Gerber Reservoir and Clear Lake rearing of shortnose sucker occurs in shallow, unvegetated areas. Larvae transform into juveniles at about 30 mm total length and move to slightly deeper water. During their first year, suckers are known as age-0 fish.

Distribution

At the time of listing, Lost River and shortnose suckers were reported from Upper Klamath Lake and its tributaries (Klamath Co., Oregon); from the Lost River (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) and Clear Lake (Modoc Co., California); the Klamath River above Keno (Klamath Co., Oregon); and in one or more of the Klamath River reservoirs below Keno (Klamath Co., Oregon, and Siskiyou Co., California) (see Figure 1) (USFWS 1988a).

The known geographic ranges of Lost River and shortnose suckers have not substantially changed since listing and they are still found primarily in Upper Klamath Lake and Clear Lake. One previously-unreported Lost River sucker and two previously-unreported shortnose sucker populations have been found since listing. A population of about a thousand adults of each species occur in the Tule Lake sumps at the terminus of the Lost River (Siskiyou Co., California) (Scoppettone *et al.* 1995). Also, shortnose suckers (or shortnose sucker x Klamath largescale sucker hybrids) are now known to occur in Gerber Reservoir (Klamath Co., Oregon), which was considered in 1994 when the Service proposed critical habitat (USFWS 1994). New genetics information casts some doubt on whether these fish in Gerber Reservoir and Clear Lake are actually shortnose suckers (ISRP 2005, Tranah and May 2006). Until that information can be further evaluated, we will continue to assume that these fish are shortnose suckers.

The total area of occupied lake habitat for Lost River and shortnose suckers is about 80,000 acres, of which about 80% or more is in Upper Klamath Lake (which has about 64,000 surface acres). The remainder of occupied habitat occurs primarily in Clear Lake (which rarely reaches its maximum surface area of about 20,000 acres).

Upper Klamath Lake is a large natural lake located in Klamath County, Oregon. Since 1921, its water levels have been modified by operation of Link River Dam, which is part of the Klamath Project (NRC 2004). The watershed occupies about 3,800 square miles, ranges in elevation from 4,100 to over 9,000 feet, and has an average annual precipitation of 27 inches (ODEQ 2002). The lake surface area averages about 64,000 acres and averages 6-8 feet deep (USBR 2005b). Its three major tributaries are the Sprague, Williamson, and Wood rivers.

Clear Lake is a natural lake located in Modoc County, California. It is in the 700-square-mile Lost River watershed, which ranges in elevation from approximately 4,500 to 6,100 feet (USBR 1970). Annual precipitation equals about 13 inches. Upstream stock ponds and diversions reduce inflows somewhat, and over half of the annual inflow is lost to seepage and evaporation (USBR 1970). The lake has one major tributary, Willow Creek, where suckers spawn (Scoppettone *et al.* 1995). The size of Clear Lake was increased by construction of a dam constructed by Reclamation in 1910. During the 65-year period prior to 1970, annual net inflow has fluctuated from 18,000 to 370,000 acre feet (USBR 1970). The lake has never reached its capacity of 450,000 acre feet.

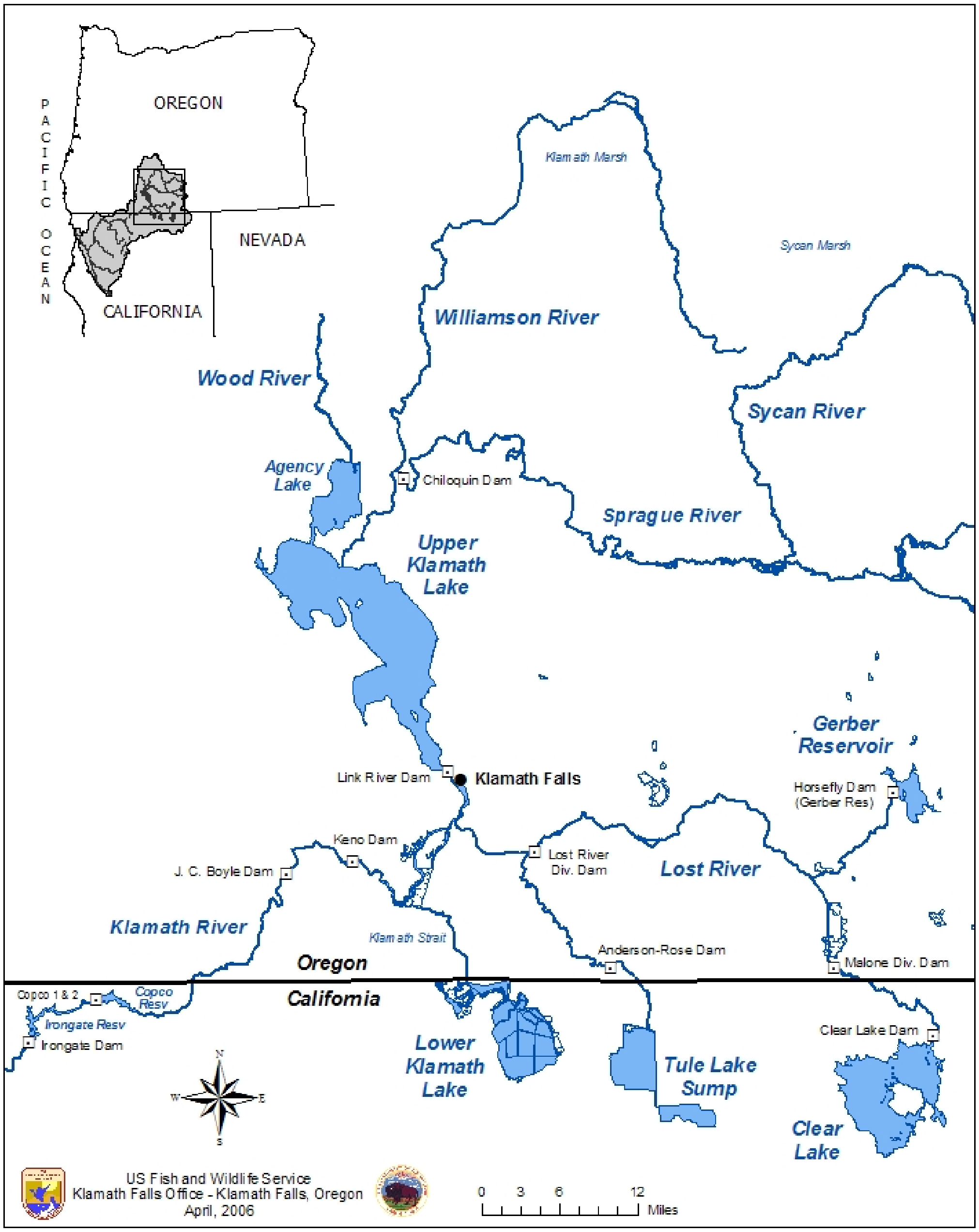

Figure 1. Map of major water bodies in the upper Klamath River Basin.

Population Abundance and Trends

Estimation of fish population size is an inexact science. All estimation methods have limitations caused by environmental conditions or by other factors such as lost tags, timing and geographic range of sampling, unmet statistical assumptions, and broad statistical confidence intervals. Thus, because population size often cannot be precisely estimated, assessment of population trends is used to evaluate the health of fish populations (R. Shively, pers. comm. 2005). The following discussion is based upon an assessment of Lost River and shortnose sucker population trends.

At the time of listing, the Lost River and shortnose sucker population numbers were unknown, but surveys had shown general downward trends. In Upper Klamath Lake, surveys in 1984 resulted in an estimate of 2,650 shortnose suckers and 11,000 to 23,000 Lost River suckers, and subsequent information indicated that population reductions had occurred (USFWS 1988a). Information gathered in recent years indicates that sucker population estimates made at the time of listing were probably inaccurate. Because assumptions necessary for modeling population sizes were likely not met, the actual sizes of the populations at that time are uncertain. Available data on distribution of age classes showed that little recruitment (the addition of fish to the reproducing population) had occurred in nearly 18 years, a major fish die-off in 1986, and substantial harvest by a sport fishery that was open until 1987 (USFWS 1988a, Markle and Cooperman 2002, NRC 2004). Thus, the listing was based on a variety of data, all indicating a downward trend (USFWS 1998c).

On this issue of population trends at the time of listing, the National Research Council (NRC) (NRC 2004) stated: "For purposes of ESA actions, the critical facts, which are known with a high degree of certainty, are that the fish are much less abundant than they originally were and that they are not showing an increase in overall abundance."

Information gathered since listing indicates that there may be several tens of thousands of adult Lost River and shortnose suckers in Upper Klamath Lake (ISRP 2005). Gerber Reservoir and Clear Lake also have shortnose sucker populations numbering in the thousands of adults (ISRP 2005). Clear Lake has a Lost River sucker population that probably numbers in the tens of thousands of adults.

A small population of about one thousand adult Lost River and shortnose suckers occurs in the Tule Lake sumps at the terminus of the Lost River (J. Hodge, pers. comm. 2008). It is isolated from upstream spawning areas by a series of dams. Small populations of adult shortnose suckers (probably in the hundreds of individuals) also occur in the Lost River, Keno Reservoir, J.C. Boyle Reservoir, Copco Reservoir, and Iron Gate Reservoir (Desjardins and Markle 2000, Piaskowski 2003, USGS 2000, USBR 1993, Ziller and Buettner, unpublished data 1987).

Population trends in Upper Klamath Lake have been evaluated by comparing an adult abundance index or cumulative catch-per-unit effort in the Williamson River (R. Shively, pers. comm. 2007). These data indicate that sucker populations in Upper Klamath Lake have varied considerably in size and age structure owing to fluctuating recruitment and periodic die-offs (NRC 2004), and that sharp and substantial population declines can occur in a span of just a few years (Perkins *et al.* 2000).

In 1995, the adult abundance index for Lost River and shortnose suckers populations spawning in the Williamson River system were the highest observed between 1995 and 2005 (ISRP) 2005, USGS 2003). Between 1995 and 1997, die-offs in Upper Klamath Lake reduced the Williamson River abundance index by over 90 percent. In 2000 and 2001, recruitment increased for both species, although it was greater for Lost River sucker than shortnose sucker (Janney and Shively 2007, Janney *et al.* in review). In 2003, another die-off occurred but was much smaller in magnitude than those in 1995-1997. From 2003-2005, the Lost River sucker index increased gradually, but was still only about 40 percent of the 1995 value. The shortnose sucker index has remained low, less than 10 percent of the 1995 level (ISRP 2005, Janney and Shively 2007).

Mark-recapture data from 1995 through 2004 have been analyzed to estimate annual survival rates for Lost River and shortnose sucker in Upper Klamath Lake (Janney and Shively 2007).

Based upon a mean survival rate of 0.76 for the 10 year period, it is estimated that the average life expectancy of shortnose suckers entering the spawning population was only 3.6 years. Mean annual survival rate for Upper Klamath Lake shoreline spawning Lost River suckers from 1995 to 2004 was estimated at ~0.9. Based on this survival probability, average life expectancy of Lost River suckers after recruiting into the spawning population was approximately 7.8 years. These short estimated life expectancies are of concern because the species are believed to be normally long-lived (up to 30-40 years); thus suggesting that adults are dying before reproducing often enough for population replacement (USFWS 2007c,d).

Although Clear Lake Lost River and shortnose suckers populations appear to number in the thousands of individuals, a substantial reduction in mean body size has occurred in the last decade. Between 1996 and 2000 there was a reduction of over 30 percent in mean size of adult Lost River and shortnose suckers (Barry *et al.* 2007). In 2005 and 2006, adult suckers were represented by mostly smaller size classes.

The Gerber Reservoir shortnose sucker population appears to be viable with evidence of frequent recruitment and large numbers of adults (Barry *et al.* 2007, Piaskowski and Buettner 2003).

Population monitoring at Tule Lake, Lost River, and Klamath River reservoirs has not been intensive enough to determine trends. However, the limited survey information collected over the last two decades suggests populations have remained at relatively low levels (hundreds of individuals) (Buettner and Scoppettone 1991, Desjardins and Markle 2000, USFWS 2007c,d).

Habitat Characteristics

Shortnose and Lost River suckers use a variety of specific aquatic habitats at various stages in their lives, from larvae to adults. Adult spawning habitats are gravel substrates in streams and rivers. They are also known to spawn along the lake margins of Upper Klamath Lake, but that currently appears to be a rare occurrence (NRC 2004, R. Shively, pers. comm. 2005). After hatching, most larvae swim up (emerge) from gravel and quickly emigrate downstream to a lake environment where they occupy “shallow, near-shore, and vegetated” habitats (Cooperman and Markle 2004, NRC 2004).

Researchers have found high densities of larvae in the shallow, near-shore areas of Upper Klamath Lake (Buettner and Scoppettone 1990, Klamath Tribes 1996, Markle and Simon 1993, Simon *et al.* 1995, Simon *et al.* 1996, Cooperman and Markle 2004). Although larval densities as high as 120 larvae/square meter have been reported in emergent vegetation along Upper Klamath Lake, only 2 percent of trawls have densities over 10 larvae /square meter (D. Markle, pers. comm. 2007). Sucker larvae generally occur at higher densities in and adjacent to emergent vegetation than in areas devoid of vegetation (Klamath Tribes 1996, Cooperman and Markle 2004). The term "emergent vegetation" refers to plants that are rooted in lake sediment, with tops extending above the water. Cattails and bulrushes are common examples of emergent vegetation. Larvae do not appear to use submerged vegetation as an alternative to emergent vegetation, primarily because submerged vegetation is slow to develop in the spring and therefore is largely not available early in the summer when larvae are present (Cooperman and Markle 2004).

Emergent vegetation along lakeshore areas is believed to be particularly important larval habitat for several reasons. Emergent vegetation provides cover from predators, and also provides habitat for sucker food items such as zooplankton, macroinvertebrates, and periphyton (the community of microscopic organisms that live on submerged surfaces in aquatic environments) (Klamath Tribes 1996, Cooperman and Markle 2004, Markle and Dunsmoor 2007). Emergent wetlands also may provide protection from currents and turbulence; and water temperatures can be higher in emergent vegetation so larvae likely grow faster.

Juveniles suckers use relatively shallow (less than about 1.2 meters), vegetated and un-vegetated shoreline with a variety of substrate types ranging from cobble to mud (Hendrixson *et al.* 2007). Adult suckers use water depths of 1 to 4.5 meters, but prefer depths of 1.5 to 3.4 meters (Reiser *et al.* 2001, NRC 2004), and spawn in streams and rivers or lakes, as described above. Sub-adults are assumed to be similar to non-spawning adults in their requirements and habits (NRC 2004).

Conservation Measures

Since the early 1990's, the Service, Reclamation, State of Oregon, Klamath Tribes, other partners, and private landowners have been working to improve water quality and aquatic habitat conditions in the Upper Klamath Basin and to make progress towards the recovery of the Lost River and shortnose suckers. The Service and its partners have supported approximately 400 habitat restoration projects in the Upper Klamath Basin, including 50 wetland and 150 riparian projects. The cost of these projects has been shared by many entities, including State and Federal programs such as Partners for Fish and Wildlife, Hatfield Restoration, Jobs in the Woods, and Oregon Resources Conservation Act programs as well as private grant programs and contributions from landowners.

Major habitat restoration efforts focusing on endangered suckers have been completed or initiated. These include: (1) restoration of over 25,000 acres of wetlands adjacent to Upper Klamath Lake and in the watershed above the lake; (2) removal of Chiloquin Dam; (3) screening of the outlet of Clear Lake Dam; (4) construction of a new fish ladder at Link River Dam; (5) screening of the main irrigation diversion of the Klamath Project (A-Canal); (6) 13 fish passage improvement projects, including screening and fish ladders; and many other actions.

Wetland Restoration

Restoration of the Williamson River Delta, approximately 6,500 acres of open water, deep water wetland, riparian/wet prairie, and upland plant communities is expected to provide substantial benefits toward the recovery of sucker populations in Upper Klamath Lake (see Figure 1). Based on pilot wetland restoration projects at River Bend and Goose Bay, restoration and reconnection of wetlands at the Williamson River Delta are expected to provide good habitat for larval suckers increasing survivorship and reducing vagrancy and dispersal out of Upper Klamath Lake where survival is currently minimal (Hendrixson 2006 and 2007, Markle *et al.* in review).

Levees surrounding The Nature Conservancy (TNC) property keep lake and river water from flooding former agricultural lands inside the levees. The agricultural lands within the levees have subsided through the years as a result of repeated cultivation of organic soils. TNC has attempted to restore wetland vegetation prior to levee removal by active water management of isolated fields. At present, TNC estimates approximately 1,000 acres of emergent wetlands will remain in 2008 following levee breaches on the Tulana Farm property which was breached in fall 2007 (Elseroad 2004, M. Barry, pers. comm. 2007). Elseroad (2004) estimated the surface area to be colonized by emergent vegetation after several years as 2,640 acres for the entire Lower Williamson River Delta (Tulana and Goose Bay). The estimated 2,640 acres of emergent vegetation yet to establish on the Williamson River Delta is a large increase from previous areas of emergent vegetation there, which was only about 15 acres (Dunsmoor *et al.* 2000). Should only a fraction of this habitat be used by larval and juvenile suckers, the habitat increase could result in increased survivorship and numbers of sucker at the two earliest life history stages. This becomes especially true if habitat has been a limiting factor for sucker survivorship in Upper Klamath Lake.

Agency Lake Ranch and the Barnes properties (9,700 acres) along the northern and northwestern shores of Agency Lake have been acquired by Reclamation and used as water storage areas. The properties will be managed by the Service as an addition to Upper Klamath National Wildlife Refuge. Levees along these properties are likely to be breached within the next 10 years. Emergent wetland plant communities have reestablished over the last several years with seasonal flooding and draining (USBR 2007). However, because of subsidence much of the property will be too deep to maintain emergent wetland vegetation (>5 feet deep) and will become open water habitat. At maximum lake elevation only about 820 acres are likely to be suitable for the development of emergent vegetation, based on depth preferences of local emergent plant species distributed around Upper Klamath Lake (Watershed Sciences 2007, Elesroad 2004). It is not understood how suckers will use these future wetland habitats on the Agency Lake Ranch and Barnes properties.

Chiloquin Dam Removal

In 2008, Reclamation and Bureau of Indian Affairs removed the Chiloquin Dam near the confluence of the Sprague and Williamson Rivers. This will increase fish access to habitats in the Sprague River watershed as far upstream as Beatty (river kilometer [rkm] 120) where sucker spawning and rearing have been recently documented (Tyler *et al.* 2007, Ellsworth *et al.* 2007). Although continued monitoring will determine the impact of dam removal on suckers in the watershed, the anticipated benefits of dam removal are increasing access to spawning areas at least 118 rkm upstream. A redistribution of spawning suckers from the lower 2 km of the Sprague River below Chiloquin Dam to spawning habitats in the Chiloquin Narrows (rkm 2-13), Ninemile Creek area (rkm 30-32), S'Ocholis Canyon (rkm 47-52), and Beatty Gap (rkm 112-120), and possibly the lower Sycan River (rkm 0-15), may increase sucker production if spawning habitat in the lower Williamson and Sprague Rivers below Chiloquin Dam was a limiting factor to survival of fertilized eggs (see Figure 1). Furthermore, redistribution of spawning suckers could reduce hybridization rates and limit risks associated with catastrophic events, such as flood scour, that can adversely impact concentrated spawning.

Sprague River Habitat Restoration

The Service, NRCS, and other state and local entities have focused watershed restoration and land and water conservation activities in the Sprague River watershed since 2002 (D. Ross, pers. comm. 2007; J. Regan-Vienop, pers. comm. 2007). There have been approximately 500 acres of wetland restored, 100 miles of riparian fencing installed, 5 miles of river channel realigned, and four spring complexes reconnected and enhanced. Approximately, 3,000 acres of floodplain habitat has been enrolled in permanent easements under the Wetland Reserve Program and Conservation Reserve Enhancement Program Program. NRCS has restored over 2,000 acres of wetland habitat and conservation of over several thousand acre-feet of on-farm water. More than 70 percent of the private lands in the Sprague River Valley are partnering with local, state, and Federal agencies on land conservation and natural resource actions (D. Ross, pers. comm. 2007).

Fish Passage Improvements
Reclamation has made significant progress on reducing entrainment and improving fish passage at Federally-owned facilities since the last Klamath Project BO issued in 2002. Reclamation formed the Klamath Fish Passage Technical Committee (KFPTC) in 2002 to help guide efforts to install Federal and State approved fish screens and/or ladders on the Klamath Project and in the Upper Klamath Basin. The KFPTC, composed of biologists, engineers, and water users, have met several times per year to discuss, review, plan, and design fish screen/passage issues and concepts.

A-Canal Fish Screen and Fish Bypass Facility
Reclamation completed construction of a state-of-the-art fish screen at the entrance to the A-Canal in Upper Klamath Lake in March 2003 to reduce the high rates of fish entrainment known to occur at this diversion site. Lost River and shortnose suckers larvae and juvenile life stages were particularly vulnerable to entrainment at A-Canal before the screen was installed (Gutermuth *et al.* 1998, 2000).

3.5. Modoc sucker, *Catostomus microps*

Listing Status and Critical Habitat

The Modoc sucker, *Catostomus microps*, was listed as endangered with critical habitat on June 11, 1985. At the same time, critical habitat was designated for the Modoc Sucker in Modoc County, California to include a total of approximately 26 miles of the streams and a 50-foot riparian zone on either side of the stream channel. There is no critical habitat for the Modoc sucker in Oregon because the species was not known to occur there at the time critical habitat was designated. The constituent elements for critical habitat listed in the final rule include: (1) intermittent and permanent water; and (2) surrounding land areas that provide vegetation for cover and protection from erosion (USFWS 1985a). A recovery plan is not available for the Modoc sucker. However, recovery strategies and actions are outlined in an Action Plan for the Recovery of the Modoc Sucker that was signed in 1984; refer to section 4.5 for a more detailed discussion.

Life History

The Modoc sucker is a relatively small member of the sucker family (*Catostomidae*), generally maturing around 3-4 inches, and usually reaching only 7 inches in total length. Rutter differentiated the Modoc sucker from the sympatric Sacramento Sucker, *C. occidentalis*, and the nearby Klamath largescale sucker, *C. snyderi*, by its small eye, small conical head, small scales and a nearly closed frontoparietal fontanelle (Rutter 1908). Martin (1967, 1972) further characterized the morphometric and meristic characters and elucidated osteological differences in the jawbones of the two species. Subsequent authors and researchers have differentiated the two species primarily by lateral line scale and dorsal fin ray counts, or locality.

The similarity in non-breeding coloration and external morphology between Modoc and Sacramento suckers have made it difficult to field-identify specimens visually without the excessive handling necessary for meristic counts. Differentiation of the two species has been further confused by dependence on relatively few Modoc sucker specimens for the analysis of meristic characters. Recent analysis of an extensive data set of several hundred Modoc and Sacramento suckers, suggests that there is natural overlap in the meristic counts for the two species, and that the actual range for the Modoc sucker is 73-91 lateral line scales and 9-12 dorsal rays (Kettratad 2001).

Non-breeding coloration is similar in both sexes and is similar to Pit River Sacramento suckers of similar size (Moyle 2002). The back varies from greenish brown through bluish to deep grey and olive. The sides are lighter with generalized mottling, and usually with 3-4 darker blotches along the sides, which are also evident in immature Sacramento Suckers. The belly is white to cream or yellowish but unmarked and the caudal and paired fins are light yellow-orange.

Breeding coloration is particularly marked in males, which develop a strong reddish-orange lateral stripe and intensified orange coloration on the caudal fin and paired fins (Moyle 2002). Some spawning males develop strong counter-shading, with a dark back and light belly (S. Reid, pers. obs.). The lower limit of the dark dorsal coloration is about one width of the orange lateral band below the lateral line and about at (or slightly below) the level of the bottom of the eye, such that the orange lateral band is bounded by dark coloration above and below. This line of demarcation is also evident in males exhibiting a more blotchy coloration pattern intermediate to that of non-spawning individuals. Spawning males also develop extensive tuberculation on various parts of the body and fins, which varies between individuals and perhaps state of readiness to spawn. Females occasionally exhibit a weak, dull orange lateral stripe and reduced tuberculation on the fins.

Distribution

At the time of listing in 1985, the historical range of the Modoc sucker was thought to be limited to Ash and Turner sub-drainages, which are small tributaries of the Pit River in Modoc and Lassen counties, California (USFWS 1985a, Figure 2). However, it is now recognized that the historical range of the Modoc sucker also includes the Goose Lake sub-basin in southern Oregon and northern California, a currently disjunct, upstream sub-basin of the Pit River (Reid 2007a, Figure 2). Goose Lake has been hydrologically disconnected from the Pit River since the 1800's because it has not substantially overflowed into the North Fork of the Pit River since occasional events in the 1800's (Laird 1971). Although the California and Oregon populations are isolated, the Modoc sucker population in the Goose Lake sub-basin is morphologically and genetically similar to the populations in the Pit River (Dowling 2005a; Topinka 2006; Reid, unpub. data 2008).

The distribution of the Modoc sucker within its natural range currently includes populations in ten streams in three sub-drainages (Reid 2008b, Figures 2 and 3). At the time of listing, the distribution of the Modoc sucker was considered to be restricted to the Turner and Ash Creek sub-drainages of the Pit River in California (*i.e.,* Turner, Hulbert and Washington creeks [all tributaries to Turner Creek], and Johnson Creek [a tributary of Rush Creek]). The original listing also recognized four additional creeks (Ash, Dutch Flat, Rush, and Willow creeks) as having been occupied historically. However, these populations were presumed lost due to hybridization with Sacramento suckers (*Catostomus occidentalis*), although there was no genetic corroboration of hybridization available at that time (Ford 1977, Mills 1980, USFWS 1985a).

The Service is currently aware of three additional populations not considered in the original listing (*i.e.,* Coffee Mill and Garden Gulch creeks in the Turner sub-drainage and Thomas Creek in the Goose sub-basin), and has revised information on the four populations considered lost to hybridization in 1985. The seven populations that were not considered as occupied in the 1985 distribution are reviewed below. The Thomas Creek population is in the Goose Lake sub-basin of Oregon; all of the other populations are in the Pit River sub-basin in California.

1. **Coffee Mill Creek** – In 1987, CDFG transplanted twenty Modoc suckers from Washington Creek to Coffee Mill Creek, a tributary of Washington Creek (Figure 2) that appeared to have suitable habitat but was considered historically fishless due to a possible high gradient barrier at its mouth. The transplant included 12 adults and 8 juveniles, and was intended to establish an additional population in the Turner Creek drainage (CDFG 1986). Modoc suckers appear to be well established and relatively abundant in Coffee Mill Creek; spawning adults and juvenile suckers have been consistently observed there during recent visual surveys (Reid 2008b).

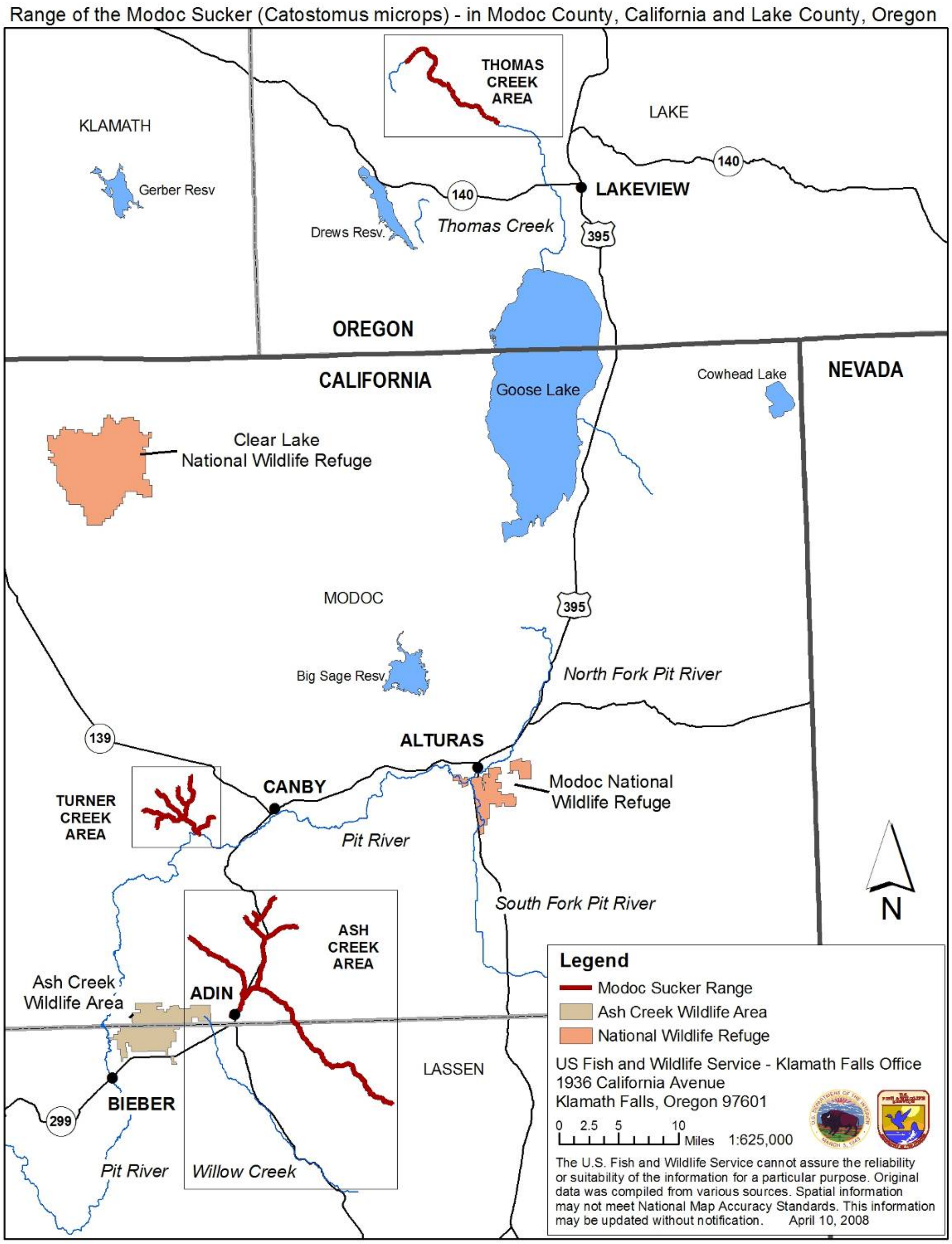

Figure 2. Map showing Modoc sucker range in Lake County, Oregon and Modoc and Lassen counties, California.

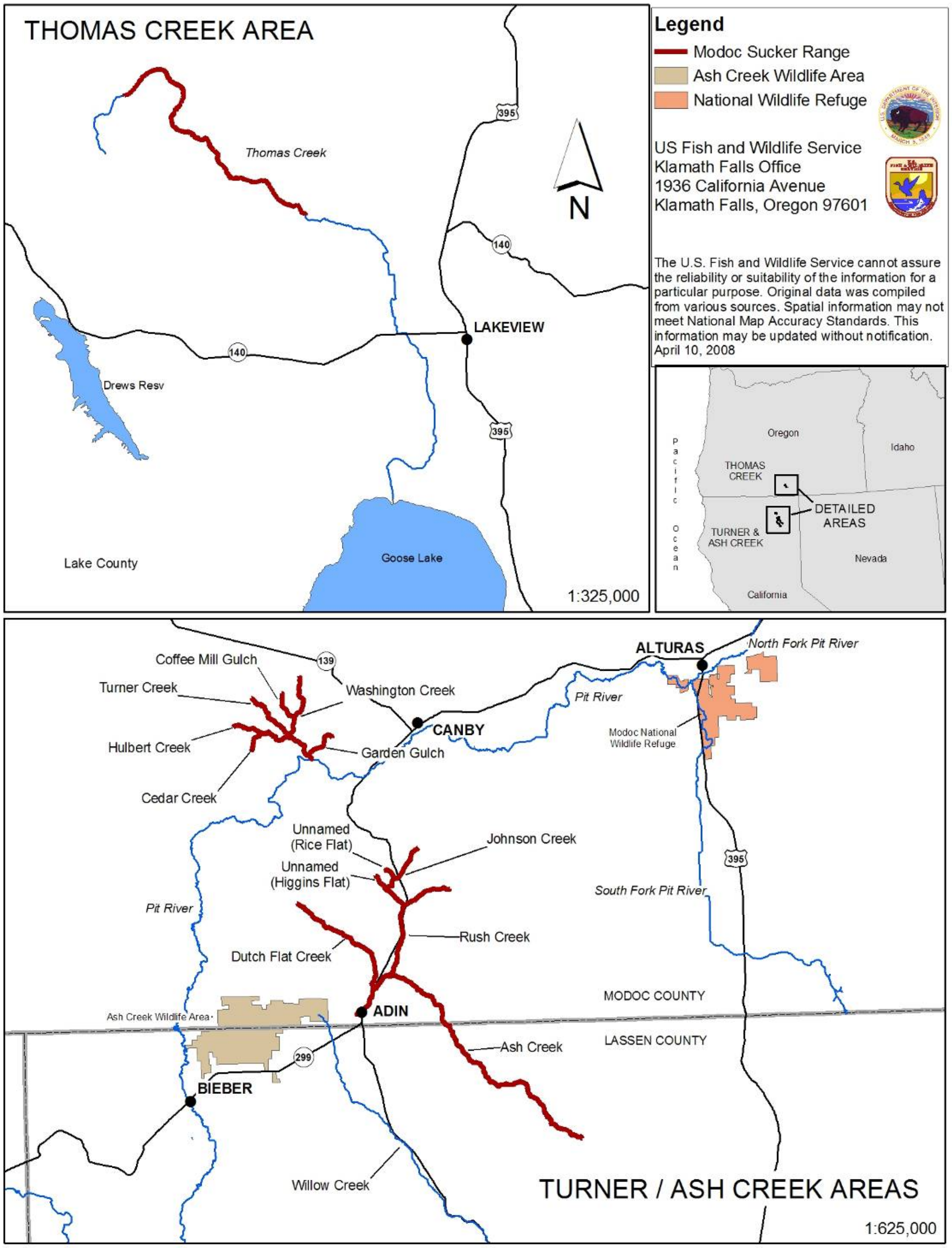

Figure 3. Map showing detailed distribution of the Modoc sucker in the Thomas Creek drainage, Oregon, of the Goose Lake sub-basin and the Turner/Ash Creek drainages, California, in the upper Pit River sub-basin.

2. **Garden Gulch** – A previously unreported population of Modoc suckers has been found in Garden Gulch, a small tributary of Turner Creek near its confluence with the Pit River and about two miles downstream of Hulbert and Washington Creeks (Reid, unpub. data 2001; Moyle 2002; Topinka 2006, Figure 2). Garden Gulch contains

about 1 mile of suitable habitat. The population was estimated at about 50, 1+ year-old Modoc suckers (Reid 2008c).

3. **Thomas Creek –** At the time of listing, the historical range of the Modoc sucker was thought to have been limited to small streams tributary to the Pit River in Modoc and Lassen counties, California (USFWS 1985a, Figure 2). However examination of the Oregon State University fish collection revealed several lots of Modoc suckers collected in Thomas Creek that were misidentified as Sacramento suckers (S. Reid, pers. comm. 2001). Modoc sucker specimens were found in collections from five sites on Thomas Creek and included collections from 1954, 1974, 1993 (two collections), and 1997.

   In 2007, surveys confirmed that Modoc suckers were present throughout at least 14 miles of upper Thomas Creek (Reid 2007a, Heck *et al.* 2008). Surveys focused on all principal Oregon streams in the Goose Lake Basin within the known elevational range (4900-5700 feet) of the Modoc Sucker population in Thomas Creek to determine the distribution of the Modoc and Sacramento suckers. The results of these surveys indicate that Thomas Creek holds the only substantial population of Modoc Suckers occupying higher elevation streams (>4900 feet) outside the distribution of the Goose Lake sucker (*Catostomus occidentalis lacusanserinus*, a sub-species of the Sacramento sucker found in the Goose Lake drainage). Modoc suckers were found only in Thomas Creek, where they were continuously distributed and relatively common, from 4900 feet (lower survey limit at the waterfall) up to 5840 feet above Cox Flat, a distance of 14.2 miles. This extended the Modoc sucker's distribution in Thomas Creek by 2.0 miles and 140 feet of elevation. Modoc suckers may extend farther upstream at lower densities or during other seasons. Goose Lake suckers were found in the lower reaches of nine streams, with an elevational upper limit ranging from 4880-5265 feet. No Goose Lake suckers were, or have been, collected from the surveyed reach of Thomas Creek above the waterfall however, there is evidence that the distribution of Modoc suckers extends farther downstream onto the valley floor in Thomas Creek and its tributaries (S. Reid, pers. comm. 2008).

4. **Dutch Flat Creek** – Recent collections and preliminary genetic analysis indicate that, 23 years after the original listing, Modoc suckers in Dutch Flat Creek (tributary to Ash Creek) exhibit little introgression (the entry or introduction of an allele from one population into another, as by hybridization between species) of Sacramento sucker alleles (Topinka 2006).

5. **Ash Creek** – Thirty years after previous collections (Moyle and Marciochi 1975, Moyle and Daniels 1982), suckers exhibiting the morphological characteristics of Modoc suckers are still present in Ash Creek; however, based on genetic analysis, there is considerable introgression with sympatric (occurring in the same streams) Sacramento suckers in this population (Topinka 2006; Reid, unpub. data 2002, Figures 2 and 3). Sacramento suckers have also been reported from upper Ash Creek since 1963, and were collected from about 10 miles downstream in 1898, with no intervening barriers (Miller 1963, Rutter 1908, Reid 2008a). Therefore it is believed that Sacramento suckers have not recently invaded the Ash Creek system and that the observed introgression is a historically natural phenomenon. Due to its unique

introgressed character and full sympatry with Sacramento suckers, the Ash Creek population is treated herein as an extant population, but for the purpose of evaluating the status of the species, it is not included in counting secure populations, because it is uncertain how genetically secure this population is.

6. **Rush Creek** – Rush Creek is a tributary to Ash Creek (Figure 3), and contains the type locality of the Modoc sucker. Visual surveys there indicate that Modoc suckers still occupy the historically occupied reaches (Reid 2008b), and there has been no change in the fish fauna or replacement with warm-water fishes that would likely be associated with Sacramento suckers (*e.g.,* Sacramento pikeminnow [*Ptychocheilus grandis*], hardhead [*Mylopharodon conocephalus*], and non-native sunfishes [family Centrachidae]; Moyle and Daniels 1982).

7. **Willow Creek** – Surveys and collections in Willow Creek (Lassen County, tributary to Ash Creek; Figure 3) in the early 1970's and more recently in 2000, 2002, and 2008 have encountered only Sacramento suckers; although, some Modoc sucker genetic markers are present in the population (Moyle and Daniels 1982; Reid 2007b, 2008b; Topinka 2006). Previous reports of Modoc suckers in Willow Creek are based on limited and unverifiable reports (Reid 2008b). Therefore, it is unknown if a population of Modoc suckers was present in Willow Creek in the recent past, and for the purpose of this status review, Willow Creek is not considered to contain an extant population of Modoc suckers.

Population Dynamics

There have been five attempts to estimate the population sizes of the Modoc sucker (Table 2). All of these surveys were for populations in the Pit River drainage of California; no population size estimates are currently available from the Oregon portion of the range.

At the time of listing in 1985, it was thought there were less than 5,000 Modoc suckers, of which only an estimated 1,300 were considered genetically "pure," the remainder being treated as hybrids with Sacramento suckers (USFWS 1985a). These estimates were based on limited sampling and visual surveys along with qualitative estimates of un-surveyed stream reaches or populations (Moyle 1974, Ford 1977).

Table 2. Comparison of Pit River system Modoc Suckers population estimates.

Stream Drainage	**Estimated Population Size**				
	Moyle 1974	Ford 1977	White 1989	Scoppettone *et al.* 1992	Reid 2008
Turner Creek Drainage	100	-	-	640+	552+
Turner	-	100	-	249+	265+
Washington	-	50	-	230	100+
Coffee Mill	-	-	-	50	106+
Hulbert	-	500	-	106	31+
Garden Gulch	-	-	-	-	~50
Ash Creek Drainage	-	-	-	-	-
Johnson	3,163	700	-	653	128+
Rush	535	1,000		-	-

Stream Drainage	Estimated Population Size				
	Moyle 1974	Ford 1977	White 1989	Scoppettone *et al.* 1992	Reid 2008
Dutch Flat	-	40	133-358	1,300+	101+
Ash	300	200	-	-	-
Willow	-	15[3]	-	-	0

Moyle (1974) suggested that the total number of Modoc suckers in the known populations was unlikely to exceed 5,000 individuals (Table 2). This was based on his 1973 sampling of 124 stream sections (mostly about 108 feet long), primarily focused on the Rush Creek drainage (67 reaches). He estimated a population size of 3,500 Modoc suckers for most of the Rush Creek drainage, plus an additional 150 to 200 suckers in un-sampled irrigation ditches off lower Rush Creek. There was considerable uncertainty in the exact population size because the standard deviations reported generally exceeded the estimates owing to high variance in counts from each segment. Also, too few samples were taken in other streams to quantify populations. No population estimates are available from Thomas Creek in the Goose Lake sub-basin. However, Moyle estimated probably less than 300 Modoc suckers in Ash Creek and less than 100 in the entire Turner Creek drainage.

Ford (1977) estimated a total population of 2,600 Modoc suckers, with about half occurring on USFS-managed lands (Table 2). His estimates included all known populations, including: Willow (15), Ash (200), Dutch Flat (40), Rush (1,000), Johnson (700), Turner (100), Hulbert (500) and Washington (50). Mills (1980), who was cited in the 1985 listing, did not actually survey, but cited Moyle (1974) and Ford (1977), then reduced the estimate of what he considered "pure" Modoc suckers to 1,250 (including only those from Hulbert, Washington, and Johnson Creeks) based on an assumption that all Modoc sucker populations sympatric with Sacramento suckers were lost as a result of hybridization.

Two additional attempts to estimate Modoc sucker population sizes were made by in the 1980s and 1990s by Scoppettone *et al.* (1992) and White (1989). Scoppettone *et al.* (1992) carried out preliminary surveys in the Turner Creek drainage, Johnson Creek, and Dutch Flat Creek near the end of a substantial drought. They primarily surveyed visually from the bank, with snorkel surveys in the lower reaches of all but Dutch Flat Creek. Suckers were counted but not identified to species; however, it is reasonable to assume that most of the suckers, with the exception of those in the lowest stratum of Turner Creek, were Modoc suckers. Excluding the lower Turner stratum ("Stratum 6"), they counted a minimum of 640 suckers in the upper Turner drainage, over 1,300 suckers in Dutch Flat Creek, and 650 suckers in Johnson Creek. This results in a very conservative total of over 2,600 Modoc suckers, not including Garden Gulch, Rush, or Ash creeks (Table 1).

The results of surveys done in the Turner Creek drainage and in Johnson Creek in 1992 by Scoppettone *et al.* (1992) suggest that the Modoc sucker populations in those systems had remained relatively stable, when compared to estimates by Ford (1977), and were much higher than those estimated by Moyle (1974) for the entire Turner Creek system (including Hulbert, Washington, and Coffee Mill creeks). A one-day survey of Dutch Flat Creek by White (1989) counted 130 definite suckers and 225 probable suckers, and Scoppettone *et al.*'s 1992 estimate

[3] These 15 suckers are most likely Sacramento suckers based on their morphology (Reid 2007b, 2008b).

for the Dutch Flat population substantially exceeded Ford's (1977) estimate of 40 individuals by over 1,200 individuals.

Reid (2008d) recently developed a survey protocol that has several advantages over previous methods, and it was used in 2008 to survey for Modoc suckers in the Pit River portion of the range (Reid 2008c, Table 2). The surveys were done at night and counts were made of ≥ 2.4 inches standard length (distance between the snout and caudal peduncle) (1+ year old) because they are more visible and more readily identified than smaller fish. Although the surveys were done at night when suckers are most visible, the numbers are minimums, because it is likely that some suckers were not seen.

Population estimates by Reid (2008e) are similar to those of Scoppettone *et al.* (1992) for most streams. The primary exception is Dutch Flat where Scoppettone *et al.* (1992) had estimated >1,000 individuals and Reid (2008e) estimated approximately 100 individuals. It is not known what accounts for these differences, but it could be due to differences in sizes of suckers counted by the two researchers. Scoppettone *et al.* (1992) counted all suckers regardless of size, whereas Reid (2008e) only counted those estimated to be ≥ 2.4 inches standard length. Therefore it is likely that the higher counts by Scoppettone *et al.* (1992) were due to the inclusion of the more numerous young-of-the-year suckers. Based on available habitat in Dutch Creek, Reid is skeptical that it could support many more 1+ year old Modoc suckers than he observed (S. Reid, pers. comm. 2009).

Although the population estimates presented in Table 2 are subject to error, they do suggest that the populations have been relatively stable over the 35 years that the species has been monitored. Additionally, as discussed below, the species has occupied most of the available habitat. These data suggest that the populations are resilient to threats such as drought and exotic predators that affect survival and reproduction.

Habitat Characteristics

Modoc suckers are primarily found in relatively small (second- to fourth-order), perennial streams. They occupy an intermediate zone between the high-gradient and higher elevation, coldwater trout zone and the low-gradient and low elevation, warm-water fish zone. Most streams inhabited by Modoc suckers (Turner and Ash creek drainages) are second- to fourth-order streams with moderate gradients (15-50 feet drop per mile), low summer flows (1-4 cubic feet per second), and relatively cool (59-72° F) summer temperatures (Moyle and Daniels 1982).

In the Pit River system, Modoc suckers occupy stream reaches above the Sacramento sucker/pikeminnow/hardhead zone of the main-stem Pit River and the lower reaches of its primary tributaries (Moyle and Marciochi 1975, Moyle and Daniels 1982). The known elevational range of Modoc sucker is from about 4,200 to 5,000 feet in the upper Pit River drainage (Ash and Turner Creeks) and from about 4,700 to 5,800 feet in the Goose Lake sub-basin (Reid 2007a,b). However, most known populations are constrained upstream by the effective limit of the permanent stream habitat. Only Rush and Thomas creeks extend substantially above the elevations occupied by Modoc suckers.

The pool habitat occupied by Modoc suckers generally includes soft to small cobble bottoms, substantial detritus, and abundant in-water cover. Cover can be provided by overhanging banks, larger rocks, woody debris, and aquatic rooted vegetation or filamentous algae. Larvae occupy shallow vegetated margins and juveniles tend to remain free-swimming in the shallows of large pools, particularly near vegetated areas, while larger juveniles and adults remain mostly on, or close to, the bottom (Martin 1967, 1972; Moyle and Marciochi 1975).

Modoc suckers often segregate themselves along the length of a stream by size with larger individuals being more common in lower reaches of streams. This may indicate a temperature-growth relationship or it may indicate that larger Modoc suckers move downstream into larger, deeper, warmer pool habitats as they outgrow the relatively limited habitat in upper stream reaches. Spawning often occurs in the lower end of the pools over gravel-dominated substrates containing gravels, sand, silt and detritus. Intermittent tributaries are apparently also used for spawning, when these habitats are available. The limited number of observations and the diversity of the observation sites limits the extent to which specific spawning habitat requirements can be characterized, other than to reinforce the overall importance of gravel substrates and relatively low energy habitat.

Spawning occurs in the spring from mid-April through early June, with localized spawning activity restricted to 3-4 weeks (Martin 1967; Moyle and Marciochi 1975; Boccone and Mills 1979; S. Reid, pers. obs.). In some years, suckers do not even become apparent in visual observations of spawning pools until May (Johnson Creek, Washington Creek and Garden Gulch), suggesting that inter-annual flow and/or temperature differences may influence timing of spawning activity (S. Reid, pers. obs. 2001-2003).

Because spawning and rearing habitats are relatively non-specific and common, suitable habitat is not considered limiting except during severe droughts. There are approximately 40 miles of suitable habitat within their range and most of that is occupied (see Table 3).

Table 3. Comparison of available and occupied perennial habitat of Modoc sucker.

Drainage: Stream	Available Habitat (miles)[4]	Occupied Habitat 2008 (miles)
Turner Creek Drainage:		
Turner	5.5	5.5
Washington	4.5	3.4
Coffee Mill	1.5	0.8
Hulbert	~ 3.0	~3.0
Garden Gulch	0.3	1.0
Ash Creek Drainage:		
Johnson	2.7+	2.7
Rush	4.6	4.6
Dutch Flat	~ 2.0	~1.4
Ash	?	~2.0
Willow	?	?
Goose Lake Drainage:		
Thomas Creek (above the falls)	15.2+	15.2

[4] A plus (+) sign indicates that additional habitat is present but has not been surveyed.

Drainage: Stream	Available Habitat (miles)[4]	Occupied Habitat 2008 (miles)
Thomas Creek (below the falls)	~5.0+	~5
Totals	**>40**	**>40**

Source: Reid 2008b

Modoc suckers appear to be opportunistic feeders, similar to other catostomids, feeding primarily on algae, small benthic invertebrates, and detritus (Moyle 2002). Moyle and Marciochi (1975) reported the digestive tracts contained detritus (47 percent by volume), diatoms (19 percent), filamentous algae (10 percent), chironomid larvae (18 percent), crustaceans (mostly amphipods and cladocerans; 4 percent), and aquatic insect larvae (mostly tricopteran larvae, 2 percent). The contents suggest that the suckers were feeding in low-energy pool environments, where detritus settles and chironomids live.

Although no comprehensive study of activity patterns has been done for Modoc suckers, they do appear to exhibit both diurnal and seasonal differences in activity. They are most active, and visible to creek-side observers, later in the morning and through the afternoon. At this time they are frequently seen foraging on the substrate (including rocks) and along submerged plant stems (Reid 2008b). While they spend much of their time apparently resting on the bottom, they are quick to swim away and respond to disturbance, but even during undisturbed observations, they frequently change positions and locations within a pool. In contrast, extensive night snorkeling observations indicate that Modoc suckers are resting and relatively somnolent after dusk (Reid 2008b).

Genetics

In 1999, the Service initiated a program to examine the genetics of suckers in the upper Pit River drainage (including Goose Lake) and determine the extent and role of hybridization between the Modoc and Sacramento suckers (discussed below under Factor E) using both nuclear and mitochondrial genes (Palmerston *et al.* 2001 – allozymes; Wagman and Markle 2000 – nuclear genes; Dowling 2005a – mitochondrial genes; Topinka 2006 – nuclear amplified fragment length polymorphisms (AFLP's); Abernathy Fish Technology Center [FTC], unpubl. data 2008– microsatellites). The results from all approaches indicate that the two species are genetically similar, suggesting that they are relatively recently differentiated and/or have a history of introgression throughout their range that has obscured their differences (Wagman and Markle 2000, Dowling 2005a, Topinka 2006). Although the available evidence does not allow rejection of either hypothesis, the genetic similarity in all three sub-drainages, including those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006; Abernathy Fish FTC, unpubl. data 2008), suggests that introgression has occurred on a broad temporal and geographic scale and therefore is not a localized or recent phenomenon caused or affected by human activities.

A phylogenetic analysis using mitochondrial DNA placed Modoc and Sacramento suckers in the same lineage, distinct from neighboring sucker species, but did not distinguish the two morphological species, suggesting either recent divergence or the broad replacement of one species' mitochondrial genome by that of the other (Dowling 2005a). The analysis did, however, identify geographic patterns of distinctiveness between the three sub-drainages examined (*i.e.,* Ash, Turner, Goose), suggesting relatively low levels of genetic exchange.

The analyses using nuclear AFLP's and faster evolving microsatellites also show differences between sub-drainages (Topinka 2006; Abernathy FTC, unpubl. data 2008). However, they further identified consistent species-specific alleles (different forms of a gene) indicating reproductive independence in the two species. Therefore, the available evidence supports the distinctiveness of the two species and the management of the three sub-drainage populations of Modoc sucker as separate units.

Preliminary microsatellite results indicate that the amount of genetic diversity observed within populations of Modoc suckers (as measured by allelic diversity at 8 microsatellite loci) is similar to, but slightly lower than, that observed in Sacramento suckers (Abernathy FTC, unpubl. data 2008). This result is reassuring given that Modoc sucker populations are considerably smaller than Sacramento sucker populations and that the samples of the latter were pooled from large populations at multiple sites along the upper Pit River.

3.6. Oregon chub, *Oregonichthys crameri*

Listing Status and Proposed Critical Habitat

The Service listed the Oregon chub as an endangered species on October 18, 1993 (USFWS 1993c). A final recovery plan for the Oregon chub was published in the Federal Register on September 03, 1998 (USFWS 1998d). In 2008, the Service completed a 5-year review of the Oregon chub, concluding that downlisting criteria had been met and the species should be down listed to threatened (USFWS 2008d). A proposal to downlist the Oregon chub is expected by the Service in 2009.

A proposed critical habitat rule for the Oregon chub was published in the Federal Register on March, 10, 2009 (USFWS 2009). In the proposed rule, the Service determined that 25 units totaling approximately 53.5 ha (132.1 acres) in Benton, Lane, Linn and Marion counties meet the proposed definition of critical habitat. Land ownership of the proposed critical habitat is as follows: 13.3 ha (32.9 acres) private, 12.2 ha (30.11 acres) state, 26.8 ha (66.3 acres) Federal and 1.2 ha (2.8 acres) other governmental lands. As proposed, the PCEs of Oregon chub critical habitat are the habitat components that provide:

1. Off-channel water bodies such as beaver ponds, oxbows, side-channels, stable backwater sloughs, low-gradient tributaries, and flooded marshes, including at least 500 continuous square meters (0.12 acres) of surface area and depths between approximately 0.5 and 2.0 m (1.6 and 6.6 ft).

2. Aquatic vegetation covering a minimum of 250 square meters (0.06 ac) (or between approximately 25 and 100 percent of the total surface area of the habitat). This vegetation is primarily submergent for purposes of spawning, but also includes emergent and floating vegetation, and algae, which is important for cover throughout the year. Areas with sufficient vegetation are likely to also have the following characteristics:

    a. Gradient less than 2.5 percent;

b. No or very low water velocity in late spring and summer;
c. Silty, organic substrate; and
d. Abundant minute organisms such as rotifers, copepods, cladocerans, and chironomid larvae.

3. Late spring and summer subsurface water temperatures between 15 and 25 °C (59 and 78 °F), with natural diurnal and seasonal variation.

4. No or negligible levels of nonnative aquatic predatory or competitive species. Negligible is defined for the purpose of this proposed rule as a minimal level of nonnative species that will still allow the Oregon chub to continue to survive and recover.

Species Description

The Oregon chub is a small minnow (Family: *Cyprinidae*) with an olive-colored back grading to silver on the sides and white on the belly. Scales are relatively large with fewer than 40 occurring along the lateral line and scales near the back are outlined with dark pigment (Markle *et al.* 1991, Bond 1994). Adults are typically less than nine centimeters (3.5 inches) in length. Several size classes of Oregon chub have been collected. Young of the year are 7 to 32 millimeters (0.25 to 1.25 inches), those presumed to be 1-year old are 33 to 46 millimeters (1.25 to 1.75 inches), those presumed to be 2-years old are 47 to 64 millimeters (1.75 to 2.5 inches), and those presumed to be 3-years old are more than 65 millimeters (2.5 inches) (Pearsons 1989). The largest Oregon chub on record was collected from the Santiam River and measured 89 millimeters (3.5 inches) (Scheerer *et al.* 1995).

Life History and Habitat Needs

The Oregon chub is endemic to the Willamette River drainage of western Oregon. This species was formerly distributed throughout the Willamette River Valley in off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes (Snyder 1908). Historical records show Oregon chub were found as far downstream as Oregon City and as far upstream as Oakridge. Records of Oregon chub collections exist for the Clackamas River, Molalla River, Mill Creek, South Santiam River, North Santiam River, Luckiamute River, Long Tom River, McKenzie River, Calapooia River, Muddy Creek, Mary's River, Coast Fork Willamette River, Middle Fork Willamette River, and the mainstem Willamette River (Markle *et al.* 1991, Scheerer and McDonald 2000).

Based on a 1987 survey (Markle *et al.* 1989) and compilation of all known historical records, at the time of the petition for listing in 1991, viable populations of the Oregon chub occurred in Dexter Reservoir, Shady Dell Pond, Buckhead Creek near Lookout Point Reservoir, Elijah Bristow State Park, William L. Finley National Wildlife Refuge, Greens Bridge, and East Fork Minnow Pond. These locations represented a small fraction (estimated as two percent based on stream miles) of the species' formerly extensive distribution within the Willamette River drainage.

Of the known Oregon chub populations, the sites with the highest diversity of native fish, amphibian, and reptile species have the largest populations of Oregon chub (Scheerer and McDonald 2000). Beavers (*Castor canadensis*) appear to be especially important in creating and maintaining habitats that support these diverse native species assemblages (Scheerer and Apke 1998).

Oregon chub are found in slack water off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes. These habitats usually have little or no water flow, are dominated by silty and organic substrate, and contain considerable aquatic vegetation providing cover for hiding and spawning (Pearsons 1989, Markle *et al.* 1991, Scheerer and McDonald 2000). The average depth of habitat utilized by Oregon chub is less than six feet, and summer water temperatures typically exceed 61 °F.

Adult chub seek dense vegetation for cover and frequently travel in the mid-water column in beaver channels or along the margins of aquatic plant beds. Larval chub congregate in shallow near-shore areas in the upper layers of the water column, whereas juveniles venture farther from shore into deeper areas of the water column (Pearsons 1989). In the winter months, Oregon chub can be found buried in the detritus or concealed in aquatic vegetation (Pearsons 1989). Fish of similar size school and feed together. In the early spring, Oregon chub are most active in the warmer, shallow areas of the ponds.

Oregon chub spawn from April through September. Individuals are not known to spawn more than once a year. Spawning activity has only been observed at water temperatures exceeding 61 °F. Males over 35 millimeters (1.4) inches have been observed exhibiting spawning behavior (Pearsons 1989). Egg masses have been found to contain 147 to 671 eggs (Pearsons 1989).

Oregon chub are obligatory sight feeders (Davis and Miller 1967). They feed throughout the day and stop feeding after dusk (Pearsons 1989). Chub feed mostly on water column fauna. The diet of Oregon chub adults collected in a May sample consisted primarily of minute crustaceans including copepods, cladocerans, and chironomid larvae (Markle *et al.* 1991). The diet of juvenile chub also consists of minute organisms such as rotifers, copepods, and cladocerans (Pearsons 1989).

Population Dynamics

Since the time of listing, several Oregon chub populations have been extirpated, a number of new populations have been discovered, and there have been a number of successful introductions. According to ODFW's 2008 Monitoring Report, Oregon chub now occur at approximately 38 locations in the Santiam River, McKenzie River, Mid-Willamette River, Middle Fork Willamette River, Coast Fork Willamette River drainages (Bangs *et al.* 2008).

The Recovery Plan for the Oregon Chub (USFWS 1998d) established recovery criteria for downlisting the species to "threatened" and for delisting the species. The criteria for downlisting the species are: (1) establish and manage 10 populations of at least 500 adult fish; (2) all ten populations must exhibit a stable or increasing trend for five years; and (3) at least three populations meeting criterion 1 and 2 must be located in each of the three recovery areas (Middle Fork Willamette River, Santiam River, and Mid-Willamette River tributaries).

In 2006, there were 18 populations totaling 500 or more individuals (Sheerer *et al.* 2006). Thirteen of these populations also met the second recovery criteria. Of the 13 populations meeting recovery criteria 1 and 2, eight were located in the Middle Fork Willamette drainage, three were located in the Mid-Willamette River drainage, and two were located in the Santiam River drainage. In 2007, Oregon chub reached the downlisting criteria (from "endangered" to "threatened") outlined in the Oregon chub recovery plan (USFWS 1998d). Nineteen populations totaled 500 or more individuals and 15 of these populations also met the second recovery criteria. Of the 15 populations meeting recovery criteria 1 and 2, eight were located in the Middle Fork Willamette River drainage, four were located in the Mid-Willamette River drainage, and three were located in the Santiam River drainage (Scheerer *et al.* 2007b, USFWS 2008d).

Reasons for Listing and Threats

A variety of factors are likely responsible for the decline of the Oregon chub. These include habitat loss and alteration; the proliferation of non-native fish and amphibians; accidental chemical spills; runoff from herbicide or pesticide application on farms and timberlands or along roadways, railways, and power line rights-of way; the application of rotenone to manage sport fisheries; desiccation of habitats; unauthorized water withdrawals, diversions, or fill and removal activities; sedimentation resulting from timber harvest in the watershed, and possibly the demographic risks that result from a fragmented distribution of small, isolated populations (USFWS 1998d).

The establishment and expansion of non-native species in Oregon have contributed to the decline of the Oregon chub and limits the species' ability to expand beyond its current range. Many species of non-native fish have been introduced to, and are common throughout, the Willamette Valley, including largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), crappie (*Pomoxis* sp.), bluegill (*Lepomis macrochirus*), and western mosquitofish (*Gambusia affinis*). The bullfrog, a non-native amphibian, also occurs in the valley and breeds in habitats preferred by the Oregon chub (Hjort *et al.* 1984, Scheerer *et al.* 1992).

The current pattern of distribution and abundance of Oregon chub populations reflects the fundamental alteration in the natural processes under which the species evolved. Sites with Oregon chub can be categorized as having high or low connectivity to the Willamette River and its tributaries; those sites with low connectivity tend to have large populations of chub and fewer species of non-native fish (Scheerer *et al.* 2002). Thus, Oregon chub now thrive particularly in habitats that are isolated and bear little resemblance to the species' dynamic natural environment. Efforts to restore floodplain function and connectivity may facilitate the introduction of non-native fishes into isolated habitats, which could have devastating effects to populations of Oregon chub (Scheerer *et al.* 2002).

3.7. Fender's blue butterfly, *Icaricia icarioides fenderi*

Listing Status and Critical Habitat

Fender's blue butterfly was listed as endangered, without critical habitat, on January 25, 2000 (USFWS 2000a). Critical habitat for the Fender's blue butterfly was designated on October 6, 2006 (USFWS 2006c). A draft recovery plan that includes this species (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 (USFWS 2008b).

Critical habitat units have been designated in Benton, Lane, Polk and Yamhill counties, Oregon.

The PCEs of critical habitat for the Fender's blue butterfly are the habitat components that provide:

1. Early seral upland prairie or oak savanna habitat with undisturbed subsoils that provides a mosaic of low growing grasses and forbs, and an absence of dense canopy vegetation allowing access to sunlight needed to seek nectar and search for mates;

2. Larval host plants: *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine), *L. arbustus* (longspur lupine), or *L. albicaulis* (sickle-keeled lupine);

3. Adult nectar sources, such as: *Allium acuminatum* (tapertip onion), *Allium amplectens* (narrow-leaved onion), *Calochortus tolmiei* (Tolmie's mariposa lily), *Camassia quamash* (common camas), *Cryptantha intermedia* (clearwater cryptantha), *Eriophyllum lanatum* (common woolly sunflower), *Geranium oreganum* (Oregon geranium), *Iris tenax* (Oregon iris), *Linum angustifolium* (pale flax), *Linum perenne* (blue flax), *Sidalcea campestris* (meadow checker-mallow), *Sidalcea malviflora* ssp. *virgata* (rose checker-mallow), *Vicia cracca* (bird vetch), *V. sativa* (common vetch) and *V. hirsute* (tiny vetch); and

4. Stepping stone habitat: undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie, oak savanna plant community (well drained soils), within and between natal lupine patches (about 2 km [1.2 miles]), necessary for dispersal, connectivity, population growth, and, ultimately, viability. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the PCEs, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

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. Although the type specimen for this butterfly was collected in 1929, few collections were made between the time of the subspecies' discovery and Macy's last observation of the Fender's blue on May 23, 1937, in Benton County, Oregon (Hammond and Wilson 1992). Uncertainty regarding the butterfly's host plant caused researchers to focus their survey efforts on common lupine species known to occur in the vicinity of Macy's collections. Fifty years passed before the butterfly was found again.

Fender's blue butterfly was rediscovered in 1989 at the McDonald Research Forest, Benton County, Oregon; it was found to be associated primarily with *Lupinus sulphureus* ssp. *kincaidii*, a rare lupine, and occasionally *L. arbustus* or *L. albicaulis* (Hammond and Wilson 1993). Recent surveys have determined that Fender's blue butterfly is endemic to the Willamette Valley and persists at about 30 sites on remnant prairies in Yamhill, Polk, Benton and Lane counties (Hammond and Wilson 1993, Schultz 1996, Schultz *et al.* 2003, U.S. Fish and Wildlife Service unpublished data). Fender's blue butterfly populations occur on upland prairies characterized by native bunch grasses (*Festuca* spp.) The association of Fender's blue butterfly with upland prairie is mostly a result of its dependence on *Lupinus sulphureus* ssp. *kincaidii*, although Fender's blue butterfly often uses wet prairies for nectaring and dispersal habitat. Sites occupied by Fender's blue butterfly are predominantly located on the western side of the Willamette

Valley, within 33 km (21 miles) of the Willamette River. A recent synthesis of existing data found the current rangewide number of butterflies to be about 3,000 to 5,000 individuals (Schultz *et al*. 2003). Fewer than ten sites with populations of 100 adult butterflies or more are known. On 30 sites surveyed for Fender's blue butterfly on non-Federal lands between 2000 and 2007, the average estimated number of butterflies per site, averaged across years, was 144. The median number of butterflies (averaged across sites and years) was 51, with a low of 2 and a high of 1040 (U.S. Fish and Wildlife Service, unpublished data).

Life History and Ecology

Adult Fender's blue butterflies live approximately 10 to 15 days and apparently rarely travel farther than 2 km (1.2 miles) over their entire life span (Schultz 1998). Although only limited observations have been made of the early life stages of Fender's blue butterfly, the life cycle of the species likely is similar to other subspecies of *Icaricia icarioides* (Hammond and Wilson 1993). 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 10 to 15-day lifespan, of which perhaps fewer than two will survive to adulthood (Schultz 1998, Schultz *et al*. 2003). 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 (Ballmer and Pratt 1988). 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. Once diapause is broken, the larvae feed and grow through three to four additional instars, enter their pupal stage, and, after about two weeks, emerge as adult butterflies in May and June (Schultz *et al.* 2003).

Fender's blue butterflies have limited dispersal ability. Adult butterflies may remain within 2 km (1.2 miles) of their natal lupine patch (Schultz 1998), although anecdotal evidence exists of adult Fender's blues dispersing as far as 5 to 6 km (3.1 to 3.7 miles) (Hammond and Wilson 1992, Schultz 1998); dispersal of this magnitude is not likely anymore because of habitat fragmentation. At large patches like the main area at Willow Creek in Lane County, 95 percent of adult Fender's blue butterflies are found within 10 m (33 feet) of lupine patches (Schultz 1998).

Habitat Characteristics

Habitat requirements for Fender's blue butterfly include lupine host plants (*Lupinus sulphureus* ssp. *kincaidii* or *L. arbustus*, and occasionally *L. albicaulis*) for larval food and oviposition sites and native wildflowers for adult nectar food sources. Nectar sources used most frequently include *Allium amplectens*, *Calochortus tolmiei*, *Sidalcea malviflora* ssp. *virgata*, *Eriophyllum lanatum* and *Geranium oreganum* (Wilson *et al.* 1997, York 2002, Schultz *et al.* 2003). Non-native vetches (*Vicia sativa* and *V. hirsuta*) are also frequently used as nectar sources, although they are inferior to the native nectar sources (Schultz *et al.* 2003). Population size of Fender's blue butterfly has been found to correlate directly with the abundance of native nectar sources (Schultz *et al.* 2003). At least 5 ha (12 acres) of high quality habitat are necessary to support a population of Fender's blue butterflies (Crone and Schultz 2003, Schultz and Hammond 2003);

most prairies in the region are degraded and of low quality, and thus a much larger area is likely required to support a viable butterfly population.

Lupinus sulphureus ssp. *kincaidii* is the preferred larval host plant at most known Fender's blue butterfly populations. At two sites, Coburg Ridge and Baskett Butte, Fender's blue butterfly feeds primarily on *Lupinus arbustus*, even though *Lupinus sulphureus* ssp. *kincaidii* is present (Schultz *et al.* 2003). A third lupine, *Lupinus albicaulis*, is used by Fender's blue butterfly where it occurs in poorer quality habitats (Schultz *et al.* 2003). It is interesting to note that Fender's blue butterfly has not been found to use *Lupinus latifolius* (broadleaf lupine), a plant commonly eaten by other subspecies of *Icaricia icarioides*, even though it occurs in habitats occupied by the butterfly (Schultz *et al.* 2003).

Reasons for Listing

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 (USFWS 2000a).

The prairies of western Oregon and southwestern Washington have been overtaken by non-native plants, which shade out or crowd out important native species. Fast growing non-native shrubs (*Rubus armeniacus* [Armenian blackberry] and *Cytisus scoparius* [Scotch broom]), non-native grasses such as *Arrhenatherum elatius* (tall oatgrass), and non-native forbs, such as *Centaurea* x *pratensis* (meadow knapweed), can virtually take over the prairies, inhibiting the growth of the lupine larval host plants and native nectar sources (Hammond 1996, Schultz *et al.* 2003). When these highly invasive non-native plants become dominant, they can effectively preclude butterflies from using the native plant species they need to survive and reproduce (Hammond 1996). In the absence of a regular disturbance regime, native trees and shrubs also threaten to overtake prairie habitats; common native species found to encroach on undisturbed prairies include *Pseudotsuga menziesii* (Douglas-fir), *Quercus garryana* (Oregon white oak), *Fraxinus latifolia* (Oregon ash), *Crataegus douglasii* (Douglas' hawthorn) and *Toxicodendron diversilobum* (poison oak).

Habitat fragmentation has isolated the remaining populations of Fender's blue butterfly to such an extent that butterfly movement among suitable habitat patches may now occur only rarely, which is not expected to maintain the population over time (Schultz 1998). The rarity of host lupine patches and fragmentation of habitat are seen today as the major ecological factors limiting reproduction, dispersal, and subsequent colonization of new habitat (Hammond and Wilson 1992, 1993, Hammond 1994, Schultz 1997, Schultz and Dlugosch 1999). Extirpation of remaining small populations is expected from localized events and probable low genetic diversity associated with small populations (Schultz and Hammond 2003).

Recent population viability analyses have determined that the Fender's blue butterfly is at high risk of extinction throughout most of its range (Schultz and Hammond 2003). Even the largest populations have a poor chance of survival over the next 100 years (Schultz *et al.* 2003).

Conservation Measures

Biologists from Federal and state agencies and private conservation organizations are engaged in active research and monitoring programs to improve the status of Fender's blue butterfly. Recent research has focused on population viability analyses (Schultz and Hammond 2003), metapopulation dynamics and the effects of habitat fragmentation (Schultz 1998), population response to habitat restoration (Wilson and Clark 1997, Kaye and Cramer 2003, Schultz *et al.* 2003), and developing protocols for captive rearing (Shepherdson and Schultz 2004).

Recent studies have shown that Fender's blue butterfly populations respond positively to habitat restoration. Mowing, burning and mechanical removal of weeds have all resulted in increasing Fender's blue butterfly populations. At two sites in the West Eugene Wetlands (The Nature Conservancy's Willow Creek Natural Area and the BLM's Fir Butte site), both adults and larval Fender's blue butterflies have increased in number following mowing to reduce the stature of herbaceous non-native vegetation, although the response to habitat restoration is often complicated by other confounding factors, such as weather fluctuations (Schultz and Dlugosch 1999, Fitzpatrick 2005, Kaye and Benfield 2005a). Wilson and Clark (1997) conducted a study on the effects of fire and mowing on Fender's blue butterfly and its native upland prairie at Baskett Slough National Wildlife Refuge in the Willamette Valley. Although fire killed all larvae in burned patches, female Fender's blue butterflies from the nearby unburned source patch were able to colonize the entire burned area, including lupine patches that were 107 m (350 feet) from the unburned source plants. They found that Fender's blue butterfly eggs were 10 to 14 times more abundant in plots that were mowed or burned compared to undisturbed, control plots. Woody plants were reduced 45 percent with burning and 66 percent with mowing.

Fender's blue butterfly population trends have been correlated with lupine vigor; high leaf growth appears to produce larger butterfly populations. At the U.S. Army Corps of Engineers' Fern Ridge Reservoir, the Fender's blue butterfly population has increased dramatically since fall mowing of lupine patches has been implemented. The abundance of Fender's blue butterfly eggs was found to be correlated with the abundance of Kincaid's lupine leaves at a number of study sites (Kaye and Cramer 2003); egg abundance increased substantially at sites which had been treated to control non-native weeds (Schultz *et al.* 2003).

Fender's blue butterfly populations occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's Baskett Slough National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, the BLM's West Eugene Wetlands, The Nature Conservancy's Willow Creek Preserve and Coburg Ridge easement, and on a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest. All of these parcels have some level of management for native prairie habitat values. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats; native prairie restoration and Fender's blue butterfly recovery are key focus areas of the program in the Willamette Valley.

3.8. Golden Indian paintbrush, *Castilleja levisecta*

Listing Status and Critical Habitat

Golden paintbrush was listed as threatened, without critical habitat, on June 11, 1997 (USFWS 1997). A recovery plan was published for this species on August 23, 2000 (USFWS 2000b). A draft recovery plan that includes conservation measures to restore this species in the Willamette Valley (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 and will augment, not replace, the existing recovery plan for Golden paintbrush when it is finalized (USFWS 2008b).

Population Trends and Distribution

Historically, golden paintbrush has been reported from more than 30 sites in the Puget Trough of Washington and British Columbia, and as far south as the Willamette Valley of Oregon (Hitchcock *et al.* 1959, Sheehan and Sprague 1984, Gamon 1995, Gamon *et al.* 2001). Many populations have been extirpated as their habitats were converted for agricultural, residential, and commercial development. Eleven populations are currently known to exist in Washington and British Columbia; more than half of these populations occur on Whidbey, San Juan and Lopez islands off the north coast of the Washington mainland. In Oregon, golden paintbrush historically occurred in the grasslands and prairies of the Willamette Valley in Linn, Marion and Multnomah counties; the species was apparently extirpated from all of these sites as the habitat has been changed or modified by urbanization or agriculture. The last sighting of a naturally-occurring golden paintbrush in Oregon was in 1938 in Linn County; recent surveys have failed to re-locate the species in Oregon (Sheehan and Sprague 1984, Caplow 2004). Recently, small populations of golden paintbrush have been planted in the Willamette Valley from seed taken from Washington populations. One of these populations, at the Fish and Wildlife Service's Baskett Slough National Wildlife Refuge, appears to be successfully established; another population at William L. Finley National Wildlife Refuge may also survive and be counted as a new, established population in Oregon (K. Norman, pers. comm. 2008).

Life History and Ecology

Golden paintbrush is a short-lived perennial herb. Individual plants generally do not survive longer than 5 to 6 years. This species apparently reproduces exclusively by seed; vegetative spread has never been observed or reported. Plants may flower as early as February, and flowers are observed into summer. The fruit is a capsule, which matures in August; by mid-summer, the plants senesce, although some plants produce shoots in the fall that overwinter. Capsules persist on the plants well into winter.

The genus *Castilleja*, like many others in the figwort family, is hemi-parasitic (Center for Plant Conservation 2005). Roots of paintbrushes are capable of forming parasitic connections to roots of other plants. Paintbrush plants are probably not host-specific (Mills and Kummerow 1988). It has been clearly shown that golden paintbrush grows well independently of a host plant and that they do not necessarily require a host to survive. This evidence suggests that this species of *Castilleja* as a facultative root parasite.

The breeding system of golden paintbrush has not been thoroughly documented. Evans *et al.* (1984) reported that a species of bumblebee, *Bombus californicus,* was observed visiting golden paintbrush. Pollinator exclusion experiments showed that fruits can be produced in the absence of pollinator visitation, but fruit set was almost five times greater in unbagged inflorescences compared to inflorescences bagged to prevent visits from pollinators (Wentworth 1994).

Although seed dispersal has not been directly observed, the seeds are probably shaken from the seed capsules and fall a short distance from the parent plant. The seeds are light and could possibly be dispersed short distances by the wind.

Habitat Characteristics

Habitat descriptions for golden paintbrush are based on those extant populations in Washington and British Columbia; absent comparable habitat information for Oregon, we assume that the habitat of the extirpated populations in the Willamette Valley was similar. Golden paintbrush occurs in upland prairies, on generally flat grasslands, including some that are characterized by mounded topography. Low deciduous shrubs are commonly present as small to large thickets. In the absence of fire, some of the sites have been colonized by trees, primarily *Pseudotsuga menziesii,* and shrubs, including *Rosa nutkana* (wild rose) and *Cytisus scoparius,* an aggressive non-native shrub.

The mainland population in Washington occurs in a gravelly, glacial outwash prairie. Other populations occur on clayey soils derived from either glacial drift or glacio-lacustrine sediments (in the northern end of the species' historic range). All of the extant populations are on soils derived from glacial origins. At the southern end of its historic range, populations occurred on clayey alluvial soils, in association with *Quercus garryana* woodlands. Recent analyses of likely sites for reintroduction of golden paintbrush found that habitats are dominated by non-native annuals, and will require management before successful reintroductions can be expected (Lawrence 2005).

Reasons for Listing

Threats to golden paintbrush include habitat modification as succession causes prairies and grasslands to become shrub and forest lands; development for commercial, residential, and agricultural use; low potential for expansion of golden paintbrush populations and their refugia because existing habitat is constricted; and recreational picking and herbivory (USFWS 1997).

Conservation Measures

Some research has been conducted on the population biology, fire ecology, propagation and restoration of golden paintbrush (Dunwiddie *et al.* 2001, Gamon *et al.* 2001, Kaye 2001, Kaye and Lawrence 2003, Caplow 2004, Lawrence 2005). The results of these studies have been used to direct the management of the species at sites managed for upland prairies, and are critical to the future reintroduction and recovery of the species. A reintroduction plan has been prepared (Caplow 2004), as directed by the Golden Paintbrush Recovery Plan (USFWS 2000b); reintroduction into likely historical habitat is the best hope for the species to recover in the prairies of Oregon and southwestern Washington. Recent research has considered the most appropriate seed sources and site characteristics for the reintroduction of golden paintbrush to the Willamette Valley (Lawrence 2005). The findings of this study are consistent with those recommended for the other prairie species addressed in this restoration program, in that the optimal sites for reintroduction were high quality prairies dominated by native perennial species with low abundance of non-native plant species. Furthermore, the study recommended against using genetic diversity, effective population size, or geographic distance in determining source material for reintroductions, instead suggesting that plant materials from Whidbey Island, Washington, had the greatest potential for successful reintroductions to the Willamette Valley (Lawrence 2005). Greenhouse trials and surveys of potential reintroduction sites in the Willamette Valley have recently been completed (Lawrence 2005). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

3.9. Bradshaw's lomatium, *Lomatium bradshawii*

Listing Status and Critical Habitat

Bradshaw's lomatium (also known as Bradshaw's desert-parsley) was listed as endangered, without critical habitat, on September 30, 1988 (USFWS 1988b). A recovery plans for this species was published in 1993 (USFWS 1993a). A draft recovery plan that includes this species (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 (USFWS 2008b), and replaces and supersedes the earlier plan.

Population Trends and Distribution

Bradshaw's lomatium was historically overlooked and poorly documented, and there were no known collections between 1941 and 1969, leading to the assumption that the taxon might be extinct. By 1980, following a study of the species, six populations of the species had been located, including one large population (Kagan 1980). Since 1980, over 40 new sites have been discovered, including three large populations.

For many years Bradshaw's lomatium was considered an Oregon endemic, its range limited to the area between Salem and Creswell, Oregon (Kagan 1980). However, in 1994, two populations of the species were discovered in Clark County, Washington. There are currently about 38 occurrences of Bradshaw's lomatium in three populations centers located in Benton, Lane, Linn and Marion counties, Oregon (Gisler 2004, Oregon Natural Heritage Information Center 2004). Most of these populations are small, ranging from about 10 to 1,000 individuals, although the two largest sites each have over 100,000 plants.

Some populations that were large when discovered have since declined in size substantially. A large population at Buford Park near Eugene, Oregon, dropped from about 23,000 plants in 1993 to just over 3,000 plants in 1994 (Greenlee and Kaye 1995), and continued to decline to less than 1,000 plants in 1999. Herbivory by a booming vole population was the suspected to be the cause of the decline. The Washington populations, though fewer in number, are larger in population size, with one site estimated to have over 800,000 individuals (U.S. Fish and Wildlife Service unpublished data).

Life History and Ecology

Bradshaw's lomatium blooms in the spring, usually in April and early May. The flowers have a spatial and temporal separation of sexual phases, presumably to promote outcrossing, resulting in protandry on a whole plant basis, and protogyny within the flowers. A typical population is composed of many more vegetative plants than reproductive plants. The plant is pollinated by insects. Over 30 species of solitary bees, flies, wasps and beetles have been observed visiting the flowers (Kaye and Kirkland 1994, Jackson 1996). The very general nature of the insect pollinators probably buffers Bradshaw's lomatium from the population swings of any one pollinator (Kaye 1992).

Bradshaw's lomatium does not spread vegetatively and depends exclusively on seeds for reproduction (Kaye 1992). The large fruits have corky thickened wings, and usually fall to the ground fairly close to the parent. Fruits appear to float somewhat, and may be distributed by water. The fine-scale population patterns at a given site appear to follow seasonal, microchannels in the tufted hairgrass prairies, but whether this is due to dispersal, habitat preference, or both, is not clear (Kaye 1992, Kaye and Kirkland 1994).

In a genetic study that included six populations of Bradshaw's lomatium, the species displayed little population differentiation but the level of diversity was high across the species (Gitzendanner 2000). Isolated populations in Washington appear to have lower levels of diversity, but they do not appear to be genetically differentiated from the other populations of the species, consistent with historical gene flow among all populations, and a recent bottleneck in the Washington populations.

The species generally responds positively to disturbance. Low intensity fire appears to stimulate population growth of Bradshaw's lomatium. The density and abundance of reproductive plants increased following fires (Kaye and Pendergrass 1998, Pendergrass *et al.* 1999), although monitoring showed the effects to be temporary, dissipating after one to three years. Frequent burns may be required to sustain population growth, as determined from population models (Caswell and Kaye 2001, Kaye *et al.* 2001a,b).

Habitat Characteristics

Bradshaw's lomatium is restricted to wet prairie habitats. These sites have heavy, sticky clay soils or a dense clay layer below the surface that results in seasonal hydric soils. Most of the known Bradshaw's lomatium populations occur on seasonally saturated or flooded prairies, which are found near creeks and small rivers in the southern Willamette Valley (Kagan 1980). The soils at these sites are dense, heavy clays with a slowly permeable clay layer located between 15 and 30 cm (6 and 12 inches) below the surface. This slowly permeable clay layer, which results in a perched water table in winter and spring, allows soils to be saturated to the surface or slightly inundated during the wet season. The soils include Dayton silt loams, Natroy silty clay loams or Bashaw clays; other soils on which the species has been found include Amity, Awbrig , Coburg, Conser, Courtney, Cove, Hazelair, Linslaw, Oxley, Panther, Pengra, Salem, Willamette, and Witzel.

Less frequently, Bradshaw's lomatium populations are found on shallow, basalt areas in Marion and Linn County near the Santiam River. The soil type is characterized as Stayton Silt Loam; it is described as well drained, in alluvium underlain by basalt (Kaye and Kirkland 1994). The shallow depth to bedrock, 50 cm (20 inches) or less, results in sites which are poorly suited to agriculture. This soil type occurs at scattered locations in sites with deeper soils belonging to the Nekia-Jory association, which were originally vegetated by grassland and oak savanna (Alverson 1990). Bradshaw's lomatium at these sites occurs in areas with very shallow soil, usually in vernal wetlands or along stream channels.

Bradshaw's lomatium is often associated with *Deschampsia cespitosa*, and frequently occurs on and around the small mounds created by senescent *Deschampsia cespitosa* plants. In wetter areas, Bradshaw's lomatium occurs on the edges of *Deschampsia cespitosa* or sedge bunches in patches of bare or open soil. In drier areas, it is found in low areas, such as small depressions, trails or seasonal channels, with open, exposed soils. The grassland habitat of Bradshaw's lomatium frequently includes these species: *Carex* spp., *Danthonia californica*, *Eryngium petiolatum* (coyote-thistle), *Galium cymosum* (bedstraw), *Grindelia integrifolia* (Willamette Valley gumweed), *Hordeum brachyantherum* (meadow barley), *Juncus* spp., *Luzula campestris* (field woodrush), *Microseris laciniata* (cut-leaved microseris), and *Perideridia* sp. (yampah) (Siddall and Chambers 1978, Kagan 1980). In most sites, introduced pasture grasses (*Anthoxanthum odoratum* [sweet vernal grass], *Holcus lanatus* [velvet grass], *Poa pratensis* [Kentucky bluegrass], *Agrostis capillaries* [colonial bentgrass], *Dactylis glomerata* [orchard-grass]and *Festuca arundinacea* [tall fescue]) are present.

Reasons for Listing

Expanding urban development, pesticides, encroachment of woody and invasive species, herbivory and grazing are threats to remaining Bradshaw's lomatium populations (USFWS 1988b). The majority of Oregon's Bradshaw's lomatium populations are located within a 16-km (10-mile) radius of Eugene. The continued expansion of this city is a potential threat to the future of these sites. Even when the sites themselves are protected, the resultant changes in hydrology caused by surrounding development can alter the species' habitat (Meinke 1982, Gisler 2004). The majority of sites from which herbarium specimens have been collected are within areas of Salem or Eugene which have been developed for housing and agriculture (Siddall and Chambers 1978). The populations in Washington occur on private lands and are not protected (Gisler 2004).

Populations occurring on roadsides are at risk from maintenance activities, and from adverse effects of management on adjacent lands. Pesticide use on agricultural fields and herbicide application adjacent to roads may harm Bradshaw's lomatium populations across its range. There is concern that pesticides kill the pollinators necessary for plant reproduction; Bradshaw's lomatium does not form a seed bank, therefore, any loss of pollinators (and subsequent lack of successful reproduction) could have an immediate effect on population numbers (Kaye and Kirkland 1994). Herbicides may drift, and even when Bradshaw's lomatium is not the target, applications near a population may damage or kill the plants outright. For example, an herbicide application on private land adjacent to the William L. Finley National Wildlife Refuge drifted onto the refuge and damaged or killed Bradshaw's lomatium plants in 2006 (J. Beall, pers. comm. 2008).

One of the most significant threats is the continued encroachment into prairie habitats by woody vegetation. Historically, Willamette Valley prairies were periodically burned, either by wildfires or by fires set by Native Americans (Johannessen *et al.* 1971). Since Euro-American settlers arrived, fire suppression has allowed shrubs and trees to invade grassland habitat, which ultimately will replace the open prairies with woody plant communities.

Conservation Measures

Extensive research has been conducted on the ecology and population biology of Bradshaw's lomatium, effective methods for habitat enhancement, and propagation and reintroduction techniques (Kagan 1980, Kaye 1992, Kaye and Kirkland 1994, Kaye and Meinke 1996, Caswell and Kaye 2001, Kaye and Kuykendall 2001b, Kaye *et al.* 2003a). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

Propagation studies have found that long-term (8 weeks) cold stratification was necessary to fully break dormancy in this species (Kaye *et al.* 2003a). Bradshaw's lomatium plants can be grown from seed in a greenhouse environment (Kaye *et al.* 2003a). Plants may be successfully established at existing populations or new locations through out-planting of greenhouse-grown plants. Fertilizing transplants may have a negative effect on survival in some cases. Direct seeding has a relatively high success rate (17 to 38 percent), and is improved by removal of competing vegetation (Kaye and Kuykendall 2001b, Kaye *et al.* 2003a). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

Studies of the effects of cattle grazing on Bradshaw's lomatium populations show mixed results. Grazing in the springtime, when the plants are growing and reproducing, can harm the plants by biomass removal, trampling and soil disturbance; however, late-season livestock grazing, after fruit maturation, has been observed to lead to an increase in emergence of new plants, and the density of plants with multiple umbels, although it did not alter survival rates or population structure (Drew 2000). Observed increases in seedlings may be due to small disturbances in the soil, a reduction of shading by nearby plants, and reduced herbivory by small mammals.

Populations of Bradshaw's lomatium occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's William L. Finley and Oak Creek units of the Willamette Valley National Wildlife Refuge Complex, the U.S. Army Corps of Engineers at Fern Ridge Reservoir, the BLM at the West Eugene Wetlands, The Nature Conservancy at Willow Creek Natural Area and Kingston Prairie Preserve, and Lane County at Howard Buford Recreation Area. All of these parcels have some level of management for native prairie habitat values. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats; native prairie restoration is a key focus area of the program in the Willamette Valley.

3.10. Nelson's checker-mallow, *Sidalcea nelsoniana*

Listing Status and Critical Habitat

Nelson's checker-mallow was listed as threatened, without critical habitat, on February 12, 1993 (USFWS 1993b). A recovery plan was published for this species in 1998 (USFWS 1998b). A draft recovery plan that includes this species (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 (USFWS 2008b), and replaces and supersedes the former plan.

Population Trends and Distribution

In the past, Nelson's checker-mallow has been collected in Benton, Clackamas, Linn, Marion, Polk, Tillamook, Yamhill and Washington counties, Oregon, and Cowlitz and Lewis counties, Washington. Nelson's checker-mallow is currently know from about 65 sites, distributed from southern Benton County, Oregon, northward through the central and western Willamette Valley, to Cowlitz and Lewis counties, Washington (CH2MHill 1997, USFWS 1998b). This species also occurs in several higher elevation west slope Coast Range meadows that flank the western Willamette Valley in Yamhill, Washington and Tillamook counties, Oregon. Known populations range in elevation from 45 to 600 m (145 to 1,950 feet).

In the Willamette Valley, populations of Nelson's checker-mallow occur at low elevations (below 200 m [650 feet]) within a mosaic of urban and agricultural areas, with concentrations around the cities of Corvallis and Salem. In the Coast Range, Nelson's checker-mallow populations range in elevation from 490 to 600 m (1,600 to 1,960 feet), and are found in open, grassy meadows within a larger matrix of coniferous forest.

Life History and Ecology

In the Willamette Valley, Nelson's checker-mallow begins flowering as early as mid-May, and continues through August to early September, depending upon the moisture and climatic conditions of each site. Coast Range populations experience a shorter growing season and generally flower later and senesce earlier. Nelson's checker-mallow inflorescences are indeterminate, and often simultaneously exhibit fruits, open flowers, and unopened buds. Seeds are deposited locally at or near the base of the parent plant and may be shed immediately or persist into winter within the dry flower parts that remain attached to the dead stems. Above-ground portions of the plant die back in the fall, usually followed by some degree of regrowth at the base, with the emergence of small, new leaves that persist through the winter directly above the root crown. It is not uncommon for some plants to continue producing some flowers into the fall and early winter, although this is usually limited to one or two small stems per plant, with little consequent seed production (USFWS 1998b).

Perfect-flowered Nelson's checker-mallow are protandrous, with complete temporal separation of male and female phases in individual flowers (Gisler and Meinke 1998). This prevents self-fertilization, and combined with the bottom-to-top foraging observed among most bee visitors, also discourages selfing through geitonogamy. Outcrossing is encouraged because pollinators leave male-phase flowers at the top of one raceme and then fly to female phase flowers on the bottom of the next raceme. Some selfing will still occur in perfect-flowered plants, however, due to within-plant, between-raceme foraging. Female plants, which lack male flowers, are obligately outcrossed (Gisler and Meinke 1998). In most Willamette Valley (but not Coast Range) populations, female (male-sterile) Nelson's checker-mallow plants vastly outnumber perfect plants. Nelson's checker-mallow is also capable of vegetative expansion via rhizomes or laterally spreading root systems that form multiple crowns bearing distinct clusters of flowering stems (CH2MHill 1986, Glad *et al.* 1994).

Nelson's checker-mallow is pollinated by a variety of insects, including at least 17 species of bees, 3 species of wasps, 9 species of flies, 6 species of beetles, and 5 species of lepidopterans (Gisler 2003). Three species of bumblebees (*Bombus californicus*, *B. sitkensis* and *B. vosnesenskii*) were the most common and active pollinators (Gisler 2003). One solitary bee pollinator, *Diadasia nigrifrons*, is a checker-mallow specialist, and may also pollinate Nelson's checker-mallow in the Willamette Valley (Gisler and Meinke 1998).

Pre-dispersal seed predation by weevils (*Macrorhoptus sidalceae*) is extremely high in many populations, and may severely curtail, if not virtually eliminate, seed survival in many populations (Gisler and Meinke 1998). The weevils appear to be restricted to Willamette Valley, southwestern Washington and lower Coast Range populations (around Grand Ronde), but do not infest the Coast Range populations in Yamhill, Tillamook, and Washington counties. The weevils are native, host-specific, and are themselves parasitized by tiny undescribed wasps (Gisler and Meinke 1998).

Four other native *Sidalcea* species are found within the geographic range of Nelson's checker-mallow (Hitchcock and Cronquist 1973, Gisler 2004). *Sidalcea malviflora* ssp. *virgata* is typically shorter and begins flowering earlier than the other checker-mallows in the region, tends to occupy somewhat dryer, more upland sites, and has forked or branched stem hairs and distinctively deep pink to rose-colored flowers. *Sidalcea campestris* is the tallest checker-mallow in the region, and can be distinguished by its large, pale pink to white flowers. *Sidalcea cusickii* (Cusick's checker-mallow) occurs only within the extreme southern portion of Nelson's checker-mallow range, barely extending north of the city of Eugene, Oregon, and is discernable by generally forked stem hairs, broad calyx lobes, and prominently veined petals. *Sidalcea hirtipes* (Bristly-stem checker-mallow) has a longer and fuzzier calyx, longer petals, and longer hair on the stem; its range overlaps that of Nelson's checker-mallow in the Coast Range and Lewis County, Washington. *Sidalcea hirtipes* is itself considered endangered in Washington by the state's Natural Heritage Program (Washington Natural Heritage Program 2005).

There is a strong potential for interspecific hybridization among Nelson's checker-mallow and its congeners in the region, although there are some ecological and genetic reproductive barriers to prevent it from occurring (Gisler 2003, 2004). Nelson's checker-mallow flowers later in the year than sympatric populations of *Sidalcea malviflora* ssp. *virgata*, but allopatric populations sometimes overlap in flowering periods. The two species are sexually compatible, thus human-mediated movement of the plants could result in formation of hybrids. Nelson's checker-mallow and *S. cusickii* are also fully compatible, and they also share pollinators and flowering times, but their geographic ranges are parapatric, with nearest populations narrowly separated by less than a mile at the south end of Finley National Wildlife Refuge (Gisler 2004). If these species come into contact through human-mediated dispersal, hybridization could easily occur. Nelson's checker-mallow is frequently found growing together with *S. campestris*, and they also share pollinators and flowering times, but they exhibit very low sexual compatibility (probably due to chromosomal pairing problems resulting from polyploidy) (Gisler 2004). Reproductive barriers among all the checker-mallows likely evolved in response to selective pressure against hybridization; managers should be aware of the potential for hybridization as plants are moved around within the region.

Habitat Characteristics

In the Willamette Valley, Nelson's checker-mallow is known from wet prairies and stream sides. Although occasionally occurring in the understory of *Fraxinus latifolia* woodlands or among woody shrubs, Willamette Valley Nelson's checker-mallow populations usually occupy open habitats supporting early seral plant species. These native prairie remnants are frequently found at the margins of sloughs, ditches, and streams, roadsides, fence rows, drainage swales and fallow fields. Soil textures of the occupied sites vary from gravelly, well drained loams to poorly drained, hydric clay soils (CH2MHill 1986, Glad *et al.* 1994).

Some of the native plants commonly associated with Nelson's checker-mallow in the Willamette Valley include: *Achillea millefolium* (yarrow), *Juncus effusus* (common rush), *Carex* spp (sedge), *Spiraea douglasii* (western spiraea), *Crataegus douglasii*, *Geum macrophyllum* (large-leaved avens), and *Fraxinus latifolia* (Oregon Department of Agriculture 1995). Most sites have been densely colonized by invasive weeds, especially introduced forage grasses; common non-native species found with Nelson's checker-mallow include: *Festuca arundinacea*, *Rosa* spp. (rose), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (common St. John's wort), *Rubus* spp. (blackberry), *Phleum pratense* (timothy), *Holcus lanatus*, *Vicia* spp., *Chrysanthemum leucanthemum* (oxeye-daisy), *Agrostis tenuis* (colonial bent-grass), *Alopecurus pratensis* (meadow foxtail), *Phalaris arundinacea* (red canary grass), *Geranium* spp. (geranium), *Lotus corniculatus* (bird's-foot trefoil) and *Daucus carota* (wild carrot)(Oregon Department of Agriculture 1995).

Coast Range Nelson's checker-mallow populations typically occur in open, wet to dry meadows, intermittent stream channels, and along margins of coniferous forests, with clay to loam soil textures (Glad *et al.* 1987). These areas generally support more native vegetation than Willamette Valley sites. Native plants commonly associated with Nelson's checker-mallow in the Coast Range include: *Senecio triangularis* (spear-head senecio), *Fragaria virginiana*, *Juncus* spp., *Carex* spp., and *Achillea millefolium*; non-native associated species often include *Senecio jacobaea* (tansy ragwort), *Holcus lanatus, Phleum pretense.*

A variety of animal species are associated with Nelson's checker-mallow. Stems and inflorescences are commonly eaten by deer and elk. Nelson's checker-mallow flowers are visited by a diverse assemblage of insects, including leafcutter bees (Megachilidae), honey bees (Apidae), bumble bees (Bombidae), hover flies (Syrphidae), butterflies (Hesperiidae), and pollen-foraging beetles (Cerambycidae and Meloidae). The species is also a host for various phytophagous insects such as aphids (Aphididae), stinkbugs (Pentatomidae), scentless plant bugs (Rhopalidae), spotted cucumber beetles (Chrysomelidae), plant bugs (Miridae), milkweed bugs (Lygaeidae), spittlebugs (Cercopidae), butterfly larvae (Lycaenidae: *Strymon melinus*; Nymphalidae: *Vanessa anabella*), and in the Willamette Valley, weevils (Curculionidae: *Macrohoptus sidalcae*). Other insects found in association with Nelson's checker-mallow include ants (Formicidae) and earwigs (Forficulidae) (Bureau of Land Management 1985, CH2M Hill 1986, Oregon Department of Agriculture 1995).

Reasons for Listing

Nelson's checker-mallow is threatened by urban and agricultural development, ecological succession that results in shrub and tree encroachment of open prairie habitats, and competition with invasive weeds (USFWS 1993b).

At many Willamette Valley sites, seedling establishment is inhibited by the dense thatch layer of non-native grasses (Gisler 2004). Other factors specific to Nelson's checker-mallow include pre-dispersal seed predation by weevils (Gisler and Meinke 1998), the potential threat of inbreeding depression due to small population sizes and habitat fragmentation (Gisler 2003).

Conservation Measures

Extensive research has been conducted on the ecology and population biology of Nelson's checker-mallow, methods of seed predator control, and propagation and reintroduction techniques (Gisler and Meinke 1998, Bartels and Wilson 2001, Gisler and Meinke 2001, Gisler 2003, Wilson 2004). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

Studies of the reproductive ecology of Nelson's checker-mallow have shown that it has a highly complex breeding system that facilitates both outcrossing and selfing (Gisler and Meinke 1998); this study also suggested that control of seed predation by native weevils may be needed to enhance reproductive success at some populations which are heavily infested with weevils. Research into habitat management techniques indicates that burning may not be directly beneficial to Nelson's checker-mallow, and that caution should be used in management of native prairie fragments with populations of Nelson's checker-mallow (Bartels and Wilson 2001, Wilson 2004). The species has proved to be readily grown in controlled environments, and several approaches have successfully cultivated healthy plants for augmentation of existing populations (Gisler 2003). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

Populations of Nelson's checker-mallow are protected on lands managed by the U.S. Fish and Wildlife Service at William L. Finley and Baskett Butte National Wildlife Refuges, the Confederated Tribes of the Grand Ronde in Polk County, and by the BLM at Walker Flat in Yamhill County, Oregon. In December 2007, Ridgefield National Wildlife Refuge, in Clark County, Washington, outplanted 2530 seedlings to establish a new population of Nelson's checker-mallow at the refuge; monitoring and management of the new population is ongoing. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats; native prairie restoration is a key focus area of the program in the Willamette Valley.

3.11. Willamette daisy, *Erigeron decumbens* var. *decumbens*

Listing Status and Critical Habitat

Willamette daisy was listed as endangered, without critical habitat, on January 25, 2000 (USFWS 2000a). A draft recovery plan that includes this species (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 (USFWS 2008b).

Critical habitat was designated on October 6, 2006 (USFWS 2006c). Critical habitat units for Willamette daisy have been designated in Benton, Lane, Linn, Marion and Polk counties, Oregon. The PCEs of critical habitat are the habitat components that provide early seral upland prairie or oak savanna habitat with a mosaic of low growing grasses, forbs, and spaces to establish seedlings or new vegetative growth, with an absence of dense canopy vegetation providing sunlight for individual and population growth and reproduction, and with undisturbed subsoils and proper moisture and protection from competitive invasive species. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the PCEs, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980, and the plant was presumed to be extinct (Clark *et al.* 1993, Gisler 2004). The species was rediscovered in 1980 in Lane County, Oregon, and has since been identified at more than 30 sites. Willamette daisy has been collected in Benton, Clackamas, Lane, Linn, Marion, Polk, Yamhill, and Washington counties, Oregon, but today the species occurs in Benton, Lane, Linn, Marion, and Polk counties, Oregon; at those sites, there are about 116 ha (286 acres) of occupied habitat.

Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye 2002). The population at Baskett Butte declined to 48 percent of the original measured population between 1993 and 1999 (Clark 2000, Ingersoll *et al.* 1993, 1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of sporadic flowering from year to year. They suggested that some plants may not flower in some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark *et al.* (1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap.

Life History and Ecology

Willamette daisy is an herbaceous perennial that occurs as single plants or clumps of genetically identical ramets (Clark *et al.* 1993). It blooms in June and early July and produces seeds in late summer (Cronquist 1955). Seedlings emerge in late winter or early spring, and plants require two to four years in the wild to reach flowering size. Large plants appear to spread vegetatively, but this spread is localized around the established plant (Clark *et al.* 1995). Field investigators have developed a distance-based rule for consistently differentiating closely-spaced plants. If it is unclear that two adjacent clumps are united underground, they are assumed to be distinct individuals if they are separated by 7 cm (3 inches) or more. Clumps closer than 7 cm (3 inches) are assumed to be part of the same plant (Kaye and Benfield 2005b).

The fruits of Willamette daisy are single-seeded achenes, like those of other *Erigeron* species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Population size can substantially affect reproductive success in this species. Populations of Willamette daisy with fewer than 20 individuals appear to suffer a high rate of reproductive failure due to inbreeding depression and reduced probability of being pollinated by a compatible mate (Wise and Kaye 2006).

A variety of insects have been observed to visit the flowers of Willamette daisy; potential pollinators include solitary bees (*Ceratina* sp., *Megachile* sp., *Nomada* sp., *Halictus ligatus,* and *Ashmeadiella* sp.), beetles (*Meligethes nigrescens* and *Acanthoscelides pauperculus*), flies

(*Toxomerus marginata, T. occidentalis* and *Tachina* sp.), and butterflies (*Phyciodes campestris*) (Kagan and Yamamoto 1987, Clark *et al.* 1993, Jackson 1996, Gisler 2004).

Habitat Characteristics

Willamette daisy typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark *et al.* 1993). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community is typically dominated by *Deschampsia cespitosa* (tufted hairgrass), *Danthonia californica* (California oatgrass) and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching *Deschampsia cespitosa* (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include *Aster hallii*, *Festuca idahoensis* ssp. *roemeri* (Roemer's bunchgrass) and *Toxicodendron diversilobum* (Meinke 1982, Clark *et al*. 1993). Willamette daisy prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel.

Reasons for Listing

Like many native species endemic to Willamette Valley prairies, Willamette daisy is threatened by habitat loss due to urban and agricultural development, successional encroachment into its habitat by trees and shrubs, competition with non-native weeds, and small population sizes (Kagan and Yamamoto 1987, Clark *et al.* 1993, Gisler 2004). The U.S. Fish and Wildlife Service (2000a) estimated that habitat loss is occurring at 80 percent of the remaining 84 remnants of native prairies occupied by Willamette daisy and *Lupinus sulphureu*s ssp. *kincaidii*. At the time of its listing, we estimated that 24 of the 28 extant Willamette daisy populations occurred on private lands and, "without further action, are expected to be lost in the near future" (USFWS 2000a).

Populations occurring on private lands are the most vulnerable to threats of development, because state and Federal plant protection laws have little effect on private lands, although publicly owned populations are not immune from other important limitations or threats to the species. For instance, Clark *et al.* (1993) identified four populations protected from development on public lands (Willow Creek, Basket Slough National Wildlife Refuge, Bald Hill Park, and Fisher Butte Research Natural Area), but stated that even these appear to be threatened by the proliferation of non-native weeds and successional encroachment of brush and trees. Likewise, vulnerability arising from small population sizes and inbreeding depression may be a concern for the species, regardless of land ownership, especially among 17 of the 28 remaining sites that are smaller than 3.5 ha (8 acres) (USFWS 2000a). Given that the majority of populations are on private lands, working with private landowners is critical if we are to promote the eventual conservation and recovery of Willamette daisy.

Conservation Measures

Some research has been conducted on the ecology and population biology of Willamette daisy, effective methods for habitat enhancement, and propagation and reintroduction techniques (Ingersoll *et al.* 1993, 1995, Clark *et al.* 1995, 1997, Wilson and Clark 1997, Kaye and Kuykendall 2001b, Leininger 2001, Kaye *et al.* 2003b). The results of these studies have been used to direct the management of Willamette daisy populations at sites that are managed for native prairie values.

The efficacy of mowing and burning as tools to restore habitat for Willamette daisy is under investigation. Preliminary findings indicate that Willamette daisy responded with increased crown cover in mowed plots as compared to unmowed plots; this study is continuing and will also evaluate the effects of fire on Willamette daisy (Kaye *et al*. 2003b).

Several studies have investigated the feasibility of growing Willamette daisy in controlled environments for augmentation of wild populations. Cold stratification or seed-coat scarification is necessary for successful germination (Clark *et al.* 1995, Kaye and Kuykendall 2001b). Stem and rhizome cuttings have also been used successfully to establish plants in the greenhouse (Clark *et al.* 1995, Wilson *et al.* 2001). Attempts to establish Willamette daisy at new sites has shown that transplanting cultivated plants is much more effective than sowing seeds directly (Kaye *et al.* 2003a). It is likely that conservation of Willamette daisy may require augmenting small populations with propagated individuals (Clark *et al*. 1995). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

Habitat for Willamette daisy occurs on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's Baskett Slough National Wildlife Refuge, the U.S. Army Corps of Engineers' Fern Ridge Reservoir, the BLM's West Eugene Wetlands, and The Nature Conservancy's Willow Creek Preserve. All of these parcels have some level of management for native prairie habitat values. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats; native prairie restoration is a key focus area of the program in the Willamette Valley.

3.12. Kincaid's lupine, *Lupinus sulphureus* var. *kincaidii*

Listing Status and Critical Habitat

Kincaid's lupine was listed as threatened, without critical habitat, on January 25, 2000 (USFWS 2000a). A recovery outline for the species was published in 2006 (USFWS 2006d), and a draft recovery plan that includes this species (the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington) was published in August of 2008 (USFWS 2008b).

Critical habitat was designated on October 6, 2006 (USFWS 2006c). Critical habitat units for Kincaid's lupine have been designated in Benton, Lane, Polk and Yamhill counties, Oregon, and Lewis County, Washington. The PCEs of critical habitat are the habitat components that provide: (1) early seral upland prairie or oak savanna habitat with a mosaic of low growing grasses, forbs, and spaces to establish seedlings or new vegetative growth, with an absence of dense canopy vegetation providing sunlight for individual and population growth and reproduction, and with undisturbed subsoils and proper moisture and protection from competitive invasive species; and (2) the presence of insect pollinators, such as bumblebees (*Bombus mixtus* and *B. californicus*), with unrestricted movement between existing lupine patches, critical for successful lupine reproduction. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the PCEs, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

Kincaid's lupine is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley. Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Kincaid's lupine is currently known at about 57 sites, comprising about 160 ha (395 acres) of total coverage (Kaye and Kuykendall 1993, Wilson *et al.* 2003). Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 km (100 miles) from the nearest population in the Willamette Valley. In 2004, two small populations were found at Drew's Prairie and Lacamas Prairie to the east of the Boistfort Valley in Lewis County; only one plant was observed at Drew's Prairie, and more than 40 plants were found at Lacamas Prairie (Caplow and Miller 2004; T. Thomas, pers. comm. 2006). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat.

Monitoring the size of Kincaid's lupine populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson *et al.* 2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005a).

Life History and Ecology

Flowering begins in April and extends through June. As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson *et al.* 2003). Pollination is largely accomplished by small native bumblebees (*Bombus mixtus* and *B. californicus*), solitary bees (*Osmia lignaria*, *Anthophora furcata*, *Habropoda* sp., *Andrena* spp., *Dialictus* sp.) and occasionally, European honey bees (*Apis mellifera*) (Wilson *et al.* 2003). Insect pollination appears to be critical for successful seed production (Wilson *et al.* 2003).

Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson *et al.* 2003), and become quite large with age, producing many flowering stems. Excavations and morphological patterns suggest that plants 10 m (33 feet) or more apart can be interconnected by below-ground stems, and that clones can exceed 10 m (33 feet) across (Wilson *et al.* 2003). As part of a genetic evaluation, collections taken from small populations of Kincaid's lupine at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston *et al.* 1995). Reproduction by seed is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003).

Kincaid's lupine is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented, and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*) has also been reported (Kuykendall and Kaye 1993, Schultz 1995). The vegetative structures of Kincaid's lupine support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson *et al.* 2003). Kincaid's lupine is the primary larval host plant of the endangered Fender's blue butterfly (Wilson *et al.* 2003). Female Fender's blue butterflies lay their eggs on the underside of Kincaid's lupine leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz *et al.* 2003). Kincaid's lupine, like other members of the genus *Lupinus,* is unpalatable to vertebrate grazers. Kincaid's lupine forms root nodules with *Rhizobium* spp. bacteria that fix nitrogen, and also has vesicular-arbuscular mycorrhizae, which may enhance the plant's growth (Wilson *et al.* 2003).

Habitat Characteristics

In the Willamette Valley and southwestern Washington, Kincaid's lupine is found on upland prairie remnants where the species occurs in small populations at widely scattered sites. A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Common native species typically associated with Kincaid's lupine include: *Festuca idahoensis* ssp. *roemeri*, *Danthonia californica*, *Calochortus tolmiei*, *Eriophyllum lanatum*, and *Fragaria virginiana* (wild strawberry). The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson *et al.* 2003).

In Douglas County, Oregon, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80 percent (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including *Pseudotsuga menziesii*, *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), *Pinus ponderosa* (ponderosa pine), *Calocedrus decurrens* (incense cedar), *Arctostaphylos columbiana* (hairy manzanita) and *Toxicodendron diversilobum*.

In contrast to historical ecosystem composition, invasive non-native species are a significant component of Kincaid's lupine habitat today. Common invasives include: *Arrhenatherum elatius*, *Brachypodium sylvaticum* (slender false brome), *Dactylis glomerata*, *Festuca arundinacea*, *Rubus armeniacus* and *Cytisus scoparius* (Wilson *et al.* 2003). In the absence of fire, some native species, such as *Toxicodendron diversilobum* and *Pteridium aquilinum* (bracken fern), invade prairies and compete with Kincaid's lupine.

Reasons for Listing

The three major threats to Kincaid's lupine populations are habitat loss, competition from non-native plants and elimination of historical disturbance regimes (Wilson *et al.* 2003). Habitat loss from a wide variety of causes (*e.g.*, urbanization, agriculture, silvicultural practices and roadside maintenance) has been the single largest factor in the decline of Kincaid's lupine (USFWS 2000a). Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by Kincaid's lupine in 2000 at the time listing occurred were on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000a).

Habitat fragmentation and isolation of small populations may be causing inbreeding depression in Kincaid's lupine. The subspecies was likely wide-spread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston *et al.* 1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between Kincaid's lupine and *Lupinus arbustus* has been detected at Baskett Slough National Wildlife Refuge (Liston *et al.* 1995).

Invasion by a few aggressive plant species is a threat to many prairies and the presence of other non-native species within degraded prairies contributes to lower prairie quality and concomitant reduced population viability of native species, including Kincaid's lupine. Some aggressive non-native plants form dense monocultures, which compete for space, water and nutrients with the native prairie species, and ultimately inhibit the growth and reproduction of Kincaid's lupine by shading out the plants (Wilson *et al.* 2003).

Most prairie sites require frequent disturbances to hold back the natural succession of trees and shrubs. Before settlement by Euro-Americans, the regular occurrence of fire maintained the open prairie habitats essential to Kincaid's lupine. The loss of a regular disturbance regime, primarily fire, has resulted in the decline of prairie habitats through succession by native trees and shrubs, and has allowed the establishment of numerous non-native grasses and forbs. When this species was listed, we estimated that 83 percent of upland prairie sites were succeeding to forest in the range of Kincaid's lupine (USFWS 2000a).

Conservation Measures

Active research efforts have focused on restoring the essential components of Kincaid's lupine habitat by mimicking the historical disturbance regime with the application of prescribed fire, mowing and manual removal of weeds. Research and habitat management programs for Kincaid's lupine have been implemented at several sites, including Baskett Slough National Wildlife Refuge, BLM's Fir Butte site and The Nature Conservancy's Willow Creek Preserve (Wilson *et al.* 2003, Kaye and Benfield 2005a). Prescribed fire and mowing before or after the growing season have been effective in reducing the cover of invasive non-native plants; following treatments, Kincaid's lupine has responded with increased leaf and flower production (Wilson *et al.* 2003). Research has also been conducted on seed germination, propagation and reintroduction of Kincaid's lupine (Kaye and Kuykendall 2001a, 2001b, Kaye and Cramer 2003, Kaye *et al.* 2003a). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

The BLM, Umpqua National Forest and Service completed a programmatic conservation agreement for Kincaid's lupine in Douglas County, Oregon, in April 2006 (Roseburg Bureau of

Land Management *et al*. 2006). The objectives of the agreement are: (1) to maintain stable populations of the species in Douglas County by protecting and restoring habitats, (2) to reduce threats to the species on BLM and Forest Service lands, (3) to promote larger functioning metapopulations, with increased population size and genetic diversity, and (4) to meet the recovery criteria in the Recovery Outline for the species (USFWS 2006d).

Populations of Kincaid's lupine occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's William L. Finley National Wildlife Refuge and Baskett Slough National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, BLM units in Lane and Douglas counties, the Umpqua National Forest, The Nature Conservancy's Willow Creek Preserve, and at a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest. All of these parcels have some level of management for native prairie habitat values. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with private landowners to restore wildlife habitats; native prairie restoration is a key focus area of the program in the Willamette Valley.

4. ENVIRONMENTAL BASELINE

The environmental baseline is defined as "the past and present impacts of all Federal, state or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation in process [50 CFR 402.02]."

4.1. Bull trout

The action area encompasses the Oregon portion of the range of the species. The bull trout environmental baseline in the action area is described below using data compiled and summarized during the comprehensive Bull Trout Five Year Review process (USFWS 2005a, USFWS 2008a), the draft bull trout Recovery Plan chapters (USFWS 2002b, USFWS 2004a,b,c), the Washington Department of Natural Resources Forest Practices Habitat Conservation Plan BO (USFWS 2006a) and the Final Rule designating bull trout critical habitat (USFWS 2005b). These data are the most recent and comprehensive in analyzing current bull trout recovery status, including review of (from broad-scale to fine-scale) interim recovery units (former DPSs), Management Units, Core Areas, and associated population abundance, trends, risks and current status. The Service therefore incorporates these documents by reference for purposes of describing bull trout environmental baseline; these documents considered adverse effects and incidental take determined from past bull trout biological opinions in the action area.

Critical habitat designated in Oregon includes 939 stream miles and 27,322 acres of lakes or reservoirs and an additional 17 stream miles designated in Oregon/Idaho within nine critical habitat units, as follows: Klamath River Basin, Willamette River Basin, Hood River Basin, Deschutes River Basin, Umatilla-Walla Walla River Basins, Grand Ronde River Basin, Imnaha-Snake River Basins, Hells Canyon Complex, and the Malheur River Basin. Only areas that were found to be occupied within the last twenty years, that contain features essential to the conservation of bull trout, and that do not already have conservation efforts in place were designated. Over 75 percent of the lands adjacent to designated critical habitat are private, with the remainder under local government, State, Tribal and Federal ownership (USFWS 2005b).

Two interim recovery units (formerly known as DPSs) occur in the action area: Columbia River and Klamath River. The Columbia River interim recovery unit includes the Willamette River, Hood River, Deschutes River, Odell Lake, John Day River, Umatilla-Walla Walla Rivers, Grande Ronde River, Imnaha-Snake Rivers, Hells Canyon Complex and Malheur River Management Units. The Klamath River interim recovery unit includes the Klamath River Management Unit (see Figure 4).

Columbia River Interim Recovery Units

Willamette River Management Unit: Upper Willamette Core Area. The Upper Willamette Core Area is comprised of three local populations: McKenzie River, South Fork McKenzie, and Trailbridge Reservoir. Population estimates indicate less than 300 adult bull trout survive in this core area. Annual redd counts have decreased gradually over the last five years (2000-2004) in the mainstem McKenzie River local population, from a high of 92 redds in 2000, to 61 redds in 2003. Over the same time frame, redd counts have remained stable for the South Fork McKenzie River local population (annual average of 29), and increased in the Trail Bridge local population from two redds in 2000 to 25 redds in 2004. The ODFW has been annually reintroducing bull trout fry into historic, unoccupied habitat in the Middle Fork Willamette River. No reproduction has been noted, but adult bull trout were captured in Hills Creek Reservoir in 2003 and 2004, and several age classes of bull trout were collected in and below the bull trout release sites. While there is some limited connectivity within and among local populations in this core area, there are some significant fish passage barriers posed by large dams. Habitat and population baseline conditions for the bull trout in the Willamette Basin are sub-optimal based on current condition, elevated risk from stochastic events, and the low probability of recolonization through dispersal due to the distance to other bull trout core areas in the lower Columbia River.

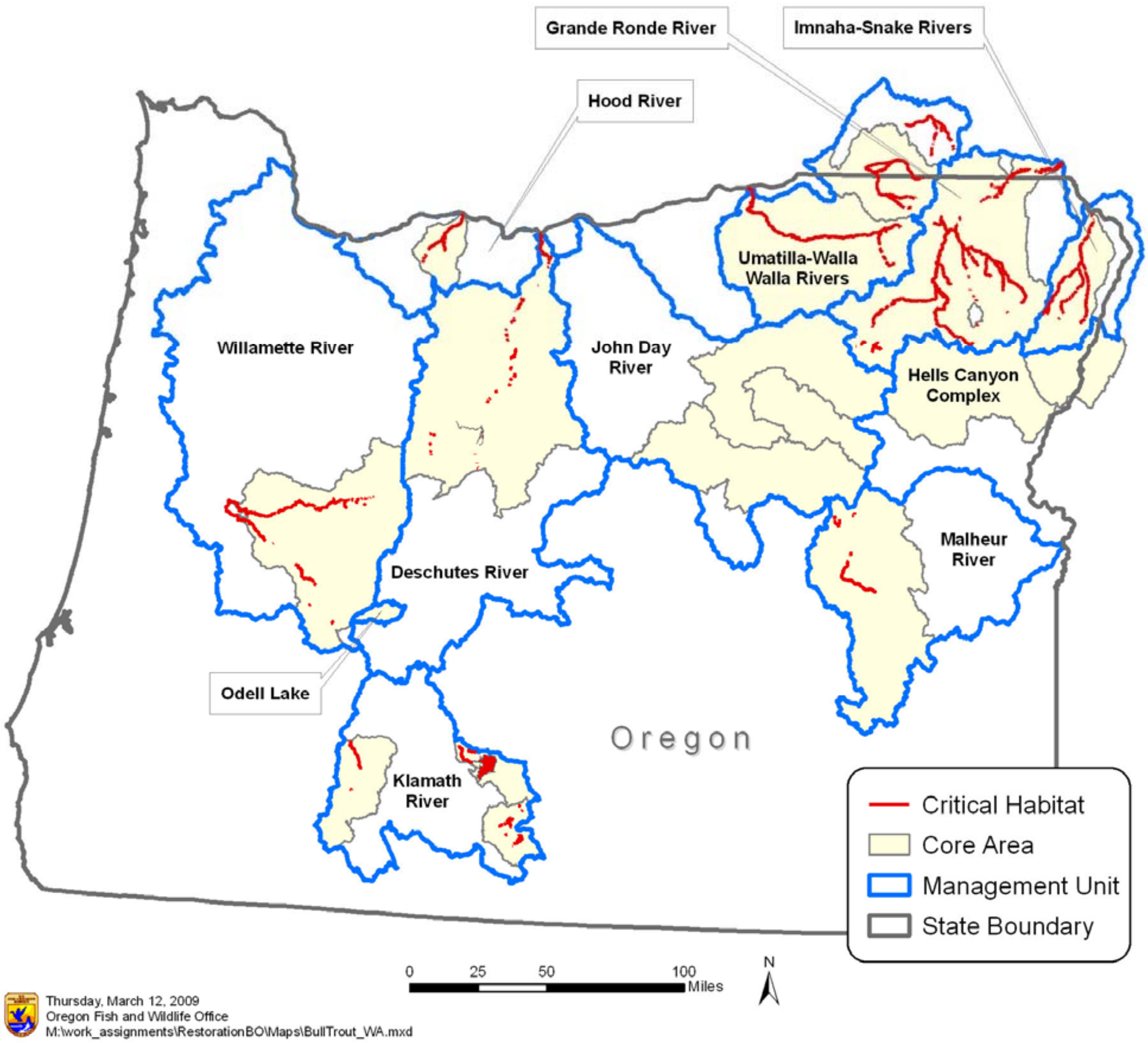

Figure 4. Overview map showing management units, core areas, and designed critical habitat for bull trout in the action area (Oregon).

<u>Hood River Management Unit: Hood River Core Area.</u> The Hood River Core Area is comprised of two local populations: Clear Branch River and Hood River. Accurate adult abundance estimates for the Hood River Core Area are not available; however, 300 or less bull trout are believed to occur in the core area. Trap count and snorkel count data support this belief: snorkel surveys conducted at Clear Branch above the dam found a total of 51 to 200 bull trout annually between 1996 and 2003, while surveys below the dam found a total of zero to three bull trout annually between 1996 and 2003. Some migratory forms occur in the core area, and are believed to overwinter in the lower Hood River and Bonneville Pool of the Columbia River. The two local populations are isolated by an impassable dam. Bull trout are consistently found in the Hood River, the Middle Fork Hood River and the Clear Branch of Hood River. Bull trout distribution in the East and West Forks of Hood River are based on isolated, infrequent sightings. Historical distribution is believed to approximate current distribution based on existing knowledge. Habitat baseline conditions are degraded in the Hood River Core Area, with

numerous water diversions impacting connectivity. The USFS has undertaken numerous habitat restoration activities in the Clear Branch local population area.

Lower Deschutes River Management Unit: Lower Deschutes Core Area. The Lower Deschutes Core Area includes all current and historic bull trout habitat in the Deschutes River and tributaries from Big Falls downstream to the confluence of the Deschutes with the Columbia River. It contains five local populations: Shitike Creek, Warm Springs River, Whitewater River, Jefferson/Candle/Abbot river complex, and Canyon/Jack/Heising/mainstem Metolius river complex. Spawning, rearing, foraging, migrating and overwintering habitats are present in the core area. Redd count data collected between 1998 and 2004 found that bull trout spawner numbers had generally increased in two of the three Metolius River basin local populations (Jefferson/Candle/ Abbot complex and Canyon/Jack/Heising/mainstem Metolius river complexes combined redd counts increased from 180 in 1998 to 1,045 in 2004), remained stable in the Metolius basin's Whitewater River (data from the Whitewater River are limited, but suggest that the population there is about 30 adults), and remained stable in the lower Deschutes River's Shitike Creek and Warm Springs River populations (Shitike Creek remained steady between 1998 and 2004: 117 redds were counted in 1998, and counts have averaged 137 redds (110 adults) in the last five years. In the Warm Springs River 101 redds were counted in 1998, and redd counts averaged 89 redds (71 adults) in the last five years.

In late summer of 2003, the 91,902 acre B&B fire burned through large areas of the Metolius River basin. It burned areas of the Jefferson/Candle/Abbot river complex and Canyon/Jack/Heising/mainstem Metolius river complex, but did not affect the Whitewater River population. Habitat conditions in the two burned local populations are at elevated risk from increased sediment delivery, with resultant changes including sedimentation of spawning areas, loss of juvenile rearing habitat, increases in peak flows, and increases in stream temperature.

Odell Lake Management Unit: Odell Lake Core Area. The Odell Lake Core Area has a single local population, the Odell Lake local population, encompassing Odell Lake and its tributaries (including Odell Creek and its tributaries). The number of adult spawning bull trout in the Odell Lake Core Area is estimated to be below 100 individuals. Redd surveys for Trapper Creek, the only tributary where Odell Lake bull trout spawn, were zero to 24 between 1994 and 2004. Juvenile bull trout counts in Trapper Creek have been consistent between 1996 and 2004, totaling between 26 and 208 juveniles annually. Small numbers of juvenile bull trout also have been observed in Odell Creek and its tributaries.

Odell Lake Core Area bull trout have been isolated from other core areas for nearly 6000 years. Recent genetic analysis indicated Odell Lake bull trout have very little genetic variability and have experienced significant genetic drift.

Threats to Odell Lake bull trout include kokanee salmon redd superimposition on bull trout redds, limited spawning and rearing habitat, introduced lake trout in Odell Lake, and introduced brook trout in Odell Lake basin tributary streams. Several habitat improvement projects have been recently completed in the basin.

John Day River Management Unit: Middle Fork John Day River, North Fork John Day River, and John Day River (Upper Mainstem) Core Areas. The Middle Fork John Day Core Area consists of three local populations: Granite Boulder Creek, Big Creek, and Clear Creek. Total numbers of bull trout, consisting of primarily juvenile and subadult fish, were estimated in 1999 to be 1,950 individuals in Big Creek, 640 individuals in Clear Creek, and 368 individuals in Granite Boulder Creek. Resident bull trout are the predominant life history form in the core area, and occupy tributary habitats, but some migratory bull trout have been collected in the Middle Fork John Day River and on spawning locations within tributaries. Sedimentation within this core area is a severe problem. Catastrophic fires burned through the core area in recent years causing erosion and high sediment yields. These effects combine with sedimentation from mining, the removal of streamside vegetation by livestock, and already existing habitat fragmentation to make the path to bull trout recovery difficult.

The North Fork John Day River Core Area consists of seven local populations: Upper North Fork John Day River, Upper Granite Creek, Boulder Creek, Clear/Lightning creeks above ditch, Clear Creek below ditch, Desolation Creek, and South Fork Desolation Creek above the falls. Resident and migratory forms are found in the core area. Overall population trend for the North Fork John Day Core Area is upward. Habitat fragmentation, connectivity and water quality issues still occur. The threats associated with mining still exist, but have been reduced through improved administration and cooperation between the USFS and local miners. The presence of brook trout throughout the core area, including the high mountain lakes, continues to be a serious threat to bull trout.

The John Day River Core Area consists of two local populations: Upper John Day River and Indian Creek. Spawning surveys in 1999 and 2000 of bull trout habitat in tributary streams to the mainstem John Day River showed few fish spawning in the local population, with most occupied streams having less than 20 redds. Redd surveys in 1990 estimated that the upper mainstem, and Call and Rail creeks may have more than 300 total spawning adults. Some new, small populations of resident bull trout have been discovered in smaller Core Area streams. Migratory bull trout commonly occur from the John Day River headwaters to the City of John Day, with at least seasonal use as far down as the town of Spray, below the John Day and North Fork John Day rivers' confluence. Indian Creek is seasonally blocked by a diversion that dewaters the lower reaches and creates a migration barrier. The overall trend for bull trout in this core area is upward. Water quality issues, passage problems and competition from brook trout all continue to be major problems.

Umatilla-Walla Walla Rivers Management Unit: Umatilla River and Walla Walla Core Areas. The Umatilla River Core Area consists of two local populations: Upper Umatilla River Forks and North Fork Meacham Creek. Adult bull trout abundance in the Core Area in 2000 was estimated at 385 individual bull trout. Resident forms occur in the North Fork Meacham local population, and resident and migratory forms exist in the Upper Umatilla River local population. Bull trout in the Umatilla Core Area persist at low numbers. In 1998 and 2000, adult bull trout population estimates in the North Fork Umatilla River were 192 and 327 individuals, respectively. Most spawning occurs between Coyote and Woodward creeks, a total of five river kilometers. Very low numbers of bull trout occupy and spawn in the North Fork Meacham Creek local population. Based on limited collections, migratory adult and juvenile bull trout appear to use the mainstem Umatilla River downstream to Pendleton for migratory and overwintering habitat. Numerous opportunities exist for habitat restoration and re-connection of isolated habitats in this Core Area.

The Walla Walla River Core Area consists of three local populations: Walla Walla River, Touchet River, and Mill Creek. The Walla Walla local population is supported mainly by the

South Fork Walla Walla bull trout population. The local population occurs in Oregon, though fluvial fish may seasonally occur in Washington. Population estimates for the South Fork Walla Walla River for 2003 was 8,533 fish. Redd counts have been done each year since 1998 on the South Fork Walla Walla River and sporadically in the North Fork Walla Walla River. Despite some annual variability, redd totals have generally been increasing on the South Fork Walla Walla River, with annual redd counts below 200 from 1994-1997, but consistently above 330 since 1999, including a peak of 483 redds in 2001). Very little spawning is occurring on the North Fork Walla Walla River (8 redds found in 2002, zero redds in 2003 and 2004). Physiological and physical barriers to bull trout passage and rearing are extensive in terms of stream miles affected. Water temperature appears to be the most critical physiological barrier, particularly for passage or rearing. Seasonal temperature-related barriers for bull trout generally occur in lower areas of the Walla Walla River. Connectivity between populations and habitat conditions (*i.e.,* water temperature, instream flows, passage barriers) in the mainstem Walla Walla River continue to be of concern. However, considerable progress has been made in eliminating barriers to fish passage on the Walla Walla River through screening irrigation ditches, consolidating ditches, and modifying diversion structures. In 2001, for the first summer in nearly a century, increased Walla Walla River flows resulted in a watered stretch of the river between Milton-Freewater, Oregon, and the WA/OR state line. Since implementation of the flow agreement, there has not been a fish stranding problem in this area. In 2001, a major new fish ladder was installed at Nursery Bridge near Milton Freewater to facilitate passage of bull trout.

The Touchet River local population includes bull trout in the Wolf Fork, North Fork, and South Fork of the Touchet River, Washington. Wolf Fork Touchet River supports the largest bull trout population in the Touchet River local population, although redd totals on that stream have fluctuated a great deal (from 71 in 1994, down to four in 1997, then up to 101 in 2003). Despite the high variability, the overall trend in redds per year has been upward in Wolf Fork since 1998. On the North Fork Touchet River, redd totals hovered in the 40s from 1998 to 2001, but have dropped each year since to a low of 22 in 2004, which is in the vicinity of counts from the mid-1990s. It is unclear if this represents natural fluctuations or a steady decline. A new spawning population of migratory bull trout was discovered in the South Fork Touchet River in 2000. However, after 16 redds were observed in the South Fork in 2001, the count dropped to one redd in 2002, and no redds were seen in 2003 and 2004 surveys. The upper Touchet watershed has one of the relatively high quality salmonid habitats remaining in the Walla Walla River Basin. However, the lower and middle portions of the South Fork Touchet River maintain very low flows during summer months, and instream large woody debris throughout the upper Touchet is limited, which has resulted in a lack of pool habitat. Throughout the Touchet River local population, barriers and impediments to bull trout passage and rearing (physical and physiological) are extensive in terms of stream miles affected.

The Mill Creek local population supports sizeable bull trout populations. Sections of Mill Creek occur in both Oregon and Washington, and bull trout have been observed in both states. Mill Creek redd counts have been conducted each year since 1998. Redd count totals have generally been stable on Mill Creek. Since 1994, annual redd counts have stayed in a range between 118 and 220, with an average of 170, and no discernible up or downward trend. Numerous barriers exist in the local population; many barriers are physical structures or dewatered streambeds that block movement, others are physiological barriers (*e.g.,* temperature, sediment, lack of pools). Physiological and physical barriers to bull trout passage and rearing were extensive in terms of stream miles affected. Connectivity between populations and habitat conditions (*i.e.,* water temperature, instream flows, passage barriers) in middle and lower sections of Mill Creek and the mainstem Walla Walla River continue to be areas of concern. However, considerable progress has been made in eliminating barriers to fish passage on Mill Creek through screening irrigation ditches, consolidating ditches, and modifying diversion structures. In 2004, a video monitoring effort was initiated at the Mill Creek Diversion Dam (Bennington Dam) and 20 bull trout passing up the ladder were detected.

Grande Ronde River Management Unit: Grande Ronde River and Little Minam River Core Areas. The Grande Ronde Core Area has eight local populations: Upper Grande Ronde complex, Catherine Creek and tributaries, Indian Creek and tributaries, Minam River/Deer Creek complex, Lostine River/Bear Creek complex, Upper Hurricane Creek, Wenaha River, and Lookingglass Creek, and are described below.

Current distribution of bull trout in the Grande Ronde River Management Area includes the mainstem Grande Ronde River from its headwaters in Oregon to the confluence with the Snake River in Washington, and possibly into the Snake River for overwintering; tributaries including Catherine Creek, Indian Creek, Lookingglass Creek, Wallowa River and its tributaries (Minam, Deer, Bear, Lostine, and Hurricane creeks), and the Wenaha River and its tributaries. Wenatchee Creek historically had bull trout, but has not been surveyed recently. To the best of our knowledge, with the exception of the Wallowa River above Wallowa Dam, historic distribution is closely reflected by the current distribution. Approximately 4,000 bull trout spawned in each of the past few years in the Grande Ronde Core Area. The majority of spawning likely occurs in the Wenaha River and Minam River/Deer Creek complex, both which exists primarily in wilderness areas. In the Little Minam Core Area approximately 750 bull trout spawned in each of the past few years.

Redd count data averaged 104.5 redds from 1999 to 2004 for three combined stream index reaches within Lostine River/Bear Creek, Lookingglass Creek, and Catherine Creek (surveys from North Fork Catherine Creek) local populations. The year 2002 had a low of 69 redds and 2001 and 2003 had a high of 123 and 125 redds, respectively. The overall population trends for the above three local populations within this core area is estimated to be stable (for the past 6 years).

The general status for all populations in the Grande Ronde Core Area appears to be stable, and contains both migratory and resident bull trout. The Wenaha River local population is one of the strongholds as it has multiple age classes, contains fluvial fish, has an anadromous prey base, has connectivity with the Grande Ronde and Snake rivers, and contains pristine habitat (consistent redd count data unfortunately is not available for this population). Other healthy bull trout populations include Lookingglass Creek, Lostine River, and Deer Creek. Minam River has had surveys conducted by ODFW in past years, with limited documentation of bull trout observed. Hurricane Creek is at high risk of extinction due to low numbers of resident bull trout, hybridization with brook trout, and limited habitat due to their isolation in the headwaters upstream of Alder Slope diversion dam and downstream of Slick Rock Falls. Lostine River and Bear Creek contain brook trout and the degree of hybridization is unknown. Limited redd count data is available on Bear Creek and this portion of the Lostine River/Bear Creek local population has been listed as special concern. The Upper Grande Ronde River, Catherine Creek, and Indian Creek populations contain primarily resident life history forms and are at moderate risk of extinction. Limited data is available is available for these systems, with the exception of Catherine Creek. Catherine Creek has some limited numbers of fluvial size fish as reported at the CTUIR adult weir on Catherine Creek. North Fork Catherine Creek has redd count data collected from 1998 to 2004 and the trend appears to be stable. Connectivity between local populations is limited by two major dams, numerous water diversions, and various culverts and other blockages, introduced brook trout, and water quality (thermal warming and sediment) and other habitat degradation concerns exist in these local populations.

The Little Minam River Core Area has a single local population: Little Minam River. Most, if not all, of the current spawning activity appears to occur in the mainstem of the Little Minam River above the barrier waterfall or in Dobbin Creek. Only resident bull trout are present, due to the waterfall barrier. Redd count data averaged 306 redds from 1997 to 2004 for the Little Minam River local population. The year 2003 had a low of 209 redds and 2001 had a high of 432 redds. The overall population trend for the Little Minam River population is estimated to be stable (for the past 8 years). The Little Minam River local population lies within a wilderness area, and has good quality habitat.

<u>Imnaha-Snake Rivers Management Unit: Imnaha River Core Area.</u> The Imnaha River Core Area contains four local populations: Imnaha River (above the mouth of Big Sheep Creek), Big Sheep Creek, Little Sheep Creek, and McCully Creek.

Depending on the season, bull trout can be found throughout the Imnaha River. Summer distribution in the mainstem Imnaha River extends from at least river mile 40 to the Forks at river mile 73, whereas fall and spring distributions include the lower Imnaha and Snake Rivers. Bull trout have been observed throughout the mainstem of the Imnaha River as well as in the South Fork, Middle Fork, and North Fork of the Imnaha. In the Middle Fork, upstream distribution appears to be limited by a waterfall that is approximately 1.2 river miles from the mouth. Bull trout have also been observed in Bear, Blue, and Soldier Creeks, all tributaries to the South Fork of the Imnaha River. Although there have been isolated reports of bull trout in Lightning Creek, standard surveys have not been able to document meaningful numbers of spawning and rearing fish.

Spawning in the Imnaha River presumably occurs in the headwater areas as well as in some headwater tributaries. Most known summer rearing and holding areas in the Imnaha River are on National Forest or wilderness lands above Summit Creek. On an intermittent basis, bull trout can also be found distributed throughout the mainstem Imnaha River, perhaps migrating to and from various tributaries or following sources of food. It is certain that some fluvial bull trout from the Imnaha River migrate out of the Imnaha River and overwinter in the Snake River and, given recent radiotelemetry data, fish found in the Imnaha River below Summit Creek are probably moving between summer or spawning habitat and overwinter habitat in the lower Imnaha or Snake Rivers. Fluvial adults appear to migrate upstream in the Imnaha River during the months of May, June, July, and perhaps August. Fluvial adults appear to move downstream in the Imnaha River during the months of August, September, October, and perhaps November.

Redd count data averaged 5.8 redds/mile or 239 total redds, from 2000 to 2004 for combined index reached in the Big Sheep and Imnaha local populations. 2000 had a low of 2.8 redds/mile or 104 redds, and 2001 and 2004 had a high of 7.9-7.4 redds/mile, or 315-336 redds, respectively. The overall population trends for the above two populations is estimated to be stable (for the past five years). The Imnaha River local population is rated at low risk of extinction, Little Sheep is rated at high risk of extinction, McCully Creek is rated at moderate risk of extinction, and Big Sheep is rated "of special concern". A major canal bisects three of the local populations, and bull trout have been observed in the canal, indicating artificial, one-way movement between local populations as well as potential entrainment loss onto agricultural fields. In addition, the canal has no upstream passage at any of its stream crossings, therefore migratory bull trout cannot ascend into Big Sheep, Little Sheep, or McCully Creeks and access their respective local populations of bull trout.

<u>Hells Canyon Complex Management Unit: Pine-Indian-Wildhorse and Powder River Core Areas.</u> The Pine-Indian-Wildhorse Core Area within the action area has four local populations: Upper Pine Creek, Clear Creek, East Pine Creek, and Elk Creek. Bull trout abundance in the Pine Creek basin in 1994 was estimated for four streams. Maximum estimated abundance for bull trout was less than 400 individuals for each stream. In the eight streams where bull trout redd index sites exist, the actual number of redds observed ranged from 0 to 43 per site during 1998 through 2000, which is equivalent to 0 to 60.0 redds per mile of stream length. The majority of bull trout in this local population are resident, however, radiotelemetry studies have identified that migratory bull trout do occur in the local population. However, the Pine Creek basin has numerous water diversions, which impede upstream fish passage and entrain bull trout moving downstream.

The Powder River Core Area has eight local populations: Upper Powder River, North Powder River, Big Muddy Creek, Anthony Creek, Wolf Creek, Salmon Creek, Pine Creek, and Lake Creek. Less than 500 bull trout are thought to occur in this Core Area. All bull trout inhabiting the Powder River basin are thought to be resident fish. Bull trout densities were estimated in five tributaries of the upper Powder River and North Powder River in 1996. Mean densities of bull trout were 1.0 to 9.5 individuals per 330 feet of stream length. Multiple redd counts were conducted annually in September and October 1996 through 1999. The total number of redds observed per year in the study was 7 to 36 redds. A total of 885 bull trout greater than 5 inches were estimated to occur in Silver Creek in 1999. Existing local populations of bull trout in this core area are isolated and with the exception of Silver Creek, have low numbers. Bull trout only remain in the uppermost parts of the watershed that have not been degraded. Thief Valley, Wolf Creek, and Mason Dams have isolated bull trout local populations within the Powder River drainage and prevent two-way fish passage. Brownlee Dam has further isolated bull trout populations in this core area and eliminated connectivity between the Powder, Burnt River, and adjacent drainages.

<u>Malheur River Management Unit: Malheur River Core Area.</u> The Malheur River Core Area contains two local populations: Upper Malheur River and North Fork Malheur River. Resident and some migratory forms of bull trout occur in the Upper Malheur River Core Area. Redd data collected in the upper Malheur subbasin is confounded by the presence of brook trout. Spawning index reaches on Meadow Fork Big Creek and Snowshoe Creek had 49 to 54 redds per year in 1998-2000. A high count of 108 redds was recorded in 2001, then counts dropped again to 16 and 6 in 2002 and 2003 respectively. The survey results for 2002 did not include Snowshoe Creek due to the inability of conducting surveys while firefighting activities were ongoing. Effects from the forest fire in 2002 (9,873 acres) contributed to degraded habitat conditions in Meadow Fork Big Creek. A debris torrent in July of 2003, severely scoured the stream, displacing bull trout and severely altering the stream substrate. In sections, the stream substrate

was displaced approximately 6 feet lower in elevation than prior to the debris flow event. Zero bull trout redds were recorded for Meadow Fork Big Creek in 2003. Declines in bull trout redd counts within the two combined index reaches are likely due to a combination of several years of low stream flow, a debris torrent in 2003 which altered spawning habitat, and the presence of brook trout which hybridize with and compete with bull trout.

Fluvial and adfluvial forms of bull trout occur in the North Fork Malheur River local population. Spawning has been documented in the mainstem North Fork Malheur upstream of the mouth of Deadhorse Creek and in the following tributaries: Horseshoe Creek, Swamp Creek, Sheep Creek, Elk Creek, Crane Creek, and Little Crane Creek. Bull trout have been observed in Cow Creek during spawning surveys, but no redds have been found. Habitat conditions in the spawning areas are of generally good quality, however, downstream rearing areas are impacted by ongoing livestock grazing. Continuous redd count history dating 1992 to 2003 for North Fork Malheur streams indicate an increasing trend from 1992 to 2000. Redd counts ranged from as few as 8 to 38 in early 1990's, rising to approximately 153 redds in 2000. Since 2000, redd counts have declined, with only 63 bull trout redds recorded during 2003. Subadult rearing and adult foraging occurs from the headwaters of the North Fork Malheur River down to, and in, Beulah Reservoir. Bull trout rearing habitat occurs in the North Fork Malheur River downstream to Little Malheur River confluence, as well as within numerous North Fork Malheur River tributaries. Studies of bull trout in Beulah Reservoir indicate that bull trout are entrained through the outlet works of the dam. Once entrained through the dam, there is no existing facility for fish to return to the reservoir. Habitat conditions in the stream below the reservoir are not optimal for bull trout survival, given the elevated summer stream temperatures and numerous irrigation water withdrawals.

Klamath River Interim Recovery Unit

<u>Klamath River Management Unit: Sycan Core Area.</u> The Sycan Core Area is comprised of two local populations: Long Creek and Coyote Creek. The distribution, range, and abundance of bull trout in the Sycan Core Area is greatly reduced from historic conditions, and most bull trout are now restricted to headwater locations. Recent population trends seem to indicate declines in resident bull trout abundance in Long Creek, and some remnant migratory bull trout in lower Long Creek. Coyote Creek population status and trends are unknown. Little connectivity occurs between these local populations. Habitat quality decreases in a downstream direction. Brook trout are a major threat.

<u>Klamath River Management Unit: Upper Klamath Lake Core Area.</u> The Upper Klamath Lake Core Area is comprised of three local populations: Sun Creek, Threemile Creek, and Lost Creek. Population and trends in Sun and Threemile creeks have recently improved, following brook trout eradication efforts. No population information is available for the Lost Creek local population. Resident forms of bull trout predominate in this core area, with no connectivity between local populations. Habitat quality decreases in a downstream direction in these streams. Brook trout hybridization with bull trout is a major threat below recently-treated habitats on Sun and Threemile creeks.

<u>Klamath River Management Unit: Upper Sprague River Core Area.</u> The Upper Sprague River Core Area is comprised of seven local populations: Deming Creek, Boulder Creek, Dixon Creek, Brownsworth Creek, Leonard Creek, North Fork Sprague River, and Sheepy Creek. With the

exception of Brownsworth Creek (slight population improvement between 2000 and 2004 surveys), the status of local bull trout populations in the Upper Sprague River Core Area is unknown. Populations continue to survive in fragmented and degraded habitats, and are subject to interspecific competition with non-native brook and brown trout and hybridization with non-native brook trout. Local populations consist mainly of isolated, headwater populations of resident fish, with a small, remnant migratory component occurring in the North Fork Sprague River below the confluence of Boulder/Dixon creeks. Habitat quality decreases in a downstream direction in these streams; however, due to close geographic proximity, significant opportunity exists within the core area to reconnect isolated local populations via habitat restoration actions.

Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of characterizing the current condition of the species. To assess consulted-on effects to the bull trout, we conducted a review of all of the BOs received by the Region 1 and Region 6 Offices, from the time of listing until August 2003; this totaled 137 BOs. Of these, 124 BOs (91 percent) applied to activities affecting bull trout in the Columbia Basin DPS, 12 BOs (9 percent) applied to activities affecting bull trout in the Coastal-Puget Sound DPS, 7 BOs (5 percent) applied to activities affecting bull trout in the Klamath Basin DPS, and 1 BO (<1 percent) applied to activities affecting the Jarbidge and St. Mary Belly DPSs (Note: these percentages do not add to 100, because several BOs applied to more than one DPS). The geographic scale of these consultations varied from individual actions (*e.g.,* construction of a bridge or pipeline) within one basin to multiple-project actions occurring across several basins.

Our review shows that we consulted on a wide array of actions which had varying level of effects. Many of the actions resulted in only short-term adverse effects and some with long-term beneficial effects. Some of the actions resulted in long-term adverse effects. No actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery (*i.e.,* jeopardy determination) of the bull trout or adversely modify critical habitat.

4.2. Lahontan cutthroat trout

The action area encompasses the Oregon portion of the range of the species. In Oregon, Lahontan cutthroat trout occur in the Coyote Lake subbasin, Quinn River subbasin, and in the Alvord Lake subbasin. Alvord Lake subbasin populations originated from Coyote Lake subbasin transplants. Five of the six native Lahontan cutthroat trout populations in Oregon exist in the Coyote Lakes basin of southeast Harney County in Willow Creek, Whitehorse Creek, Little Whitehorse Creek, Cottonwood Creek, Doolitle Creek and Fifteen Mile Creek.

In surveys of Coyote Lake subbasin streams conducted by ODFW in 2005, locations of high population density were found to be similar to those detected in 1995, 1989, and 1994, although it is worth noting that different methodologies were used. Lahontan cutthroat trout occupy approximately 32 kilometers (20 miles) of stream in the Willow Creek drainage, and approximately 63 kilometers (39 miles) of stream in the Whitehorse Creek complex. In the 2005 surveys, ODFW also detected Lahontan cutthroat trout at two of four sample sites in Shepline Creek, a stream where presence had been suspected but not verified. They were not detected in Antelope Creek near an area where they were detected in 1998. Because of low water levels and dry conditions in the creek, ODFW believes the absence of trout may represent the loss of the Antelope Creek population (Jones *et al.* 1998, Gunckel and Jacobs 2006).

Lahontan cutthroat trout also occur in the Quinn River Basin; distribution in Oregon is limited to 15 kilometers (9 miles) in Sage and Line Canyon creeks (ODFW 2005). Quinn River subbasin Lahontan cutthroat trout populations are at risk of extinction, as three of four populations have been extirpated due to hybridization with non-native rainbow trout (Tenmile Creek, Oregon Canyon Creek, and McDermitt Creek and all its tributaries except Sage Creek). Lahontan cutthroat trout are found in approximately 13 kilometers (8 miles) of stream in the Sage Creek complex, only resident forms exist, and adult Lahontan cutthroat trout population numbers are low (<200 adults)(ODFW 2005). Alvord Lake subbasin Lahontan cutthroat trout populations were all introduced from Coyote Lake subbasin stocks, and currently naturally reproduce. All populations are very limited in extent and population size.

Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of characterizing the current condition of the species. To assess consulted-on effects to the Lahontan cutthroat trout, we conducted a general review of all BOs completed at the Oregon Fish and Wildlife Office from January 1993 until March 2009. A total of 56 formal BOs were addressed during this time frame.

Our review shows that we consulted on a wide array of actions which had varying level of effects. The primary action consulted on was associated with livestock grazing activities on Bureau of Land Management's (BLM) grazing allotments. Some of the other actions included habitat improvements/restoration, management plans, and water quality issues. No actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery (*i.e.,* jeopardy determination) of the Lahontan cutthroat trout.

4.3. Warner sucker

The action area encompasses the Oregon portion of the range of the species. The Warner sucker inhabits the lakes and low gradient stream reaches of the Warner Valley, and is comprised by two life history forms: lake and stream morphs. The lake suckers normally spawn in the streams unless upstream migration is blocked by low stream flows during low water years or by irrigation diversion dams. When this happens spawning may occur in nearshore areas of the lakes (White *et al.* 1990). During droughts, the suckers inhabiting the lakes have been lost in the past when lakes have dessicated; lakes have been recolonized by suckers in the streams (White *et al.* 1991, Allen *et al.* 1994). The stream suckers inhabit and spawn in three major tributary drainages: Honey, Deep, and Twentymile Creeks (Scheerer *et al.* 2007a).

ODFW surveys in 2006 and 2007 found lake populations of Warner suckers to be depressed, and populations in tributaries have patchy distributions with zero suckers in a large proportion of the survey reaches and rare pockets of relatively high sucker abundance. Survey results were similar to stream Warner sucker population assessments last available in 1994, although the recent surveys documented a broader distribution than the 1994 surveys. Recent surveys documented suckers in lower Deep Creek, which had not been sampled earlier. Data suggest that lower Deep

Creek may provide important sucker spawning and rearing habitat (Scheerer *et al.* 2006b, Scheerer *et al.* 2007a).

In 1991, BLM installed a modified steep-pass Denial fish passage facility on the Dyke diversion on lower Twentymile Creek. The fishway is intended to re-establish a migration corridor, and allow access to high quality spawning and rearing habitats. The Dyke diversion structure is a 1.2 meter (4 feet) high irrigation diversion that was impassable to Warner sucker and redband trout before the fishway was installed. It blocked all migration of fishes from the lower Twentymile Creek, Twentymile Slough and Greaser Reservoir populations from moving upstream to spawning or other habitats above the structure. To date, no suckers have been observed or captured passing the structure, but redband trout have been observed and captured in upstream migrant traps.

An evaluation of fish passage alternatives has been done for diversions on Honey Creek which identifies the eight dams and diversions on the lower part of the creek that are barriers to fish migration (Campbell-Craven Environmental Consultants 1994). In May 1994, a fish passage structure was tested on Honey Creek. It consisted of a removable fishway and screen. The ladder immediately provided passage for a small redband trout. These structures were removed by ODFW shortly after their installation due to design flaws that did not pass allocated water.

Research through 1989 summarized in Williams *et al.* (1990) consisted of small scale surveys of known populations. Williams *et al.* (1990) primarily tried to document spawning and recruitment of the Hart Lake population, define the distributional limits of the Warner sucker in the streams, and lay the groundwork for further studies. White *et al.* (1990) conducted trap net surveys of the Anderson Lake, Hart Lake, Crump Lake, Pelican Lake, Greaser Reservoir, and Twentymile Slough populations. A population estimate was attempted for the Hart Lake population, but was not successful. Lake spawning activity was observed in Hart Lake, though no evidence of successful recruitment was found.

White *et al.* (1991) documented the presence of suckers in the Nevada reach of Twelvemile Creek. This area had been described as apparently suitable habitat by Williams *et al.* (1990), but suckers had not previously been recorded there. Kennedy and North (1993) and Kennedy and Olsen (1994) studied sucker larvae drift behavior and distribution in streams in an attempt to understand why recruitment had been low or nonexistent for the lake morphs in previous years. They found that larvae did not show a tendency to drift downstream and theorized that rearing habitat in the creeks may be vital to later recruitment.

Tait and Mulkey (1993a,b) investigated factors limiting the distribution and abundance of Warner sucker in streams above the man-made stream barriers. A population estimate of Warner sucker in streams was conducted in 1993 on the Honey Creek and Twentymile Creek drainages (Tait and Mulkey 1993b). Approximately 20 percent of available stream habitat in the Honey Creek drainage was sampled. The population within the area sampled was estimated at 77 adults, 172 juveniles, and 4,616 young of year. Approximately 60 percent of the available stream habitat in the Twentymile Creek drainage was also sampled. The population estimates within this area sampled was 2,563 adults, 2,794 juveniles, and 4,435 young of year. The detrimental effects of these barriers are well-known, but there may be other less obvious factors that are also affecting the suckers in streams. These studies found that general summertime stream conditions, particularly water temperature and flows, were poor for most fish species.

Recent studies have concentrated on population estimates, marking fish from Hart Lake and monitoring the recolonization of the lakes by native and non-native fishes (Allen *et al.* 1995a, Allen *et al.* 1995b, Allen *et al.* 1996).

The Federal agencies responsible for management of the habitat in the Warner Basin have consulted on activities that might impact the Warner sucker. On May 21, 1995, the BLM, USFS, National Marine Fisheries Service and the Service signed the Streamlining/Consultation Guidelines to improve communication and efficiency between agencies. In the Warner Basin, the outcome of streamlining has been regular meetings between the Federal agencies conducting and reviewing land management actions that may affect Warner sucker. These meetings have greatly improved the communication among agencies and have afforded all involved a much better understanding of issues throughout the entire watershed. As a result of close coordination, the USFS and BLM have modified many land management practices, thus reducing negative impacts, and in many cases bringing about habitat improvements to Warner sucker and Warner Valley redband trout.

Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of characterizing the current condition of the species. To assess consulted-on effects to the Warner sucker, we conducted a general review of all BOs completed at the Oregon Fish and Wildlife Office from January 1993 until March 2009. A total of 64 formal BOs were addressed during this time frame.

Our review shows that we consulted on a wide array of actions which had varying level of effects. Since the listing of Warner sucker as threatened in 1985, the Lakeview Resource Area has completed numerous consultations on BLM actions affecting Warner sucker. The following lists the subject and year the consultation was completed: Habitat Management Plan for the Warner Sucker 1985; Fort Bidwell-Adel County road realignment 1987; Warner Wetlands Habitat Management Plan 1990; relocation of Twentymile stream gauge 1993; Lakeview BLM grazing program 1994; reinitiation of consultation on grazing program 1995; Noxious Weed Control Program 1996; reinitiation of consultation on grazing program 1996; informal consultation on guided fishing activities 1997; reinitiation of consultation on grazing program and consultation on a number of small non-grazing projects 1997; reinitiation of consultation on grazing program 1999; informal consultation on Long Canyon Prescribed Fire 1999; grazing permit renewal concurrence 1999; consultation on the Resource Management Plan for BLM activities 2003; reinitiation of consultation on grazing program 2000 through 2004; and Hart Lake pump station and screen installation and operation 2006.

In 1994, Lakeview Resource Area determined that ongoing site-specific livestock grazing actions were likely to adversely affect Warner sucker in the Warner Valley Watersheds and has, to date, consulted under recurring biological opinions with the Service. Present grazing prescriptions and monitoring protocols are in accordance with biological opinions issued by the Service, and results of grazing monitoring appear annually in reports to the Service. Consultation for Lakeview Resource Area's grazing activities has been reinitiated due to changes in the action, changes due to new information, and for failure to comply with terms and conditions of the biological opinions.

Some of the other actions included habitat improvements/restoration, management plans, water quality issues, and roadway construction (*e.g.,* Warner sucker population and habitat monitoring in Oregon funded by the Service's Federal Aid Section 6 Grants 2006, Caspian tern management in the Columbia River Estuary 2005 by the Service and U.S. Army Corps of Engineers, and consultation on three irrigation system projects in the Warner Basin funded by the Natural Resources Conservation Service's Environmental Quality Incentives and Conservation Security programs 2007). None of these actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery (*i.e.,* jeopardy determination) of the Warner sucker.

4.4. Lost River and Shortnose suckers

The action area encompasses the Oregon portion of the range of the species (see Figure 1). The factors affecting the species environment in the action area include: degradation and loss of habitat as a result of Klamath Irrigation Project facilities and operations; agricultural and livestock grazing activities; Klamath Hydroelectric Project facilities and operations; non-native fish interactions; and poor water quality (*i.e.,* high pH, high ammonia, low dissolved oxygen) resulting from watershed alterations associated with agriculture, livestock grazing, and forest practices (Eilers *et al.* 2004, Bradbury *et al.* 2004, USFWS 2002a). These factors have resulted in the threats and impacts discussed below.

Degradation and Loss of Habitat

Historically, Lost River and shortnose suckers occupied four lakes: Clear Lake, Tule Lake, Upper Klamath Lake and Lower Klamath Lake and their associated tributaries in the Upper Klamath Basin (USBR 2002, Figure 1). Watershed development, including construction of the Klamath Project, associated agriculture and refuge development, and construction of dams on the Klamath River for hydroelectric power, substantially changed sucker habitat. New sucker habitat was created as a result of construction of Gerber, J.C. Boyle, Copco, and Iron Gate Dams and reservoirs, and sucker habitat in Clear Lake has expanded as a result of construction of the dam. In contrast, major reductions in habitat at Tule Lake (75-90 percent reduction from pre-development levels) and Lower Klamath Lake (97 percent reduction) occurred as a result of reclamation projects (USBR 2002). Moderate reductions (66 percent) in sucker habitat have occurred in Upper Klamath Lake as a result of diking and draining projects unrelated to those on the Klamath Project (Geiger 2001, ASR 2005). Most of this loss was related to private diking and draining of emergent wetlands. However, approximately 18,000 acres of open water and wetland habitat around Upper Klamath Lake is currently being restored and reconnected to the lake.

Changes in lake size resulted in changes in available sucker habitat. In the late 1800s, prior to most watershed development, 223,000-330,000 acres (276,000 average) of shallow lake and associated wetland habitat existed (Akins 1970, USBR 2002) compared to 76,000-122,000 acres (99,000 average) currently. Overall, suckers' lake and wetland habitat has decreased approximately 64 percent (177,000 acres) over the last century (Reclamation 2002). A concurrent, substantial decline in sucker populations over this time period was related in part to the large loss of lake and wetland habitat areas, but was also attributable to suckers' blocked access to spawning and rearing areas, low instream flows, entrainment losses resulting from diversions, and other factors (USFWS 2002a).

Review of recent U.S. Army Corps of Engineers section 7 ESA consultations indicate that some relatively minor wetland losses still occur in the Upper Klamath Basin, but effects of these actions on sucker populations are minimized during project planning and consultation (USFWS 2007b). In an attempt to compensate for wetland losses over the last century, both the Federal and State governments and privately funded organizations have purchased former farmed and ranched wetland areas and are reclaiming these areas as wetlands.

Migration Barriers

Dams block sucker migration corridors, isolate population segments, prevent genetic exchange between populations, and concentrate suckers in limited spawning areas, possibly increasing the likelihood of hybridization between species (USFWS 2002a). Dams may also change stream channel, alter water quality, and provide habitat for non-native fish that prey on suckers or compete with them for food and habitat (Reclamation 2001). There are seven major Project dams that may affect the migration patterns of listed suckers: Clear Lake, Link River, Gerber, Malone, Miller Creek, Wilson, and Anderson-Rose Dams. Only the Link River Dam is equipped with a fish ladder designed specifically for sucker passage; it was completed in 2005.

Entrainment

Entrainment is defined as the downstream movement of fish into power or irrigation diversions or spillways caused by water management as opposed to passive drift due to wind- or gravity-driven currents or volitional emigration. Historically, before construction of Link River Dam and development of the Klamath Project, suckers probably dispersed downstream and reared in Lake Ewauna and Lower Klamath Lake (USFWS 2002a). Reports of large runs of suckers up the Link River indicated that many of these fish survived to return to Upper Klamath Lake. The rate of entrainment of suckers that leave the lake may be much different now than what it was prior to the development of the Project because of changes in habitat conditions in Upper Klamath Lake and tributaries where suckers spawn, changes in lake levels and in the timing and amount of flow at the lake outlet, the channel cut through the reef at the lake outlet, and construction of Link River Dam and Eastside and Westside power diversions. Survival of suckers leaving the lake is much lower now because of habitat degradation and loss downstream and blocked passage at Link River Dam (USFWS 2007c,d). Upstream passage for adult fish was improved in 2005 when Reclamation installed a sucker-friendly fish ladder at the dam.

Instream Flows

Because the Lost River and shortnose suckers are lake dwellers and riverine spawners, adequate instream flows are necessary for access to and availability of spawning habitat and transport of larvae downstream to lacustrine rearing areas (Buettner and Scoppettone 1990, Perkins *et al.* 2000, Cooperman and Markle 2004). Most of the tributaries supporting the major populations of Lost River and shortnose suckers (Clear Lake, Gerber Reservoir, and Upper Klamath Lake) are minimally regulated particularly during the spawning season and therefore have little effect on sucker spawning, egg incubation, and larval emigration (USFWS 2002a). However, instream flows that are intensively managed in the Link River, Miller Creek, and Lost River are likely to benefit suckers when there are flows and adversely affect them when flows are stopped (USBR 2000, 2007; USFWS 2002a).

Watershed Alterations Affecting Water Quality in Upper Klamath Lake

Upper Klamath Lake was historically eutrophic but is now hypereutrophic (ODEQ 2002). It has been suggested that large scale watershed development from the late 1800s through the 1900s has contributed to Upper Klamath Lake's current hypereutrophic condition (Bortleson and Fretwell 1993, Eilers *et al.* 2001, Bradbury *et al.* 2004, Eilers *et al.* 2004; ASR 2005). Accelerated sediment and nutrient loading to Upper Klamath Lake consistent with land use practices in the Upper Klamath watershed have contributed to erosion and transport of nutrients to Upper Klamath Lake (Eilers *et al.* 2004). This nutrient loading has resulted in algae blooms of higher magnitude and longer duration (Kann 1997). These blooms have led to extreme water quality conditions (high pH, low dissolved oxygen, and high ammonia) that likely impact fish health and increase the size and frequency of fish die-offs (Perkins *et al.* 2000). In recent decades, Upper Klamath Lake has experienced serious water quality problems that have resulted in massive fish die-offs, as well as pronounced horizontal re-distribution of suckers in response to changes in water quality (Buettner and Scoppettone 1990, Peck 2000, Banish *et al.* 2007).

Nutrient Loading

High nutrient loading to Upper Klamath Lake promotes correspondingly high algae production, which in turn, modifies physical and chemical water quality characteristics that can directly diminish the survival and production of fish populations. Accelerated phosphorus loading is likely a key factor driving the massive Aphanizomenon flos-aquae (AFA, blue-green algae) blooms that now dominate Upper Klamath Lake. Through modeling and analysis efforts, ODEQ (2002) determined that phosphorus reduction would be the most effective means of improving water quality conditions in Upper Klamath Lake. In 2002, ODEQ established a Total Maximum Daily Load (TMDL) for Upper Klamath Lake. This TMDL targets the reduction of phosphorus as a means to reduce AFA production and improve water quality conditions. Although nitrogen is also an important nutrient for structuring algae communities and determining algal productivity, AFA is able to fix atmospheric nitrogen to meet its nitrogen needs in what may otherwise be a nitrogen-limiting environment (ODEQ 2002). Thus, phosphorus loading is particularly important in Upper Klamath Lake in determining algal productivity and biomass, which in turn influences water quality conditions affecting native fishes (ODEQ 2002). However, there is debate as to whether external phosphorus load reduction will improve water quality conditions within Upper Klamath Lake (NRC 2004) due to internal nutrient loading driven by the release of phosphorous from the lake bed sediments (Laenen and Le Tourneau 1996, Fisher and Wood 2004, NRC 2004, Kuwabara *et al.* 2007).

Although high background phosphorus levels in Upper Klamath Basin tributaries existed before development, data from several studies indicates that phosphorus loading and concentrations are elevated above these background levels (Miller and Tash 1967, USACE 1982, Campbell 1993, Kann and Walker 1999, Bradbury *et al.* 2004, Eilers *et al.* 2004). This accelerated phosphorus loading occurred at the same time as an increase in development and intensive land use activities in the Upper Klamath Basin, including substantial timber harvesting, drainage of wetlands, and agricultural activities (Bradbury *et al.* 2004, Eilers *et al.* 2004, ODEQ 2002).

Throughout the Upper Klamath Basin, timber harvesting and associated activities (road building) by Federal, State, tribal, and private landowners have resulted in soil erosion on harvested lands and transport of sediment into streams and rivers adjacent to or downstream from those lands (USFWS 2002a). Past logging and road building practices often did not provide for adequate soil stabilization and erosion control. Risley and Laenen (1999) reported that timber harvest and associated roads have contributed to the high sediment and nutrient inputs to Upper Klamath Lake from tributary watersheds. However, the magnitude of impact from timber harvest on nutrient and sediment input to Upper Klamath Lake is unquantified. Timber harvest peaked in the 1940s at about 800 million board feet (mbf) and ranged from about 400 to 450 mbf from 1970 to 1990 (Risley and Laenen 1999). Since the 1990s there has been a substantial reduction in harvest; in 2003, 200 mbf were harvested in Klamath County. Nevertheless, a high density of forest roads remain in the watershed and many of these are located near streams where they likely contribute sediment (USFS 1994, 1995 a & b, 1996, 1997, 1998).

Livestock grazing, the major agricultural activity in the Upper Klamath Lake watershed has likely accelerated erosion leading to an increase in sediment and nutrient loading rates to Upper Klamath Lake (USFWS 2002a). Livestock, particularly cattle, have heavily grazed flood plains, wetlands, forest, rangelands, and riparian areas, resulting in the degradation of these areas. The increase in sediment accumulation and nutrient loading are consistent with the changes in land use in the Upper Klamath watershed occurring over the last century (Eilers *et al.* 2001, Bradbury *et al.* 2004, Eilers *et al.* 2004, ASR 2005). However, the magnitude of impact from agriculture and livestock grazing on nutrient and sediment input to Upper Klamath Lake is unquantified. Approximately 35 percent of the watershed above Upper Klamath Lake is used for livestock grazing. Cattle production in Klamath County peaked in 1960 with 140,000 animals (Eilers *et al.* 2001). In the Wood River Valley approximately 35,000 cattle graze on pastures during the summer and fall and less than 1,000 during the other months (Eilers *et al.* 2001). In the Sprague River Valley approximately 20,000 cattle graze on pastures in summer and approximately 1,500 graze during winter (Eilers *et al.* 2001). In recent years the number of cattle has been reduced by approximately 50 percent; in 2007 the number of cattle reported was 81,000 (USBR 2007).

Diking and draining of wetlands for non-Project agricultural development accounted for a conversion of over 50,000 acres in the Upper Klamath Lake watershed (ASR 2005). Note that some of these reclaimed wetlands still are classified as wetlands because they hydric (wetland) soils and are seasonally flooded; however, some functions, such as water quality improvement, are lost. Of the 50,000 acres of converted wetlands, about 35,000 acres immediately adjacent to Upper Klamath Lake that provided habitat for fish were converted to agricultural lands from the 1880s to 1960s (ASR Resources 2005, Snyder and Morace 1997).

The drained wetlands are also a source of nutrients to Upper Klamath Lake. Direct phosphorus loading from drained wetland properties surrounding Upper Klamath Lake is also very high (188 kg/km^2; Kann and Walker 1999). Nutrient loading studies indicate that despite contributing only 3 percent of the water inflow (43,000 acre-feet/year), direct agricultural input from pumps that remove water from the drained wetlands around Upper Klamath Lake accounted for 11 percent of the annual external phosphorus budget (21 metric tons/year) and as much as 32 percent of the total during the peak pumping period of February through May (Kann and Walker 1999). However, in recent years about 18,000 acres of drained wetlands are in the process of being converted back to wetland and lake habitat, likely resulting in a decrease in nutrient loading to Upper Klamath Lake (ASR 2005).

Internal phosphorus loading is another significant component of the nutrient budget affecting algal bloom dynamics and water quality in Upper Klamath Lake (Barbiero and Kann 1994, Leanen and Le Toureau 1996, Kann 1998, Kann and Walker 1999). Nutrient loading studies show that the largest flux of phosphorus to Upper Klamath Lake during the summer months comes from internal sources (Kann and Walker 1999). On average, the internal loading accounts for approximately 60 percent while external loading accounts for approximately 40 percent of the annual phosphorus load to Upper Klamath Lake (Walker 2001).

Algae Productivity and Associated Poor Water Quality

In hypereutrophic lakes with large amounts of nutrient input, algal production increases and algal biomass accumulates until light, nutrients or some other factor limits further growth. As biomass increases, the available soluble forms of nitrogen and phosphorus decrease because the nutrients are progressively accumulated in the algal biomass and are therefore unavailable for further algal production. The nutrient needed for growth that is in the shortest supply, thus becomes the limiting nutrient. When light, nutrients, or other conditions for algae become unfavorable, the production of the algal bloom will cease or rapidly decline, resulting in an algal "crash".

The massive blooms of AFA and the subsequent rapid decline (crash) can cause extremes in water quality including elevated pH, low dissolved oxygen concentrations (hypoxia), and elevated levels of un-ionized ammonia, which can be toxic to fish (Kann and Smith 1993, Kann and Smith 1999, Perkins *et al.* 2000, Walker 2001, Welch and Burke 2001, Wood *et al.* 2006, Kuwabara *et al.* 2007, Morace 2007). In the process of rapid growth, algal biomass can form extremely dense blooms, which can vary in magnitude depending on the availability of growth-promoting conditions (Kann and Smith 1993, Kann and Smith 1999, Perkins *et al.* 2000). During the same bloom conditions and following a bloom crash, particularly when coupled with high rates of nighttime respiration, dissolved oxygen can drop to levels that that can be stressful or even lethal to fish. In addition, when dense algae blooms die off, the microbial decomposition of the algae and organic matter in the sediment can further deplete dissolved oxygen and produce increased concentrations of ammonia (Kann and Smith 1993, Risley and Laenen 1999, Perkins *et al.* 2000).

Fish Health

Disease and parasite prevalence were not identified as threats at the time of listing for Lost River and shortnose suckers. However, recent information indicates that pathogens affect sucker health and survival, especially during adverse water quality events (USFWS 2007c; USFWS 2007d, Appendix 2). Fish susceptibility to pathogens in the Upper Klamath Basin may, in part, be affected by stressful water quality conditions, as well as a variety of other factors including low water levels and a high biomass of fish. Although adult sucker die-offs that occurred in Upper Klamath Lake in the 1990s were likely a response to low levels of dissolved oxygen, disease outbreaks also probably contributed to mortality during these events (Perkins *et al.* 2000, NRC 2004).

A number of pathogens have been identified from sick and dying suckers, but Columnaris disease seems to be the primary organism involved (Foott 1997, Holt 1997). Columnaris disease is caused by the bacterium *Flavobacterium columnare,* which can cause massive damage to the gills and produces lesions elsewhere on the body. This leads to respiratory problems, an imbalance of internal salt concentrations, and provides an entry route for systemic pathogens that can cause death (USFWS 2007c,d).

Non-native Fish Interactions

In the last century, the Upper Klamath Basin has been invaded by about 20 non-native fish species (Logan and Markle 1993, Moyle 2004). Most of these species are not particularly common in the basin, but some are abundant and widespread and their effects on listed suckers are poorly understood.

Non-native fishes can have complex interactions with native fishes, and their relative impact can depend on the presence or absence of altered habitats such as impoundments and on the availability of smaller-scale habitat structure such as substrates (Markle and Dunsmoor 2007). In highly modified habitats like Lost River, Klamath River, and Klamath River reservoirs, non-native fish appear to be dominant and have a greater negative impact on endangered suckers (Koch and Contreras 1973, Desjardins and Markle 2000). Many of the non-native fish species are more tolerant of habitat degradation and occupy a wider range of habitats than the suckers (Moyle 2004). The degraded habitats have resulted in less shoreline vegetation that provided suckers protection from predation by non-native fish (Markle and Dunsmoor 2007, NRC 2004).

Human-induced Climate Change

Climate change is expected to significantly affect water resources in the western United States by the mid 21st century (Leung *et al.* 2004, Barnett *et al.* 2008). Climate change is generally predicted to result in increased air and water temperatures, decreased water quality, increased evaporation rates, increased proportion of precipitation as rain instead of snow, earlier and shorter runoff seasons, and increased variability in precipitation patterns (Adams and Peck 2006, Doppelt *et al.*2008). Several studies have shown declining snowpack, earlier spring snowmelt, and earlier stream runoff in the western United States over the past few decades (Hamlet *et al.* 2005, Stewart *et al.* 2005, Doppelt *et al.* 2008). Winter precipitation and snowpack have been shown to be strongly correlated with stream flow in the Pacific Northwest (Leung and Wigmosta 1999).

Increasing temperature trends are the major drivers of these observed trends, particularly at the moderate elevations and relatively warm winter temperatures characteristic of the Pacific Northwest (Hamlet *et al.*, 2005, Stewart *et al.*, 2005). In southern Oregon, annual average temperatures are likely to increase from 1 to 3° F (0.5 to 1.6° C) by around 2040, and 4 to 8° F (2.2 to 4.4° C) by around 2080, and summer temperatures may increase dramatically reaching 7 to 15° F (3.8 to 8.3° C) above baseline by 2080, while winter temperatures may increase 3 to 8°F (1.6 to 3.3° C; Doppelt *et al.* 2008). Projections of changes in precipitation with climate change vary widely among models, but some investigators report that increasing temperatures and resulting evapotranspiration losses will result in decreasing April 1st snow packs that will offset any precipitation increases in the region (Hamlet *et al.* 2005).

A preliminary analysis of climatologic and hydrologic information for the Upper Klamath River Basin indicates Upper Klamath Lake inflows, particularly baseflows, have declined over the last several decades (Mayer 2008). Net inflow to Upper Klamath Lake and tributary flow to Upper Klamath Lake (an independent measure of inflow) are both strongly dependent on climate, particularly precipitation, as demonstrated in Mayer (2008). Part of the decline in baseflows is explained by decreasing precipitation but there may be other factors involved as well, including increasing temperatures and the resulting decrease in April 1st snow water equivalent; increasing evapotranspiration and consumptive use; or increasing surface water diversions or ground water pumping above the lake.

Both the Oregon Climate Division 5 temperature dataset and the U.S. Historical Climatological Network temperature dataset for Crater Lake show increasing trends in winter temperatures since the 1970s. Present-day winter temperatures are as warm or warmer than at any time during the last 80 to 100 years. Bartholow (2005) found that water temperatures in the Lower Klamath River have been increasing by about 0.5EC per decade since the 1960s.

At most snow-course locations in the western U.S., April 1st snow water equivalent (SWE) has been found to be the maximum annual value of snowpack and is highly correlated with stream flow (MaCabe and Dettinger 2002). April 1st SWE in the southern Cascades has declined since the 1930s, based on data from two high elevation sites near Crater Lake (Mayer 2008). Trends in the April 1st SWE at the two sites may be related to trends in winter temperature as well as precipitation.

One of the most intriguing studies on long-term climate trends in the basin is the study by Petersen *et al.* (1999) correlating tree-ring growth with annual precipitation and lake levels at Crater Lake. In the paper, the authors view Crater Lake as the "world's largest rain gage" and they create a surrogate record of precipitation and lake levels based on tree-ring growth over the last three hundred years or more. Their results suggest that both precipitation and lake levels have been in a multi-century decline since about 1700.

Much of the decline in Upper Klamath Lake net inflows and tributary flows is certainly due to associated trends in climate. The observed changes are consistent with regional observations of climate change-related phenomena throughout the western U.S. Other factors such as increased consumptive use or ground water pumping above the lake may contribute to the decline too. Regardless, the implications of these declines are that there will be less water available in the system, particularly during the baseflow period. Hydrologic modeling and inflow forecasting based on historic lake inflows may not be representative of future conditions to the extent that it overestimates available water.

In addition to having multiple effects on water resources, such as reducing snow-pack, increasing winter run-off, increasing evapotranspiration-related water losses from wetlands and open water, and increasing agricultural water demand, climate change may directly and indirectly affect biological resources in the Klamath Basin. Climate change could exacerbate existing poor habitat conditions for suckers by further degrading water quality. Higher temperatures could increase the incidence of episodes of peak summer temperatures and contribute to the low dissolved oxygen events that are responsible for sucker die-offs. The weather conditions documented during the last three fish die-offs in Upper Klamath Lake were characterized by higher than average temperatures (Wood *et al.* 2006) suggesting that temperature plays a role in the events. Because Upper Klamath Lake is shallow, water temperatures tend to closely follow air temperatures so even a week of high air temperatures will affect water temperatures in the lake (Wood *et al.* 1996).

Higher water temperatures could have multiple adverse effects on suckers including: (1) stressing AFA, causing bloom collapse; (2) increasing respiration rates of microorganisms, thus elevating dissolved oxygen consumption in the water column and in sediments; (3) raising respiration rates for suckers and other fish making it more difficult for them to obtain sufficient dissolved oxygen; and (4) reducing the dissolved oxygen holding-capacity of water which is highest in cold water. The productivity of Upper Klamath Lake and sucker growth rates might increase as a result of higher temperatures, but if higher temperatures lead to reduced water quality, the benefits could be negated. Because of the complex nature of the lake ecosystem, it is difficult to predict what ecological changes are likely to occur, but it is certain that some changes will happen.

Genetics

Hybridization was identified as a threat to Lost River and shortnose suckers at the time of listing (USFWS 1988a). New data suggest that hybridization among four Klamath Basin suckers (Lost River sucker, shortnose sucker, Klamath largescale sucker (*Catostomus snyderi*) and Klamath smallscale sucker (*Catostomus rimiculus*) does occur (Dowling 2005b, Tranah and May 2006). Hybridization can be cause for concern for an imperiled species, even leading to extinction (*e.g.,* Rhymer and Simberloff 1996). However, at this time, scientists who have studied Klamath suckers consider any hybridization among them is not unusual (Dowling 2005b, Tranah and May 2006). The evidence indicates that hybridization has been common throughout the evolutionary history of suckers, in general, and Klamath Basin suckers, in particular (Dowling 2005b, Markle *et al.* 2005).

Despite any hybridization that occurs, Lost River and shortnose suckers are distinguishable, for the most part, from the other Klamath Basin suckers using morphological characteristics (Dowling 2005b, Markle *et al.* 2005). They also show evidence of behavioral and ecological differences (Markle *et al.* 2005). The taxonomy of Lost River and shortnose suckers is not being questioned at this time.

Status of Proposed Critical Habitat within the Action Area

There are six proposed critical habitat units (CHU): (1) Clear Lake and watershed; (2) Tule Lake; (3) Klamath River; (4) Upper Klamath Lake and watershed; (5) Williamson and Sprague Rivers; and (6) Gerber Reservoir and watershed (Figure 5, below).

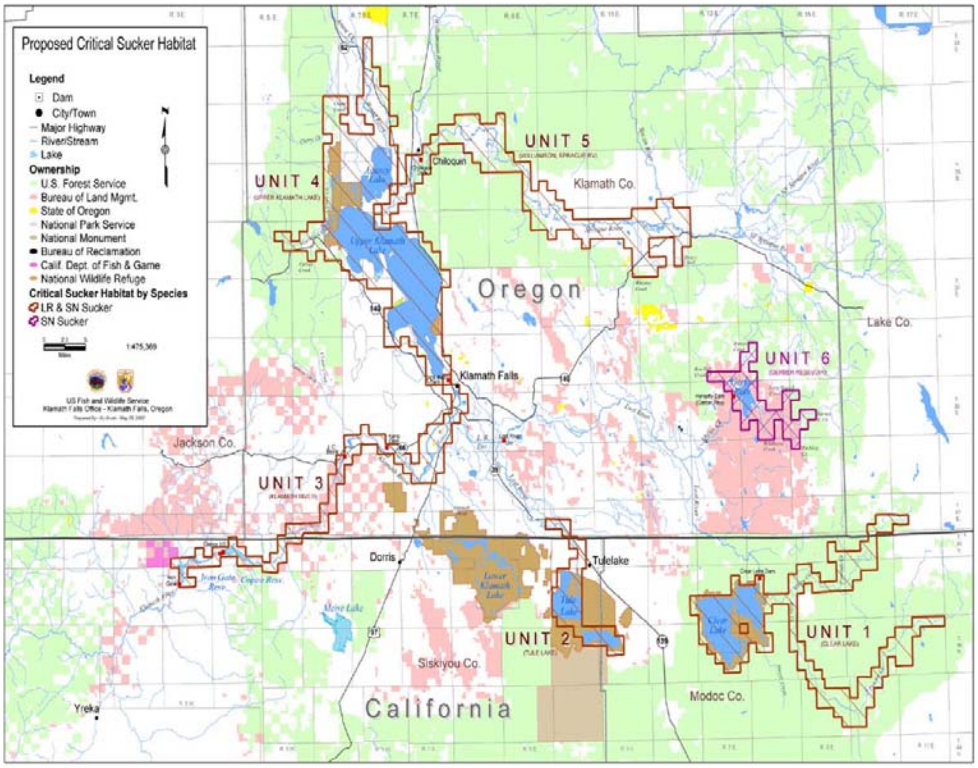

Figure 5. Map showing the six proposed critical habitat units for the Lost River and shortnose suckers.

CHU 1 (Clear Lake and watershed): Only a small portion of CHU 1 occurs within Oregon. Water quantity, water quality and physical habitat for spawning, feeding, rearing, and travel corridors are generally sufficient for Lost River and shortnose suckers. However, during extended drought conditions when Clear Lake recedes to a small size with low lake levels, reduced water quality, primarily low dissolved oxygen, both in summer and in winter below an ice cover are likely to occur. Under these stressful conditions fish are at greater risk of disease parasitism, and fish die-offs. Competition and predation by non-native fish species including Sacramento perch, and brown bullhead likely impact sucker populations particularly at low lake levels. A migration barrier at Clear Lake Dam isolates Lost River and shortnose suckers populations and prevents genetic exchange with other populations in the Upper Klamath Basin.

CHU 2 (Tule Lake): Only a small portion of CHU 2 occurs within Oregon. Physical habitat for feeding and rearing is very limited due to shallow water depths. Spawning habitat is restricted to a small area in the lower Lost River. There are no passage facilities at Anderson Rose Dam and habitat alteration in the Lost River and additional dams without passage have eliminated spawning habitat upstream. Travel corridors in the lower Lost River are restricted by shallow depths affected by sedimentation and low flows during the spawning period. Degraded water quality during the summer including high pH, ammonia, nutrients, pesticides, and low dissolved oxygen negatively impacts sucker populations. Fish die-offs in winter below an ice cover are likely to occur. Sedimentation in Tule Lake sumps limits adult habitat and restricts assess to the upstream spawning site. Competition and predation by non-native fish species likely impacts survival of larval and juvenile suckers.

CHU 3 (Klamath River): Water quality in the Klamath River reservoirs is stressful to suckers during the summer when large blue-green algae blooms and crashes occur (NRC 2004). Fish die-offs are common in Keno Reservoir (Tinniswood 2006). Emergent wetlands and shallow shoreline habitat used by larval and juvenile suckers are extremely limited in the Klamath River reservoirs with the exception of J.C. Boyle Reservoir. Spawning habitat is also lacking or limited due to high gradient and velocity of the river and absence of gravel spawning substrate. Non-native fish populations are also very large in all of the Klamath River reservoirs. Competition and predation by species including fathead minnows, yellow perch, bullheads, crappie, and largemouth bass likely impact sucker populations in the Klamath River reservoirs.

CHU 4 (Upper Klamath Lake and watershed): Seasonal reductions in water surface elevations during summer and fall of dry years negatively impact the quantity and quality of emergent wetland rearing habitat for larval and juvenile suckers, and the loss of deep-water habitats and water quality refuge areas for older fish. Substantial wetland habitat restoration is underway to provide a major increase in high quality habitat at the Williamson River delta. Water quality conditions are stressful for Lost River and shortnose suckers every summer due to massive AFA blooms and crashes that result in increased pH and ammonia, and reduced dissolved oxygen. Periodic fish die-offs occur as a result of poor water quality associated with AFA bloom crashes. Entrainment of larval and juvenile suckers at the outlet of the lake is significant and negatively impacts recruitment. Non-native fish species including fathead minnows and yellow perch likely compete for resources and prey upon suckers (Markle and Dunsmoor 2007). Tributaries to Upper Klamath Lake including the Wood River, Crooked Creek, Sevenmile Creek, and Fourmile Creek, the historic spawning habitat for suckers in Upper Klamath Lake, are degraded due to channelization and agricultural development.

CHU 5 (Williamson and Sprague Rivers): Physical habitat in the Sprague and Williamson Rivers used for spawning, larval, and juvenile rearing is degraded due to the lack of habitat complexity. These areas lack riparian vegetation, backwater wetlands, and sinuous river channels. Fish passage was restricted by Chiloquin Dam reducing access to upstream spawning habitat; however, the dam was removed in 2008. Water quality in the Sprague River is degraded due to water withdrawals during the summer and sedimentation and nutrient loading from agricultural and forestry practices adjacent to the river. Competition and predation by non-native fish species including yellow perch, largemouth bass, fathead minnows, and brown bullheads likely negatively affect larval and juvenile sucker survival.

CHU 6 (Gerber Reservoir and watershed): Water quantity, water quality, and physical habitat for spawning, feeding, rearing, and travel corridors are generally sufficient for shortnose sucker. However, during extended drought conditions when Gerber Reservoir recedes to a small size with low lake levels, reduced water quality, primarily low dissolved oxygen, both in summer and in winter below an ice cover are likely to occur. Under these stressful conditions fish are at greater risk of disease and parasitism and fish die-offs. Competition and predation by non-native fish species including yellow perch, crappie, and brown bullhead likely impact sucker populations particularly at low lake levels. A migration barrier at Gerber Dam isolates shortnose sucker populations and prevents genetic exchange with other shortnose sucker populations in the Upper Klamath basin. The dam also prevents access by Lost River suckers.

Relationship of the Action Area to Conservation of the Suckers

Conservation of the Lost River and shortnose suckers is dependent on preserving several viable self-sustaining populations of suckers in as much of their historic range as possible: (1) populations must be of adequate size and of diverse age structure to withstand stochastic events and remain viable; (2) populations must be interconnected for demographic and genetic support; and (3) adequate spawning, rearing, feeding, and over-wintering habitat must be present throughout the species range to support viable populations.

Currently, the largest populations of Lost River and shortnose suckers are found in Upper Klamath Lake and its tributaries (USFWS 2007c,d). These species rear, feed and over-winter in the lake and are affected by water level management that affects habitat availability including shoreline spawning areas for Lost River suckers, emergent wetlands and shallow shoreline areas for larvae and to a lesser extent age 0 juveniles, deeper open water habitat for juvenile and adults, and water quality refuge areas. Substantial entrainment of larval and juvenile suckers occurs at the outlet of Upper Klamath Lake. Although we cannot determine all of the factors causing the downstream movement and loss of larval and juvenile suckers at Link River Dam, Reclamation's management of the dam contributes to this loss and therefore represents a risk to the Lost River and shortnose suckers. See Entrainment section for a more detailed description.

Currently, Clear Lake has a relatively large population of Lost River and shortnose suckers. A potential threat to Clear Lake population is lack of access to Willow Creek, the principal spawning tributary. However, the proposed action is anticipated to provide adequate water depths for sucker spawning access in all years. The effects of fluctuating water elevations at Clear Lake on sucker populations in terms of population size, age-class distribution, recruitment, or decreased fitness are not fully understood. However, available information indicates that the Clear Lake sucker populations have remained viable under the current management regime and we do not anticipate that this will change unless there is a prolonged drought.

There is also a robust population of shortnose suckers in Gerber Reservoir. Similar to Clear Lake, the effects of fluctuating water levels on the shortnose sucker population in Gerber Reservoir is not fully understood. However, available information indicates that the shortnose sucker population has remained viable under the current management regime and we do not anticipate that will change unless there is a prolonged drought.

The long-term survival of suckers in Tule Lake is in doubt because of the lack adult rearing habitat (areas with water depth greater than 3 feet) and lack of flows and spawning habitat in the Lost River under the proposed action. The Tule Lake population of Lost River suckers may be crucial to recovery of that species since it represents one of only three Lost River sucker populations. Spreading the risk of extirpation among three Lost River sucker populations rather than just two populations could significantly decrease the threat of extinction risk to the species.

The Lost River and Keno Reservoir are highly altered systems and currently support small sucker populations. However, because Keno Reservoir is adjacent to Upper Klamath Lake and large numbers of suckers disperse there from upstream, it has the potential to provide rearing habitat for a large number of suckers that ultimately migrate back to Upper Klamath Lake to spawn along shoreline areas or in the tributaries. Therefore, habitat and water quality improvements in Keno Reservoir are justified.

4.5. Modoc sucker

The action area encompasses only the Oregon portion of the species range. In recent surveys, Modoc sucker were only documented in approximately 14.2 miles of stream in upper Thomas Creek primarily on U.S. Forest Service land within the Goose Lake Basin. They may extend further upstream, or downstream onto lands under private ownership on the valley floor in Thomas Creek and its tributaries (S. Reid, pers. comm. 2008). The factors affecting the species environment in the action area include: changes in habitat quantity and quality; presence of movement barriers; predation; hybridization; and drought and climate change. Ecosystem restoration and other recovery actions are taking place in efforts to meet recovery criteria from the 1984 Recovery (Action) Plan. CREP projects could potentially improve, and help to extend the amount of suitable and occupied Modoc sucker habitat.

Habitat Quantity and Quality

The 1985 listing rule stated that land management activities had: (1) dramatically degraded Modoc sucker habitat, (2) removed natural passage barriers allowing hybridization with Sacramento suckers and providing access to predaceous fishes, and (3) decreased the distribution of the Modoc sucker to only four streams (USFWS 1985a). Thomas Creek, in the Oregon portion of the Goose Lake sub-basin, was not considered to contain Modoc suckers in the original listing, because at that time the range of the sucker was considered to be confined to California. The majority of the upper Thomas Creek watershed and the stream reaches containing Modoc suckers are managed by Fremont-Winema National Forests. Prior to the recognition that there were Modoc suckers in the drainage, the Forest Service in 1986 established the Thomas Creek Riparian Recovery Project with the objective to halt erosion, stabilize stream banks, and reduce water temperatures for the benefit of native fishes. As part of this project, there have been numerous riparian restoration and channel improvement projects to promote deeper pool development and water retention, as well as improved grazing management.

There are two privately-owned meadow reaches of Thomas Creek above the lower forest boundary that are characterized by low gradient and large open pools. Both are managed for grazing by the USFS permittee. The lower parcel, which is unfenced and grazed with neighboring USFS allotments, contains substantial populations of Modoc sucker (Reid 2007a). The upper parcel is fenced and has not been surveyed, although Modoc suckers are abundant in pools at its boundaries and therefore the suckers are likely occur on the un-surveyed stream reach. At this time, the Service has no indication that current land management practices on public and private lands on Thomas Creek that are compatible with the conservation of the species will not continue, and therefore upward habitat trends are expected to continue.

Movement Barriers

The original listing assumed that natural passage barriers in streams occupied by Modoc suckers had been eliminated by human activities, allowing hybridization between the Modoc and Sacramento suckers, as well as providing access to Modoc sucker streams by non-native predatory fishes. However, review of all streams where Modoc suckers occur indicates no evidence for historical natural barriers that would have physically separated the two species in the past, particularly during higher springtime flows when Sacramento suckers make their upstream spawning migrations (Reid 2008b). There is no evidence showing that the historical range of the Modoc sucker, or its distribution within that range, has been substantially reduced in the recent past. To the contrary, continued field surveys have resulted in recent expansions of our understanding of the species' range and distribution. Furthermore, the distribution of Modoc suckers within the stream populations recognized in 1985 has either remained stable over the past 22 years, or slightly expanded, and the ten populations appear to occupy all available and suitable habitat.

Predation

The original listing identified the presence of introduced and highly piscivorous brown trout (*Salmo trutta*) as an adverse element that reduced sucker numbers through predation (USFWS 1985a). Nonnative predatory fish are a problem in parts of the range in California (Reid 2008b); however, in Thomas Creek, no nonnative fishes have been found (Reid 2007a, Heck *et al.* 2008). The Modoc sucker, which rarely exceeds 7 inches standard length in small streams, typically occupies habitat where the only native predatory fish is the native redband trout (*Oncorhynchus mykiss* ssp.). Stream-resident redband trout, which are not substantially larger than the Modoc sucker, is a primarily insectivorous species that occasionally feeds on small fishes (Moyle 2002). Because stream-resident redband trout are small and primarily feed on insects we do not believe they pose a threat to the Modoc sucker.

Hybridization

The 1985 listing identified hybridization with the Sacramento sucker, also native to the Pit River drainage, as a principal threat to the Modoc sucker. Hybridization can be cause for concern in a species with restricted distribution, particularly when a closely related non-native species is introduced into its range, and can lead to loss of genetic integrity or even extinction (Rhymer and Simberloff 1996). In 1985, it was assumed that hybridization between Modoc and Sacramento suckers had been prevented in the past by natural physical barriers, which had been recently eliminated by human activities, allowing contact between the two species. Modoc sucker populations from streams in which both species were present were considered hybrid populations and were excluded when evaluating the Modoc sucker's distribution in 1985. The assumption that extensive hybridization was occurring was based solely on the opportunity presented by co-occurrence and the identification of a few specimens exhibiting what were thought to be intermediate morphological characters. At that time, genetic information to assess this assumption was not available.

Modoc and Sacramento suckers are naturally sympatric (occurring in the same streams) in the Pit drainage. There is no indication that Sacramento suckers are recent invaders to the Pit River or its tributaries. Both morphological and preliminary genetic data suggests that the upper Pit River population of Sacramento suckers is distinct from other Sacramento River drainage populations (Ward and Fritsche 1987; Dowling, unpub. data. 2005). There is also no available information suggesting Modoc and Sacramento suckers were geographically isolated from each other in the recent past by barriers within the Pit Drainage. Separation of the two species appears to be primarily ecological, with Modoc suckers occupying smaller, headwater streams typically associated with trout and speckled dace, while Sacramento suckers primarily occupy the larger, warmer downstream reaches of tributaries and main-stem rivers with continuous flow (Moyle and Marciochi 1975, Moyle and Daniels 1982, Reid 2008b). Further reproductive isolation is probably reinforced by different spawning times in the two species and their size differences at maturity (Reid 2008b).

The morphological evidence for hybridization in 1985 listing was based on a limited understanding of morphological variation in the Modoc and Sacramento suckers, derived from the small number of specimens available at that time. Subsequent evaluation of variability in the two species, based on a larger number of specimens, shows that the overlapping character states (primarily lateral line and dorsal ray counts), interpreted by earlier authors as evidence of hybridization, are actually part of the natural meristic (involving counts of body parts such as fins and scales) range for the two species and are not associated with genetic evidence of introgression (Kettratad 2001, Reid 2008b). Furthermore, the actual number of specimens identified as apparent hybrids by earlier authors was very small and in great part came from streams without established Modoc sucker populations.

In 1999, the Service initiated a program to examine the genetics of suckers in the Pit River drainage and determine the extent and role of hybridization between the Modoc and Sacramento suckers using both nuclear and mitochondrial genes (Palmerston *et al.* 2001, Wagman and Markle 2000, Dowling 2005a, Topinka 2006). The two species are genetically similar, suggesting that they are relatively recently differentiated and/or have a history of introgression throughout their range that has obscured their differences (Wagman and Markle 2000, Dowling 2005a, Topinka 2006). Although the available evidence cannot differentiate between the two hypotheses, the genetic similarity in all three sub-drainages, including those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006), suggests that introgression has occurred on a broad temporal and geographic scale and is not a localized or recent phenomenon. Consequently the evidence indicates that introgression is natural and is not caused or measurably affected by human activities.

There is no evidence that the observed hybridization has been affected by human modification of habitat, and genetic exchange between the two species under such conditions may be a natural phenomenon and a part of their evolutionary legacy. A similar situation has been observed in suckers in the nearby Klamath River drainage, where four species have hybridized to varying degrees, but in general retain morphological, behavioral, and ecological separation (Markle *et al.* 2005, Dowling 2005a, Tranah and May 2006).

Despite any hybridization that has occurred in the past, the Modoc sucker maintains its morphological and ecological distinctiveness, even in populations showing low levels of introgression, and is clearly distinguishable from the Sacramento sucker using morphological characteristics (Kettratad 2001). Therefore, given the observed low-levels of observed introgression in nine known streams dominated by Modoc suckers, the absence of evidence for extensive ongoing hybridization in the form of first generation hybrids, the fact that Modoc and Sacramento suckers are naturally sympatric, and the continued ecological and morphological integrity of Modoc sucker populations, hybridization is not considered a threat to Modoc sucker populations.

Drought and Climate Change

The listing rule did not identify drought or climate change as threats to the continued existence of the Modoc sucker (USFWS 1985a). However, the northwestern corner of the Great Basin is naturally subject to extended droughts, during which even the larger water-bodies such as Goose Lake have dried up (Laird 1971). Regional droughts have occurred every 10 to 20 years in the last century (Reid 2008b). The "dustbowl" drought of the 1920's to 1930's appears to have been the most extreme regional drought in at least the last 270 years and probably the last 700 years (Keen 1937, Knapp *et al.* 2004).

There is no record of how frequently Modoc sucker streams went dry except for occasional pools. There is no doubt that reaches of these streams did stop flowing in the past because some reaches dry up (or flow goes through the gravel instead of over the surface) nearly every summer under current climatic conditions (Reid 2008b). Collections of Modoc sucker from Rush Creek and Thomas Creek near the end of that drought (Hubbs and Miller 1934, Merriman and Soutter 1933), and the continued persistence of Modoc sucker throughout its known range through substantial local drought years since 1985 without active management, demonstrate the resiliency of the population given availability of suitable refuge habitat. Based on this, we do not believe drought poses a substantial threat to the species.

Human-induced climate change could exacerbate low-flow conditions in Modoc sucker habitat during future droughts. A warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, reduce summer stream flows, and increase summer temperatures (IPCC 2007, PPIC 2008). Lower flows as a result of smaller snowpack could reduce sucker habitat, which might adversely affect Modoc sucker reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit non-native fishes that prey on or compete with Modoc suckers. Increases in the numbers and size of forest fires could also result from climate change (Westerling *et al.* 2006) and could adversely affect watershed function resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. While it appears reasonable to assume that the Modoc sucker will be adversely affected by climate change, we lack sufficient information to accurately determine what degree of threat it poses and when the changes will occur.

Conservation and Recovery Actions

Habitat improvement projects completed in the 1980-90's and USFS management policies continue to provide habitat benefits with upward trending conditions. Recent habitat projects include: (1) fencing to exclude grazing from newly recognized occupied habitat in upper Turner Creek (USFS in progress); (2) channel improvements in lower Dutch Flat Creek (Pit Resource Conservation District); (3) extensive channel stabilization and pool development as part of the Thomas Creek Restoration Project (USFS 1986-2002); (4) exclusion of grazing from Garden Gulch (USFS 2004) and stabilization of stream channel on private lands with increased flow duration due to hayfield irrigation sub-flow (private landowner 2002); fencing to exclude cattle along privately owned reaches of Critical Habitat on Rush Creek (USFWS and private landowner 2002) and Johnson Creek below barrier (private landowner 2002); and (5) screening of reservoir outflows in the upper Washington (USFS completed 2006). Also, there is continued outreach and collaboration with landowners on Modoc Sucker streams and throughout the Pit River watershed (Clark and Reid 2004, Pit River Native Fishes Stewardship Program).

Recovery Criteria from the 1984 Recovery (Action) Plan

At the time of proposed listing in 1984, the Service, CDFG, and the Forest Service had been developing an "Action Plan for the Recovery of the Modoc Sucker" through a number of drafts and years. The signed 1984 Plan was understood to preclude the need for a formal recovery plan at the time of listing (USFWS 1984, 1985). The stated purpose of the 1984 Action Plan was to provide direction and assign responsibilities for the recovery of the Modoc sucker; it also provided action (recovery) tasks and reclassification (downlisting/delisting) criteria.

General objectives of the various action plans:

1. To restore and maintain the quality of occupied Modoc sucker habitat within the Turner Creek and Rush Creek drainages.
2. To restore the remaining suitable, but presently unoccupied, stream reaches within the Turner Creek and Rush Creek drainages.
3. To prevent the invasion of Sacramento suckers into isolated stream reaches where it was believed "pure" Modoc sucker populations persisted (Turner-Hulbert-Washington Creek and upper Johnson Creek systems). (Note: This objective is no longer a priority; see "Hybridization" discussion in this section above.)
4. To secure additional populations of Modoc suckers in additional streams within the historical range.
5. To increase the carrying capacity of currently occupied habitat for Modoc suckers and other native species (included subsequent to 1984 Plan).
6. To increase population numbers to a point where the problems associated with small population size (inbreeding depression, genetic drift, and depletion of genetic variance) do not threaten survival of the species (included subsequent to 1984 Plan).
7. To re-establish native species composition in Modoc sucker streams (included subsequent to 1984 Plan).
8. To increase private landowner awareness of Modoc sucker needs and endangered species issues as they relate to land management (inclused subsequent to 1984 Plan).
9. To allow for the recovery of the Modoc sucker to a point where the species is secure.

Downlisting Criteria – "Consider reclassification to 'threatened' upon establishment of pure, safe populations (for 3 to 5 years) throughout Rush and Turner Creeks watersheds."

Delisting Criteria – "Consider delisting upon establishment of pure, safe populations (for 3 to 5 years) throughout Rush and Turner Creeks watersheds (downlisting criteria), and in two additional streams within historic range."

Recovery tasks identified in the 1984 recovery action plan can be divided into 5 categories: (1) improve and secure habitat; (2) reduce threats from hybridization and perform genetic studies to assess degree of introgression; (3) expand range; (4) monitor populations; and (5) perform recovery-related administrative tasks. All recovery tasks from the signed 1984 recovery action plan and subsequent draft action plans are generally completed, ongoing, or have been deemed inappropriate, based on current information or policy (Reid 2008b).

4.6. Oregon chub

The action area encompasses the entire range of Oregon chub, since they are endemic to the Willamette River Valley in Oregon. Since the time of listing, several Oregon chub populations have been extirpated, a number of new populations have been discovered, and there have been a number of successful introductions (Bangs *et al.* 2008). In 2008, ODFW confirmed the continued existence of Oregon chub at 38 locations in the North and South Santiam River, McKenzie River, Middle Fork Willamette River, Coast Fork, and several tributaries to the mainstem Willamette River downstream of the Coast Fork Willamette River/Middle Fork Willamette River confluence (Bangs *et al.* 2008). These included 26 naturally occurring and 12 introduced populations. ODFW did not find Oregon chub at seven locations where they were collected on at least one occasion between 1991-2007. Non-native fish were collected at most of these locations. New populations of Oregon chub were discovered in two sloughs in the Middle Fork Willamette drainage (Bangs *et al.* 2008).

In a 5-year review completed by the Service on the listing status of Oregon chub in 2008, the findings supported a recommendation to downlist the species (USFWS 2008d). At the time of listing in 1993, there were only eight populations of Oregon chub. These populations were exposed to various threats (destruction of its habitat, predation by nonnative fishes, and the inadequacy of regulatory mechanisms) that could have caused the extinction of the species. Due to the extremely limited number of known populations, agencies active in Oregon chub conservation focused on establishing new populations in habitats without predation from non-native species. This resulted in the creation of isolated populations throughout the Oregon chubs' historic range. These efforts have been extremely effective at protecting Oregon chub from their most significant threats (predation by non-native fishes and lack of suitable habitat) that affected the species at the time of listing. Successful conservation efforts have therefore resulted in more than a four-fold increase in the number of Oregon chub populations (USFWS 2008d).

Despite the short-term successes in increasing the abundance and distribution of Oregon chub and meeting the downlisting criteria, there are potentially significant long-term threats to the species. The recovery strategy has focused on improving Oregon chub habitats in isolation due to the loss and fragmentation of suitable habitats and the threats posed by non-native fishes. Most populations of chub are currently isolated from other chub populations due to the reduced frequency and magnitude of flood events and the presence of migration barriers such as impassible culverts and permanent, high beaver dams. Unfortunately, managing Oregon chub in isolation has potentially severe consequences (Scheerer *et al.* 2006a). Isolating populations that would normally experience gene exchange can result in general decline in local genetic diversity and a corresponding increase in divergence among populations within a drainage system (Meffe and Vrijenhoek 1988). Burkey (1989) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989 and 1995). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events (Hard 1995, Healy and Prince 1995, Rieman and Allendorf 2001, Rieman and McIntyre 1993, Spruell *et al.* 1999).

Santiam River Drainage

Oregon chub currently exist at nine sites in the Santiam River drainage (Bangs *et al.* 2008). Six are naturally occurring populations and three (including the two largest populations in the Santiam River drainage) were introduced. In 2008, ODFW population abundance estimates found three populations in the Santiam drainage that totaled 500 or more adult Oregon chub; two populations had a stable or increasing trend in abundance for the past five years and the trend for the other population is unknown. Trends for the populations at the other sites in the Santiam drainage are unknown.

Middle Fork Willamette River Drainage

The Middle Fork Willamette drainage contains the greatest concentration of large Oregon chub populations in the Willamette Valley. In 2008, Oregon chub were found at sixteen sites and there were ten populations in the Middle Fork Willamette drainage that totaled 500 or more adults (Bangs *et al.* 2008). Eight of these populations have been stable or increasing in abundance for the past five years. Two populations had declining 5-year abundance trends. Significant increases in Oregon chub abundance occurred at two sites, and significant decreases occurred at three sites. Two of the extant populations were introduced; both are populations with over 500 adults. No chub were found at three of the 2008 survey sites where relatively low numbers of chub had been documented in the past.

Mid-Willamette River Drainage (Includes the McKenzie River Drainage)

In 2008, ODFW estimated the population abundance of Oregon chub at nine locations in the Mid-Willamette River drainage (includes the McKenzie River) (Bangs *et al.* 2008). The ODFW reported that there were six populations in the Mid-Willamette drainage that totaled 500 or more adult Oregon chub. Four of these populations have exhibited a stable or increasing abundance trend over the past five years. The three largest populations in this drainage were introductions. There were significant increases in Oregon chub abundance at three sites, and a significant decline at one site. A new population was introduced in this drainage in 2008 at a site known as St. Paul Ponds.

Coast Fork Willamette River Drainage

In 2008, ODFW estimated the population abundance of Oregon chub at one site in the Coast Fork Willamette drainage (Coast Fork Side Channel; N=130 adults) (Bangs *et al.* 2008). Only three adult Oregon chub were collected at Herman Pond, an introduction site which had an estimated 180 adults in 2007. Chub were introduced to a new site within this drainage known as Sprick Pond in 2008.

Conservation and Recovery Actions

The Oregon Chub Working Group was formed in 1991 and includes Federal and state agency biologists, academics, land managers, and other concerned people who are working to improve the status of the species. The Working Group has been proactive in conserving and restoring habitat for the Oregon chub and raising public awareness of the species since before the Federal listing in 1993.

In 1992, an interagency Conservation Agreement for the Oregon Chub in the Willamette Valley, Oregon was completed and signed by the Service, USFS, BLM, ODFW, and Oregon Parks and Recreation Department (USFWS 1998d). The purpose of the coordinated plan was to facilitate Oregon chub protection and recovery and to serve as a guide for all agencies to follow as they carry out their missions. The management guidelines are to: (1) establish a task force to oversee and coordinate Oregon chub conservation and management actions; (2) protect existing populations; (3) establish new populations; and (4) foster greater public understanding of the Oregon chub, its status, the factors that influence it and the conservation agreement.

In February 1997, a draft habitat conservation plan was prepared by consultants for the City of Salem to protect and enhance the population of Oregon chub located in the drinking water treatment facility at Geren Island in the North Santiam River. In 1996, a no-spray agreement with the Oregon Department of Transportation was formalized to protect Oregon chub sites located in the Middle Fork Willamette River drainage adjacent to Highway 58 in Lane County. The agreement prohibits spraying of herbicides in the vicinity of Oregon chub sites and limits vegetation control to mechanical methods if necessary.

Additional conservation measures implemented to improve the status of Oregon chub include reintroductions of Oregon chub within the historical range, habitat enhancement projects and public education. Also, the Service has completed three individual Safe Harbor Agreements (SHA) for Oregon chub. To streamline the process for landowners to enter into a SHA with the Service in the future, a programmatic SHA is being developed. Under a SHA, property owners can undertake management activities that will benefit listed species on their properties while receiving assurances that they will not incur additional ESA-related liabilities as a result of helping to conserve and recover listed species. SHAs are designed to provide a net benefit for the species over a specified period of time, while allowing landowners to return their enrolled properties to baseline conditions for the covered species in the future if they choose to.

Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of characterizing the current condition of the species. To assess consulted-on effects to the Oregon chub, we conducted a general review of all BOs completed at the Oregon Fish and Wildlife Office from January 1993 until March 2009. A total of 48 formal BOs were completed during this time frame.

Our review shows that we consulted on a wide array of actions related to habitat, water, and facility construction/development which had varying level of effects. Some of the other actions included the reintroduction of Oregon chub to suitable habitats in its historic range. No actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery (*i.e.,* jeopardy determination) of the Oregon chub.

4.7. Listed Plants and Fender's Blue Butterfly

The environmental baselines for the listed plants addressed in this consultation (Golden Indian paintbrush, Bradshaw's lomatium, Nelson's checker-mallow, Willamette daisy and Kincaid's lupine) and Fender's blue butterfly are similar, so they are discussed together in this section.

The action area coincides with the entire range of Fender's blue butterfly and Willamette daisy. Kincaid's lupine, Bradshaw's lomatium and Nelson's checker-mallow primarily occur within Oregon. Extant populations also occur outside of the project area at a few sites in southwestern Washington. Of all of the native prairie species addressed in this consultation, only the golden paintbrush has a large portion of its range outside of Oregon. Since the action area is the entire range, or nearly the entire range, of Fender's blue butterfly, Willamette daisy, Kincaid's lupine, Bradshaw's lomatium and Nelson's checker-mallow, the Status of the Species and Critical Habitat discussed in the previous section essentially constitutes the environmental baseline for the listed prairie species.

Consulted-on Effects

The baseline for consultation 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. Other Federal actions affecting Fender's blue butterfly, the listed plants, or their designated critical habitat that required formal section 7 consultation with our office include: habitat management plans for the Army Corps of Engineers' (Corps), BLM, and Service (Baskett Slough Refuge complex), the Service issuance of section 10(a)(1)(A) recovery permits, restoration and species enhancement by the Service, Federal Highway Administration highway and bridge construction, and recreation development by the Corps and BLM. None of the completed section 7 consultations reached a jeopardy finding for Fender's blue butterfly, Willamette daisy, Kincaid's lupine, Bradshaw's lomatium, Nelson's checker-mallow or golden paintbrush nor a finding of adverse modification of designated critical habitat for Fender's blue butterfly, Willamette daisy, or Kincaid's lupine.

5. EFFECTS OF THE ACTION

Effects of the action are defined as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with the action, that will be added to the environmental baseline" (50 CFR 402.02). CREP actions are specifically designed to improve fish and wildlife habitats by restoring and enhancing stream and riparian habitats and associated wetlands and upland wildlife habitats on agricultural lands throughout Oregon. While net benefits are expected, CREP activities will also have some unavoidable adverse effects to the Service's listed species addressed in this consultation. The Service assisted FSA with the development of the effects analyses included in sections 4 and 5 of the BA, and is incorporating the full discussions about the effects of the action by reference. This section provides abbreviated discussions of the effects analyses included in the BA relevant to the species included in this BO. Further analysis and other information relevant to each species are included where appropriate.

5.1. Scope and Assumptions

FSA is not able to precisely document where CREP project sites will be located over the next ten years or describe project site-specific conditions or species effects, whether adversely or beneficially. However, the effects of the covered CREP activities on listed species have been analyzed programmatically considering the nature and scope of the various activities, project habitat types and geographical areas, and listed species needs and threats. Ultimately, all of the covered restoration activities are expected to provide long-term benefits by improving existing conditions for listed species that occur in the vicinity of CREP projects. The duration of the benefits will depend on the specific activity, and any other actions that may occur in the future at a project site after CREP actions have been completed.

CREP projects are currently authorized to take place on up to 100,000 acres during the life of the program, which has an unspecified duration. Projects have already been implemented on approximately 34,800 acres, leaving up to 65,200 acres that can be enrolled in the future (L. Loop, pers. comm. 2009). Based on the average enrollment during the first 9 years of CREP, FSA anticipates 704 more projects covering 18,000 additional acres throughout Oregon during the next five years. We assume this figure will be doubled during the ten year period covered by this BO. The actual number of projects and acreages will depend on landowner interest, project opportunities and the availability of funding and technical staff to work with landowners to enroll in the program and complete practices.

It is assumed that CREP projects will be implemented on eligible lands throughout Oregon. The duration of a restoration activity at a site may last for less than one day to several weeks depending on the extent and complexity of the activity. Activities typically occur on a single property at a time until the work is completed, although actions may sometimes be completed on multiple sites that are concentrated in an area. The Oregon CREP includes incentives that encourage more projects to be concentrated together, rather than having scattered participation by individual landowners, in order to increase program effectiveness in achieving the desired water quality and habitat benefits. This is done by offering cumulative impact incentive payments to landowners in any case where a total of at least 50 percent of the streambank within a 5-mile stream segment is enrolled.

While some negative impacts to the environment and listed species from CREP actions are likely to occur, short- and long-term benefits are also expected. Positive environmental impacts of CREP include reduced sedimentation from tillage and livestock activity, reduced introduction of agricultural chemicals into streams from adjacent croplands and increased bank stability. If grazing or cropping pressure are eliminated from the riparian area or wetland, restoration strategies will be employed based on the climate and soil, the time frame and severity of the damage to the riparian area and the presence of invasive species. A riparian area may recover quickly through natural regeneration or require active restoration to aid with recovery. In some parts of Oregon, invasive weeds may rapidly colonize a riparian area if it is left alone to recover. As native vegetation established through CREP grows and matures, stream shading will increase and stream temperatures will decrease, and habitat for terrestrial wildlife along riparian areas will increase. Riparian functions will be restored, such as providing sources of large woody debris, food and nutrient inputs into stream channels and restoring channel structure, benefiting fish and other aquatic life.

5.2. Biological Effects

5.2.1. Displacement

Short-term displacement or disturbance of threatened and endangered fish and wildlife may occur from CREP activities because of construction noise, human presence, or activities in the area that disturb or displace animals that may be foraging, resting or moving through the area. To avoid or minimize these potential effects to fish and wildlife, the applicable BMPs in sections 1.3 and 1.4 (excerpted from sections 2.4 and 2.5 of the BA) will be followed. The BMPs address ways to avoid or minimize disturbances to and displacement of listed species when accessing sites and implementing projects. It is expected that any adverse affects to listed fish and wildlife species due to disturbance or displacement will be minimal in terms of both intensity and duration.

Listed plants that require open habitat conditions (*e.g.,* prairie species) could be displaced over time due to shading or competition from newly planted or released trees and shrubs. However, technical staff will recommend species for planting that will maintain or restore habitat conditions needed to support listed plants that occur on the project sites. Plants used in revegetation efforts will be selected based on soil type and plant community type and will not grow tall enough to shade out listed shade-intolerant species that occur on site.

5.2.2. Physical Harm

Direct physical harm to fish, invertebrates and plants is not expected from most CREP projects. However, while fish and wildlife are expected to temporarily vacate restoration areas where they could be physically harmed in many cases, ground disturbances and the use of equipment and vehicles could directly affect fish redds, fish in isolated habitats with limited dispersal ability such as springs or ponds, or sites that support Fender's blue butterfly or listed plants that are not able to move away from restoration disturbances.

With the exception of mowing, soil disturbing activities and the use of equipment will not occur in areas with listed plants and Fender's blue butterfly. There are likely to be short-term adverse effects from mowing. However, the long-term effects have been shown to be almost exclusively beneficial. Extensive research has been conducted in the last decade on the effects of various mowing regimes on rare prairie species; these studies have shown that mowing is an important tool for restoring native prairies and increasing populations of associated sensitive prairie species (USFWS 2008a).

Potential physical impacts to fish could occur on projects where water is diverted and pumped for livestock watering facilities or irrigation of revegetated areas. Unscreened (versus screened) water diversions are recognized as one of the threats for Lost River, shortnose and Warner suckers and bull trout because, in addition to the diversions impacting fish by altering flows and habitat conditions, fish can be harmed or killed as they are transported into and through the diversions or become stranded in inhospitable areas such as ditches and agricultural fields (USFWS 1985b, 1988a, 1993d, 1998a,c). Water diversions are recognized as a threat to the Oregon chub and Lahontan cutthroat trout, primarily due to changes in water level or flow conditions caused by the diversions rather than the lack of screening or problems with the screens themselves (USFWS 1975, 1993c, 1995 and 1998d). Similarly, water diversions are recognized as a threat to Modoc sucker, primarily due to associated habitat reduction and increased temperatures rather than factors associated with screening (USFWS 1985a, NatureServe 2009).

The threats associated with habitat and flow alterations from water diversions under this programmatic consultation are addressed by the CREP program BMPs. All pumps must be sized to only use water amounts that fall within the allowances of the landowners' documented or estimated historic water use and legal water right(s). Only minor diversions of up to 0.5 cfs are allowed in areas where listed suckers or Oregon chub may occur to reduce the risk of adversely affecting these species. In addition, for all CREP projects involving water diversions, a BMP is in place to ensure that water withdrawals will not dewater habitats, or cause or exacerbate low stream flow conditions that could impact listed fish.

To address the threat of fish entering the diversions, pumps must be screened to meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.,* regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning) on all water diversions covered under this programmatic consultation. The screening criteria consider the swimming ability of fish, based on the needs of fry-sized anadromous salmonids of less than 60.0 mm fork length. If pumps are used to temporarily divert a stream, an acceptable fish screen must be used to prevent entrainment or impingement of small fish per the criteria. Design criteria specify that approach velocities are not to exceed 0.40 feet per second (fps) for screens used on active pump intakes, or 0.2 feet per second for passive pump intakes. The criteria also specify sweeping velocities, which are flow velocities that are parallel and adjacent to the screen face, so that fish do not become impinged on the screens (NMFS 2008). The fish screening criteria are designed to fully protect even the smallest salmonids if they have been installed and are operating correctly (A. Ritchey, pers. comm. 2009).

Screening all diversions associated with CREP projects will avoid and greatly reduce the potential for adverse affects on all listed fish species, and efforts are being made throughout the state to screen unscreened diversions that are impacting all species of listed fish. However, because the NOAA Fisheries screening criteria were designed for anadromous salmonids, the swimming abilities and other factors related to other fish species have not been specifically considered, and the criteria may not fully address their needs. Some entrainment could still occur through screened diversions, and it is possible that some fish could become impinged on screens that meet the criteria.

Larval suckers and Oregon chub may be especially susceptible to entrainment due to the small size of these fish compared with Pacific salmon, bull trout and Lahontan cutthroat trout. The mean length of fry for several Pacific salmon species has been found to range from approximately 25 to 40 mm (Groot *et al.* 1995, Groot and Margolis 1991). Newly emerged bull trout have been found to range between 23-28 mm (Shepard *et al.* 1984a, Fraley et. al 1989). The total length of newly emerged sea-run cutthroat trout fry is about 25 mm (Trotter 1997); the Lahontan cutthroat trout fry is the largest cutthroat trout species (Western Native Trout Initiative 2009) and the fry are assumed to be larger.

The sucker and chub larvae tend to be much smaller. Lost River and shortnose sucker larvae have a typical standard length of 11 mm upon hatching (Cooperman and Markle 2003). Postlarval Warner suckers have been found to range from 11 to 17 mm total length. Very little information is available about the size of Modoc sucker larvae, but fish as small as 10-15 mm in length have been detected (Moyle, pers. comm. 1975 as cited in Conservation Management Institute 1996). Oregon chub are smaller still, with larvae found to be 6.2 to 16 mm in length. The size of adult Oregon chub is comparable to salmonid juveniles, ranging from 27-58 mm in studies of Willamette and Umpqua Oregon chub (Pearsons 1989). The largest Oregon chub on record measures 89 mm (Scheerer *et al.* 1995). As far as swimming performance, suckers are considered to be fairly active, strong swimmers (McGinnis 2006), which may help keep them from being entrained through or impinged on fish screens. Oregon chub are relatively weak swimmers (P. Scheerer, pers. comm. 2009) and could be more susceptible to entrainment or impingement, although they are not likely to be found in areas used for water diversions due to their preference for habitats with slack water and vegetative cover. Warner, Modoc, Lost River and shortnose sucker larvae are also found in shallow backwater pools or along stream margins where there is little to no current, often among or near vegetation. These habitats are not ideal locations for installing water diversions, which reduces the risk of CREP project-related diversions being located in areas that may cause adverse affects to Oregon chub or sucker larvae. In addition, all species will be at least somewhat protected by measures in the screening design criteria that are intended to keep fish away from the diversions (*e.g.,* intake placement; approach and sweeping velocities).

It is worth stating that water diversions under the CREP program are only proposed where needed to achieve restoration goals (*i.e.,* to provide temporary irrigation to native riparian plantings until they are established, or to fill watering facilities designed to move livestock away from sensitive resource areas). Risks will be minimized by the minor amount of water to be diverted (*i.e.,* no more than 0.5 cfs where listed suckers and Oregon chub occur) and the screening requirement for CREP project-related diversions under this programmatic consultation which will benefit all listed fish. The threat of entrainment through the screens is limited to the larval stages of the Oregon chub and the sucker species, and impingement is not expected to be an issue with the minor diversions proposed and the NOAA Fisheries design criteria that will be met. Any loss of fish is expected to be minimal. Threats that are being addressed by the CREP program, such as poor water quality and degraded habitat conditions, are recognized as ongoing and significant factors affecting the survival and abundance of all of the listed fish (ISRP 2005, USFWS 1995, 1998c & d, 1999a, 2007c & d, 2008a). Overall, CREP actions that improve habitat and water quality are expected to benefit all listed fish species and contribute toward their recovery.

5.3. Mechanical Effects

5.3.1. Terrestrial Habitats

Mechanical activities in terrestrial habitats are generally associated with the removal of invasive and non-native vegetation by disking, tilling or grubbing. Planting, mowing, creating vernal pools, breaking tile, and installing livestock fencing, crossings and watering facilities may also involve mechanical equipment and activities that result in ground disturbance. Most of the project sites will be in areas that have been degraded due to past and present agricultural activity that has reduced or eliminated habitat suitability for many species that depend on them.

Terrestrial habitats could be directly affected by any of the restoration activities that restore or enhance riparian, upland, wetland and estuarine areas. These activities will help to restore the composition and structural diversity of native plant communities and hydrological functions. Habitat modifications will be restricted to immediate project vicinities. Soil disturbance and compaction, or removal of some desirable woody and herbaceous vegetation, may occur on project sites requiring the use of heavy equipment. Important habitat features and native vegetation will be maintained to the extent possible during construction activities, although some may be impacted. Disturbed areas will be restricted to the minimum necessary to complete the restoration activities and the effects are expected to be short-term, or avoided altogether, because of the implementation of BMPs. Dispersal and travel corridors for wildlife will be improved as project sites are stabilized and native vegetation recovers over time.

5.3.2. Aquatic Habitats

Mechanical activities may cause temporary adverse affects to aquatic habitat. It is possible that some construction-related sediments may enter a water body due to soil disturbance and use of heavy equipment, particularly during in-water work activities. These sediments may appear as localized increases in turbidity due to fine sediment movement during the implementation of an activity. Sediment could also be carried by surface runoff when erosion control structures are removed. The time duration for turbidity increases is dependent on several factors, including:

- the type of erosion control structures installed at the project site;
- ability to remove sediments from behind work isolation structures before removal;
- amount of area that was originally disturbed and the local topography of the area;
- distance between the structure or activity and the water source, including the amount and type of filter materials in the buffer area; and
- time duration between the completion of the activity and onset of high flows or heavy rains.

There is the potential for short-term shade reduction from removal of riparian weeds, which could slightly affect stream temperatures or dissolved oxygen levels. This could cause short-term stress to fish adults, juveniles and eggs. There is also a slight potential for riparian restoration activities to initially affect aquatic and terrestrial insect populations, which would possibly reduce food availability for juveniles and adults.

Short-term positive environmental impacts of CREP include reduced sedimentation by reducing tillage for agriculture and livestock activity in sensitive areas, reduced introduction of agricultural chemicals into streams from adjacent croplands and increased bank stability.

The long-term effects of CREP projects to aquatic habitats are highly beneficial. Exclusion of livestock from streams will reduce bank erosion and sediment delivery and reduce the potential for fish spawning site destruction or egg trampling. Reestablishment of riparian vegetation will increase shade, lowering stream temperatures and allowing for higher dissolved oxygen levels. Riparian vegetation will also provide bank stability, and in some areas, encourage large woody debris, food and nutrient inputs to streams, all of which will enhance aquatic habitat.

Many BMPs that are designed to minimize short-term impacts to aquatic habitats and maximize long-term benefits are included as part of the action, as listed in sections 1.3 and 1.4. Several related to aquatic habitats are as follows:

- Whenever possible, livestock will be excluded from streams and riparian areas altogether.
- If livestock crossings are needed, livestock fords will only be constructed on the smallest streams, generally 10 feet or less in width at mean high water level. Fords will not be placed on the mid- to downstream end of gravel point bars. Fords will generally be 30 feet or less in width. Fords will be appropriately rocked to stabilize soils/slopes and prevent erosion. Fords will be placed on bedrock or stable substrates whenever possible.
- Off-channel livestock watering facilities will not be located in areas where compaction and/or damage could occur to sensitive soils, slopes, or vegetation due to congregating livestock.
- Sedimentation and erosion controls will be implemented on all project sites where the implementation of restoration activities has the potential to deposit sediment into a stream or waterbody. Structures/techniques must be placed and/or anchored appropriately to prevent

adverse impacts to down slope habitats. Control structures/techniques may include, but are not limited to, silt fences, straw bale structures, seeding by hand and hydro-seeding, jute mats, and coconut logs. Grading and shaping will generally restore natural topography and hydrology.

5.4. Chemical Effects

Long-term water quality effects from CREP projects are expected to be highly positive. The quality of water resources should improve over time because of the reduction or elimination of chronic sediment sources, control of point and nonpoint source pollutants, increased dissolved oxygen, and temperature abatement. However, the adverse effects discussed below are possible.

5.4.1 Restoration-related Chemicals

Possible adverse effects to terrestrial or aquatic species could occur from contact with chemicals from equipment leaks or fuel spills. Possible adverse effects to aquatic species include runoff of eroded sediment and adsorbed chemicals to streams. However, BMPs have been included as part of the action that greatly reduce the risks of potential adverse effects associated with chemicals. Several BMPs specifically address potential impacts from pollutants. Examples include ensuring that equipment staging and refueling areas are located at least 150 feet away from aquatic habitats, equipment is cleaned and inspected daily for leaks, appropriate materials and supplies are available on-site to clean up any accidental spills, etc. (see section 1.3.4 for BMPs specifically related to chemicals other than herbicides). With the BMPs in place, the risks of adverse affects to listed species from restoration-related chemicals are minimal.

5.4.2. Herbicide Applications

On many CREP projects, landowners or contractors apply herbicides to plants or soil (1) before planting trees, shrubs and other vegetation to reduce competing vegetation; (2) after planting to reduce competing vegetation and get the plantings to a "free-to-grow" condition; and (3) periodically throughout the life of the CREP contract to control noxious weeds and invasive plants. The decision of whether or not to use herbicides to control vegetation competing with CREP plantings over other control methods is based on integrated weed management principles. Decisions are made based on which methods or combinations of methods are known to be effective. In most cases, if an herbicide is selected, it is used in combination with other methods. For example, initial treatment on an invasive species may involve use of an herbicide, but then manual or mechanical methods are implemented as maintenance treatments over the long-term.

Herbicides interfere with plant metabolic processes, stopping growth and usually killing the plant. They may control all types of vegetation (non-selective herbicides), or they selectively control either some broadleaf plants or grasses while not affecting others (selective). Some herbicides may control only actively growing vegetation at the time of application, or they may provide invasive plant control through root uptake from the soil (short-term to over a few years). Those differences in selectivity are the basis for developing herbicide recommendations in CREP planting plans that strive to minimize adverse effects and facilitate success of the CREP plantings. The choice of herbicide is based on the target competing species, how it reproduces, its seed viability, the size of its population, site conditions, known effectiveness of treatments under similar site conditions and the ability to mitigate effects on non-target species.

Physical forms of herbicides vary. Some are oil- or water-soluble molecules dissolved in liquids, or attached to granules for dry application to soil surface. Each herbicide is sold as one or more commercial products, called formulations. In any case, product labels for each herbicide formulation provides legally binding directions on its use, including safe handling practices, application rates, and practices to protect human health and the environment. Label application restrictions can also limit the specific herbicides available to control any site-specific invasive plant infestations.

Herbicides may be applied with a variety of equipment and techniques. The techniques vary in effectiveness, environmental effects and costs. Herbicides may be spot sprayed with backpack sprayers, applied in granular form around seedlings planted through CREP, or sprayed via ground vehicles with hose sprayers or booms using an array of spray nozzles. Some application equipment is most often used for selective treatment and/or to minimize non-target effects. Backpack sprayers are most frequently used to spray the foliage, stem, and/or surrounding soil of target invasive plants. Other equipment includes herbicide-soaked wicks or paintbrushes for wiping target vegetation, and lances, hatches or syringes for injection of herbicide onto stems of target plants. Granular herbicides may be applied using hand-held seeders or other specialized dispensing devices.

Herbicides may move from their location of application through leaching (dissolved in water as it moves through soil), dissolution in surface runoff, volatilization (moving through air as a dissolved gas), spray drift and erosion (adsorbed by molecular electrical charges to soil particles that are moved by wind or water). In soil and water, herbicides may persist or be decomposed by sunlight, microorganisms, hydrolysis or other factors.

Generally, active ingredients have been tested on only a limited number of species and mostly under laboratory conditions. While laboratory experiments can be used to determine acute toxicity and effects to reproduction, cancer rates, birth defect rates, and other effects to fish and wildlife, laboratory experiments do not typically account for species in their natural environments and little data is available from studies focused specifically on the listed species in this BO. This leads to uncertainty in risk assessment analyses. Environmental stressors can increase the adverse effects of contaminants, but the degree to which these effects may occur for various herbicides is largely unknown. Lethal effects are possible, and sub-lethal adverse effects to fish and wildlife can occur that affect their ability to compete for food, locate and/or capture food, avoid or fight off predators or reproduce.

The potential effects of the CREP herbicide applications to various representative groups of species have been evaluated for each proposed herbicide, as presented in section 4.3.1 of the BA (incorporated by reference). The effects of herbicide applications using spot spray, hand/select, and broadcast spray methods were evaluated under several exposure scenarios, which were: (1) runoff from riparian (above high water mark) application along streams, lakes and ponds, (2) runoff from treated ditches and dry intermittent streams, and (3) application within perennial streams (dry areas within channel and emergent plants). The potential for herbicide movement from broadcast drift was also evaluated. Risks associated with the potential for exposure and associated affects were also evaluated for terrestrial species.

The risk of adverse effects to fish and wildlife and their habitats was evaluated in terms of hazard quotient (HQ) values and "no observable effect concentration" (NOEC) levels. Hazard quotients are calculated by dividing the expected environmental concentration by the effects threshold concentration. If this value is >1, then adverse effects are considered likely to occur.

In the effects analyses for listed fish and their critical habitats, hazard quotient values were calculated for fish, aquatic invertebrates, algae, and aquatic macrophytes. Adverse effect threshold values for each species group were defined as either 1/20th of the LC_{50} value for listed salmonids, 1/10th of the LC_{50} value for non-listed aquatic species, or the lowest acute or chronic NOEC, whichever was lower, found in available literature. Generally, effect threshold values for listed salmonids were lower than values for other fish species groups, so values for salmonids were also used to evaluate potential effects to other listed fish. In the case of sulfometuron methyl, threshold values for fathead minnow were lower than salmonid values, so threshold values for minnow were used to evaluate effects to listed fish.

Significant adverse effects to fish, and the aquatic invertebrate, algal, and aquatic macrophyte habitat elements, are likely to occur from herbicide use for CREP projects. However, the magnitude and areal extent of adverse effects to listed fish and critical habitat are likely to be low. Herbicides and application scenarios likely to adversely affect listed fish and associated species groups or habitat elements are summarized in Table 4, which was presented and discussed in section 4.3.1.4 of the BA. These findings are based on the detailed affects analyses included in section 4.3.1 and Appendix E of the BA (incorporated by reference), which were researched and written in large part by Rick Golden at NOAA Fisheries and are similar to affects analyses that have been completed recently for other Service and NOAA Fisheries consultations with the USFS in the Pacific Northwest (*e.g.,* formal consultation on the Invasive Plant Project with the Umatilla and Wallowa-Whitman National Forests completed in 2009).

Table 4. Herbicide treatments likely to adversely affect fish and associated species groups.

	Proposed Treatment Categories			
Species Group	Riparian Areas (above high water mark)	Ditches and Intermittent Channels	Perennial Channel Instream (dry areas within channel and emergent plants)	Broadcast Drift
Fish	glyphosate, picloram, triclopyr	glyphosate, dicamba, picloram, triclopyr	glyphosate, triclopyr	glyphosate, picloram, triclopyr
Aquatic Invertebrates	---	dicamba	---	---
Algae	chlorsulfuron, glyphosate, imazapyr, hexazinone, triclopyr, 2,4-D	glyphosate, imazapyr, dicamba, picloram, hexazinone, triclopyr,	---	dicamba, hexazinone, imazapyr, metsulfuron, sulfometuron, triclopyr, 2,4-D
Aquatic Macrophytes	chlorsulfuron, imazapyr, metsulfuron, sulfometuron, hexazinone, picloram, triclopyr, 2,4-D	imazapic, imazapyr, dicamba, picloram, hexazinone, triclopyr	---	chlorsulfuron, hexazinone, imazapic, imazapyr, metsulfuron, sulfometuron, triclopyr, 2,4-D

The following has been excerpted from section 4.3.1.4 of the BA to describe the effects of the proposed herbicide use and provide a narrative summary of the information presented in Table 4:

> *"Significant adverse effects to listed fish are likely to result from glyphosate and triclopyr application in all four treatment categories (riparian, ditch/dry intermittent channels, perennial streams, and broadcast drift), from picloram in three treatment categories (riparian, ditch/intermittent channels, and broadcast drift), and dicamba in one treatment category (ditches/intermittent channels). Significant adverse effects to listed fish from short-term exposures to low (i.e. single digit) HQ exceedences are reasonably likely to occur – for example, increased respiration, reduced feeding success, impaired olfactory function, and subtle behavioral changes that can increase predation risk. When treatments occur that utilize two or more herbicides in close proximity, exposures to mixtures may occur.*
>
> *Exposures to estimated maximum concentrations of chlorsulfuron, aminopyralid, clopyralid, imazapyr, imazapic, sulfometuron, metsulfuron, hexazinone, 2,4-D, and sethoxydim are not likely to result in adverse effects to listed fish. However, simultaneous exposure to these herbicides may increase the level of adverse effects from glyphosate, triclopyr, picloram, or dicamba exposure. Additional adverse effects from co-exposure are most likely to manifest as an additive, and not synergistic, response in fish. Dose addition is considered most appropriate for mixtures with components that affect the same endpoint by the same mode of action, and are believed to behave similarly with respect to uptake, metabolism, distribution, and elimination (Choudhury et al. 2000). The precise toxic mechanisms in fish are not clearly documented for the 14 herbicides contained in the activity description, but effects to the kidney and liver are typical endpoints in terrestrial wildlife. In addition, it is known that the proposed herbicides are relatively soluble and have bioconcentration factors that fall within a range that does not indicate bioconcentration risk (all bioconcentration factors <32). Thus, it is believed that the assumption of similar uptake, metabolism, distribution, and elimination is adequately met in fish for dose-addition analysis at low concentrations.*
>
> *Significant adverse effects to aquatic invertebrates are only likely to occur from dicamba exposure resulting from application in ditches/intermittent channels approaching the maximum labeled rate.*
>
> *As summarized in Table 17* [Table 4 above]*, adverse effects to algae and aquatic macrophytes are likely to result from herbicide application in riparian areas, ditches/intermittent channels, and from broadcast drift. Adverse effects to algae and aquatic macrophytes that translate to significant indirect adverse effects (via alteration in food supply, cover, etc.) to listed fish may not result from brief exposures to herbicide concentrations causing lower (single digit) HQ exceedences. The highest risk to aquatic macrophytes is from intensive application to ditches where the HQ values for ditch effluent at stream channel confluences can potentially be greater than 10 (imazapic and triclopyr) or 100 (dicamba, hexazinone, and imazapyr).*
>
> *The chronic exposure analysis determined that adverse effects to aquatic macrophytes are likely for chlorsulfuron when 10 or more streamside acres are treated at application rates greater than about 0.08 pounds a.i./acre (0.056 pounds a.i./acre is the typical rate,*

and 0.25 pounds a.i./acre is the maximum rate). No other chronic effect risks were identified.

Since the herbicides included in the activity description target four different plant metabolic pathways, additive and synergistic effects to aquatic macrophytes may occur when co-exposure to multiple herbicides results from treatments utilizing two or more herbicides in close proximity."

The use of herbicides inherently poses significant potential risks to listed plants. In the effects analyses for listed plants, and host plants for the Fender's blue butterfly, risks associated with the proposed herbicides were evaluated by considering the soil half-life, foliar half-life, movement rating, mode of uptake and estimates of drift from broadcast and hand applications. It is also possible that the Fender's blue butterfly could be harmed by coming into contact with herbicides. BMPs were developed that place limitations on herbicide use and application methods and include protective measures that will greatly reduce the potential for exposure that could result in harm to the butterfly and listed plants.

Abbreviated herbicide effect analyses that are relevant to the Service's listed species are included in the discussions by species below in section 5.5.

5.5. Summary of Effects to Listed Species and Critical Habitats

The Service worked closely with FSA to incorporate BMPs into the proposed action that are designed to avoid and minimize adverse effects to listed species that could occur from restoration activities, although some short-term or minor adverse effects are not completely avoidable and are still reasonably certain to occur. The Service also worked with FSA to develop the effect analyses that are included in the BA for the listed species in this consultation, and used the discussions from the BA in developing the sections on the effects to listed species below. NOAA Fisheries staff assisted FSA extensively with the effects analyses and the interpretation and use of the best available information (*e.g.,* SERA risk assessments) related to the proposed herbicide use. The Service's evaluation of herbicides relies on the findings from the herbicide effects analyses presented in the BA, with acknowledgement that there are inherent uncertainties with regards to the risk of exposure and effects of herbicides on listed species.

5.5.1. Inland Fish

The types of restoration activities implemented under the Oregon CREP are identified as needed recovery actions in the draft and final recovery plans for the Warner sucker, Lost River sucker, shortnose sucker, Oregon chub, Lahontan cutthroat trout and bull trout, and are expected to contribute towards the recovery of listed fish species over the long-term. Some short-term adverse affects are likely to occur during project construction and as project sites are becoming established. Minor long-term adverse affects are possible at some sites due to the permanent footprint needed for facilities such as livestock crossings or watering troughs that may require the removal of a small amount of native vegetation, or for ongoing minor water diversions to maintain water in off-channel livestock watering facilities. However, the potential for adverse affects to listed species will be avoided or greatly minimized by the BMPs, and net benefits are expected as the overall purpose of each CREP project is to improve fish and wildlife habitat and water quality. More detailed discussions about the effects to specific listed fish species are discussed below in sections 5.5.1.1 through 5.5.1.6.

5.5.1.1. Bull trout

The potential effects of CREP projects on bull trout and their critical habitats are comparable within the two interim recovery units that occur in the action area (*i.e.,* Columbia River and Klamath River), and therefore the effects discussions apply to both areas. Bull trout require streams with high channel complexity, clean substrate and cold water. They are vulnerable to many of the same threats that have reduced salmon populations. Due to their need for very cold waters and a long incubation time, bull trout are more sensitive to increased water temperatures, poor water quality and degraded stream habitat than many other salmonids.

CREP activities could result in adverse effects to bull trout and some of the PCEs of designated bull trout critical habitat. Most adverse effects are expected to be short-term in duration, although some fairly small scale long-term adverse effects may occur in situations where a net long-term benefit to habitat or water quality is expected (*e.g.,* loss of native vegetation within the immediate vicinity of a livestock crossing). Specifically, the potential adverse effects to fish may result from a loss of vegetation, shade reduction, water withdrawals, sedimentation, turbidity, soil compaction, impacts from herbicides and other chemicals and direct disturbance to fish during project construction. PCEs involving water temperature, suitable substrate and an abundant food base may be adversely affected over the short-term. While negative impacts are possible, design criteria and BMPs are in place to avoid and minimize the potential risks to listed species, as discussed below.

Loss of vegetation and shade

Reduced shade over streams due to construction activities or after weeds are removed and before native vegetation becomes established could slightly increase water temperatures over the short-term. Consequently, it is possible that the optimal temperature range for bull trout in streams where bull trout occur and in designated critical habitats could be exceeded or result in reduced oxygen levels that could cause stress to bull trout or their prey in the short-term. However, shade loss that significantly affects water temperature is likely to be rare, occurring primarily from treating large-scale streamside monocultures (*e.g.,* knotweed and blackberry), and possibly from cutting streamside woody species (*e.g.,* tree of heaven, scotch broom, etc.).

The loss of shade would persist until native vegetation reaches and surpasses the height of the invasive plants that were removed. Shade recovery may take one to several years, depending on the success of invasive plant treatment and revegetation, stream size and location, topography, growing conditions for the replacement plants, and the density and height of the invasive plants when treated. Some possible long-term negative impacts to fish are possible due to vegetation and shade reduction associated with livestock watering devices and stream crossings. Vegetation removal to create livestock crossings could reduce overhead cover and shade at some sites, but this impact would be very small-scale and riparian vegetation improvements along the remainder of the stream are expected to more than compensate for this loss and significantly improve upon degraded riparian areas. In addition, a BMP is in place that limits the removal of any native vegetation to the amount that is necessary to complete a construction activity.

Water withdrawals

Water withdrawals from streams for CREP project site irrigation (*i.e.,* watering native plantings as they are becoming established) or to maintain water in livestock watering facilities could potentially reduce stream flows during low flow periods. However, the amount of water to be diverted to irrigate or fill watering facilities is not expected to be significant, will not exceed existing water rights, and a BMP is in place to avoid creating or exacerbating low flow conditions that could impact listed fish. In addition, irrigated areas will typically be riparian zones that drain back toward the stream; water loss from transpiration and evaporation is not expected to exceed natural riparian conditions.

If water is pumped from streams in areas with listed fish, including bull trout, fish screens that meet NOAA Fisheries screening criteria (NMFS 2008) will be used with a requirement that they be kept clean and in properly functioning condition. The NOAA Fisheries screening criteria are expected to address the needs of bull trout and Lahontan cutthroat trout (the salmonids addressed in this consultation) due to their similarities with the anadromous salmonids upon which the criteria are based. The Service currently encourages the use of the NOAA Fisheries criteria in areas where listed species occur. While the criteria may not fully address the needs of all fish species, the Service believes that diversions such as those proposed in the CREP program that are screened in accordance with the criteria are not likely to result in take of bull trout (USFWS 1999c).

Sedimentation and turbidity

Sediment delivery could occur that results in short-term water quality impacts or increased substrate embeddedness due to site preparation activities that could cause erosion, such as tillage and invasive species removal. Driving vehicles in the riparian area could increase soil compaction, reducing infiltration and increasing the risk of erosion or making vegetation establishment more difficult. Sediment could be stirred up in the stream or erode from the banks during construction of livestock crossings, watering facilities or re-shaped banks to improve bank slopes for planting. Hand pulling of emergent vegetation is likely to result in localized turbidity increases and mobilization of fine sediments, with the degree of effect proportionate to the extent of the infestation treated, type of substrate in which the plants are rooted, rooting depth, and whether or not hand tools are required (such as a weed wrench, shovel, etc.).

Increased turbidity can disturb or harm listed fish. Localized turbidity increases are likely to cause some juveniles and adults to seek alternative habitat, which could contain suboptimal cover and forage and cause increases in behavioral stress (*e.g.,* avoidance and displacement), and sub-lethal responses (*e.g.,* increased respiration, reduced feeding success, and reduced growth rates). Turbidity and sediment can also reduce embryo survival and juvenile bull trout rearing densities. Fine sediments can clog gravel interstices, reducing water flow over the eggs and limiting oxygen delivery, removal of metabolic wastes, and the ability of fry to emerge. Excessive sediment can clog the gills of juvenile fish, reduce prey availability, and reduce juvenile success in catching prey.

While sedimentation and turbidity could increase in the stream from CREP projects over the short-term, CREP program BMPs are in place to control erosion with the aim of preventing sediment from entering the stream from adjacent areas. In addition, the size, area, locations and construction timing of instream and streambank projects is limited to avoid and minimize impacts to fish. For instance, Oregon guidelines for the timing of in-water work will be followed or modified by ODFW if needed to better protect resident listed fish. Stream crossings will not be placed within 300 feet upstream of known or suspected spawning areas. Streambank shaping will only be implemented where streambank stability is extremely poor or where necessary to restore riparian functions, and will not exceed 30 linear feet of streambank on an individual CREP site under this programmatic consultation. Livestock stream crossings will only be constructed on small streams (generally 10 feet wide or less), and will be appropriately rocked to stabilize soils/slopes and prevent erosion. See sections 1.3 and 1.4.1 for a complete listing of the BMPs that will be followed in areas that may be occupied by bull trout.

Chemicals from mechanical equipment

There is some potential for adverse affects to fish due to exposure to chemicals from mechanized equipment used during construction and tillage, and the use of fuel to run water pumps for irrigation or livestock watering due to fuel spills or leaks in riparian areas or streams. However, BMPs are in place to prevent and minimize the risk of fish becoming exposed to chemicals. For instance, equipment staging and refueling areas will be located at least 150 feet from any stream or other water body, and any stationary equipment within 150 feet of aquatic habitat must be diapered to prevent leaks and/or enclosed in a containment device (*e.g.,* non-permeable drip pan) of adequate capacity to retain equipment fluids (*e.g.,* gasoline, diesel fuel, and oil) if a leak occurs. All equipment will be cleaned and inspected daily for fuel leaks. All detected leaks must be repaired in the staging area before the equipment resumes operation.

Herbicides

The use of herbicides poses risks to bull trout. Herbicides applied to control invasive and competing vegetation on CREP revegetation sites may enter streams through drift, spillage, or overspray; be dissolved and travel to streams in surface runoff; or be attached to sediment particles that run into streams. The herbicide-related BMPs outlined in sections 1.3.3 and 1.4 will be followed, and the proposed herbicides, application methods and use zones are limited as discussed in section 2.3.2.1 of the BA (incorporated by reference), but herbicides could still reach areas where bull trout and their critical habitats occur and cause adverse affects. Herbicide delivery to surface water can result in mortality to fish during incubation, or lead to altered development of embryos. Mortality or sub-lethal effects such as reduced growth and development, decreased predator avoidance, or modified behavior could occur. Herbicides can also impact the food base for bull trout and other fish, which includes terrestrial organisms of riparian origin, aquatic macroinvertebrates and forage fish.

Forage and water quality are related to the PCEs of critical habitat for bull trout. Herbicides can kill or affect growth of fish prey items or affect the growth of aquatic plants that fish or their prey species consume, decreasing food availability. In addition, reduction in cover due to killing non-target vegetation increases the vulnerability of fish to predation. The effects of herbicide applications to other critical habitat PCEs should be minimal. Herbicides may temporarily reduce cover along streams, but the vegetation removed will generally be non-native vegetation and restoration of native species will result in long-term benefits to critical habitat. See additional discussion related to the effects of herbicide applications in section 5.4.2.

Benefits

CREP projects will benefit bull trout and their critical habitat, and support many of the actions identified in the draft bull trout recovery plan (USFWS 2002b, USFWS 2004c). Over the long-term, it is anticipated that streams will become more complex with habitat features such as woody debris, pools and undercut banks as riparian areas are improved. If projects affect stream hydrographs, they are likely to more closely resemble natural conditions due to improved wetland, riparian and floodplain functions and the leasing of instream water rights to maintain or restore stream flows needed for spawning, egg survival, larval development and migration. Wetland restoration such as breaking tiles and restoring native plant communities increases water storage in wetlands and floodplains, creating additional fish habitat and enhancing subsurface flow into streams during the summer. Some wetland restoration projects may also benefit estuarine areas, which are critical to migrating salmonids as they transition between fresh water and saltwater. Springs used for livestock watering facilities are likely to continue to contribute to stream flows. The purpose of watering facilities is to address water quality concerns by removing livestock from sensitive areas and using erosion control measures that address sedimentation problems.

Exclusion of livestock from riparian areas and streams should lessen physical disturbance to fish immediately, and reduced sediment delivery is expected to result in more suitable spawning sites, better water quality and increased egg-to-fry survival. Establishment of native trees, shrubs, grasses and forbs along streams will increase shade, increase dissolved oxygen levels, and promote instream habitat complexity. Tillage and deep ripping to facilitate tree planting will reduce soil compaction, increasing infiltration and soil storage capacity and enhancing the health and growth of riparian plant communities. Increased riparian vegetation and instream cover should increase aquatic insect populations, enhancing food availability for fish.

Overall effects to bull trout critical habitat are expected to be highly beneficial by reducing trampling and sedimentation in spawning areas, improving water quality, increasing shade, reducing stream temperatures, increasing overhanging banks and other refugia, increasing food availability and increasing large woody debris. Projects that improve wetlands and floodplains can help protect and restore habitat by controlling erosion, recycling organic and inorganic nutrients, maintaining or improving water quality, and increasing natural water storage capacity and release that can improve stream flows.

In summary, while CREP projects in areas with bull trout are expected to benefit the species and its critical habitat over the long-term, and BMPs will be followed that will avoid and minimize many potential impacts of CREP activities, we agree that some CREP activities may affect, and are likely to adversely affect bull trout and their critical habitat, mostly over the short-term. Adverse affects may result from increases in turbidity, fine-sediment deposition, disturbance of individuals during instream work, exposure to herbicides, and adverse effects to algae, aquatic macrophytes and aquatic macroinvertebrates from herbicides and sedimentation.

5.5.1.2. Lahontan Cutthroat Trout

The potential effects to Lahontan cutthroat trout are similar to those described for bull trout (see section 5.5.1.1). However, one difference is that herbicide use for all species under the Service's jurisdiction except for bull trout is limited to chemicals and measures that are expected, based on the combined results of all of the herbicide analyses presented section 4.3.1 and Appendix E of the BA (incorporated by reference), to result in exposures that are below threshold risk levels (HQ values less than 1 or NOAC levels) for fish as well as aquatic invertebrates, algae and aquatic macrophytes. Aquatic invertebrates, algae and macrophytes were evaluated because they are susceptible to adverse affects from herbicides, are related to the PCEs for designated and proposed critical habitats and provide food resources for listed fish. The specific herbicide limitations that apply to listed inland fish are described in section 1.4.1. The BMPs limit the specific herbicides, application rates, rainfall levels and distances from aquatic resources to only those that were found in the analyses to be below the threshold risk levels for all evaluated species groups. Therefore, as proposed with the BMPs, the risk of adverse effects from herbicide use on CREP projects has been greatly reduced and potentially avoided for Lahontan cutthroat trout, Oregon chub and the listed suckers.

Temporary loss of shade after weeds are removed and before native vegetation is established could be of concern for Lahontan cutthroat trout. However, this species is not as susceptible to higher water temperatures as some of the other listed fish. They have been found to be tolerant of high temperatures (>20 C) and large daily fluctuations of up to 20 C (Behnke 1992, LaRivers 1962), although they do require spawning and nursery habitat that is characterized by cool water and relatively silt free rocky substrate in riffle-run areas (USFWS 1995). CREP projects could result in increased stream sediment during project construction and as restoration sites are becoming stable, but this is expected to be minimized with the BMPs in place.

While the potential for adverse affects has been greatly reduced through the BMPs, we agree with FSA's determination that some CREP activities may affect, and are likely to adversely affect the Lahontan cutthroat trout. Adverse effects may include short-term, localized increases in turbidity, fine-sediment deposition and direct disturbance of individuals during instream work periods. Water quality is a key habitat factor for Lahontan cutthroat trout (USFWS 1995). Any loss of shade and increased temperatures that result will be short-term in duration or minimal in scale. Risks associated with exposure to chemicals from equipment are possible, but are low due to the precautions to be taken in accordance with the BMPs. While herbicide use will be limited to chemicals and methods designed to avoid adverse affects to inland fish such as the Lahontan cutthroat trout, there are inherent risks associated with the use of herbicides and uncertainties in the herbicide analyses, and it is possible that herbicide delivery to aquatic habitat could still adversely affect this species or its habitat.

Overall, any CREP projects in areas with Lahontan cutthroat trout are expected to benefit the species over the long-term as habitat and water quality are improved. The CREP program supports actions that have been identified in the recovery plan, such as promoting voluntary partnerships with private landowners to manage and improve Lahontan cutthroat trout habitat (USFWS 1995). CREP projects will address some of the threats to this species, such as habitat loss associated with livestock grazing practices (by fencing, installing crossings and building watering facilities to protect sensitive areas), water diversions (by leasing water rights for instream use) and poor water quality (by restoring riparian areas and wetlands).

5.5.1.3. Warner Sucker

The Warner sucker occurs in streams (including headwaters), lakes and associated marshes. CREP activities may occur on those portions of occupied Warner sucker habitat that are privately owned agricultural lands. Land on the floor of the Warner Valley is primarily in private ownership and used for cattle grazing and crop production. Away from the valley floor, much of the habitat used by the Warner sucker is within BLM holdings (USFWS 1995), which are not eligible for CREP.

The potential effects to the Warner sucker are similar to those described for the previously discussed listed fish (see discussions in sections 5.5.1.1 and 5.5.1.2), with the herbicide use limitation as described in the Lahontan cutthroat trout section above (see section 5.5.1.2). However, one difference is that the larvae of the Oregon chub and sucker species addressed in this consultation are assumed to be more susceptible to entrainment due to their small size and differences in swimming performance compared to Pacific salmon, bull trout and Lahontan cutthroat trout fry (see discussion in section 5.2.2). To address this issue, on CREP projects where listed suckers or Oregon chub may be affected, pumps may only be installed under this programmatic consultation if water delivery will be under 0.5 cfs (minor volume diversions) and the number of operational water diversions covered under this consultation will be limited per the terms and conditions (see section 8.4). CREP projects involving the installation of pumps for water diversions over 0.5 cfs in habitat for the Oregon chub or listed suckers will be evaluated under separate consultations on an as-needed basis so that fish screens and other site-specific design criteria can be developed to further minimize potential adverse affects to the species.

In any case, eligible pumps associated with CREP projects must be screened to meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.,* regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning). While some entrainment or impingement of suckers is possible, the screens and minor amount of water to be diverted for projects under this programmatic consultation will greatly reduce potential losses. Adults will be large enough to be kept out by the screens, and the diversions will be small with relatively low currents, further reducing the risk of entrainment or impingement. The larval stage is the primary stage that will be vulnerable. Sucker larvae are produced in large numbers and suffer very high rates of natural mortality, thus their loss due to entrainment is generally not currently considered to be a substantial threat at the population level for Lost River and shortnose suckers (ISRP 2005, USFWS 2007c,d) and presumably Warner and Modoc suckers as well. A BMP for water diversions is also in place to avoid creating or exacerbating low flow conditions that could adversely affect listed fish.

Sedimentation and turbidity caused by CREP activities could impact the silt-free, gravel bottomed flowing sections of creeks used by the Warner sucker for spawning. However, this is not expected to be a great concern with the limited activities proposed and the BMPs in place. Installation of livestock crossings and installation of offstream livestock watering facilities are the only instream activities covered by this programmatic consultation. Up to 30 linear feet of streambank at a site may be re-shaped for the installation of livestock crossings, where bank stability is extremely poor or where necessary to restore riparian functions. The goal of these types of projects is to reduce erosion and water quality problems in sensitive areas and improve riparian vegetation. Instream crossings will not be placed in areas used for spawning or within 300 feet upstream of spawning areas, and the Oregon guidelines for the timing of in-water work will be followed unless otherwise allowed to better meet the needs of resident listed fish.

As with the other listed fish species, habitat complexity is important to the Warner sucker. Shallow backwater pools, stream margins where there is no current, deep still pools and faster-flowing areas near the heads of pools are all important at various periods in the life history of the Warner sucker. Adults occupy stretches of stream where the gradient is low enough to allow the formation of long pools. These pools tend to have undercut banks, large beds of aquatic plants, root wads or boulders, a vertical temperature differential of at least 2 degrees Celsius, a maximum depth of 1.5 meters, and overhanging vegetation.

While weed removal may temporarily reduce shade and overhanging vegetation, replacement with native species is likely to improve habitat complexity and features such as pools and undercut banks over the long-term. During project construction instream or elsewhere, there is potential for erosion and sediment delivery to streams, but this will be minimized by the BMPs. Once established, revegetated and restored areas are expected to help retain soils as well as provide other ecological functions that will improve instream, riparian and floodplain habitats.

Critical habitat for the Warner sucker includes 50 feet on either side of the stream banks of designated streams. PCEs of Warner sucker critical habitat include streams 15 feet to 60 feet wide with gravel-bottom shoal and riffle areas and intervening pools. Streams should have clean, unpolluted flowing water and a stable riparian zone. The streams should support a variety of aquatic insects, crustaceans, and other small invertebrates for food. Activities that could adversely affect the Warner sucker or adversely modify its critical habitat include application of herbicide in or near streams or lakes inhabited by the Warner sucker, which could be toxic to this species or its food, pollution of stream or lake habitat by silt or other pollutants, and removal of natural vegetation within or along streams (USFWS 1985a).

Generally, any CREP projects that occur in areas with Warner sucker are expected to benefit the species and its critical habitat over the long-term as stream and riparian habitats are improved. CREP projects will address some of the threats to this species by fencing livestock away from streams, improving riparian and stream conditions and leasing water rights for instream flows. BMPs will be followed that will avoid and minimize many of the potential adverse impacts of CREP activities. BMPs that limit, but still allow some herbicide use in areas where this species may occur will greatly reduce the potential for adverse effects to the species while restoration projects move forward under this programmatic consultation.

In summary, while the potential for adverse affects has been greatly reduced through the BMPs, the Service agrees with FSA's determination that some CREP activities may affect, and are likely to adversely affect the Warner sucker and its critical habitat. Adverse effects may result from short-term increases in turbidity, fine-sediment deposition and direct disturbance of individuals during instream work and due to the potential entrainment of larval suckers. Any loss of shade and increased temperatures that result will be short-term in duration or minimal in scale. Risks associated with exposure to chemicals from equipment are possible, but are low due to the precautions to be taken in accordance with the BMPs. While herbicide use will be limited to chemicals and methods designed to avoid adverse affects to inland fish, there are inherent risks associated with the use of herbicides and uncertainties in the herbicide analyses, and it is possible that herbicide delivery to aquatic habitat could still adversely affect this species or its habitat.

CREP projects that occur in areas that support this species are expected to benefit the species and its critical habitat over the long-term and contribute to its recovery by improving habitat conditions on non-federal lands. The recovery plan calls for the actions that are implemented through the CREP program, such as working with landowners to make land management changes that will maintain or improve Warner sucker habitat while still providing for the social and economic value of those lands, improving poor quality habitat conditions, developing livestock watering facilities to protect and restore high quality habitats, improving stream flows (*e.g.,* by leasing water rights for in-stream use) and providing funding assistance to implement these and other recovery actions on non-Federal lands (USFWS 1998c).

5.5.1.4. Shortnose and Lost River Suckers

The potential effects to shortnose and Lost River suckers and their proposed critical habitats are similar to those described for the other listed fish discussed above (see sections 5.5.1.1, 5.5.1.2 and 5.5.1.3).

The shortnose and Lost River suckers are found in the deeper water of lakes and streams. Springs or streams are used for spawning, preferably in areas with gravel or cobble and a fairly shallow shoreline with an abundance of aquatic vegetation. Shoreline vegetation in both lake and stream habitats is important for the rearing of larval and juvenile suckers. PCEs of proposed critical habitats for these species include water that is of sufficient quantity and quality (*i.e.,* temperature, dissolved oxygen, flow rate, pH, nutrients, lack of contaminants, turbidity, etc.) to provide conditions required during the various life stages of each species; physical habitats for use as refugia, spawning, nursery, feeding, corridor or rearing areas; and a biological environment with an adequate food supply and a natural scheme of predation, parasitism, and competition.

Some of the factors that have contributed to the decline of the shortnose and Lost River suckers and their habitats include loss of aquatic and riparian vegetation which has lead to increases in stream temperatures, high levels of nutrients, reduction in food resources, unnaturally high levels of predation and competition, and serious sedimentation and turbidity problems in streams. Such water quality problems have reduced the availability of suitable sucker habitat and have resulted in major fish mortality. Other factors affecting the decline of these species include pollution from pesticides, herbicides and other chemicals and altered stream flows (USFWS 1988a).

Proposed critical habitat for the Lost River and shortnose suckers includes designated streams as well as the area needed provide long-term stream function, which has been described as the associated 100-year FEMA floodplains, or 300-foot wide setbacks if floodplains are not mapped (USFWS 1994). CREP activities will primarily take place within these streamside areas. Generally, any CREP projects that may occur in areas with shortnose or Lost River sucker are expected to improve current conditions for these species as habitat is improved. The CREP program is designed to address some of the threats to these species through activities such as fencing portions of streams to reduce cattle-caused erosion, restoring native vegetation to riparian areas, improving water quality by altering agricultural practices and leasing water rights for instream use. Projects that improve wetlands and floodplains can help protect and restore sucker habitat by controlling erosion, recycling organic and inorganic nutrients, maintaining or improving water quality, and increasing natural water storage capacity and release that can improve stream flows.

At the time of listing, loss of juvenile and adult shortnose and Lost River suckers in unscreened irrigation diversions was identified as a significant risk factor for these species. Since that time, significant efforts have been made to address this threat by screening diversions. Some of the most problematic diversions have now been addressed, and at this time, most remaining unscreened small diversions are not believed to pose a serious threat to listed sucker populations. Part of the reason for this is that suckers that are most susceptible to entrainment by small diversions are larvae, which are produced in large numbers and suffer very high rates of natural mortality (ISRP 2005).

Requiring that all CREP project-related diversions be screened will minimize the risks to suckers, and the number of operational water diversions covered under this consultation will be limited per the terms and conditions (see section 8.4). Very few diversions are anticipated; from 1998 through 2009, only three stream diversions for off-site water facilities have been installed in Klamath County (L. Loop, pers. comm. 2009). While some entrainment or impingement of suckers is possible, the screens will greatly reduce potential losses. Adults will be large enough to be kept out by the screens, and the diversions will be small with relatively low currents, further reducing the risk of entrainment or impingement. The larval stage is the primary stage that will be vulnerable, but as stated earlier, sucker larvae are produced in large numbers and suffer very high rates of natural mortality, thus their loss due to entrainment is not currently considered to be a substantial threat at the population level (ISRP 2005, USFWS 2007c,d).

BMPs will be followed that will avoid and minimize many of the potential impacts of CREP activities. CREP projects involving the installation of pumps for water diversions over 0.5 cfs in habitat for this species will be evaluated under separate consultations on an as-needed basis so that fish screens and other site-specific design criteria can be developed to minimize potential adverse affects to the species. A BMP is in place to avoid creating or exacerbating low flow conditions that could adversely affect listed fish. The BMPs that limit, but still allow some herbicide use in areas where these species may occur, greatly reduce the potential for adverse effects to the species while restoration projects move forward under this programmatic consultation.

While the potential for adverse affects to these species has been greatly reduced through the BMPs, the Service agrees with FSA's determination that some CREP activities may affect, and are likely to adversely affect the shortnose and Lost River suckers and their proposed critical habitats. Adverse effects may include short-term decreases in aquatic and streamside vegetation, increases in turbidity, fine-sediment deposition and direct disturbance of individuals during instream work and due to the potential entrainment of larval suckers. Any loss of shade and increased temperatures that result will be short-term in duration or minimal in scale. Risks associated with exposure to chemicals from equipment are possible, but are low due to the precautions to be taken in accordance with the BMPs. While herbicide use will be limited to chemicals and methods designed to avoid adverse affects to inland fish, there are inherent risks associated with the use of herbicides and uncertainties in the herbicide analyses, and it is possible that herbicide delivery to aquatic habitat could still adversely affect these species or their habitats.

CREP projects that occur in areas that support this species are expected to benefit the species and their proposed critical habitats over the long-term and contribute toward their recovery. CREP projects will support some of the actions identified in the recovery plan for these species by restoring riparian areas and wetlands and their functions, augmenting base flows, and implementing other actions that will reduce the impacts of grazing and farming and improve habitat and water quality (USFWS 1993d).

5.5.1.5. Modoc Sucker

The potential effects to the listed fish discussed above are similar to those for the Modoc sucker (see sections 5.5.1.1, 5.5.1.2, 5.5.1.3 and 5.5.1.4).

Preferred habitat of the Modoc sucker consists of small streams characterized by large shallow pools with cover, soft sediments, and clear water. Food consists of benthic invertebrates, algae, and detritus. During spring spawning runs, the species ascends creeks or tributaries that may be dry during summer months (*i.e.,* ephemeral and intermittent streams). According to the critical habitat designation for this species, constituent elements of Modoc sucker habitat include intermittent and perennial creeks and surrounding areas (50-feet on either side of streams) that provide vegetation for cover and protection from erosion (USFWS 1985a). No critical habitat for Modoc sucker has been designated in Oregon; the species was only recently rediscovered in the state.

Threats faced by Modoc sucker, and opportunities for CREP projects to address them, are similar to those described for other listed fish. Any CREP projects that may occur in areas with Modoc sucker are expected to improve current conditions for this species as habitat and water quality is improved. CREP activities such as fencing portions of streams to reduce cattle-caused erosion, replanting streambanks with native vegetation, improving agricultural practices, leasing water rights for instream use, and improving wetlands and floodplains can help protect suckers and their habitat by controlling erosion, supporting the food web, providing inputs of woody material, increasing channel complexity, recycling organic and inorganic nutrients and maintaining water quantity and quality.

BMPs will be followed to avoid and minimize many of the potential adverse impacts of CREP activities. CREP projects involving the installation of pumps for water diversions over 0.5 cfs in habitat for this species will be evaluated under separate consultations on an as-needed basis so that fish screens and other site-specific design criteria can be developed to minimize potential adverse affects to the species. Allowing screened diversions for only those projects involving 0.5 cfs or less will minimize the risk of suckers becoming entrained or impinged on the screens due to the minimal flows. In addition, the number of water diversions covered under this consultation that can be operational at any one time is limited per the terms and conditions (see section 8.4), as based on the low number of diversions that have been installed for CREP projects from 1998 through 2009 (L. Loop, pers. comm. 2009). A BMP is also in place to avoid creating or exacerbating low flow conditions that could adversely affect listed fish. The BMPs that limit, but still allow some herbicide use in areas where these species may occur should reduce the potential for adverse effects to the species while restoration projects move forward under this programmatic consultation. BMPs are in place to avoid and reduce the potential for projects to increase sedimentation and turbidity over the short-term as projects are becoming established.

While the potential for adverse affects has been greatly reduced through the BMPs, the Service agrees with FSA's determination that some CREP activities may affect, and are likely to adversely affect the Modoc sucker. The will be no effect on Modoc sucker critical habitat. Adverse effects to the species involving a small amount of take is likely to result from decreases in aquatic and streamside vegetation, increases in turbidity, fine-sediment deposition and direct disturbance of individuals during instream work and due to the potential entrainment of larval suckers. Any loss of shade and increased temperatures that result will be short-term in duration or minimal in scale. Risks associated with exposure to chemicals from equipment are possible, but are low due to the precautions to be taken in accordance with the BMPs. While herbicide use will be limited to chemicals and methods designed to avoid adverse affects to inland fish, there are inherent risks associated with the use of herbicides and uncertainties in the herbicide analyses, and it is possible that herbicide delivery to aquatic habitat could still adversely affect this species.

CREP projects that occur in areas that support the Modoc sucker are expected to benefit the species over the long-term and contribute toward its recovery.

5.5.1.6. Oregon Chub

The potential effects to the listed fish discussed above are similar to those for the Oregon chub (see sections 5.5.1.1, 5.5.1.2, 5.5.1.3, 5.5.1.4 and 5.5.1.5).

Oregon chub are found in slack water off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes. Refugia populations also occur in isolated ponds. These habitats usually have little or no water flow, silty and organic substrate, and aquatic vegetation as cover for hiding and spawning. Adults feed on the larvae of aquatic invertebrates, such as mosquitos and other insects. Adult Oregon chub seek dense vegetation for cover and frequently travel in the mid-water column in beaver channels or along the margins of aquatic plant beds. Larval chub congregate in near shore areas in the upper layers of the water column in shallow areas. Juvenile Oregon chub venture farther from shore into deeper areas of the water column. In the winter months, Oregon chub can be found buried in the detritus or concealed in aquatic vegetation.

Some of the factors responsible for the decline of the chub that may be addressed by CREP projects include habitat alteration, runoff from herbicide or pesticide application on farms, desiccation of habitats, water diversions and sedimentation. The types of CREP activities that may remedy these problems include leasing water rights for instream use, restoring native riparian vegetation, and keeping livestock away from sensitive areas.

BMPs will be followed that will avoid and minimize many of the potential impacts of CREP activities. The BMPs that limit, but still allow some herbicide use in areas where these species may occur greatly reduce the potential for adverse effects to the species while restoration projects move forward under this programmatic consultation. CREP projects may involve the installation of pumps for water diversions less than 0.5 cfs in habitat for this species, but those that are over 0.5 cfs will be evaluated under separate consultations on an as-needed basis so that fish screens and other site-specific design criteria can be developed to minimize potential adverse affects to the species. NOAA Fisheries screening criteria will be followed whenever water diversions are installed.

While some entrainment or impingement of Oregon chub is possible, the screens will greatly reduce the risk of potential losses. Adults will be large enough to be kept out by the screens, and the diversions will be small (up to 0.5 cfs) with relatively low currents, further reducing the risk of entrainment or impingement. The larval stage is the primary stage that will be vulnerable because larvae are small enough that they could potentially move through the screens, although the screening design criteria include measures (*e.g.,* intake placement; approach and sweeping velocities) that are intended to keep fish away from the diversions. In addition, few diversions are anticipated in areas where chub may be present and the number that can be operational at any given time under this consultation is limited per the terms and conditions (see section 8.4). From 1998 through 2009, a total of only thirteen stream diversions were installed for off-site water facilities in counties where Oregon chub occur (L. Loop, pers. comm. 2009). The chub is primarily found in slack water off-channel habitats (USFWS 1998d) and areas with vegetative cover (Pearsons 1989), which are generally not as conducive for water diversions and pumping as sites in areas with more open water and flow. The lack of screening and problems associated with screens on diversions are not noted threats for Oregon chub (USFWS 1993c and USFWS 1998d). Any loss of individuals from CREP project-related diversions is expected to be very low.

While the potential for adverse affects to the species has been greatly reduced through the BMPs, the Service agrees with FSA's determination that some CREP activities may affect, and are likely to adversely affect the Oregon chub. The FSA mentioned in its BA that critical habitat had not yet been designated for this species, but was expected to be proposed as soon as March 2009. While the FSA was unable to specifically analyze effects on the proposed critical habitat because the proposal was not available when the BA was completed, the effects analyses in the BA included discussions about Oregon chub habitat in general. Since that time, critical habitat has been proposed, and therefore it has been considered in this BO.

Potential adverse effects to the Oregon chub and its proposed critical habitat include short-term decreases in aquatic and streamside vegetation, increases in turbidity, sedimentation and direct disturbance of individuals during instream work and due to potential entrainment through water diversions. Any loss of shade and increased temperatures that result will be short-term in duration or minimal in scale. The effects to aquatic vegetation and temperature are associated with the PCEs of proposed critical habitat that may be affected. Risks associated with exposure to chemicals from equipment are possible, but are low due to the precautions to be taken in accordance with the BMPs. While herbicide use will be limited to chemicals and methods designed to avoid adverse affects to inland fish, there are inherent risks associated with the use of herbicides and uncertainties in the herbicide analyses, and it is possible that herbicide delivery to aquatic habitat could still adversely affect this species.

CREP projects that occur in areas that support the Oregon chub are expected to benefit the species and contribute toward its recovery over the long-term. CREP projects will support some of the actions identified in the Oregon chub recovery plan, such as maintaining and restoring vegetative cover, addressing erosion and sedimentation problems caused by livestock, and restoring streams and associated riparian, floodplain and wetland habitats (USFWS 1998d).

<u>5.5.2. Fender's blue butterfly</u>

CREP activities on project sites that support Fender's blue butterfly have been limited to minimize potential adverse impacts to the butterfly and its habitat. The BMPs in section 1.4.2 were developed specifically to reduce potential adverse short- and long-term impacts on the butterfly, and will be followed in addition to any BMPs that are applicable from section 1.3.

Shading could negatively affect butterfly habitat, which consists of native prairie. Prairie vegetation is an early seral community that requires natural or human-induced disturbance in order for it to be maintained or restored. The vast majority of the prairies where the butterfly occurs would eventually be forested if left undisturbed. CREP projects that involve the removal of invasive trees and shrubs can help to maintain prairie conditions. Subsequent revegetation with woody species could negatively impact prairie habitat. However, trees and shrubs will only be planted outside of habitats where the butterfly or its critical habitat occurs so that activities will not impact butterfly habitat due to shade, or competition with or displacement by woody species.

Adverse effects to the Fender's blue butterfly could occur from soil disturbance and compaction caused by vehicles and equipment. Soil disturbing activities, such as disking, tillage and fence building may take place on CREP sites that may be occupied. However, soil disturbing activities will not occur when or where the Fender's blue butterfly could be physically harmed. In addition, with the exception of mowers, vehicles and machinery will not be driven on areas where the Fender's blue butterfly could be affected. Foot traffic poses a minor risk of crushing larvae that may be in the duff, or eggs or larvae that may be on host plants.

Mowing may result in short-term adverse affects to the Fender's blue butterfly, but long-term benefits are expected (the discussion on mowing to follow is from an intra-Service consultation on prairie habitat restoration completed in 2008). Mowing in habitat patches with eggs or larvae of Fender's blue butterfly at any time during the year may crush or otherwise kill a small number of individuals of these life stages of the butterfly. However, studies in the southern Willamette Valley have found that both adult and larval Fender's blue butterflies increased in number following mowing to reduce the stature of herbaceous non-native vegetation, (Fitzpatrick 2005, Kaye and Benfield 2005).

A study on the effects of fire and mowing on Fender's blue butterfly and native upland prairie at Baskett Slough National Wildlife Refuge found that Fender's blue butterfly eggs were 10 to 14 times more abundant in plots that were mowed or burned compared to undisturbed, control plots; woody plants were reduced 66 percent with mowing (Wilson and Clark 1997). At the U.S. Army Corps of Engineers' Fern Ridge Reservoir, the Fender's blue butterfly population has increased dramatically since fall mowing of lupine patches has been implemented (Messinger 2006). Fender's blue butterfly population trends have been correlated with lupine vigor; high leaf growth appears to produce larger butterfly populations. The abundance of Fender's blue butterfly eggs was found to be correlated with the abundance of Kincaid's lupine leaves at a number of study sites (Kaye and Cramer 2003); egg abundance increased substantially at sites which had been treated to control non-native weeds (Schultz *et al.* 2003)

The effect of mowing on designated critical habitat for Fender's blue butterfly is a short-term reduction in some PCEs with clear long-term benefits. Spring mowing will temporarily reduce the cover of native prairie species, which would be an adverse effect to that PCE. It will also reduce the cover of larval host plants and reduce the availability of nectar sources for Fender's blue butterfly. Concomitantly, spring mowing will have beneficial effects to critical habitat as it removes competing non-native plant species. Spring mowing will only happen in unoccupied butterfly habitat. Fall mowing is not likely to have any adverse effects to the PCEs. Both spring and fall mowing have clear beneficial effects in the long-term; mowing has been shown to be one of the most effective techniques for increasing native prairie species cover and reducing the dominance of competitive invasive species (Kaye and Benfield 2005, Messinger 2006).

Little is known about the specific impacts of the proposed herbicides on Fender's blue butterfly, but several effects to the butterfly and its critical habitat are possible. Butterfly eggs or larvae, host plants or desirable nectar species may be affected due to exposure to herbicides from drift or spray reaching these non-target species. However, the types of herbicides to be used in butterfly habitats is limited, and herbicide-related BMPs in section 1.4.2 have been developed to minimize the potential for herbicides to come into contact with Fender's blue butterflies and their host plants.

Herbicide may only be used on sites with butterflies when they are in diapause. During this time, larvae are typically located at or near the base of host plants. Host plants (*i.e.,* Kincaid's, sickle-keeled, and spur lupine) will be covered during spraying, even if they have senesced, to protect any butterfly larvae that may be on the plant or on the ground in the immediate vicinity. We cannot calculate the number of larvae that will be killed or injured by incidental exposure to herbicides, but expect the actual effect to very low since larvae should be shielded at the time of application, and they are expected to feed on fresh lupine leaflets that have not been sprayed when they emerge.

The effect of chemical treatments on designated critical habitat for Fender's blue butterfly is a short-term reduction in some PCEs with clear long-term benefits. Herbicide treatment may temporarily reduce the cover of native prairie species. It may also reduce the availability of nectar sources for Fender's blue butterfly. In the long-term, use of chemical treatments to restore prairie habitat for the Fender's blue butterfly will benefit the butterfly and increase the availability of habitat containing PCEs by controlling invasive woody species and non-native plants and providing open areas for native plants and nectar sources for Fender's blue butterfly to become established.

If there are opportunities to support Fender's blue butterfly recovery efforts or improve butterfly critical habitat on CREP project sites, CREP projects may be designed to include actions that will specifically benefit the butterfly species where landowners are interested. In addition, other partners such as the U.S. Fish and Wildlife Service may be invited to participate in CREP projects that could benefit prairie species by providing additional technical and possible financial assistance.

In summary, CREP actions covered by this programmatic consultation may affect, and are likely to adversely affect Fender's blue butterfly and its critical habitat over the short-term due to the risks associated with mowing, foot traffic and herbicide applications. The level of injury and mortality to butterflies and loss of desirable habitat elements are expected to be very low. Risks have been greatly minimized due to the BMPs and limitations on the activities that may occur in Fender's blue butterfly habitats. Some CREP projects may be designed to benefit the butterfly and its proposed critical habitat over the long-term.

5.5.3. Listed Plants

CREP activities may affect Kincaid's lupine, Willamette daisy, Nelson's checker-mallow, Bradshaw's lomatium and golden paintbrush and critical habitat for the Willamette daisy and Kincaid's lupine primarily due to mowing on prairie sites in the Willamette Valley. Soil disturbing activities, such as disking, tillage and fence building may take place on CREP sites that support listed plants. However, soil disturbing activities will not occur where listed plants could be physically harmed (*e.g.,* fence post holes will not be located where listed plants occur). In addition, with the exception of mowers, vehicles and machinery will not be driven on areas where listed plants occur.

There are likely to be some short-term adverse effects to these species from mowing, but ultimately, long-term benefits are expected and that is why mowing has been proposed as part of the action (the discussion on mowing to follow is from an intra-Service consultation on prairie restoration completed in 2008). Spring mowing within patches of listed plants may remove much of the above ground growing parts of the plants, which would reduce growth and reproductive success for that year. Fall mowing is not likely to have any adverse effects to listed plants, as the above ground portions of the listed plants will have senesced. Nelson's checker-mallow may be an exception, as it may not become senescent by the beginning of the fall mowing window; in these cases, loss of some of the above ground growing parts of the plant can be expected.

Research on prairie management techniques has shown that mowing is an effective method for reducing non-native plants, with generally positive effects to native prairie species. Annual fall mowing has significant positive effects, including increased leaf, flower and foliar cover, on Kincaid's lupine (Kaye and Thorpe 2006). A recent study found that Willamette daisy did not respond with increased crown cover in mowed plots, but suggests that the indirect effects (*e.g.*, reduced cover of invasive plants) positively affect the species (Thorpe and Kaye 2006). A two-year study on the effects of mowing and burning on Nelson's checker-mallow found that the species did not respond positively to mowing in the short-term, although the reduction in cover of competing woody plants would likely benefit Nelson's checker-mallow in the long-term (Wilson 2004).

The effect of mowing on designated critical habitat for Kincaid's lupine and Willamette daisy is a short-term reduction in some PCEs, with clear long-term benefits. Spring mowing will temporarily reduce the cover of native prairie species, which would be an adverse effect to that PCE for these species. Concomitantly, spring mowing will have beneficial effects to critical habitat for these species as it removes competing non-native plant species. Fall mowing is not likely to have any adverse effects to the PCEs of designed critical habitat for any of the species. Both spring and fall mowing have clear beneficial effects in the long-term; mowing has been shown to be one of the most effective techniques for increasing native prairie species cover and reducing the dominance of competitive invasive species (Kaye and Benfield 2005, Messinger 2006).

The use of herbicides poses significant risks to listed plants. However, the BMPs developed for herbicide use on sites with listed plants greatly reduce the potential for harm. The BMPs address risks related to the types of herbicides to be used, application methods, proximity to listed plants, and potential exposure, greatly minimizing the potential for listed plants to come into contact with herbicides that could harm them.

For all spray applications, listed plants will be physically shielded (*e.g.,* covered with buckets or some other barrier that will not harm the plants) as needed to protect them from drift, unless they are dormant; plants will be uncovered immediately after spraying has been completed. The potential for exposure from drift will be further addressed by minimizing fine particle size, using the lowest nozzle pressure needed, keeping spray nozzles close to the ground, spraying only when there are no or low breezes, directing spray away from listed plants, and maintaining no-spray buffers for some applications. Even if listed plants are physically shielded, a minimum 10-foot buffer will be maintained between listed plants and the application area for herbicides that have a higher tendency to move through the soil and that could get taken up by the roots. Runoff that could carry herbicides will be minimized by avoiding applications during periods of rain, snow, or melting snow, and by using hand application methods such as wicking, wiping, and hack and squirt where appropriate. (See section 1.4.3 for a complete listing of herbicide-related BMPs for listed plants.)

The effect of chemical treatments on designated critical habitat for the Kincaid's lupine and Willamette daisy is a short-term reduction in some PCEs with clear long-term benefits. Herbicide treatment may temporarily reduce the cover of native prairie species, which would be an adverse effect to a PCE for both species. In the long-term, use of chemical treatments to restore prairie habitat for listed plants will benefit these species and increase the availability of habitat containing PCEs by controlling invasive woody species and non-native plants and providing open areas for native prairie plants to become established.

Shading has the potential to result in adverse affects to listed prairie plants. While many listed plant species could benefit from invasive species removal, reduced grazing pressure and reduced physical disturbance from livestock, some could be shaded out by CREP plantings or outcompeted by other vegetation because of the lack of grazing. Also, increased thatch may reduce successful seed establishment of some species. However, to avoid long-term shading out of shade-intolerant species, technical staff involved in CREP projects will recommend species for planting that will maintain or restore habitat conditions needed to support listed plants and that are appropriate to the site based on soil type and plant community type that will not grow tall enough to shade out the listed species. Therefore, shading is not likely to adversely affect listed plants.

To avoid and minimize harm to threatened and endangered plants from CREP activities, all applicable project BMPs listed in section 1.3 will be followed, as well as those listed in section 1.4.3 for listed plants. CREP activities are likely to adversely affect Kincaid's lupine, Willamette daisy, Nelson's checker-mallow, Bradshaw's lomatium and golden paintbrush and critical habitat for Kincaid's lupine and Willamette daisy during the short-term due to the risks associated with mowing. If any adverse effects occur to listed plants from herbicide applications, they are expected to be minimal due to the BMPs. The level of injury to listed plants and loss of desirable habitat elements are expected to be very low, and risks have been greatly minimized due to the BMPs and limited activities that may occur in listed plant habitats. Some CREP projects may be designed to benefit threatened and endangered plants and their critical habitats over the long-term.

6. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

It is anticipated that existing threats to the species addressed in this BO are reasonably certain to continue. As discussed for each species in section 2, threats include habitat loss and degradation due to invasive non-native plants, pollutants, agricultural and forestry practices, commercial and residential development and other factors.

CREP projects will primarily occur on agricultural lands in riparian areas along streams and rivers, and on associated wetland and upland habitats throughout Oregon. The extent of effects from current and future human activities in the action area is unknown. However, most habitats on lands eligible for CREP funding are likely to continue to be used for agricultural purposes if they are not enrolled in CREP or similar programs, and are therefore not likely to contribute in new ways toward either listed species recovery or declines. Those lands that are enrolled in CREP and other similar conservation programs are expected to contribute to the recovery of listed species over time, especially listed fish since they occur in streams on private agricultural lands in Oregon that are the focus of CREP activities.

7. CONCLUSION

7.1. Inland Fish

After reviewing the status of the listed bull trout, Lahontan cutthroat trout, Warner sucker, shortnose sucker, Lost River sucker, Modoc sucker and Oregon chub, the status of bull trout and Warner sucker designated critical habitats in Oregon, proposed critical habitats for shortnose sucker, Lost River sucker and Oregon chub, the environmental baseline for species that may be affected in the action area, the effects of the proposed actions and cumulative effects, the Service concludes that the proposed actions are not likely to jeopardize the continued existence of these species, nor are they likely to destroy or adversely modify their designated or proposed critical habitats.

The determinations of no jeopardy and no adverse modification of critical habitat are based on the following considerations:

- The listed fish addressed in this BO have declined due to numerous factors. The one factor for decline shared by all of these species is the degradation of aquatic habitats. Agricultural practices, urbanization and other land uses and activities in the Pacific Northwest have caused significant negative changes to aquatic habitat across the range of listed fish. All of the proposed actions addressed by this consultation are intended to improve degraded habitat and water quality, thereby benefiting listed fish species and their critical habitats.
- Generally, lands eligible to be enrolled in CREP have been significantly modified from use as crop or pasture lands. CREP actions will improve these habitats and contribute toward meeting the conservation and recovery needs of the listed fish species by addressing threats

to the species, restoring and enhancing aquatic habitats and their ecological functions, and implementing actions that have been identified for recovering listed fish.

- Some listed fish are likely to experience exposures to various concentrations of herbicides, turbidity, fine sediment deposition, and increased water temperatures that exceed effect thresholds and result in harm. However, these exposures are likely to be minor in magnitude (generally sublethal) and extent (generally on one property at a time, averaging 28 acres in size including about 2.5 stream miles based on past CREP enrollments) and occur infrequently.
- Listed sucker larvae and Oregon chub are susceptible to entrainment through water diversions. However, the number of water diversions where these species occur is expected to be low and the risks have been minimized by the BMPs.
- BMPs designed to avoid and minimize all foreseeable direct and indirect adverse affects to listed species from project activities have been incorporated into the action.
- Due to the low magnitude and extent of effects resulting from implementation of the proposed action, the abundance, productivity, distribution, and connectivity of the listed fish and their critical habitats will not be significantly or permanently affected.

In conclusion, some limited adverse effects will likely result from implementation of CREP project activities to the listed fish species addressed in this BO. However, the overall effect of CREP actions will be to improve aquatic habitat conditions and water quality. Therefore, it is expected that the Oregon CREP will contribute toward the long-term survival and recovery of listed fish, and will improve the function of their designated and proposed critical habitats.

7.2. Fender's blue butterfly and listed plants

After reviewing the current status of Fender's blue butterfly, Willamette daisy, Bradshaw's lomatium, Kincaid's lupine, Nelson's check-mallow and Golden Indian paintbrush, designated critical habitat for Fender's blue butterfly, Kincaid's lupine and Willamette daisy, the current status of the species in the action area, the effects of the proposed action, and the cumulative effects within the action area, it is the Service's conclusion that the action, as proposed, is not likely to jeopardize the continued existence of Fender's blue butterfly or the five listed plants, and is not likely to adversely modify designated critical habitat for Fender's blue butterfly, Willamette daisy or Kincaid's lupine. Although restoration activities are likely to result in short-term adverse effects to these listed species and their critical habitats, best management practices are in place to avoid and minimize adverse effects. While the Oregon CREP is not focused on the restoration of prairie habitats such as those in the Willamette Valley where these listed species occur, some actions designed to benefit prairie species may be incorporated into CREP projects.

The determinations of no jeopardy and no adverse modification of critical habitat are based on the following considerations:

- Soil disturbing activities, such as disking, tillage and fence building will not take place and vehicles and machinery, with the exception of mowers, will not be driven in locations that could cause physical harm to the Fender's blue butterfly or listed plants.
- Trees and shrubs will only be planted outside of habitats where the Fender's blue butterfly or listed prairie plants may occur, and outside of their critical habitats.

- None of the proposed activities are likely to permanently decrease reproduction, numbers, or distribution of Fender's blue butterfly, Willamette daisy, Bradshaw's lomatium, Kincaid's lupine, Nelson's check-mallow or Golden Indian paintbrush.
- BMPs for mowing include seasonal timeframes and buffers to avoid and minimize potential impacts on list plants and Fenders' blue butterfly, thus any adverse impacts from mowing will be very small, and temporary.
- BMPs for herbicide treatments are in place to avoid exposing listed plants, Fender's blue butterfly, and butterfly host plants to herbicides that could harm them.
- Harassment and mortality of butterflies affected by habitat restoration activities are expected to be very low. Recent research indicates that few larvae are killed by mowing, and the population generally rebounds in the year after treatment.
- Management activities that are implemented when plants are growing (*e.g.,* spring mowing, weed treatment including herbicide use) will be done in a manner that minimizes effects to listed plants. Although some plants will be negatively affected, the improved habitat quality and reduction in competition from invasive plants will result in larger, more robust populations of the listed species.
- Mowing can have a beneficial effect on Fender's blue butterfly, Kincaid's lupine and Willamette daisy critical habitat because it can promote new vegetative growth and establishment of Kincaid's lupine, Willamette daisy and other low growing grasses and forbs.
- Techniques used to control invasive species expansions can improve habitat quality for Fender's blue butterfly and listed plants.
- Controlling invasive species can benefit critical habitat for Fender's blue butterfly, Kincaid's lupine and Willamette daisy by reducing dense non-native vegetation that can block sunlight and compete for resources necessary for the growth and reproduction of listed plants as well as host and nectar plants needed for the butterfly, and impede movement of the butterfly.

8. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of State law or regulations or in the course of any violation of a state criminal trespass law.

The measures described below are non-discretionary, and must be undertaken by the FSA so that they become binding conditions of any grant or permits issued to others conducting the work, as appropriate, for the exemption in section 7(o)(2) to apply. The FSA has a continuing duty to regulate the activity covered by the incidental take statement. If the FSA (1) fails to assume and implement the terms and conditions or (2) fails to require their grantees or permitees to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FSA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

8.1. Amount or Extent of Take Anticipated

8.1.1. Inland fish

As described in the effects of the action discussion, the Service expects that the action, as proposed by FSA with the BMPs, will minimize incidental take of bull trout, Lahontan cutthroat trout, the listed suckers and Oregon chub. However, the BMPs and other protective measures do not completely eliminate the potential for take and some incidental take associated with herbicide use, increases in turbidity, fine-sediment deposition, shade reduction, disturbance of individuals during instream work, entrainment associated with water diversions, and adverse effects to algae, aquatic macrophytes and aquatic macroinvertebrates from herbicides and sedimentation is likely to occur. While some adverse effects are likely to occur, the frequency, duration, extent and severity of the adverse effects are likely to be low. Any take associated with herbicide use and erosion is expected to be in the form of non-lethal harm, caused by short-term exposures of listed fish to sub-lethal concentrations of herbicides and associated compounds. Sub-lethal effects include short-term impairments (hours) of normal functions and behaviors such as olfaction, respiration, and feeding from chemical exposures that result from herbicide applications (*e.g.,* emergent vegetation treatments, riparian applications, or applications in dry or intermittent streams). These effects are only likely to occur to bull trout. The herbicide use proposed by FSA is not expected to reach streams in concentrations that will adversely affect Lahontan cutthroat trout, the listed suckers or Oregon chub due to the additional herbicide limitations described in the BMPs that apply where these species occur, although some uncertainties about the potential effects to these species are inherent in the herbicide analyses.

The number of significant herbicide exposures to bull trout, and expectedly insignificant exposures to other listed fish (due to the more restrictive BMPs), is likely to vary from year to year, and will depend on the proximity of areas treated with herbicides to occupied habitats, number and nature of the riparian and in-channel sites treated, the types and amounts of herbicides used, the timing of the application, the amount of time elapsed between manual, mechanical, and herbicide treatments and rainfall, and the intensity of rainfall. Potential for juveniles, fry, or eggs to be directly harmed or displaced by workers walking or standing in stream channels or from sediment or turbidity will also vary by location and year.

Entrainment of larval suckers or Oregon chub is possible where CREP projects include water diversions. Entrainment would likely result in mortality. Impingement is highly unlikely because of the minor amount of water that can be diverted in areas with these species under this programmatic consultation. We expect that bull trout and Lahontan cutthroat trout will be fully protected by the requirement that diversions be screened in accordance with NOAA Fisheries screening criteria, which are designed to avoid all take of similar listed species (*i.e.,* anadromous salmonids). The levels of take of the suckers and Oregon chub are expected to be low because only minor diversions are covered and these species will be at least partially protected by the screens. Diversions will typically be located away from areas where Oregon chub and sucker larvae are expected to occur. In addition, water diversions installed to irrigate CREP plantings will be temporary and are expected to cease after plants become established. Diversions used to maintain water in livestock watering facilities will be in use over the long-term, but these will require very little, intermittent flow and pose minimal risk to fish.

Despite the use of best scientific and commercial data available, the Service cannot quantify the specific number of individual fish that will be incidentally taken by this action. The Service anticipates that incidental take of individual listed fish would be difficult to detect or quantify because of the sublethal nature of most of the take and the low likelihood of finding any affected eggs, larvae or fry, juveniles or adults. We expect that the number of individual fish exposed to sublethal concentrations of herbicides or levels of sedimentation or turbidity that could result in harm will be low, and will only be associated with treatments and other work within and adjacent to spawning and rearing habitat. Take associated with the entrainment of larval suckers or Oregon chub through screened water diversions is also expected to be low, and is not likely to affect adult fish.

In the absence of information about specific project locations, potential listed species occurrences on future CREP project sites, and sufficient data to quantify the number of individuals that will be affected by CREP activities, the Service relies on estimates of habitat that may be affected as a reasonable surrogate for describing the extent of take. FSA anticipates that an average of 3,600 acres (ranging from 3,000 to 5,000 acres per year) will be enrolled in CREP annually over the next five years based on past enrollments. They have also stated that landowner interest in the CREP and enrollments in Oregon continue to increase. Lands may continue to be enrolled over a series of years until the approved cap of an additional 65,000 acres is reached. The vast majority of CREP projects will be located along streams. We do not anticipate that listed inland fish will occur in the vicinity of all CREP project sites, but each of the listed species is likely to occur on or within the vicinity of some percentage of the project areas.

We estimated the amount of occupied habitat that may be encountered annually by species based on species distributions in Oregon counties, anticipated CREP enrollments, the average size of CREP projects (28 acres with 2.5 stream miles) and estimates of how often CREP activities may occur within occupied habitats. For simplicity, we assumed that statewide CREP enrollments will average 5,000 acres per year over the next ten years based on FSA's reported and predicted CREP enrollments and trends, and we assumed that CREP project numbers will be evenly distributed in all 36 counties throughout the state, which equates to about 140 acres to be enrolled per county per year on average. We also assumed that CREP projects will occur more often in habitats occupied by listed fish than they would if projects were randomly distributed, since the Oregon CREP is a restoration program and one of its purposes is to benefit listed species. While actual enrollments will vary by area and will be higher in some counties and watersheds than others, we believe our overall estimates of occupied habitats that may be affected are reasonable based on the available information and all of the factors considered.

Bull trout

Bull trout occur in Baker, Crook, Deschutes, Grant, Harney, Hood River, Jefferson, Klamath, Lake, Lane, Linn, Malheur, Umatilla, Union, Wallowa, Wasco and Wheeler counties. Assuming that 140 acres per county will be enrolled in CREP, 2,380 acres will be enrolled in these 17 counties annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 85 projects involving work along an estimated 213 stream miles in these counties annually. If we assume that 30 percent of the CREP sites will occur in occupied areas, it is estimated that take of bull trout may occur in up to 64 stream miles per year on average or 640 stream miles over the 10 year period covered by this programmatic consultation. Any take of bull trout that occurs is expected to be sub-lethal and short-term, with the exception of potential lethal take associated with herbicide use that will occur at some project sites over the short-term.

Lahontan cutthroat trout

Lahontan cutthroat trout occur in Harney and Malheur counties. Assuming that 140 acres per county will be enrolled in CREP, 280 acres will be enrolled in these two counties annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 10 projects involving work along an estimated 25 stream miles in these counties annually. If we assume that 30 percent of the CREP sites will occur in occupied areas, it is estimated that take of Lahontan cutthroat trout may occur in up to 7.5 stream miles per year on average or 75 stream miles over the 10 year period covered by this programmatic consultation. Any take of Lahontan cutthroat trout that occurs is expected to be sub-lethal and short-term.

Shortnose and Lost River suckers

Shortnose and Lost River suckers occur in Klamath County. Assuming that 140 acres per county will be enrolled in CREP, 140 acres will be enrolled in this county annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 5 projects involving work along an estimated 12.5 stream miles in this county annually. If we assume that 50 percent of the CREP sites will occur in these occupied areas, it is estimated that take of shortnose and Lost River suckers may occur in up to 6.25 stream miles per year on average or 62.5 stream miles over the 10 year period covered by this programmatic consultation. Any take of shortnose and Lost River suckers that occurs is expected to be sub-lethal and short-term, with the exception of potential lethal take of larvae associated with entrainment through water diversions if the screening criteria are not fully protective during all life stages.

Warner sucker

Warner sucker occurs in Lake County. Assuming that 140 acres per county will be enrolled in CREP, 140 acres will be enrolled in this county annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 5 projects involving work along an estimated 12.5 stream miles in this county annually. If we assume that 30 percent of the CREP sites will occur in these occupied areas, it is estimated that take of Warner suckers may occur in up to 3.75 stream miles per year on average or 37.5 stream miles over the 10 year period covered by this programmatic consultation. Any take of Warner sucker that occurs is expected to be sub-lethal and short-term, with the exception of potential lethal take of larvae associated with entrainment through water diversions if the screening criteria are not fully protective during all life stages.

Modoc sucker

Modoc sucker occurs in Lake County. Assuming that 140 acres per county will be enrolled in CREP, 140 acres will be enrolled in this county annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 5 projects involving work along an estimated 12.5 stream miles annually. In recent surveys, the Modoc sucker has only been documented in approximately 14.2 miles of stream (Thomas Creek) in Oregon. The known occupied habitat is primarily on land managed by the U.S. Forest Service, which is not eligible for CREP. However, Modoc suckers may extend farther upstream at lower densities, or downstream into areas of Thomas Creek and its tributaries that include private agricultural lands. Considering the very limited distribution of Modoc sucker in Oregon, we estimate that one CREP project will occur in occupied habitat annually, on average. Thus, it is estimated that take of Modoc sucker may occur in up to 2.5 stream miles (the average length of stream affected by CREP projects) each year on average, which equates to 25 stream miles over the 10 year period covered by this programmatic consultation. Any take of Modoc sucker that occurs is expected to be sub-lethal and short-term, with the exception of potential lethal take of larvae associated with entrainment through water diversions if the screening criteria are not fully protective during all life stages.

Oregon chub

Oregon chub occur in Benton, Lane, Linn, Marion and Polk counties. Assuming that 140 acres per county will be enrolled in CREP, 700 acres will be enrolled in these five counties annually. With enrollments averaging 28 acres and about 2.5 stream miles per site, this equates to about 25 projects involving work on the 700 acres and along an estimated 62.5 stream miles in these counties annually. Oregon chub are very limited in distribution, and occur in isolated ponds and wetlands in some cases. If we assume that 10 percent of the CREP projects in these counties will occur on sites with occupied habitats, it is estimated that take of Oregon chub may occur on up to 2.5 projects that may include occupied wetlands or ponds and up to 6.25 stream miles on average per year. This equates to 62.5 stream miles and 25 projects that may include occupied ponds or wetlands over the 10 year period covered by this programmatic consultation. We assume that water diversions will not be installed in ponds or wetlands with Oregon chub, and have included that assumption as a requirement in the terms and conditions section of the incidental take statement. Any take of Oregon chub that occurs is expected to be sub-lethal and short-term, with the exception of potential lethal take associated with entrainment through water diversions installed on streams if Oregon chub may occur near the intakes and the screening criteria are not fully protective during all life stages.

8.1.2. Fender's blue butterfly

The Service anticipates incidental take of Fender's blue butterfly will be difficult to detect because the presence and number of individuals is difficult to determine within a project area and detecting a dead or impaired specimen is highly unlikely. Although the Service anticipates Fender's will be incidentally harassed and harmed (killed or injured) as a result of restoration and maintenance activities, accurately quantifying these effects is difficult. For instance, injured butterflies that fly off to areas well beyond the project corridor before dying or that are consumed by birds, bats or other predators because of injuries, are not likely to be located for estimating take. Additionally, larvae and eggs that are trampled or mowed will be extremely difficult to find in order to quantify incidental take. Therefore, even though take is expected to occur, data are not available and are not sufficient to enable the Service to estimate an exact number of individuals which are incidentally taken for most of the proposed activities. For this reason, we will specify the amount or extent of incidental take associated with mowing, foot traffic and herbicide applications using an estimate of the occupied acres where these activities may occur on an annual basis as a surrogate.

As described in the inland fish section, we assumed that statewide CREP enrollments will average 5,000 acres per year over the next ten years based on FSA's reported and predicted CREP enrollments and trends, and we assumed that CREP project numbers will be evenly distributed in all 36 counties throughout the state, which equates to about 140 acres to be enrolled per county per year on average. The Fender's blue butterfly occurs in Benton, Lane, Linn, Polk and Yamhill counties and may be rediscovered or reintroduced at some point in Marion County. Therefore, an estimated 840 acres per year are expected to be enrolled in these six counties annually.

CREP projects are not expected to occur on sites occupied by the butterfly very frequently. At the time of listing in 2000, the Fender's blue butterfly was known to occupy only 32 sites across 408 acres (165 hectares) (USFWS 2000a). In 2006, 3,010 acres (1,218 hectares) was designated as critical habitat for the butterfly, comprising only 0.07 percent of the land within Benton, Lane, Polk and Yamhill counties (U.S. Census Bureau 2009) of which about 66 percent is private land and the rest is public (USFWS 2006c). The private lands are used for pastures, hayland, cropland, vineyards, nurseries, Christmas tree farms, woodlands, and urban and rural areas managed as open spaces or left as remnant prairies. Only those agricultural lands that have been recently used for cropland or pastureland are eligible for CREP. Generally, the prairie habitat on these lands has been significantly degraded and does not currently support the butterfly. In addition, the butterfly primarily occurs in upland prairies, out of wetlands and often away from streamside habitats where most CREP projects will take place. Over time, CREP projects may increase the amount of potentially suitable habitat.

We assume that CREP activities in Fender's blue butterfly habitat will be infrequent. Based on the limited extent of occupied Fender's blue butterfly habitat and the fact that CREP activities are not specifically focused on upland prairies, we estimate that projects will occur on sites that include occupied habitats up to ten percent of the time in the six counties where the species may be found. This equates to an average of 84 acres or three project sites per year (based on the average size of a CREP enrollment reported by FSA, which is 28 acres). Therefore, it is estimated that take of Fender's blue butterfly may occur on up to thirty projects, estimated to total up to 840 acres, on sites with occupied habitat over the 10 year period covered by this programmatic consultation. On these lands, we anticipate that death or injury of a small percentage of larvae and eggs in the action area may occur due to crushing or soil compaction by mowers, suction by mowers, trampling by foot traffic and from chemical treatment activities.

8.2. Effect of the Take

In the accompanying BO, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of designated or proposed critical habitat when the reasonable and prudent alternatives and terms and conditions in sections 8.3 and 8.4 are implemented.

8.3. Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of the listed species included in this consultation.

Reasonable and Prudent Measure 1 (RPM 1): FSA is responsible for ensuring that CREP activities subject to this programmatic consultation are carried out in a manner that is consistent with its provisions.

Reasonable and Prudent Measure 2 (RPM 2): Water diversions in areas with listed suckers and Oregon chub will be limited.

Reasonable and Prudent Measure 3 (RPM 3): FSA will submit an annual report to the Service summarizing CREP activities and listed species encountered.

8.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the FSA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

Terms and Conditions necessary for the implementation of RPM 1:

- FSA shall ensure that its staff and designated responsible parties have a thorough understanding of the requirements and BMPs that must be followed to design, review and implement projects, and to fulfill monitoring and reporting requirements, as relevant to their roles in carrying out CREP activities covered under this consultation.

Terms and Conditions necessary for the implementation of RPM 2:

- It has been assumed that very few water diversions will be installed in areas with listed suckers or Oregon chub based on the low numbers of diversions installed for CREP projects to date, as reported by FSA[5]. No more than five water diversion projects associated with the CREP projects covered under this consultation may be in operation annually in areas that may adversely affect any one species of listed sucker, and no more than fifteen may be installed on streams where Oregon chub may be adversely affected (*i.e.,* no more than the given number of diversions may be operational at a time per species).
- Water diversions will not be installed in ponds or wetlands that support Oregon chub.

[5]The number of stream diversions that have been installed for CREP projects in counties with either listed suckers or Oregon chub for the period from 1998 through 2009: Benton (3), Klamath (3), Lake (unknown), Lane (0), Linn (7), Polk (3) and Marion (0) (L. Loop, pers. comm. 2009).

Terms and Conditions necessary for the implementation of RPM 3:

- FSA shall submit an annual report to the Service at the end of each fiscal year that summarizes the following for the covered time period: (1) the total number of projects and total acreage enrolled in the Oregon CREP by county, (2) the number and sizes (*i.e.,* acreages and stream miles) of projects that were implemented where listed species and/or proposed or designated critical habitats occur, and the CP(s) and practice components (including whether or not herbicides were used) that were implemented, summarized by species, (3) any BMPs and other conservation measures that were used to avoid take, and (4) the cumulative total amounts of take for each listed fish species and Fender's blue butterfly, based on the measures of habitat used to describe the amount or extent of take anticipated in section 8.1.

8.5. Reporting and Review Requirements

8.5.1. Reporting Sick, Injured or Dead Individuals

Upon locating dead, injured, or sick listed species individuals during the time when herbicide application or other activities are occurring on CREP sites, initial notification must be made to the Service's Division of Law Enforcement at 9025 SW Hillman Court, Suite 3134 in Wilsonville, Oregon; phone: 503-682-6131. Instructions for proper handling and disposition of such specimens will be issued by the Division of Law Enforcement. Care must be taken in handling sick or injured fish or butterflies to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured individuals or the preservation of biological materials from dead fish or butterflies, FSA has the responsibility to ensure that information relative to the date, time, and location of the listed fish or butterfly when found, and possible cause of injury or death of each individual be recorded and provided to the Service.

8.5.2. Review Requirement

The Service believes that take will not exceed the amounts for each species described in section 8.1 as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The FSA must immediately provide an explanation of the causes of the taking and review with the Service the need for and possible modification of the reasonable and prudent measures.

9. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service offers the following conservation recommendations based on opportunities for the CREP to support listed species conservation and recovery goals:

1. Encourage CREP technicians and program enrollees to become familiar with the conservation and recovery needs of listed and at-risk species they might encounter.
2. Document any new occurrences of listed and at-risk species in the action area, and work with landowners to undertake measures that will protect and benefit them.
3. Identify areas that could provide suitable habitat for listed and at-risk species in the future, and work with willing landowners to undertake measures that would support recovery efforts.
4. Contact the Service to evaluate opportunities to conserve listed species, implement recovery actions in partnership with CREP program enrollees, and to provide assurances to landowners that additional ESA liabilities will not be incurred due to their efforts to conserve listed and sensitive species (*i.e.,* through Safe Harbor or Candidate Conservation Agreements), where landowners may be agreeable.
5. Use manual and mechanical methods rather than herbicides to treat invasive species where listed species occur, or use herbicide formulations with the least toxicity to listed species and other organisms, whenever possible.
6. Monitor the effects of CREP actions on listed species and their habitats.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

10. REINITIATION – CLOSING STATEMENT

This concludes the formal programmatic consultation on CREP activities that may occur on up to 65,000 acres of agricultural land in Oregon. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

11. REFERENCES AND LITERATURE CITED

Adams, R.M., and D.E. Peck. 2006. Climate change and water resources: potential impacts and implications. Oregon State University. 18 pp.

Akins, G.J. 1970. The Effects of Land Use and Land Management on the Wetlands of the Upper Klamath Basin, Western Washington State College. Master of Science. 128 pp.

Allen, C., A. Atkins, and M. Stern. 1994. Status and Recolonization of the Warner sucker (*Catostomus warnerensis*) and other fishes in the Warner Lakes in Southeast Oregon,

1994. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 22 pp.

Allen, C., K. Hartzell, and M. Stern. 1996. Warner sucker progress report - 1996 findings. Unpublished report to Bureau of Land Management. 55 pp.

Allen, C., K. Hartzell, M. Stern and A. Munhall. 1995a. Status of the Warner sucker (*Catostomus warnerensis*) and other fishes in the Warner Basin in Southeast Oregon, 1995. Unpublished report to the Fish and Wildlife Service. 35 pp.

Allen, C., M. Stern, and A. Munhall. 1995b. Monitoring of the Warner sucker and other fishes in the Warner Basin in 1994 and 1995. Unpublished report to the Fish and Wildlife Service. 4 pp.

Alverson, E.R. 1990. Use of a county soil survey to locate remnants of native grassland in the Willamette Valley, Oregon. New York State Museum Bulletin 471:107-112.

Andreasen, J.K. 1975. Systematics and status of the family Catostomidae in southern Oregon. Doctoral dissertation. Oregon State University, Corvallis, Oregon. 76 pp.

ASR (Aquatic Scientific Resource). 2005. Preliminary Research on *Aphanizomenon flos-aquae* at Upper Klamath Lake, Oregon. Prepared for USFWS, Klamath Falls, Oregon. 158p. + Appendices A through E.

Ballmer, G.R and G.F. Pratt. 1988. A survey of the last instar larvae of the Lycaenidae (Lepidoptera). Journal of Research on the Lepidoptera 27:1-81.

Bangs, B.L., P.D. Scheerer, S.E. Tippery, M.A. Weeber, and S.E. Jacobs. 2008. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-49, E-2-51, and 101817M402. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem, Oregon. 22 pp. plus appendix.

Banish, N.P., B.J. Adams, and R.S. Shively. 2007. Distribution and habitat associations of radio-tagged adult Lost River and shortnose suckers in Upper Klamath Lake, Oregon: 2005-2006 report. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station. 45 pp.

Barlow, G.W. 1995. The relevance of behavior and natural history to evolutionarily significant units. Pages 169-175 in J. L. Nielsen editor. Evolution and the Aquatic Ecosystem. American Fisheries Society Symposium 17. Bethesda, Maryland.

Barnes, M. 2004. Habitat variation and experimental management of Kincaid's lupine. Bulletin of the Native Plant Society of Oregon 37(9):95-103.

Barnett, T.P., D.W. Pierce, H.G. Hildalgo, C. Bonfils, B.D. Santer, T. Das, G. Bala, A.W. Wood, T. Nozawa, A.A. Mirin, D.R. Cayan, and M.D. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319: 1080-1083. February 22, 2008.

Barry, P.M., B.S. Hayes, A.C. Scott, and E.C. Janney. 2007b. Monitoring of Lost River and shortnose suckers at shoreline spawning areas in Upper Klamath Lake. In: "Investigations of adult Lost River, shortnose, and Klamath Largescale suckers in Upper Klamath Lake and its tributaries, Oregon: Annual Report 2005. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station.

Bartels, M.R., and M.V. Wilson. 2001. Fire and mowing as management tools for conserving a threatened perennial and its habitat in the Willamette Valley, Oregon. Proceedings of the 17th North American Prairie Conference. Seeds for the Future; Roots of the Past. Neil P. Bernstein and Laura J. Ostrander (eds.). North Iowa Area Community College, Mason City, Iowa.

Bartholow, J.M. 2005. Recent water temperature trends in the lower Klamath River, California. North American Journal of Fisheries Management. 25:152-162.

Behnke, R.J. 1979. Monograph of the native trouts of the genus *Salmo* of eastern North America. Unpublished Manuscript. 215 pp.

Behnke, R.J. 1981. Systematic and zoogeographical interpretation of Great Basin trouts. In: R. J. Naiman, and D. L. Soltz, eds., Fishes in the North American deserts, Wiley, New York. pp. 95-124.

Berg, W.J. 1991. Selected observations and interpretations on the life-history of the Warner sucker (*Catostomus warnerensis*): conservation genetic management. Unpublished report to the Warner Sucker Working Group. 11 pp.

Berry Botanic Garden. 2005. The Seed Bank: what's in the collection? Accessed September 29, 2005 at http://www.berrybot.org/cons/cons_seed_bank_list.html.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in the foothills stream in northern Alberta. Canadian Field-Naturalist 101(1): 56-62.

Boccone, V.M. and T.J. Mills. 1979. Spawning behavior and spawning substrate preference of the Modoc sucker, *Catostomus microps* Rutter. Calif. Dept. Fish Game, Inland Fisheries Endangered Species Program Spec. Publ. 79-2. 33 pp.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 *in* P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Bond, C.E. 1994. Keys to Oregon Freshwater Fishes. Department of Fish and Wildlife (Oregon State University). Oregon State University Book Stores, Inc. Corvallis, Oregon. 53 pp.

Bortleson, G. and M. Fretwell. 1993. A review of possible causes of nutrient enrichment and decline of endangered sucker populations in Upper Klamath Lake, Oregon. U.S. Geological Survey Water Resources Investigations Report 93-4087.

Bosse, S.E., D. Hartzel, C. Allen, M. Stern, and A. Munhall. 1997. Warner Sucker Progress Report-1997 Findings. Unpublished Report to Bureau of Land Management. 78 pp.

Bradbury, J.P., S.M. Colman, and R.L. Reynolds Bradbury. 2004. The history of recent limnological changes and human impact on Upper Klamath Lake, Oregon. Journal of Paleolimnology 31: 151-165.

Brewin, P.A., M.K. Brewin, and M. Monita. 1997. Distribution maps for bull trout in Alberta. Pages 206-216 *in* W.C. Mackay, M.K. Brewin, and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Buettner, M. and C. Scoppettone. 1990. Life history and status of Catostomids in Upper Klamath Lake, Oregon. U.S. Fish and Wildlife Service, National Fisheries Research Center, Reno Field Station, Nevada. Completion report.

Bureau of Land Management. 1985. Distribution and condition of *Sidalcea nelsoniana* Piper: a report to the Fish and Wildlife Service for status determination. Unpublished report prepared by the Bureau of Land Management, Salem District. 14 pp. + appendices.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55: 75-81.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541.

Campbell-Craven Environmental Consultants. 1994. Draft evaluation of fish passage alternatives for water diversions in Honey Creek, tributary to Hart Lake, Lake County, Oregon. Prepared for Oregon Department of Fish and Wildlife. Portland, Oregon. 16 pp.

Caplow, F. 2004. Reintroduction Plan for Golden Paintbrush (*Castilleja levisecta*). Washington Natural Heritage Program, Washington Department of Natural Resources. Prepared for U.S. Fish and Wildlife Service, Western WA Fish and Wildlife Office. 44 pp. + appendices.

Caplow, F. and J. Miller. 2004. Southwestern Washington Prairies: using GIS to find rare plant habitat in historic prairies. Washington Department of Natural Resources, Natural Heritage Report 2004 – 02. 18 pp. + map.

Caswell, H. and T.N. Kaye. 2001. Stochastic demography and conservation of an endangered perennial plant (*Lomatium bradshawii*) in a dynamic fire regime. Advances in Ecological Research 32:1-51.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley), from the American northwest. California Fish and Game 64: 139-174.

CDFG (California Department of Fish and Game). 1986. Note to CDFG files regarding transfer of twenty Modoc suckers from Washington Creek to Coffee Mill Creek on 12 November 1986.

Cederholm, C.J. and L.M. Reid. 1987. Impact of forest management on coho salmon (*Oncorhynchus kisutch*) populations of the Clearwater River, Washington: a project summary.

Center for Plant Conservation. 2005. CPC National Collection Plant Profile: *Castilleja levisecta*. Accessed June 14, 2005 at http://www.centerforplantconservation.org/ASP/CPC_ViewProfile.asp?CPCNum=824.

CH2MHill. 1986. Studies of *Sidalcea nelsoniana*. Unpublished annual research report and technical memorandum prepared for McMinnville Water and Light. 232 pp. + appendices.

CH2MHill. 1997. Technical memorandum: Sidalcea nelsoniana monitoring 1997. Unpublished report submitted to U.S. Fish and Wildlife Service. 24 pp.

Clark, D. L., C. A. Ingersoll, and K. K. Finley. 1997. Regeneration of *Erigeron decumbens* var. *decumbens* (Asteraceae), the Willamette daisy. Pages 41-47 *in* T. N. Kaye, A. Liston, R. N. Love, D. L. Luoma, R. J. Meinke and M. V. Wilson, editors. Conservation and management of native plants and fungi. Native Plant Society of Oregon, Corvallis, Oregon.

Clark, D. L., K. K. Finley, and C. A. Ingersoll. 1993. Status report for *Erigeron decumbens* var. *decumbens*. Report to Conservation Biology Program, Oregon Department of Agriculture.

Clark, D. L., K. K. Finley, and C. A. Ingersoll. 1995. Regeneration biology of *Erigeron decumbens* var. *decumbens*, an endangered plant of the Willamette Valley. Report for Oregon Department of Agriculture, Plant Conservation Biology Program, Salem, Oregon.

Clark, D.L. 2000. Demographic analysis of *Erigeron decumbens* var. *decumbens*, an endangered plant species of the Willamette Valley, Oregon. 1999 field studies. Prepared for U.S. Fish and Wildlife Service Western Oregon NWR Refuge Complex. 16 pp.

Coffin, P.D. 1981. Distribution and life history of the Lahontan/Humboldt cutthroat trout, Humboldt River drainage basin. Nevada Department of Wildlife. Reno, Nevada. Federal Aid Project F-20-17, Study IX, Job No. 1-P-1. 69 pp.

Coffin, P.D. 1982. Lahontan cutthroat trout fishery management plan for the Humboldt River drainage basin. Nevada Department of Wildlife. Reno, Nevada. Federal Aid Project F-20-17, Study IX, Job No. 1-P-1. 39 pp.

Coffin, P.D. 1988. Nevada's native salmonid program: status, distribution, and management. Nevada Department of Wildlife. Reno, Nevada. 17 pp. + appendices.

Conservation Management Institute. 1996. Draft taxonomy, species: Sucker, Modoc (unpublished). Conservation Management Institute, College of Natural Resources, Virginia Tech, Blaksburg, Virginia. Accessed March 30, 2009 at http://fwie.fw.vt.edu/WWW/esis/lists/e251011.htm.

Coombs, C.I., and C.E. Bond. 1980. Report of investigations on *Catostomus warnerensis*, fall 1979 and spring 1980. Unpublished report to Fish and Wildlife Service. 32 pp.

Coombs, C.I., C.E. Bond, and S.F. Drohan. 1979. Spawning and early life history of the Warner sucker (*Catostomus warnerensis*). Unpublished report to Fish and Wildlife Service. 52 pp.

Cooperman, M.S., and D.F. Markle. 2003. Rapid out-migration of Lost River and shortnose sucker larvae from in-river spawning beds to in-lake rearing grounds. Transactions of the American Fisheries Society 132: 1138-1153.

Crone, E.E. and C.B. Schultz. 2003. Movement behavior and minimum patch size for butterfly population persistence. Pages 561-576 in: C. Boggs, W. Watt, and P. Ehrlich (eds) Butterflies: Ecology and Evolution Taking Flight. University of Chicago Press.

Cronquist, A. 1955. Compositae: Pages 1–343. *In*: C. L. Hitchcock, A. Cronquist, M. Owenby and J. W. Thompson, editors. Vascular plants of the Pacific Northwest. Part 5. University of Washington Press, Seattle.

Davis, B. and R. Miller. 1967. Brain patterns in minnows of the genus *Hybopsis* in relation to feeding habits and habitats. Copeia 1967: 1-39.

Desjardins, M., and D.F. Markle. 2000. Distribution and biology of suckers in Lower Klamath Reservoirs. 1999 Final Report. Submitted to PacifiCorp, Portland, Oregon.

Donald, D.B. and D.J. Alger. 1992. Geographic distribution, species displacement, and niche Overlap or lake trout and bull trout in mountain lakes. Canadian Journal of Zoology. 71: 238 247.

Dopplet, B. R. Hamilton, C.D. Williams, and M. Koopman. 2008. Preparing for climate change in the Rogue River Basin of Southwest Oregon: Stressors, risks, and recommendations for increasing resilience and resistance in human, built, economic and natural systems. Climate Leadership Initiative, National Center for Conservation Science and Policy, and U.S.D.A. Forest Service Pacific Northwest Research Station. 47 pp.

Dowling, T.E. 2005a. Conservation genetics of Modoc sucker. Final report to U.S. Fish and Wildlife, Klamath Falls, OR; Contract # 114500J516. 15 pp.

Dowling, T.E. 2005b. Conservation genetics of endangered Lost River and shortnose suckers. Unpublished report for the USFWS, Klamath Falls, Oregon.

Dowling, T.E. and C.L. Secor. 1997. The role of hybridization and introgression in the diversification of animals. Annual Review Ecology and Systematics 28:593-619.

Drew, A.D. 2000. Effects of livestock grazing and small mammal populations on endangered Bradshaw's desert parsley (*Lomatium bradshawii*) at Oak Creek, Willamette Valley, Oregon. M.S. Thesis. University of Oregon, Eugene, Oregon. 65 pp.

Dunham, J., G.L. Vinyard, and B.E. Rieman. 1997. Habitat fragmentation and extinction risk of Lahontan cutthroat trout. North American Journal of Fisheries Management 17: 1126-1133.

Dunn, D.B. and J.M. Gillett. 1966. The Lupines of Canada and Alaska. Canada Department of Agriculture Monograph No. 2. Queen's Printer, Ottawa.

Dunsmoor, L., L. Basdekas, B. Wood, and B. Peck Dunsmoor. 2000. Quality, composition, and distribution of emergent vegetation along the Lower River and Upper Klamath Lake shorelines of the Williamson River delta, Oregon. Completion report. Klamath Tribes, Chiloquin, Oregon, and the U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon. 27 pp.

Dunwiddie, P.W., R. Davenport and P. Speaks. 2001. Effects of burning on *Castilleja levisecta* at Rocky Prairie Natural Area Preserve, Washington: a summary of three long-term studies. Pages 161-172 *in* Conservation of Washington's native plants and ecosystems. S.H. Reichard, P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg and D.L. Salstrom, eds. Washington Native Plant Society, Seattle, Washington.

Eilers, J.M., J. Kann, J. Cornett, K. Moser, A. St. Amand, and C. Gubala. 2001. Recent paleolimnology of Upper Klamath Lake. J.C. Headwaters, Inc. report submitted to U.S. Bureau of Reclamation. March 16, 2001.

Eilers, J.M., J. Kann, J. Cornett, K. Moser, and A. St. Amand. 2004. Paleolimnological evidence of a change in a shallow, hypereutrophic lake: Upper Klamath Lake, Oregon. Hydrobiologia 520: 7-18.

Ellsworth, C.M., T.J. Tyler, C.D. Luton, S.P. VanderKooi, and R.S. Shively. 2005. Spawning migration movements of Klamath largescale, Lost River, shortnose suckers in the Williamson and Sprague Rivers, Oregon, prior to the removal of the Chiloquin Dam: Annual report 2005. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station. 42 pp.

Elseroad, A. 2004. Williamson River delta restoration program vegetation technical report. The Nature Conservancy. Portland, Oregon. 23 pp.

Evans, S., R. Schuller, and E. Augenstein. 1984. A report on *Castilleja levisecta* Greenm. at Rocky Prairie, Thurston County, Washington. Unpublished report to The Nature Conservancy, Washington Field Office, Seattle, Washington. 56 pp.

Fisher, L.H., and T.M. Wood. 2004. Effect of water-column pH on sediment-phosphorus release rates in Upper Klamath Lake, Oregon, 2001. U.S. Geological Survey Water-Resources Investigations.

Fitzpatrick, G. 2005. 2004 status of the Fender's blue butterfly (*Icaricia icarioides fenderi*) in Lane County, Oregon: population estimates and site evaluations AND Effects of mowing on the Fender's blue butterfly (*Icaricia icarioides fenderi*): implications for conservation management. Unpublished report to Oregon Natural Heritage Program and the U.S. Fish and Wildlife Service. 44pp.

Foott, J.S. 1997. Results of histological examination of sucker tissues. Memorandum 1997. U.S. Fish and Wildlife Service, Fish Health Center, Anderson, California.

Ford, T. 1977. Status summary report on the Modoc sucker. U.S.F.S., Modoc National Forest, unpubl. Technical report. 44 pp.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake river system, Montana. Northwest Science 63(4): 133-143.

FSA (Farm Services Agency). 2008. Program Biological Assessment for the Oregon Conservation Reserve Enhancement Program. Farm Services Agency, Oregon State Office, Tualatin, Oregon. 298 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road Construction and Maitenance. Chapter 8 in Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19: 297-323.

Galat, D.L., G. Post, T.J. Keefe, and G.R. Bouck. 1983. Histological changes in gill, kidney, and liver of Lahontan cutthroat trout (*Salmo clarki henshawi*) living in lakes of different salinity-alkalinity.

Gamon, J. 1995. Report on the status of *Castilleja levisecta* Greenman. Unpublished report, Washington Natural Heritage Program, Dept. of Natural Resources, Olympia, Wash. 57 pp.

Gamon, J., P.W. Dunwiddie, T. Thomas and T. Rush. 2001. Assessing the viability of golden paintbrush (*Castilleja levisecta*). Pages 52-59 *in* Conservation of Washington's native plants and ecosystems. S.H. Reichard, P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg and D.L. Salstrom, eds. Washington Native Plant Society, Seattle, Washington.

Geiger, N.S. 2001. Reassociating wetlands with Upper Klamath Lake to improve water quality. Paper presented at the Klamath Fish and Water Management Conference in Arcata, California, May 22-25, 2001.

Gerstung, E.R. 1986. The status and management of the Lahontan cutthroat trout (*Salmo clarki hemshawi*). Pp. 81-101 In: J.S. Griffith, ed. The ecology and management of the interior stocks of cutthroat trout. Western Division American Fisheries Society Special Publication.

Gisler, S.D. 2003. Reproductive isolation and interspecific hybridization in the threatened species, *Sidalcea nelsoniana*. Unpublished master's thesis, Oregon State University Department of Botany and Plant Pathology. 173 pp.

Gisler, S.D. 2004. Developing biogeographically based population introduction protocols for at-risk Willamette Valley plant species. Report to US Fish and Wildlife Service, Portland, Oregon. Native Plant Conservation Program, Oregon Department of Agriculture, Salem, Oregon. 230 pp.

Gisler, S.D. and R. Meinke. 1998. Reproductive ecology and conservation of Nelson's checker-mallow (*Sidalcea nelsoniana*) . Part I: Pre-dispersal seed predation Part II: Pollination ecology. Unpublished report to the U.S. Fish and Wildlife Service Oregon State Office. 28 pp.

Gisler, S.D. and R. Meinke. 2001. Predator control to enhance seed yields in threatened speceis, Nelson's checker-mallow (*Sidalcea nelsoniana*). Unpublished report to the U.S. Fish and Wildlife Service Oregon State Office. 29 pp.

Gitzendanner M.A. 2000. Genetic diversity in rare and widespread plant species. Ph.D. dissertation, Washington State University. 149 pp.

Glad, J.B., R. Mishaga, and R.R. Halse. 1987. Habitat characteristics of *Sidalcea nelsoniana* Piper (Malvaceae) at Walker Flat, Yamhill County, Oregon. Northwest Science 61(4):257-263.

Glad, J.B., R.R. Halse, and R. Mishaga. 1994. Observations on distribution, abundance and habitats of *Sidalcea nelsoniana* Piper (Malvaceae) in Oregon. Phytologia 76(4):307-323.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. U.S. Department of Agriculture, Forest Service, Willamette National Forest, Eugene, Oregon. 53 pp.

Greenlee, J. and T.N. Kaye. 1995. *Lomatium bradshawii*: Interim Report on Population Monitoring at Buford Park William L. Finley National Wildlife Refuge Jackson-Frazier Wetland. Unpublished report to the US Fish and Wildlife Service, Portland, Oregon. Oregon Department of Agriculture, Salem, Oregon.

Groot, C. and L. Margolis. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C. 564 pp.

Groot, C., L. Margolis, and W. C. Clarke. 1995. Physiological ecology of Pacific salmon. University of British Columbia Press, Vancouver, B.C. 384 pp.

Gunckel, S.L., and S.E. Jacobs. 2006. Population assessment of Lahontan cutthroat trout, 2005. Progress Report. Oregon Department of Fish and Wildlife, Salem, Oregon. 14 pp.

Gutermuth, B., D. Beckstrand, and C. Watson. 1998. New Earth harvest site monitoring, 1996-1997. Final report. New Earth/Cell Tech, Klamath Falls, Oregon.

Gutermuth, B., E. Pinkston, and D. Vogel. 2000. A-Canal fish entrainment during 1997 and 1998 with emphasis on endangered suckers. Cell Tech, Klamath Falls, Oregon and natural Resource Scientists, Inc. Red Bluff, California.

Hamlet, A.F., P.W. Mote, N. Mantua, and D.P. Lettenmaier. 2005. Effects of climate change on the Columbia River Basin's water resources. JISAO Center for Science in the Earth System. Climate Impacts Group and Department of Civil and Environmental Engineering, University of Washington. November 2005.

Hammond, P.C. 1994. 1993 study of the Fender's blue butterfly (*Icaricia icarioides fenderi*). Unpublished report to the Oregon Natural Heritage Program and U.S. Fish and Wildlife Service. 56 pp.

Hammond, P.C. 1996. 1995 study of the Fender's blue butterfly (*Icaricia icariodes fenderi*) in Benton, Polk, and Yamhill Counties. Report to the Oregon Natural Heritage Program and US Fish and Wildlife Service. 25 pp.

Hammond, P.C., and M.V. Wilson. 1992. Fender's blue butterfly populations: habitat descriptions and threats to survival. Report to Oregon Natural Heritage Program.

Hammond, P.C., and M.V. Wilson. 1993. Status of the Fender's blue butterfly. Unpublished report to the U.S. Fish and Wildlife Service. 66 pp.

Hard, J.J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326.

Hartzell, K.E, and K. Popper. 2002. Warner Sucker Progress Report-2001 Findings. Unpublished Report to Bureau of Land Management. 36 pp.

Hayes, J.P. 1980. Fish of the Warner Valley. Pages 131-137 in C. Gilman and J.W. Feminella, editors. Plants and animals associated with aquatic habitats of the Warner Valley. Oregon State University, Corvallis, Oregon.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and conservation of phenotype and genotype. Pages 176-184 in J. L. Nielsen editor. Evolution and the Aquatic Ecosystem. American Fisheries Society Symposium 17. American Fisheries Society, Bethesda, Maryland.

Heck, M.P. P.D. Scherer, S.L. Gunkel, and S.E. Jacobs. 2008. Status and distribution of native fishes in the Goose Lake Basin. Oregon Department of Fish and Wildlife, Fish Division. Information Reports 2008-02.

Hendrixson, H.A., S.M. Burdick, and A.X. Wilkens, and S.P. VanderKooi. 2007. Near-shore and offshore habitat use by endangered, juvenile Lost River and shortnose suckers in Upper Klamath Lake, Oregon. Annual Report 2005. Report of U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station to U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon. 98 p.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest: an illustrated manual. Univ. of Washington Press, Seattle. 730 pp.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1955. Vascular plants of the Pacific Northwest, Part 5L Compositae. University of Washington Press, Seattle.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1959. Vascular Plants of the Pacific Northwest, Part 4: Ericaceae through Campanulaceae. University ofWashington Press, Seattle, Wash. 510 pp.

Hjort, R., P. Hulett, L. LaBolle, and H. Li. 1984. Fish and invertebrates of revetments and other habitats in the Willamette River, Oregon. U.S. Army Eng. Waterways Exp. Sta. EWQOS Tech. Rep. E-84-9. 83 pp.

Holt, R. 1997. Upper Klamath Lake fish disease exam report. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Howell, P.J. and D.B. Buchanan, eds. 1992. Proceedings of the Gearhart Mountain bull trout workshop.; 1992 August; Gearhart Mountain, OR. Corvallis, OR: Oregon Chapter of the American Fisheries Society. 67 pp.

Hubbs, C.L. and R. R. Miller. 1934. Field notes - Rush Creek, 16 August 1934, Station M34-134. 2 pp.

Hunt, J.H. 1964. The Warner Valley stock company - a geographic study. Master of Science Thesis, Oregon State University, Corvallis, Oregon. 116 pp.

Ingersoll, C.A., Finley, K.K., Clark, D.L. 1993. A monitoring program for *Erigeron decumbens* var. *decumbens*, a Willamette Valley Endemic, prepared for Plant Conservation Biology Program, Oregon Department of Agriculture, Salem, Oregon.

Ingersoll, C.L., Finley, K.K. and Clark, D.L. 1995. Demography and reproduction of *Erigeron decumbens* var. *decumbens*, 1993-1994 field studies, prepared for the Oregon Plant Conservation Biology Program, Oregon Department of Agriculture, Salem, Oregon.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Summary for policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC Secretariat, World Meteorological Organization and United Nations Environment Programme, Geneva, Switzerland.

ISAB (Independent Scientific Advisory Board). 2007. Climate Change Impacts on Columbia River Fish and Wildlife. Independent Scientific Advisory Board, Portland, Oregon.

ISRP (Independent Scientific Review Panel). 2005. The current risk of extinction of the Lost River and shortnose suckers, Independent Scientific Review Panel. Unpublished report, prepared by Cascade Quality Solutions, Natural Resource Mediation and Facilitation, Klamath Falls, Oregon.

Jackson, S.A. 1996. Reproductive aspects of *Lomatium bradshawii* and *Erigeron decumbens* of the Willamette Valley, Oregon. Master's thesis. University of Oregon, Eugene, Oregon. 107 pp.

Janney, E.C., and R.S. Shively. 2007. An updated analysis on the population dynamics of Lost River suckers and shortnose suckers in Upper Klamath Lake and its tributaries, Oregon. January 2007. U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station. 18 pp.

Janney, E.C., R.S. Shively, B.S. Hayes, P.M. Barry, and D. Perkins. In Review. Demographic analysis of adult Lost River and shortnose sucker populations in Upper Klamath Lake. Submitted to the Journal of the American Fisheries Society. 36 pp.

Johannessen, C.L., W.A. Davenport, A. Millet, and S. McWilliams. 1971. The vegetation of the Willamette Valley. Ann. Ass. Am. Geogr. 61:286-302.

Jones, K.L., J.M. Dambacher, B.G. Lovatt, A.G. Talabere and W. Bowers. 1998. Status of Lahontan cutthroat trout in the Coyote Lake Basin, southeast Oregon. North American Journal of Fisheries Management 18: 308-317.

Kagan, J. S. and Susan Yamamoto. 1987. Status report for *Erigeron decumbens* subsp. *decumbens*. Unpublished report to the U.S. Fish and Wildlife Service, Portland, Oregon.

Kagan, J.S. 1980. The biology of Lomatium bradshawii (Apiaceae), a rare plant of Oregon. M.S. Thesis. University of Oregon, Eugene, Oregon. 71 pp.

Kann, J. 1997. Ecology and water quality dynamics of a shallow hypereutrophic lake dominated by cyanobacteria. Ph.D. Dissertation. University of North Carolina, Chapel Hill. 110 pp.

Kann, J., and V.H. Smith. 1993. Chlorophyll as a predictor of elevated pH in a hypertrophic lake: Estimated the probability of exceeding critical values for fish success. The Klamath Tribes Natural Resources Department Resource Report: KT-93-02, Chiloquin, Oregon. 22 pp.

Kann, J., and W.W. Walker. 1999. Nutrient and hydrologic loading to Upper Klamath Lake, Oregon, 1991-1998. Aquatic Ecosystems Sciences LLC, Ashland, Oregon. Report submitted to The Klamath Tribes, Chiloquin, Oregon and the U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon. 114 pp.

Kaye, T.N. 1992. Bradshaw's desert parsley: population monitoring and pollination biology. Kalmiopsis 2:1-4.

Kaye, T.N. 2000. Notes on the geographic distribution and taxonomy of Lupinus sulphureus ssp. kincaidii (Fabaceae): Watch for it in your neighborhood. Botanical Electronic News No. 243. Accessed at http://www.ou.edu/cas/botany-micro/ben/ben243.html.

Kaye, T.N. 2001. Restoration research for golden paintbrush (*Castilleja levisecta*), a threatened species. Institute for Applied Ecology, Corvallis, Oregon. 10 pp.

Kaye, T.N. 2002. Population monitoring for *Horkelia congesta* ssp. *congesta* at the Long Tom Area of Critical Environmental Concern: 2002 Progress Report. Institute for Applied Ecology, Corvallis, Oregon.

Kaye, T.N. and J. Cramer. 2003. Population monitoring for *Lupinus sulphureus* ssp. *kincaidii,* Fir Butte and Oxbow West Sites, West Eugene: 2002 progress report. Institute for Applied Ecology, Corvallis, Oregon and Eugene District, BLM, Eugene, Oregon. 23 pp.

Kaye, T.N. and A. Brandt. 2005. Seeding and transplanting rare Willamette Valley prairie plants for population restoration. Unpublished report to the Eugene District BLM. Institute for Applied Ecology, Corvallis, Oregon.

Kaye, T.N. and A.S. Thorpe. 2006. *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine) and *Icaricia icarioides fenderi* (Fender's blue butterfly) in the West Eugene Wetlands: population monitoring, reintroduction success, and an evaluation of experimental treatments: 2006 progress report. Institute for Applied Ecology, Corvallis, Oregon. 29 pp.

Kaye, T.N. and B.A. Lawrence. 2003. Fitness effects of inbreeding and outbreeding on golden paintbrush (*Castilleja levisecta*): Implications for recovery and reintroduction. Institute for Applied Ecology, Corvallis, Oregon and Washington Department of Natural Resources, Olympia, Washington.

Kaye, T.N. and K. Kuykendall. 1993. Status Report for *Lupinus sulphureus* ssp. *kincaidii*. Oregon Department of Agriculture, Salem, and USFWS, Portland, Oregon. 71 pp.

Kaye, T.N. and K. Kuykendall. 2001a. Effects of scarification and cold stratification on germination of *Lupinus sulphureus* ssp. *kincaidii*. Seed Science and Technology 29:663-668.

Kaye, T.N. and K. Kuykendall. 2001b. Germination and propagation techniques for restoring rare Pacific Northwest prairie plants. In, Reichard, S.H., P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg, D.L. Salstrom, editors. Conservation of Washington's Native Plants and Ecosystems. Washington Native Plant Society, Seattle, Washington. 223 pp.

Kaye, T.N. and K. Pendergrass. 1998. Population trends of *Lomatium bradshawii* before and after prairie fires: 1988-1997. Unpublished report to the Eugene District BLM. Oregon Department of Agriculture, Salem, Oregon.

Kaye, T.N. and M. Kirkland. 1994. Population biology of *Lomatium bradshawii* II. Insect interactions, phenology, and breeding system. Oregon Department of Agriculture, Salem, Oregon and Eugene District, BLM, Eugene, Oregon. 13 pp.

Kaye, T.N. and R. J. Meinke. 1996. Breeding system and insect interactions of an endangered species, *Lomatium bradshawii* (Apiaceae). Scandinavian Association for Pollination Ecology, "Ecology and Evolution of Plant Reproduction." Umea, Sweden.

Kaye, T.N., J. Cramer and A. Brandt. 2003a. Seeding and transplanting rare Willamette Valley plants for population restoration: third year (2002) report. Institute for Applied Ecology, Corvallis, Oregon. 49 pp.

Kaye, T.N., J. Cramer and B.A. Lawrence. 2003b. Population monitoring for experimental habitat manipulation of Willamette daisy, Oxbow west site, West Eugene: 2003 progress report. Institute for Applied Ecology, Corvallis, Oregon and Eugene District, BLM, Eugene, Oregon. 24 pp.

Kaye, T.N., K.L.Pendergrass, K. Finley and J.B. Kauffman. 2001. The effect of fire on the population viability of an endangered prairie plant. Ecological Applications 11:1366-1380.

Keen, F. P. 1937. Climatic cycles in eastern Oregon as indicated by tree rings. Monthly Weather Review 65 (5):175-188.

Kennedy, T.B. and G.L. Vinyard. 1997. Drift ecology of western catastomid larvae with emphasis on Warner sucker (*Catostomus warnerensis*) (Teleostei). Environmental biology of Fishes 49: 187-195.

Kennedy, T.B. and J.F. North. 1993. 1992 Report: Drift behavior and distribution of Warner sucker (*Catostomus warnerensis*) and preliminary assessment of stream habitat conditions in the Warner Valley, Oregon. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 25 pp.

Kennedy, T.B. and M. Olsen. 1994. Drift ecology of Warner sucker larvae (*Catostomus warnerensis*) and lake recolonizations by native and exotic fishes of the Warner Valley, Oregon. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 42 pp.

Kettratad, J. 2001. Systematic study of Modoc suckers (*Catostomus microps*) and Sacramento suckers (*Catostomus occidentalis*) in the upper Pit River system, California. M.S. Thesis, Humboldt State University, Arcata, California. 79 pp.

Klamath Tribes. 1996. A synopsis of the early life history and ecology of catostomids, with a focus on the Williamson River Delta. Unpublished manuscript. Natural Resources Department, Chiloquin, Oregon.

Knapp, P.A., P.T. Soulé and H.D. Grissino-Mayer. 2004. Occurrence of sustained droughts in the interior Pacific Northwest (A.D. 1733-1980) inferred from tree-ring data. Journal of Climate 17:140-150.

Kobetich, G.C. 1977. Report on survey of Warner Valley Lakes for Warner suckers, *Catostomus warnerensis*. Unpublished report to Fish and Wildlife Service. 6 pp.

Koch, D.L. and G.P. Contreras. 1973. Preliminary survey of the fishes of the Lost River system including Lower Klamath Lake and Klamath Strait drain with special reference to the Shortnose (*Chasmistes brevirostris*) and Lost River suckers (*Catostomus luxatus*). Center for Water Resources Research, Desert Research Institute, University of Nevada, Reno, Nevada.

Koch, D.L., J.J. Cooper, E.L. Lider, R.L. Jacobson, and R.J. Spencer. 1979. Investigations of Walker Lake, Nevada: Dynamic ecological relationships. Desert Research Center, University of Nevada, Reno, Nevada. 191 pp.

Kuwabara, J.S., D.D. Lynch, B.R. Topping, F. Murphy, J.L. Carter, N.S. Simon, F. Parchaso, T.M. Wood, M.K. Lindenberg, K. Wiese, and R.J. Avanzino. 2007. Quantifying the benthic source of nutrients to the water column of Upper Klamath Lake, Oregon. U.S. Geological Survey Open File Report 2007-1276. 39 pp.

Kuykendall, K. and T.N. Kaye. 1993. *Lupinus sulphureus* ssp. *kincaidii* survey and reproduction studies. BLM Roseburg District, Roseburg, Oregon and Oregon Department of Agriculture, Salem. 44 pp.

Laenen, A., and A.P. LeTourneau. 1996. Upper Klamath basin nutrient-loading study: Estimate of wind-induced resuspension of bed sediment during periods of low lake elevation. U.S. Geological Survey Open-File Report 95-414. 11 pp.

Laird, I.W. 1971. The Modoc Country. Lawton and Kennedy Printers, Alturas, California.

Lawrence, B.A. 2005. Studies to facilitate reintroduction of golden paintbrush (*Castilleja levisecta*) to the Willamette Valley, Oregon. Master's Thesis, Oregon State University, Corvallis, Oregon. 113 pp.

Leary, R.F. and F.W. Allendorf. 1997. Genetic confirmation of sympatric Bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126: 715-720.

Leininger, S. 2001. Promoting and restoring Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*) and Willamette daisy (*Erigeron decumbens* var. *decumbens*) at Baskett Slough NWF. Honors Thesis, Oregon State University, Corvallis, Oregon.

Leung, L.R., and M.S. Wigmosta. 1999. Potential climate change impacts on mountain watersheds of the Pacific Northwest. Journal of the American Water Resources 35(6): 1463-1471.

Leung, L.R., Y. Qian, X. Bian, W.M. Washington, J. Han, and J.O. Roads. 2004. Mid-century ensemble regional climate change scenarios for the western United States. Climatic Change 62: 75-113.

Liston, A., K. St. Hilaire, and M.V. Wilson. 1995. Genetic diversity in populations of Kincaid's lupine, host plant of Fender's blue butterfly. Madrono 42:309-322.

Logan, D.J., and D.F. Markle. 1993. Fish faunal survey of Agency Lake and northern Upper Klamath Lake, Oregon. In: C. Campbell (ed.), Environmental Research in the Klamath Basin, Oregon - 1992 Annual Report. U.S. Bureau of Reclamation Technical Report R-93-16. 341 pp.

Loudenslager, E.J., and G.A.E. Gall. 1980. Geographic patterns of protein variation and subspeciation in cutthroat trout, *Salmo clarki*. Systematic Zoology. 29: 27-42.

Markle, D., T. Pearsons and D. Bills. 1991. Natural history of *Oregonichthys* (Pisces: Cyprinidae), with a description of a new species from the Umpqua River of Oregon. Copeia 1991 (2): 277-293.

Markle, D.F., and D.C. Simon. 1993. Preliminary studies of systematics and juvenile ecology of Upper Klamath Lake suckers. Annual report. Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon.

Markle, D.F., and L.K. Dunsmoor. 2007. Effects of habitat volume and fathead minnow introduction on larval survival of two endangered sucker species in Upper Klamath Lake. Transactions of the American Fisheries Society 136: 567-579.

Markle, D.F., and M. Cooperman. 2002. Relationship between Lost River and shortnose sucker biology and management of Upper Klamath Lake. *In:* Water Allocation in the Klamath Reclamation Project, 2001: An assessment of natural resource, economic, social and institutional issues in the Upper Klamath Basin. W.S. Braunworth, Jr., T. Welch, and R. Hathaway (editors). Oregon State University Extension Service, Corvallis, Oregon.

Markle, D.F., M.R. Cavaluzzi, and D. Simon. 2005. Morphology and taxonomy of Klamath Basin suckers (Catostomidae). Western North American Naturalist 65(4): 473-489.

Markle, D.F., S.A. Reithel, J. Crandall, T. Wood, T.J. Tyler, M. Terwilliger, and D. Simon. In Review. Larval fish retention, the function of marshes, and the importance of location for juvenile fish recruitment in Upper Klamath Lake, Oregon. Can. J. Fish. Aquat. Sci.

Markle, D.F., T.N. Pearsons, and D.T. Bills. 1989. Taxonomic status and distributional survey of the Oregon chub, *Oregonichthys crameri*. Final report (unpublished) to Oregon Department of Fish and Wildlife (Contract No. OSU 30-262-9714). 29 pp.

Martin, M. 1967. The distribution and morphology of the North American catostomid fishes of the Pit River system, California. M.A. thesis, Sacramento State Univ., Sacramento, California. 67 pp.

Martin, M. 1972. Morphology and variation of the Modoc sucker, *Catostomus microps* Rutter, with notes on feeding adaptations. Calif. Dept. Fish and Game 58(4):277-284.

Mayer, T. 2008. Analysis of trends and changes in Upper Klamath Lake hydroclimatology. Unpublished report. U.S. Fish and Wildlife Service, Portland, Oregon. 31 pp.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

McCabe, G.J., and M.D. Dettinger. 2002. Primary modes and predictability of year-to-year snowpack variations in the western United States from teleconnections with Pacific Ocean climate. Journal of Hydrometeorology 3: 13-25.

McGinnis, S.M. 2006. Field guide to freshwater fishes of California. University of California Press, Berkeley, California. 539 pp.

McPhail, J. D. and C. B. Murray. 1979. The Early Life-history and Ecology of Dolly Varden (Salvelinus malma) in the upper Arrow Lakes. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, B.C.

Meffe. G.K., and R.C. Vrijenhoek. 1988. Conservation Genetics in the Management of Desert Fishes. 1988. Conservation Biology. Vol. 2, No. 2, 157-169.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon: an illustrated guide. Unpublished report by the Oregon Department of Agriculture for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 352 pp.

Merriman, D. and L. Soutter. 1933. Field notes: Branch of Bauer's Creek, Lake County, Oregon. August 27, 1933 (field number M-10-33).

Miller, R.R. 1963. Field notes - Ash Creek, 10 July 1963, Stations M63-23 and M63-24. 2 pp.

Miller, W.E. and J.C. Tash. 1967. Upper Klamath Lake studies, Oregon: Interim report. Pacific Northwest Water Laboratories, Federal Water Pollution Control Federation, Water Pollution Control Research Series No. WP-20-8. 37 pp.

Mills, J.N. and J. Kummerow. 1988. Root parasitism in Indian paintbrush. Fremontia (Journal of the California Native Plant Society), October issue.

Mills, T.J. 1980. Life history, status, and management of the Modoc sucker, *Catostomus microps* Rutter in California, with a recommendation for endangered classification. Calif. Dept. Fish Game, Inland Fisheries Endangered Species Program Spec. Publ. 80-6. 35 pp.

Minshall, G.W., Brock, J.T. and Varley, J.D. 1989. Wildfires and Yellowstone's stream ecosystems. BioScience 39: 707-715.

Morace, J.L. 2007. Relation between selected water quality variables, climatic factors, and lake levels in Upper Klamath and Agency Lakes, Oregon, 1990-2006. U.S. Geological Survey Scientific Investigation Report 2007-5117. 54 pp.

Moyle, P.B. 1974. Status of the Modoc sucker (*Catostomus microps*) Pisces: Catostomidae. Cal-Neva Wildlife 1974:35-38.

Moyle, P.B. 1976. Inland fishes of California. University of California Press, Berkely, California. 405 pp.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley, California. 502 pp.

Moyle, P.B. and A. Marciochi. 1975. Biology of the Modoc sucker, *Catostomus microps*, in northeastern California. Copeia 1975(3):556-560.

Moyle, P.B. and R.A. Daniels. 1982. Fishes of the Pit River system, McCloud River system, and Surprise Valley region. Univ. Calif. Publ. Zool. 115:1-82.

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1, Modoc sucker profile. NatureServe, Arlington, Virginia. Accessed March 27, 2009 at http://www.natureserve.org/explorer.

Neville-Arsenault, H. 2003. Genetic assessment of complex dynamics in an interior salmonid metapopulation. PhD Dissertation, University of Nevada, Reno, Nevada.

NMFS (National Marine Fisheries Service). 1995. Juvenile Fish Screen Criteria (with addendum). National Marine Fisheries Service, Environmental and Technical Services Division, Portland, Oregon. 15 pp.

NMFS (National Marine Fisheries Service). 2008. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon. 137 pp.

NRC (National Research Council). 2004. Endangered and threatened fishes in the Klamath River basin: cause of decline and strategies for recovery. National Academy Press. Washington, D.C., 397 pp.

ODEQ (Oregon Department of Environmental Quality). 2002. Upper Klamath Lake drainage total maximum daily load and water quality management plan. 188 pp.

ODFW (Oregon Department of Fish and Wildlife). 2005. Oregon Native Fish Status Report. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Agriculture. 1995. *Sidalcea nelsoniana*: Preliminary report of Oregon Department of Agriculture research results (1994) and examination of previous MWL-sponsored research. Unpublished report by Oregon Department of Agriculture, Plant Conservation Biology Program.

Oregon Natural Heritage Information Center. 2004. Rare, Threatened and Endangered Species of Oregon. Oregon Natural Heritage Information Center, Oregon State University. Portland, Oregon. 105 pp.

Palmerston, M., G. Tranah, and B. May. 2001. Draft report on genetics of Modoc sucker, *Catostomus microps*. Submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office; Univ. Calif. Davis.

Pearsons, T.N. 1989. Ecology and decline of a rare western minnow: the Oregon chub (*Oregonichhys crameri*). Master of Science Thesis. Oregon State University, Corvallis, Oregon. 86 pp.

Peck, B. 2000. Radio telemetry studies of adult shortnose and Lost River suckers in Upper Klamath Lake and tributaries, Oregon 1993-1999. Unpublished report. U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon.

Pendergrass, K.L., P.M. Miller, J.B. Kauffman, and T.N. Kaye. 1999. The role of prescribed burning and maintenance of an endangered plant species, *Lomatium bradshawii*. Ecological Applications 9:1420-1429.

Perkins, D.L., G.G. Scoppettone, and M. Buettner. 2000. Reproductive biology and demographics of endangered Lost River and Shortnose suckers in Upper Klamath Lake, Oregon. Draft Report. U.S. Geological Survey, Biological Resources Division, Western Fisheries Science Center, Reno Field Station, Reno, Nevada. 42 pp.

Peterson, D.L., D.G. Silsbee, and K.T. Redmond. 1999. Detecting long-term hydrological patterns at Crater Lake, Oregon. Northwest Science 73(2): 121-130.

Piaskowski, R. 2003. Movements and habitat use of adult Lost River and shortnose suckers in Kink River and Keno Impoundment, Klamath River Basin, Oregon. U.S. Bureau of Reclamation, Klamath Area Office. January 2003.

Piaskowski, R., and M. Buettner. 2003. Review of water quality and fisheries sampling conducted in Gerber Reservoir, Oregon with emphasis on the shortnose suckers and its habitat needs. U.S. Bureau of Reclamation. 90 pp.

PPIC (Public Policy Institute of California). 2008. Preparing California for a changing climate. 28 pp.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Boise, ID: Idaho Department of Fish and Game. 105 pp.

Pratt, K.L. 1992. A review of bull trout life history. In: Howell, P.J.; Buchanan, D.B., eds. Proceedings of the Gearhart Mountain bull trout workshop; 1992 August; Gearhart Mountain, Oregon. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. pp. 5-9.

Quigley, T.M. and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Ratcliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. In: Howell, P.J.; Buchanan, D.B., eds. Proceedings of the Gearhart Mountain bull trout workshop.; 1992 August; Gearhart Mountain, OR. Corvallis, OR: Oregon Chapter of the American Fisheries Society. pp. 10-17.

Reid, S.B. 2007a. Surveys for the Modoc sucker, *Catostomus microps*, in the Goose Lake Basin, Oregon - 2007. Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office, Cooperative Agreement No. 81450-6-J533.

Reid, S.B. 2007b. Management and monitoring of non-native fishes in the Turner Creek Drainage (Modoc Co.), Critical Habitat for the Modoc sucker, *Catostomus microps* – 2007. Annual Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Cooperative Agreement No. 81450-6-J532.

Reid, S.B. 2008a. Reconnaissance survey of fishes in lower Ash Creek, on the Ash Creek State Wildlife Area (Lassen Co., California). Report to the Pit River Resource Conservation District, Bieber, California. 7 pp.

Reid, S.B. 2008b. Conservation Review - Modoc sucker, *Catostomus microps*. Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Version date: 31 December 2008.

Reid, S.B. 2008c. Population survey of the Modoc sucker, *Catostomus microps*, in California - 2008. Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Cooperative Agreement No. 81450-6-J532 (partial).

Reiser, D.W., M. Loftus, D. Chapman, E. Jeanes, and K. Oliver. 2001. Effects of water quality and lake level on the biology and habitat of selected fish species in Upper Klamath Lake. Prepared for the U.S. Bureau of Indian Affairs by R2 Resource Consultants. Redmond, Washington.

Rhymer, J.M. and D. Simberloff. 1996. Extinction by hybridization and introgression. Annual Review of Ecology and Systematics 27: 83-109.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21: 756-764.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. Gen. Tech. Rep. INT-302. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Boise, ID. 38 pp.

Rieman, B.E. and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16: 132-141.

Rieman, B.E. and J.R. Lukens. 1979. Lake and reservoir investigations: Priest Lake creel census. Job Completion Rep., Proj. F-73-R-1, Subproj. III, Study I, Job I. Boise, ID. Idaho Department of Fish and Game. 105 pp.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: A synthesis of life history patterns and empirical observations. Ecology of Freshwater Fishes 9: 51-64.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136: 1552-1565.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997. Distribution, status and likely future trends of bull trout within the Columbia River and Klamath Basins. North American Journal of Fisheries Management 17(4): 1111-1125.

Risley, J.C., and A. Laenen. 1999. Upper Klamath Lake basin nutrient-loading study-assessment of historic flows in the Williamson and Sprague Rivers. U.S. Geological Survey Water-Resources Investigations Report 98-4198. 22 pp.

Roseburg Bureau of Land Management, Umpqua National Forest and the U.S. Fish and Wildlife Service. 2006. Programmatic Conservation Agreement for Kincaid's Lupine (*Lupinus sulphureus* spp. *kincaidii*) in Douglas County. Bureau of Land Management, Roseburg District, Roseburg, Oregon. 12 pp.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of the U.S, Bureau of Fisheries 27:103-152.

Scheerer, P., and G.D. Apke. 1998. Oregon Chub Research. Middle Fork Willamette and Santiam River Drainages. Annual Progress Report (E96970022). 53 pp.

Scheerer, P., C. Shafer, and K. Jones. 1992. Oregon Chub Investigations. Oregon Department of Fish and Wildlife, Fish Research Project EF-91 VII-1. 31 pp.

Scheerer, P., S. Loerts, and K. Jones. 1995. Oregon Department of Fish and Wildlife Annual Progress Report on Oregon chub (EF-94 VII- 1). 54 pp.

Scheerer, P.D. and P.J. McDonald. 2000. Oregon chub research: Middle Fork Willamette and Santiam River Drainages. Unpublished. Oregon Department of Fish and Wildlife, Fish Research Project October 1999-September 2000. Annual Progress Report, Portland. 90 pp.

Scheerer, P.D., M.P. Heck, S. L. Gunckel and S.E. Jacobs. 2007a. 2007 Warner Sucker Stream Investigations. Annual Progress Report. Contracts HLP073006 and 134206M086. Oregon Department of Fish and Wildlife, Corvallis, Oregon. 20 pp.

Scheerer, P.D., P.S. Kavanagh, and K.K. Jones. 2002. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-32. Annual Progress Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon. 73 pp.

Scheerer, P.D., P.S. Kavanagh, and S.E. Jacobs. 2006a. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-44. Annual Progress Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon. 22 pp. + appendix.

Scheerer, P.D., P.S. Kavanagh, B.L. Bangs, and S.E. Jacobs. 2007b. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project E-2-45.

Annual Progress Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon. 17 pp. + appendix.

Scheerer, P.D., S. E. Jacobs, and A. V. Munhall. 2006b. 2006 Warner Valley Fish Investigations - Warner Suckers. Annual Progress Report. Contracts HLP0630009 and 134206M093. Oregon Department of Fish and Wildlife, Salem, Oregon. 20 pp.

Schultz, C.B. 1995. Status of the Fender's blue butterfly (*Icaricia icarioides fenderi*) in Lane County, Oregon: a year of declines. Report to the Oregon Natural Heritage Program and U.S. Fish and Wildlife Service.

Schultz, C.B. 1996. Status of the Fender's blue butterfly (*Icaricia icarioides fenderi*) in Lane County, Oregon: population ups and downs. U.S. Fish and Wildlife Service Portland, Oregon.

Schultz, C.B. 1997. Planting butterfly seeds: An experiment in restoring habitat for the Fender's blue butterfly. Pp. 88-98 in T.N. Kaye, A. Liston, R. M. Love, D. L. Luoma, R. J. Meinke, and M. V. Wilson, eds. Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon, Corvallis, Oregon.

Schultz, C.B. 1998. Dispersal behavior and its implications for reserve design for a rare Oregon butterfly. Conservation Biology 12: 284-292.

Schultz, C.B. and K. Dlugosch. 1999. Nectar and hostplant scarcity limit populations of an endangered Oregon butterfly. Oecologia 119:231-238.

Schultz, C.B. and P.C. Hammond. 2003. Using population viability analysis to develop recovery criteria for endangered insects: case study of the Fender's blue butterfly. Conservation Biology 17:1372-1385.

Schultz, C.B., P.C. Hammond and M.V. Wilson. 2003. Biology of the Fender's blue butterfly (*Icaricia icariodes fenderi* Macy), an endangered species of western Oregon native prairies. Natural Areas Journal 23:61-71.

Scoppettone, G. and P. Rissler. 2001. Distribution of Cowhead Lake Tui Chub, Twelvemile Creek, Oregon (unpublished). Final Report to Fish and Wildlife Service, Oregon State Office, Portland, Oregon.

Scoppettone, G.G. 1988. Growth and longevity of the cui-ui and longevity of other catostomids and cyprinids in Western North America. Transactions of the American Fisheries Society. 117: 301-307.

Scoppettone, G.G., J.E. Harvey, S.P. Shea, B. Nielsen, and P.H. Rissler. 1992. Ichthyofaunal survey and habitat monitoring of streams inhabited by the Modoc sucker (*Catostomus microps*). National Biological Survey, Reno, Nevada. 51 pp.

Scoppettone, G.G., S. Shea, and M.E. Buettner. 1995. Information on population dynamics and life history of shortnose suckers (*Chasmistes brevirostris*) and Lost River suckers

(*Deltistes luxatus*) in Tule and Clear Lakes. National Biological Service, Reno Field Station, Nevada. 78 pp.

Severns, P.M. 2003. Inbreeding and small population size reduce seed set in a threatened and fragmented plant species *Lupinus sulphureus* ssp. *kincaidii* (Fabaceae). Biological Conservation 110:221-229.

Sevon, M. 1988. Walker Lake fisheries management plan. Nevada Department of Wildlife, Reno, Nevada. 79 pp.

Sheehan, M. and N. Sprague. 1984. Report on the status of *Castilleja levisecta*. Unpublished report submitted to the U.S. Fish and Wildlife Service, Portland, Oregon. 82 pp.

Shepard, B., K. Pratt, and J. Graham. 1984a. Life histories of westslope cutthroat and bull trout in the upper Flathead River basin, Montana. Montana Dept. of Fish, Wildlife, and Parks. Kalispell, Montana, 85 pp + 3 app.

Shepard, B., S.A. Leathe, T.M. Weaver, and M.D. Enk. 1984b. Monitoring levels of fine sediment within tributaries to Flathead Lake, and impacts of fine sediment on bull trout recruitment. Unpublished paper presented at the Wild Trout III Symposium. Yellowstone National Park, WY. On file at: Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

Shepherdson, D. and C.B. Schultz. 2004. Captive rearing of Fender's and Puget blue butterflies: Protocols and conservation consequences. AZA Conservation Endowment Fund (#498-03) Final Report. 3 pp.

Siddall, J.L. and K.L. Chambers. 1978. Status report for *Lomatium bradshawii*. Unpublished report to the Oregon State University Herbarium, Corvallis, Oregon. 16pp.

Simon, D. C. and D. F. Markle. 2005. Upper Klamath Lake Lost River and shortnose sucker year class assessment sampling, 2004. Annual Report to U.S. Bureau of Reclamation, Klamath Basin Area Office.

Simon, D.C., G.R. Hoff, D.J. Logan, and D.F. Markle. 1996. Larval and juvenile ecology of Upper Klamath Lake suckers. Annual report 1995. Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon. 60 pp.

Smith, G.R. 1978. Biogeography of intermountain fishes. Great Basin Naturalist 2: 17-42.

Smith, G.R., T. Steinback, and G. Pampush. 1984. Distribution, foraging relationships and colony dynamics of the American white pelican (*Pelecanus erythrorhynchos*) in southern Oregon and northeastern California. Oregon Department of Fish and Wildlife Nongame Wildlife Program Technical Report 83-0-04.

Snyder, D.T. and J.L. Morace. 1997. Nitrogen and phosphorus loading from drained wetlands adjacent to Upper Klamath and Agency Lakes, Oregon. U.S. Geological Survey Water-Resources Investigations Report 97-4059. 67 pp.

Snyder, J.O. 1908. Relationships of the fish fauna of the lakes of southeastern Oregon. Bulletin of the Bureau of Fisheries 27(1907): 69-102.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of bull trout populations. Ecology of Freshwater Fish 8: 114-121.

Stewart, I.T., D.R. Cayan, and M.D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate, Vol. 18: 1136-1155.

Swenson, S.C. 1978. Report of investigations on *Catostomus warnerensis* during spring 1978. Unpublished report to Fish and Wildlife Service. 27 pp.

Tait, C.K. and E.J. Mulkey. 1993a. Assessment of biological and physical factors limiting distribution of stream-resident Warner suckers (*Catostomus warnerensis*). Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 35 pp.

Tait, C.K. and E.J. Mulkey. 1993b. Estimation of stream-resident Warner sucker abundance and total habitat area in two basins using a statistically valid sampling design. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 40 pp.

Tinniswood, W. 2006. Memorandum to Amy Stuart, dated March 10, 2006, Subject: Summary of SDFW (OSGC) monthly reports of fish die-offs, fish strandings, and fish salvages from Link River Dam to below Iron Gate Dam from 1950-2006, Oregon Department of Fish and Wildlife, Klamath Watershed District, Klamath Falls, Oregon. 20 pp.

TNC (The Nature Conservancy). 2006. Sucker use of restored wetlands: An analysis of habitat use, diet and recolonization of restored lakeshore and riverine wetland by endangered Lost River and shortnose suckers at the Williamson River Delta. 2005 annual report to US Fish and Wildlife Service, Klamath Falls, Oregon.

Topinka, J.R. 2006. Chapter 3. Hybridization between sympatric endemic species? The case of the Modoc (*Catostomus microps*) and Sacramento (*Catostomus occidentalis*) suckers. Ph.D. Dissertation, University of California, Davis. 39 pp.

Tranah, G.J., and B. May. 2006. Patterns of intra- and interspecies genetic diversity in Klamath River basin suckers. Transactions of the American Fisheries Society 135: 305-316.

Trotter, P.C. 1987. Cutthroat, native trout of the west. Colorado Associated University Press. Boulder, Colorado. 219 pp.

Trotter, P.C. 1997. Sea-run cutthroat trout: life history profile *In* J.D. Hall, P.A. Bisson and R.E. Gresswell (eds.), Sea-run cutthroat trout: biology, management, and future conservation, p. 7-15. Oregon Chapter, American Fisheries Society, Corvallis, Oregon.

Tyler, T.J. 2007. Link River 2006 screw trap assessment. Bureau of Reclamation, Klamath Falls, OR. 12 p.

U.S. Census Bureau. 2009. State and County QuickFacts. Accessed April 13, 2009 at http://quickfacts.census.gov/qfd/states/41000.html. U.S. Census Bureau, Washington, D.C.

USBR (U.S. Bureau of Reclamation). 1993. Environmental research in the Klamath Basin, Oregon: 1991 Annual Report (R-93-13). U.S. Bureau of Reclamation, Research and Laboratory Services Division, Denver, Colorado.

USBR (U.S. Bureau of Reclamation). 2001. A-Canal entrainment reduction alternative assessment. Decision support document. U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, OR. 27 pp.

USBR (U.S. Bureau of Reclamation). 2005. Natural Flow of the Upper Klamath River. Klamath Falls, Oregon: 79 p. + Attachments A-H.

USBR (U.S. Bureau of Reclamation). 2007. Biological assessment. The effects of the proposed action to operate the Klamath Project from April 1, 2008 to March 31, 2018 on federally-listed threatened and endangered species. Mid-Pacific Region, Klamath Basin Area Office, Klamath Falls, Oregon. 356 pp.

USFS (U.S. Forest Service). 1994. Watershed analysis report for the Rock, Cherry, and Nannie Creek watershed area. Klamath Ranger District, Winema National Forest.

USFS (U.S. Forest Service). 1995a. Watershed analysis report for the Threemile, Sevenmile, and Dry Creek watershed. Klamath Ranger District, Winema National Forest.

USFS (U.S. Forest Service). 1995b. South of Sprague watershed analysis report. Bly Ranger District, .Fremont National Forest.

USFS (U.S. Forest Service). 1996. Watershed analysis report for north Fourmile watershed. Klamath Ranger District, Winema National Forest.

USFS (U.S. Forest Service). 1997. Final Biological Assessment for grazing management on allotments within the range of the Lost River sucker, shortnose sucker, and Warner sucker. Fremont National Forest. March 1997. 229 pp.

USFS (U.S. Forest Service). 1998. Draft Recreation Creek watershed analysis. Prepared for the Klamath Ranger District, Winema National Forest, and Pelican Butte Corporation. 103 pp.

USFWS (U.S. Fish and Wildlife Service). 1970. United States list of endangered native fish and wildlife (Lahontan cutthroat trout). Federal Register 35: 16047-16048.

USFWS (U.S. Fish and Wildlife Service). 1975. Endangered and threatened wildlife and plants; Threatened status for three species of trout (Lahontan cutthroat trout). Federal Register 40: 29863-29864.

USFWS (U.S. Fish and Wildlife Service). 1984. An action plan for the recovery of the Modoc sucker (*Catostomus microps*), revised April 27, 1983. Signatories: Calif. Dept. Fish and Game, U.S. Forest Service (Modoc National Forest), and U.S. Fish and Wildlife Service. 14 pp.

USFWS (U.S. Fish and Wildlife Service). 1985a. Endangered and threatened wildlife and plants; Determination of endangered status and critical habitat for the Modoc sucker. Federal Register 50 (112):24526-24530.

USFWS (U.S. Fish and Wildlife Service). 1985b. Endangered and threatened wildlife and plants; Determination that the Warner sucker is a threatened species and designation of its critical habitat. Federal Register 50: 39117-39123.

USFWS (U.S. Fish and Wildlife Service). 1988a. Determination of Endangered Status for the Shortnose Sucker and Lost River Sucker. Federal Register 53:27130-27134.

USFWS (U.S. Fish and Wildlife Service). 1988b. Endangered and Threatened Wildlife and Plants; Final Endangered Status for *Lomatium bradshawii* (Bradshaw's lomatium). Federal Register 53:38448-38451.

USFWS (U.S. Fish and Wildlife Service). 1993a. Bradshaw's lomatium Recovery Plan. Portland, Oregon. 52 pp.

USFWS (U.S. Fish and Wildlife Service). 1993b. Determination of threatened status for the plant "Sidalcea nelsoniana" (Nelson's checker-mallow). Federal Register 58:8235-8243.

USFWS (U.S. Fish and Wildlife Service). 1993c. Final Rule: Endangered and Threatened Wildife and Plants; Determination of Endangered Status for the Oregon Chub. Federal Register 58: 53800-53804.

USFWS (U.S. Fish and Wildlife Service). 1993d. Recovery Plan for Lost River sucker, *Deltistes luxatus* and Shortnose sucker, *Chasmistes brevirostris*. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1994. Proposed Determination of Critical Habitat for Lost River Sucker and Shortnose Sucker. Federal Register 59:61744-61759.

USFWS (U.S. Fish and Wildlife Service). 1995. Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) Recovery Plan. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1997. Determination of threatened status for *Castilleja levisecta* (golden paintbrush). Federal Register 62:31740-31748.

USFWS (U.S. Fish and Wildlife Service). 1998a. Final Rule: Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Klamath River and Columbia River Distinct Population Segments of Bull Trout. Federal Register 63: 31647-31674.

USFWS (U.S. Fish and Wildlife Service). 1998b. Recovery Plan for the Threatened Nelson's Checker-mallow (*Sidalcea nelsoniana*). Portland, Oregon. 71 pp.

USFWS (U.S. Fish and Wildlife Service). 1998c. Recovery plan for the threatened and rare native fishes of the Warner Basin and Alkali Subbasin (Warner sucker, Hutton tui chub, and Foskett speckled dace). Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1998d. Recovery Plan for the Oregon Chub (*Oregonichthys crameri*). Portland, Oregon. 69 + pp.

USFWS (U.S. Fish and Wildlife Service). 1999a. Final Rule: Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States. Federal Register 64: 58910-58933.

USFWS (U.S. Fish and Wildlife Service). 1999b. Final Rule: Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Jarbidge River Population Segment of Bull Trout. Federal Register 64: 17110-17125.

USFWS (U.S. Fish and Wildlife Service). 1999c. How Will This Bull Trout Listing Affect Me? Accessed March 30, 2009 at http://www.fws.gov/pacific/news/bulltrout/bulltaffect_fnl.htm.

USFWS (U.S. Fish and Wildlife Service). 2000a. Endangered and Threatened Wildlife and Plants; Endangered status for *Erigeron decumbens* var. *decumbens* (Willamette daisy) and Fender's blue butterfly (*Icaricia icarioides fenderi*) and proposed threatened status for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine). Federal Register 65:3875.

USFWS (U.S. Fish and Wildlife Service). 2000b. Recovery Plan for the Golden Paintbrush (*Castilleja levisecta*) U.S. Fish and Wildlife Service, Portland, Oregon. 51 pp.

USFWS (U.S. Fish and Wildlife Service). 2002a. Biological/Conference Opinion Regarding the Effects of Operation of the U.S. Bureau of Reclamation's Proposed 10-Year Operation Plan for the Klamath Project and its Effect on the Endangered Lost River Sucker (*Deltistes luxatus*) Endangered Shortnose Sucker (*Chasmistes brevirostris*), Threatened Bald Eagle (*Haliaeetus leucocephalus*) and Proposed Critical Habitat for the Lost River and Shortnose Suckers. Klamath Falls, Oregon. U.S. Department of Interior.

USFWS (U.S. Fish and Wildlife Service). 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2004a. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Volume I: Puget Sound Management Unit, 389 + xvii pp.

USFWS (U.S. Fish and Wildlife Service). 2004b. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Volume II (of II): Olympic Peninsula Management Unit. Portland, Oregon. 277 + xvi pp.

USFWS (U.S. Fish and Wildlife Service). 2004c. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Portland, Oregon. 132 pp.

USFWS (U.S. Fish and Wildlife Service). 2005a. Bull trout core area templates – complete core area by core area analysis. Fredenberg, W., and J. Chan, eds., U.S. Fish and Wildlife Service, Portland, Oregon. 660 pp.

USFWS (U.S. Fish and Wildlife Service). 2005b. Final Rule: Endangered and Threatened Wildlife and Plants; Designation of Critical habitat for the Bull Trout. Federal Register 70: 56211-56311.

USFWS (U.S. Fish and Wildlife Service). 2006a. Biological opinion for the issuance of a Section 10(a)(1)(B) incidental take permit to the State of Washington for the Forest Practices Habitat Conservation Plan (FWS Reference: 1-3-06-FWI-0301), Lacey, Washington.

USFWS (U.S. Fish and Wildlife Service). 2006b. Biological Opinion on the Part B: Effects to Bull Trout from the Implementation of Proposed Actions Associated with Plan of Operation for the Revett RC Resources Incorporated Rock Creek Copper/Silver Mine, Montana Ecological Services Field Office, Helena, Montana.

USFWS (U.S. Fish and Wildlife Service). 2006c. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Fender's Blue Butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's Lupine), and *Erigeron decumbens* var. *decumbens* (Willamette Daisy); final rule. Federal Register 71: 63862-63977.

USFWS (U.S. Fish and Wildlife Service). 2006d. Recovery Outline for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine). U.S. Fish and Wildlife Service, Portland, Oregon. 23 pp.

USFWS (U.S. Fish and Wildlife Service). 2007a. Biological Opinion and Letter of Concurrence USDA Forest Service, USDI Bureau of Land Management and the Coquille Indian Tribe for Programmatic Aquatic Habitat Restoration Activities in Oregon and Washington that Affect ESA-listed Fish, Wildlife, and Plant Species and their Critical Habitats. U.S. Fish and Wildlife Service, Portland, Oregon. 258 pp.

USFWS (U.S. Fish and Wildlife Service). 2007b. Formal consultation on the proposed relicensing of the Klamath Hydroelectric Project, FERC Project No. 2082, Klamath River, Klamath County, Oregon and Siskiyou County, California on listed species. Yreka Fish and Wildlife Office, Yreka, California. 180 pp.

USFWS (U.S. Fish and Wildlife Service). 2007c. Lost River Sucker (Deltistes luxatus) 5-year review summary and evaluation. Klamath Falls Fish and Wildlife Office, Oregon. 43 pp.

USFWS (U.S. Fish and Wildlife Service). 2007d. Shortnose Sucker (Chasmistes brevirostris) 5-Year review summary and evaluation. Klamath Falls Fish and Wildlife Office, Klamath Falls, Oregon. 41 pp.

USFWS (U.S. Fish and Wildlife Service). 2008a. Bull Trout (*Salvelinus confluentus*) 5-Year Review Summary and Evaluation. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2008b. Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. x + 212 pp.

USFWS (U.S. Fish and Wildlife Service). 2008c. Initiation of 5-Year Reviews of 58 Species in California and Nevada; Availability of Completed 5-Year Reviews in California, Nevada and Southern Oregon. Federal Register 73:11945-11950.

USFWS (U.S. Fish and Wildlife Service). 2008d. Oregon chub (*Oregonichthys crameri*) 5-Year Review Summary and Evaluation. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2009. Proposed Rule: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Oregon Chub (*Oregonichthys crameri*). Federal Register 74: 10412-10453.

USGS (U.S. Geological Survey). 2000. Fisheries investigations for Lost River and shortnose suckers in Upper Klamath Lake, 2000. Annual report of research to the U.S. Bureau of Reclamation. Klamath Falls, Oregon, Mid-Pacific Region, Klamath Area Office.

USGS (U.S. Geological Survey). 2003. Monitoring of adult Lost River and shortnose suckers in the Upper Klamath Basin, Oregon, 2002. Annual report of research to the U.S. Bureau of Reclamation. Klamath Falls, Oregon, Mid-Pacific Region, Klamath Area Office: Contract #00AA200049. 138 pp.

Walker, W.W. 2001. Development of a phosphorus Total Maximum Daily Load (TMDL) for Upper Klamath Lake, Oregon. Prepared for the Oregon Department of Environmental Quality. 81 pp.

Washington Natural Heritage Program. 2005. List of vascular plants tracked by the Washington Natural Heritage Program. Updated July 2005. Accessed at http://www.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html.

Watershed Sciences. 2007. Applied Remote Sensing and Analysis Watershed. Klamath Basin Rangeland Trust Agency Lake Fringe Wetland Restoration and Water Quality Assessment. Prepared for Klamath Basin Rangeland Trust. Prepared by Watershed Sciences. Portland, Oregon. 63 pp.

Wentworth, J.B. 1994. The demography and population dynamics *of Castilleja levisecta*, an endangered perennial. Unpublished master's thesis. University of Washington. 53 pp.

Western Native Trout Initiative. 2009. Lahontan cutthroat trout (unpublished). Accessed March 30, 2009 at http://www.westernnativetrout.org/what-is-western-native-trout/lahontan-cutthroat/.

White, R.K., T.L. Ramsey, M.A. Stern, and A.V. Munhall. 1991. Salvage operations and investigations of the range and stream habitat characteristics of the Warner sucker, *Catostomus warnerensis*, during spring and summer 1991. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 44 pp.

White, R.K., T.R. Hoitsma, M.A. Stern, and A.V. Munhall. 1990. Final report on investigations of the range and status of the Warner sucker, *Catostomus warnerensis*, during Spring and Summer 1990. Unpublished report to Bureau of Land Management, Oregon Department of Fish and Wildlife, and Fish and Wildlife Service. 66 pp.

Williams, J.E., M.A. Stern, A.V. Munhall, and G.A. Anderson. 1990. Conservation status of the threatened fishes of the Warner Basin, Oregon. Great Basin Naturalist 50(3): 243-248.

Wilson, M.V. 2004. The analysis of management strategies to restore and enhance Nelson's checker-mallow (*Sidalcea nelsoniana*) habitat at William L. Finley National Wildlife Refuge: Response to two years of restoration techniques in an existing *Sidalcea nelsoniana* habitat. Report to the US Fish and Wildlife Service. 30 pp.

Wilson, M.V. and Clark, D.L. 1997. Effects of fire, mowing, and mowing with herbicide on native prairie of Baskett Butte, Baskett Slough NWR. Prepared for U.S. Fish and Wildlife Service, Western Oregon Refuges.

Wilson, M.V., P.C. Hammond, and C.B. Schultz. 1997. The interdependence of native plants and Fender's blue butterfly. Pages 83-87 *in* T. N. Kaye, A. Liston, R.M. Love, D.L. Luoma, R.J. Meinke, and M.V. Wilson, eds. Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon, Corvallis, Oregon.

Wilson, M.V., S. Leininger, and D.L. Clark. 2001. Promoting and restoring Kincaid's lupine and Willamette daisy. Unpublished report to U.S. Fish and Wildlife Service.

Wilson, M.V., T. Erhart, P.C. Hammond, T.N. Kaye, K. Kuykendall, A. Liston, A.F. Robinson, Jr., C.B. Schultz, and P.M. Severns. 2003. Biology of Kincaid's lupine (*Lupinus sulphureus* spp. k*incaidii* [Smith] Phillips), a threatened species of western Oregon native prairies, USA. Natural Areas Journal 23(1):72-83.

Wise, C. and T.N. Kaye. 2006. Minimum population size for reproduction in Willamette daisy, Eugene District BLM, Oregon. Unpublished report to the Eugene District BLM. Institute for Applied Ecology, Corvallis, Oregon.

Wood, C. 1995. Life history variation and population structure in sockeye salmon. Pages 195-216 in J.L. Nielsen, Editor. Evolution and the aquatic ecosystem. American Fisheries Society symposium 17. American Fisheries Society, Bethesda, Maryland.

Wood, T.M., G.J. Fuhrer, and J.L. Morace. 1996. Relation between selected water-quality variables, and lake level in Upper Klamath and Agency lakes, Oregon. U.S. Geological Survey Water-Resources Investigation Report 96-4079. 65 pp.

Wood, T.M., G.R. Hoilman, and M.K. Lindenberg. 2006. Water-quality conditions in Upper Klamath Lake, Oregon, 2002-04: U.S. Geological Survey Scientific Investigations Report 2006-5209. 52 pp.

Wooton, R.J. 1990. Ecology of Teleost Fishes. Chapman and Hall, London, England. 404 pp.

Wydoski, R.S. 1978. Responses of trout populations to alterations in aquatic environments: a review. Pp. 57-92 In: J.R. Moring, ed., Proceedings of the wild trout-catchable trout symposium, Eugene, Oregon.

Wyman, K.H. 1975. Two unfished salmonid populations in Lake Chester Morse. Master of Science Thesis, University of Washington. Seattle, WA. Aitkin, J. K. 1998. The importance of estuarine habitats to anadromous salmonids of the Pacific Northwest: A literature review. U. S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.

York, M.M. 2002. Relationship between plant and butterfly community composition on upland prairies of the Willamette Valley, Oregon. Master of Science Thesis. Oregon State University, Corvallis. 107 pp.

Unpublished Data

Dowling, T. Arizona State University, Tempe, Arizona.

Reid, S. Western Fishes, Ashland, Oregon

USFWS (U.S. Fish and Wildlife Service). Abernathy Fish Technology Center, Vancouver, Washington.

Personal Communication

Barry, Matt. 2007. The Nature Conservancy, Klamath Falls, Oregon. Personal communication with the Klamath Falls Field Office, U.S. Fish and Wildlife Service.

Beall, Jock. 2008. Fish and Wildlife Service, Willamette Valley National Wildlife Refuge Complex, Corvallis, Oregon. E-mail to Jeff Dillon, Fish and Wildlife Service, Portland, Oregon, dated January 24, 2008 (subject: Re: Lomatium bradshawii questions).

Loop, Lois. 2009. Program Specialist, Farm Service Agency, Tualatin Oregon. Periodic telephone conversations and emails with Jennifer Thompson re: Oregon CREP.

Norman, Kate. 2008. Fish and Wildlife Service, Portland, Oregon. E-mail to Cat Brown, Fish and Wildlife Service, Portland, Oregon, dated February 26, 2008 (subject: Re: Fw: Castilleja levisecta).

Regan-Vienop, James. 2007. Natural Resource Conservation Service, Klamath Falls, Oregon. Personal communication with the Klamath Falls Field Office, U.S. Fish and Wildlife Service.

Reid, Stewart. 2001, 2008 and 2009. Western Fishes, Ashland, Oregon. Personal communication with the Klamath Falls Field Office, U.S. Fish and Wildlife Service.

Ritchey, Alan. 2009. Fish Screening Coordinator, Oregon Department of Fish and Wildlife, Salem, Oregon. Telephone conversation with Jennifer Thompson March 27, 2009 re: fish screening criteria.

Scheerer, Paul. 2009. Fish Biologist, Oregon Department of Fish and Wildlife, Corvallis, Oregon. Telephone conversation with Jennifer Thompson March 30, 2009 re: Oregon chub and fish screens.

Shivley, Rip. 2005 and 2007. U.S. Geological Survey, Klamath Falls, Oregon. Personal communication with the Klamath Falls Field Office, U.S. Fish and Wildlife Service.

Thomas, Ted. 2006. Fish and Wildlife Service, Lacey, Washington. E-mail to Cat Brown, Fish and Wildlife Service, Portland, Oregon, dated January 17, 2006 (subject: Re: question about Kincaid's lupine in WA).