United States Department of the Interior
U.S. FISH AND WILDLIFE SERVICE
Ecological Services
Yreka Fish and Wildlife Office
1829 South Oregon Street
Yreka, California 96097

In Reply Refer To:
08EYRE00-2021-F-0127
Docket No. P-14803- 001

December 22, 2021

Ms. Kim A. Nguyen
Chief, Environmental and Project Review Branch
Division of Hydropower Administration and Compliance
Office of Energy Projects
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: Transmittal of Biological Opinion and Conclusion of Formal and Informal Consultation for the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project, Nos. 14803-001, 2082-063

Dear Ms. Nguyen and Ms. Bose:

This letter responds to your August 2, 2021, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project No. 14803 (Project) under section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your designated non-federal representative for the Project is the Klamath River Renewal Corporation (Renewal Corporation) (Federal Energy Regulation Commission 2016). Your request indicated that the Federal Energy Regulatory Commission (FERC) adopted the March 22, 2021, draft Biological Assessment (BA) prepared by the Renewal Corporation as the final BA for this project.

We responded to your August 2, 2021, request for formal consultation on August 11, 2021, with a request for additional information to initiate consultation (50 CFR §402.14) and to correct inconsistencies in the BA. In response, we received an erratum to the BA on August 16, 2021, and on August 31, 2021, you sent us a letter with the remaining information. We responded on September 3, 2021, to inform you that the information provided on August 16, and August 31, 2021, is sufficient to initiate formal consultation for the Project. We also informed you that the Service published a final rule to list the Franklin's bumble bee as an endangered species, effective September 23, 2021 (86 FR 47221), and thus, the bee would be included in the consultation.

The final BA as modified determined that the Project *may affect and is likely to adversely affect* the Lost River sucker (*Deltistes luxatus*), shortnose sucker (*Chasmistes brevirostris*) and bull trout (*Salvelinus confluentus*) and that the Project *may affect but is not likely to adversely affect* the northern spotted owl (*Strix occidentalis caurina*) and its critical habitat, Franklin's bumble bee (*Bombus franklini*), Oregon spotted frog (*Rana pretiosa*), and critical habitat for the Lost River sucker, shortnose sucker and bull trout. The BA further determined the Project will have no effect to critical habitat for the Oregon spotted frog, to which the Service makes no response.

This letter serves three purposes. It transmits our Biological Opinion addressing the effects of the Project on the Lost River sucker, shortnose sucker, and bull trout (Enclosure 1). We concur the Project may affect, and is likely to adversely affect these three species and further conclude the Project will not jeopardize the continued existence of these three species. Refer to Enclosure 1.

This letter also provides our concurrence with the *may affect but is not likely to adversely affect* determinations that are described in the BA for the northern spotted owl and its critical habitat, the Franklin's bumble bee, the Oregon spotted frog, and critical habitat for Lost River sucker, shortnose sucker, and bull trout. This letter constitutes conclusion of informal consultation on these species and critical habitat and the rationale for our concurrence is described below.

Finally, this letter transmits Enclosure 2, which includes conservation recommendations for the Pacific lamprey (*Entosphenus tridentatus*) and freshwater mussels (*Gonidea* spp., *Margaritifera* spp. and *Anodonta* spp.). Pacific lamprey are a native anadromous species that, like salmon, historically returned to spawn in watersheds along the West Coast. They have experienced population declines and have a restricted distribution throughout Washington, Oregon, Idaho and California. Although not a federally listed species, we recommend consideration of Pacific lamprey during permitted in-water work (USFWS 2019). Lamprey are a Tribal Trust species and have a high cultural significance to Native American tribes from California to Alaska.

While no species of freshwater mussels are currently federally listed in the Pacific Northwest, they present a high cultural, ecological, and environmental value to many entities. The western ridged mussel (*Gonidea angulata)* was petitioned for listing by the Xerces Society on August 18, 2020. We will be evaluating if this species warrants protection under the ESA over the next couple of years. The Service recommends Action Agencies require considerations for the biological needs of all native freshwater mussel species for all permits requiring instream or near-stream projects.

Northern spotted owl and its Critical Habitat

The Project will not modify any suitable habitat for northern spotted owl, defined here as nesting, roosting, or foraging habitat. There is little to no suitable habitat in the project area footprint and the closest suitable habitat that could be used by owls for nesting is located approximately 1.3 miles southeast of the Copco No. 1 Reservoir. All project activities will occur outside of suitable habitat with the exception of helicopter flights that may pass by the suitable habitat that is 1.3 miles to the southeast (addressed below).

We find the Project will have discountable and insignificant effects to the northern spotted owl and its critical habitat based on the following rationale:

- It is recognized that heavy equipment, helicopters, haul trucks, and blasting to remove or modify structures, upgrade roads, or conduct restoration activities will result in loud and continuous noise. However, based on our habitat assessment and field verification, the closest suitable habitat that could be used for nesting is approximately 1.3 miles southeast of where these primary noise-generating activities will occur.

- No additional surveys are currently planned before or during project implementation (BA pp. 230-231). This consultation conservatively presumes all suitable habitat is occupied by nesting northern spotted owls.

- As noted above, helicopter flights to and from the project site may pass by the suitable nesting habitat that is approximately 1.3 miles southeast of the Copco No. 1 Reservoir. To prevent disturbance to northern spotted owls during the critical breeding and nesting season (February 1 through September 15), helicopter flight paths will be prohibited within one mile of known northern spotted owl activity centers[1] and suitable habitat (BA pp. 84, 231). If flight paths cannot avoid areas that support suitable habitat, no flights will occur between February 1 and September 15, unless the action agency and the Renewal Corporation chooses to conduct additional surveys, to determine that northern spotted owls are not nesting (BA p. 231). Effects to nesting northern spotted owls or their young are considered discountable because of the flight path prohibitions, or because of the inclusion of a limited operating period.

- The Project will remove approximately 0.4 acres of dispersal habitat (BA pp. 232, 247) in order to relocate the road for the J.C. Boyle powerhouse. This small scale of habitat removal will not significantly influence forest stand conditions that support dispersal for the owl, such as contiguous canopy cover, foraging opportunities, protection from avian predators, or roosting sites (USFWS 2011). Therefore, the removal of 0.4 acres of dispersal habitat is insignificant to northern spotted owls that may disperse through or near this part of the project area. The surrounding dispersal habitat will remain intact and available for dispersing owls.

- The same 0.4 acres of dispersal habitat that will be removed is also designated critical within the East Cascades South (ECS-2) critical habitat subunit. The function of the ECS-2 subunit is to provide both north-south connectivity between subunits, and demographic support in an area of sparse Federal land and sparse high-quality nesting habitat.

    - Critical habitat for the northern spotted owl includes four Physical and Biological Features (PBFs). These PBFs are (1) forest types that support northern spotted owl, (2) nesting and roosting habitat, (3) foraging habitat, and (4) dispersal habitat

[1] An activity center is a location or point representing the "best of detections" such as a nest stand, a stand used by a roosting pair or territorial single owls, or an area of concentrated nighttime detections. Activity centers are within the owl's core use area and are represented by this central location.

(77 FR 71875; USFWS 2012 pp. 71906-71097). Physical and Biological Features 2 and 3 will not be affected by the project.

  - The Project will remove 0.4 acres of critical habitat (PBFs 1 and 4). Physical and Biological Feature 1 is included in our analysis of PBF 4, because PBF 1 must always occur in concert with at least one other PBF (77 FR 71875; USFWS 2012, pp. 719058, 72051). Physical and Biological Feature 4 supports the movement and colonization phases of northern spotted owl dispersal, a landscape-level scale life-history need that should be assessed at a larger scale than effects to PBFs 2 or 3 (77 FR 71875; USFWS 2012 p. 71939).

- As described above, the removal of 0.4 acres of PBF 4 is small in scale and will not influence the dispersal of northern spotted owls through the project area, action area, or the ECS-2 critical habitat subunit. Given the small scale of effect to PBFs 1 and 4, and no effects to PBF 2 or PBF 3, the effects of the action and this habitat removal will have no meaningfully measurable or detectable effects to dispersing northern spotted owls and is considered insignificant. In addition, the project will not influence the continued function of critical habitat in the ECS-2 subunit or the range-wide designated critical habitat (77 FR 71875; USFWS 2012 p. 71930).

Because the Project will have no effect on nesting, roosting, or foraging habitat; includes limited operating periods to avoid disturbance to nesting northern spotted owls; and will have an insignificant effect on dispersal habitat function, we concur with the determination that the Project *may affect but is not likely to adversely affect* the northern spotted owl. Similarly, as there will be no effects to critical habitat PBFs 2 and 3, and small-scale effects to PBFs 1 and 4, we concur with the determination that the project *may affect but is not likely to adversely affect* northern spotted owl critical habitat.

Franklin's bumble bee

As noted above, Franklin's bumble bee was listed as endangered on August 24, 2021, effective September 23, 2021 (86 FR 47221). Franklin's bumble bee is a generalist forager that can use grasslands or open meadows in proximity to seeps and other wet meadow environments. It requires a constant and diverse supply of flowers that bloom throughout the colony's life cycle, from spring to autumn (Xerces Society and Thorp 2010). These resources are typically found in open (non-forested) meadows in proximity to seeps and other wet meadow environments (USFWS 2021).

Franklin's bumble bee uses a wide array of sheltered and exposed habitat types at a broad elevational range and may nest underground in abandoned rodent burrows (Thorp *et al*. 1983), in rock piles (Plowright and Stephen 1980), or in structures made by humans. The species has not been detected at any location since 2006 where it was observed near Mt. Ashland in Jackson County, Oregon. This area is approximately 24 miles northwest of the action area (BA Appendix B p. 30, USFWS 2021, 2018).

The closest detections to the project area are approximately eight miles west of Iron Gate Dam near Hornbrook, California, and 11 miles northwest of Iron Gate Dam near Hilt, California. Both of these detections occurred in 1998 and relative to the project area, are beyond the known foraging and dispersing radius for the species. The bumble bee may have a foraging distance of up to 6.2 miles (R. Thorp, personal communication, October 24, 2017), but typical dispersal distance is most likely two miles or less (R. Hatfield, personal communication, October 27, 2017, Goulson 2010).

We find the Project will have discountable and insignificant effects to Franklin's bumble bee based on the following rationale:

- While Franklin's bumble bees are not known to occur in the action area or near the proposed construction activity sites, the Project includes measures to avoid effects from herbicide exposure near known nectar and pollen resources (BA Appendix C pp. 6-9).

- The Project includes measures to minimize dust and avoid impacts to nests using on-site biological monitoring (BA Appendix B p. 32, Reservoir Area Management Plan-Appendix C).

- In addition, areas of native species preferred by bumble bees, especially milkweed (*Asclepias spp.*), horsemint (*Agastache urticifolia*), and pennyroyal or Coyote mint (*Monardella villosa*) will be identified and avoided during the herbicide application process. Other native genera that may attract the Franklin's bumble bee such as *Ceanothus* (buckbrush or other species), *Eriogonum* (buckwheat), *Lupinus* (several species of lupine), native *Trifolium* (clover), and *Veratrum* (false hellebore) will also be identified and avoided.

- The removal of the hydropower facilities and the restoration of the surrounding areas will, through time, reduce the use of herbicides (BA Appendix B p. 32). Combined with the conversion of approximately 2,500 acres of reservoir to grassland and riparian habitats, this is expected to benefit the species should the Franklin's bumble bee colonize these areas in the future.

Given there is low-to-no probability of Franklin's bumble bee occurring in the portion of the project area where ground- or habitat-disturbing activities will occur, the risk of exposure and effects to the species is considered discountable. The Project includes avoidance measures and the use of monitors to avoid any effects to individuals or habitat. We also expect future beneficial effects for Franklin's bumble bee upon completion of the restoration activities. Therefore, we concur the Project *may affect but is not likely to adversely affect* the Franklin's bumble bee. There is no critical habitat designated for this species (USFWS 2021).

Oregon Spotted Frog

The Oregon spotted frog occurs within the action area in the following locations:

- In the hydroelectric reach portion of the action area, it occurs in Spencer Creek, approximately 11 miles upstream of where it flows into J.C. Boyle Reservoir, and at the Buck Lake Complex. This complex is comprised of several adjacent wetland habitat types known as Buck Lake, Buck Meadow, Buck Marsh, West Impoundment, and Tunnel Creek (Lerum 2012).

- In the Upper Klamath Basin portion of the action area, it occurs in Sevenmile Creek, Four Mile Creek, the Wood River, Fort Creek, Annie Creek, and Sun Creek that are either tributaries to, or upstream of, Upper Klamath Lake (79 FR 51657; USFWS 2014, BA pp. 123, 233).

All of the known occupied areas are upstream of where work associated with reservoir drawdown, dam removal and channel restoration will occur. Thus, these activities will not affect the Oregon spotted frog.

Coho salmon, Chinook salmon, and steelhead are expected to be able to access creeks and rivers in the Middle and Upper Klamath Basins that are occupied by Oregon spotted frog. In the Middle Klamath, this includes Spencer Creek, where coho salmon are expected to recolonize up to the Buck Lake Complex and throughout where Oregon spotted frogs occur (Ramos 2020, Lerum 2012, Hamilton 2005). Chinook salmon and steelhead may also recolonize portions or the full extent of Spencer Creek (Fortune *et al*. 1966). In the Upper Klamath Basin, Chinook salmon and steelhead are expected to recolonize portions of Sevenmile Creek, Four Mile Creek, the Wood River, Fort Creek, Annie Creek, and Sun Creek. Fish are opportunistic feeders and may prey on younger life stages of amphibians (eggs, tadpoles, recently metamorphosed young).

Rearing habitats used by juvenile anadromous salmonids may overlap with suitable egg-laying and nursery sites for Oregon spotted frog. This includes shallow pools near flowing water or wet areas that are seasonally connected to larger bodies of water. Juvenile salmonids may also inhabit cold- and shallow-water habitats where tadpoles or recently metamorphosed young frogs may be present early in their development. However, it is expected as fish grow, they will quickly move to warmer, more productive reaches where food resources are more abundant.

We find the Project may have discountable and insignificant effects to the Oregon spotted frog based on the following rationale:

- While there will be spatial overlap, adult Chinook salmon, coho salmon and steelhead do not feed during their spawning migrations (Garner *et al*. 2009). Adult steelhead may resume feeding after spawning (J. Boyce, personal communication, September 3, 2021). We expect spatial and temporal overlap between native juvenile anadromous salmonids and Oregon spotted frogs to be limited because the fish and amphibians have separated themselves into different niches. This is especially true for reproduction and metamorphosis (T. Waterstrat, personal communication, August 26, 2021).

- Predation on Oregon spotted frog by non-native brook trout is well documented (USFWS 2019a, Pearl *et al*. 2009). We have no data or research that predation of younger life stages of Oregon spotted frog by native fish or anadromous salmonids occurs (J. O'Reilly, T. Adams, T. Waterstrat, N. Banish, and J. Spaur, personal communications, August 26, 2021). In addition:

- Feeding observations and data from coho salmon gut analyses do not demonstrate coho predation on amphibians (D. Ward, personal communication, August 31, 2021). Coho salmon mostly feed on small macroinvertebrates or flies (Diptera). Data collected from off-channel ponds in the mid-Klamath River also show no amphibians in the coho salmon diet (Krall 2016). Here, the primary prey items were zooplankton and various aquatic insects, especially small Diptera (Krall 2016).

- In Prairie Creek and Redwood Creek, amphibians were not found in coho salmon diets and primary prey consisted of amphipods (small crustacean shrimp) and small Diptera flies (D. Ward, personal communication, August 31, 2021).

- When Chinook salmon are rearing in fresh water, their principal prey appears to be larval and adult insects (Kjelson *et al*. 1982, Becker 1973). The importance of insects in fresh water indicates they feed in the water column, or at the surface on drifting food (Groot and Margolis 1991). They are not known to prey on amphibians.

- Redband trout (*Oncorhynchus mykiss* ssp.) are considered a surrogate species for steelhead and are native in the upper Klamath Basin. During an ongoing study of juvenile redband trout in the Upper Klamath Basin, predation on Oregon spotted frog and other amphibians has not been documented (J. Ortega, personal communication, February 17, 2021).

Over the long term, as anadromous salmonids recolonize Spencer Creek, as well as the Upper Klamath Basin, we anticipate the feeding and resource use behaviors by coho salmon, Chinook salmon and steelhead will be like those already reported, with their diet consisting of insects, other invertebrates, or sometimes fish eggs or fry in the case of steelhead (Benjamin *et al*. 2013, Cannamela 1992, Chapman 1966).

Given that the risk of predation, and competition for rearing space, is considered insignificant and discountable, we concur the Project *may affect but is not likely to adversely affect* the Oregon spotted frog.

Critical Habitat for the Lost River Sucker and Shortnose Sucker

The Project will facilitate upstream passage and access for anadromous salmonids into the Upper Klamath Basin, and into designated critical habitat for the Lost River and shortnose sucker. Historically, Klamath River Chinook salmon and steelhead used tributaries throughout the upper Klamath Basin (Hamilton *et al*. 2005, 2016). This includes the Williamson, Sprague, and Wood rivers (Lane and Lane Associates 1981, Nehlsen *et al*. 1991, Moyle 2002, Fortune *et al*. 1966).

Critical habitat for the Lost River sucker and shortnose sucker in the action area includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; the Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam. This designated critical habitat is known as Unit 1-Upper Klamath Lake (77 FR 73739; USFWS 2012a p. 73755). This is the only critical habitat in the action area and is the focus of our concurrence.

Critical habitat is not designated below Keno Dam, therefore there will be no effects to critical habitat for the Lost River sucker and shortnose sucker in the hydroelectric reach where reservoir drawdown, dam removal, and channel restoration occurs. Similarly, critical habitat is not designated within the Tule Lake National Wildlife Refuge. Therefore the proposed translocation of Lost River and shortnose suckers to the refuge, through a project conservation measure, will not affect critical habitat in this location.

The return of anadromous salmonids is expected to reintroduce marine-derived nutrients to the basin. These marine-derived nutrients will be introduced into the ecosystem directly, where salmon spawn and their carcasses are consumed by birds, fish, or stream invertebrates. Or, these nutrients can be released back into the aquatic system through remineralization and decomposition of salmon carcasses (Kline *et al*. 2007). The main nutrients include nitrogen, sulfur, and carbon.

To provide context for our concurrence below, the primary constituent elements (PCEs) of critical habitat for the Lost River and shortnose sucker that support the life-history processes essential to the conservation of both species include:

- PCE 1 – *Water.* Areas with sufficient water quantity and depth in lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity (77 FR 73739; USFWS 2012a p. 73750). Water must have varied depths to accommodate each life stage: Shallow water (up to 3.28 ft (1.0 m)) for larval life stage, and deeper water (up to 14.8 ft (4.5 m)) for older life stages. Water quality characteristics should include water temperatures of less than 28.0 °Celsius (82.4 °F); pH less than 9.75; dissolved oxygen levels greater than 4.0 mg per L; low levels of microcystin; and un-ionized ammonia (less than 0.5 mg per L). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph (77 FR 73739; USFWS 2012a p. 73750).

- PCE 2 – *Spawning and Rearing Habitat*. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 ft (1.3 m) with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water provide habitat for rearing and facilitate growth and survival of suckers, and provide protection from predation and protection from currents and turbulence (77 FR 73739; USFWS 2012a p. 73750).

- PCE 3 – *Food*. Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates (77 FR 73739; USFWS 2012a p. 73750).

We find the Project will have insignificant effects to critical habitat for the Lost River sucker and shortnose sucker based on the following rationale:

- For water (PCE 1), changes in dissolved oxygen and pH levels may occur from marine-derived nutrients. Based on research examining the effects of marine-derived nutrients and these water quality parameters, the effects in the basin will not be meaningfully measured, detected, or evaluated and any potential changes are considered insignificant. This is because pH levels are not expected to increase above 9.75, and dissolved oxygen is not expected to decrease below 4.0 milligrams per liter (Guyette 2012, Compton 2006, O'Keefe and Edwards 2002). The Project will have no effect on water quantity, depth, and temperature; un-ionized ammonia; or mycrosystin levels in critical habitat for these two species. The existing hypereutrophic (extremely rich in nutrients and minerals) conditions in Upper Klamath Lake may be increased by additional marine-derived nutrients, however, these impacts will depend on annual inputs from the amount of upstream migration and spawning by anadromous salmonids.

- The Project will not influence or affect spawning or rearing habitat (PCE 2) for either species. This is because the recolonization by anadromous salmonids will have no effect on spawning and rearing habitat needs and conditions for the Lost River and shortnose sucker.

- For food (PCE 3), the marine-derived nutrients from recolonizing anadromous salmonids will indirectly increase and benefit food resources for the Lost River and shortnose sucker over the long term.

Because the Project will have insignificant to no effects on PCE 1 (water), no effect on PCE 2 (spawning and rearing habitat), and beneficial effects on PCE 3 (food) in Critical Habitat Unit 1, we concur with the determination that the Project *may affect but is not likely to adversely affect* critical habitat for the Lost River sucker and shortnose sucker.

Critical Habitat for Bull Trout

The Project will facilitate upstream passage and access for anadromous salmonids into designated critical habitat for bull trout. Critical habitat for bull trout in the action area consists of the Klamath River Basin Critical Habitat Unit and its three sub-units: (1) Upper Klamath Lake; (2) Sycan River; and (3) Upper Sprague River, where historical use by Chinook salmon and steelhead is documented (Hamilton *et al*. 2005, Butler and Stevenson 2010). Bull trout, Chinook salmon and steelhead have evolved sympatrically[2] throughout most of the bull trout range and there is historical evidence that this sympatry included the Klamath River's upper basin (Hamilton *et al*. 2005).

To provide context for our concurrence below, the primary constituent elements (PCEs) of critical habitat for bull trout that are necessary to sustain the essential life-history functions and conservation of the species include (75 FR 63897; USFWS 2010 pp. 63931-63932):

- PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

- PCE 2: Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine

[2] Occupying the same geographical range without loss of identity from interbreeding.

foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

- PCE 3: An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and fish.

- PCE 4: Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

- PCE 5: Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia (cold water) when temperatures exceed the upper end of this range. Specific temperatures within this range will depend on the life history stage of the bull trout, geography, elevation, daily and seasonal variation, shading, streamflow and local groundwater influences.

- PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

- PCE 7: A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

- PCE 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

- PCE 9: Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

We find the Project will have discountable, insignificant and beneficial effects to critical habitat for bull trout based on the following rationale:

- Critical habitat for bull trout is not designated downstream of Upper Klamath Lake and the effects from reservoir drawdown and dam removal in the hydroelectric reach will not affect critical habitat for this species.

- The Project will not influence or affect PCEs 1, 2, or 4 through 7.

- The Project will affect PCE 3 (abundant food base) for bull trout because the removal of the four dams will facilitate upstream passage and access for anadromous salmonids into their designated critical habitat. The effects are expected to be beneficial because of the increase in food resources and marine-derived nutrients. This includes salmonid carcass flesh, eggs, fry, and smolts (Hamilton *et al*. 2010).

- The Project may affect PCE 8 and water quality parameters such as dissolved oxygen, or pH levels. However, these effects will not be meaningfully measurable or detectable and are considered insignificant (Guyette 2012, Compton 2006, O'Keefe and Edwards 2002).

- With respect to PCE 9, anadromous salmonids are not considered nonnative predatory, interbreeding, or competing fish species and therefore we expect discountable effects to PCE 9.

As the Project will have beneficial effects to PCE 3 (food), insignificant effects to PCE 8 (water quality), and discountable effects to PCE 9 (nonnative, predatory competing fish), we concur with the determination that the Project *may affect but is not likely to adversely affect* critical habitat for the bull trout in the Klamath River Basin critical habitat unit.

<u>Conclusion</u>

This concludes informal consultation pursuant to Section 7 of the Act for the potential effects of the Project on the northern spotted owl and its critical habitat, Franklin's bumble bee, the Oregon spotted frog, and critical habitat for the Lost River sucker, shortnose sucker, and bull trout.

As noted, this letter transmits the enclosed Biological Opinion, which concludes formal consultation for the Lost River sucker, shortnose sucker, and bull trout. The Biological Opinion includes our Incidental Take Statement, which also includes Reasonable and Prudent Measures and Terms and Conditions.

As stated in the enclosed Biological Opinion, Reasonable and Prudent Measure #2 requires the FERC to include a reopener clause in any license surrender order or other authorization for the amended surrender application for the Lower Klamath Project. The reopener clause provides for the possible amendment of the order or other authorization to incorporate any reasonable and prudent alternatives, reasonable and prudent measures, terms and conditions, and monitoring requirements resulting from any reinitiated consultation on the authorized action.

Lastly, the Service is currently reviewing the listing status of other species that may be affected by the Project. Listing determinations may be made under the ESA during Project implementation. This includes the little brown bat (*Myotis lucifugus*), Western bumble bee (*Bombus occidentalis*), Western pond turtle (*Actinemys marmorata*), monarch butterfly (*Danaus plexippus*), and possibly other species we do not yet know about. The Renewal Corporation has already addressed the effects of the Project to the monarch butterfly (see BA-Appendix B) and the Project includes minimization measures to reduce impacts to this candidate species.

Similarly, we recommend drafting conservation measures for and an analysis of project-level effects for the little brown bat, Western bumble bee, and Western pond turtle. We make this recommendation to minimize possible delays to the Project if any of these species were to become listed prior to surrender and decommissioning. We are available to provide technical assistance to assess project effects and suggest possible conservation measure. We recommend drafting these items in the next couple of months and look forward to working with you and/or the Renewal Corporation on this.

It will be necessary to contact our office if: 1) The amount or extent of incidental take described in Enclosure 1 is exceeded, 2) New information reveals effects from the action that may affect a listed species or critical habitat in a manner or to an extent not considered in this consultation, 3) The action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation; or 4) A new species is listed or critical habitat is designated that may be affected by the action.

If you have any additional questions regarding this letter, or the enclosed Biological Opinion, please contact me at (530) 841-3115 or by email at jenny_ericson@fws.gov, or contact my Deputy, Gina Glenne, at (530) 841-3112 or by email at gina_glenne@fws.gov. We will be happy to assist you.

Sincerely,

JENNY ERICSON

Digitally signed by JENNY ERICSON
Date: 2021.12.22 09:12:06 -08'00'

Jenny Ericson
Field Supervisor

Enclosure 1 – Biological Opinion for the Lower Klamath Project
Enclosure 2 – Conservation Recommendations for Pacific lamprey and Freshwater Mussels

cc. Diana Shannon, Ecologist, Federal Energy Regulatory Commission, OEP-Division of Hydropower Administration and Compliance, Diana.Shannon@ferc.gov
Mark Bransom, Chief Executive Officer, Klamath River Renewal Corporation, Mark@klamathrenewal.org

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Enclosure 1

Biological Opinion for the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project, Nos. 14803-001, 2082-063

Biological Opinion
LOWER KLAMATH PROJECT
08EYRE00-2021-F-0127
Federal Energy Regulatory Commission, California

Agency:
U.S. Fish and Wildlife Service
Region 10
Sacramento, CA

Biological Opinion Written by:
Yreka Fish and Wildlife Office
U.S. Fish and Wildlife Service
Region 10, Pacific Southwest Region
December 22, 2021

JENNY ERICSON
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Jenny Ericson, Project Leader
Yreka Fish and Wildlife Office

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
ac	Acres
AFA	*Aphanizomenon flos-aquae*
BA	Biological Assessment
BO	Biological Opinion
°C	degrees Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	Centimeter
DDT	Dichlorodiphenyltrichloroethane
DO	dissolved oxygen
ESA	Endangered Species Act
°F	degrees Fahrenheit
FR	Federal Register
ft	Feet
HCP	Habitat Conservation Plan
in	Inches
L	Liter
LOESS	locally estimated scatterplot smoothing
LRDC	Lost River Diversion Channel
m	Meters
mg	Milligram
mm	Millimeters
NMFS	National Marine Fisheries Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
ODEQ	Oregon Department of Environmental Quality
OWRD	Oregon Water Resources Department
PIT	Passive Integrated Transponder
POR	period of record
RPM	Reasonable and Prudent Measure
sec	Seconds
TAF	thousand acre-feet
TID	Tulelake Irrigation District
TMDL	Total Maximum Daily Load
UKL	Upper Klamath Lake
USBR	U.S. Bureau of Reclamation
USDI	U.S. Department of Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service

INTRODUCTION

This Biological Opinion (BO) responds to the August 2, 2021, request from the Federal Energy Regulatory Commission (FERC) for formal consultation regarding the consequences of the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project No. 14803 to the endangered Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*), and the threatened bull trout (*Salvelinus confluentus*) in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). The proposed action is hereafter defined as the Lower Klamath Project or project.

The Lower Klamath Project consists of removing four of the mainstem Klamath River hydroelectric facilities; J.C. Boyle Dam, Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, as well as the associated buildings and other infrastructure. Removing the dams will remove the reservoirs behind the dams where Lost River and shortnose suckers are currently found. These reservoirs are considered a population sink for these species.[1] The Klamath River will be restored to a free-flowing condition from the prior upstream extent of J.C. Boyle Reservoir in Oregon through the location of Iron Gate Dam in California (refer to BO-section 1.2).

As described in chapter 5, the Klamath Basin's hydrologic system consists of a complex of interconnected rivers, lakes, marshes, dams, diversions, wildlife refuges, wilderness areas, other federal and state lands, and private lands. Alterations to the natural hydrologic system began in the late 1800s and accelerated in the early 1900s. Currently, there is a complex network of water uses in the Klamath Basin, including the operation of several hydroelectric dams by the privately owned PacifiCorp, the United States Bureau of Reclamation, and multiple diversions by private users.

The FERC is the action agency for the Lower Klamath Project (project) and the Klamath River Renewal Corporation (Renewal Corporation), is FERC's designated non-federal representative for consultation on license surrender and decommissioning of the project. Before the project begins, the Renewal Corporation and the states of California and Oregon, as co-licensees, must accept the license transfer order approved by the FERC on June 17, 2021 and the FERC must approve the license surrender order. The dams can then be removed by the Renewal Corporation consistent with the decommissioning plans already submitted to the FERC (see section 5.9 for additional background; see also NMFS' Biological Opinion for additional history and background regarding the decommissioning process (NMFS 2021)). After the dams are removed, the Renewal Corporation will complete the channel restoration in the Klamath River, and other associated project monitoring, included in the project's design.

On March 22, 2021, the Renewal Corporation submitted the draft Biological Assessment (BA) they prepared for the project to the FERC. The FERC adopted the draft BA as a final BA on August 2, 2021. The BA determined the project *may affect and is likely to adversely* affect the Lost River sucker, shortnose sucker, and bull trout. As described in our transmittal letter for this BO, we

[1] A population in a low-quality habitat in which the birth rate is generally lower than the death rate and population density is maintained by immigrants from "source populations," which are generally more robust.

concur the project *may affect, but is not likely to adversely affect*, designated critical habitat for these three species. Therefore, this BO does not address effects to their critical habitat.

The conclusions for Lost River sucker, shortnose sucker, and bull trout in this BO are based on the analyses presented in the BA dated March 22, 2021, and its appendices. They are also based on information available during the Service's independent analysis. This includes 1) project maps and GIS data, 2) meeting notes and field visits, 3) recovery plans, 4) sampling results for suckers in the hydroelectric reach[2] from 2018-2020 (Renewal Corporation 2021), 5) terrestrial and aquatic resource management plans, 6) other scientific literature and studies, and 7) other supporting documents, data and additional information provided through August 31, 2021 when we received all of the information required to initiate formal consultation.

Clarifications and further interpretations regarding the project and its effects took place during interagency meetings, and through telephone conversations and email correspondence involving staff biologists and managers from the Yreka, Klamath Falls, and Arcata Fish and Wildlife Offices through December 22, 2021. Various site visits were also made to the action area by Field Office biologists during the planning phase from 2017 through 2021, informing our understanding of the project.

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) is addressing the effects of the Lower Klamath Project on listed anadromous[3] salmonids and other listed species under their jurisdiction in a separate BO (NMFS 2021).

This BO routinely references several key documents:

- The Revised Recovery Plan for the Lost River Sucker and Shortnose Sucker (USFWS 2013)
- The Recovery Plan for the Coterminous United States Population of Bull Trout (USFWS 2015a) and Klamath Recovery Unit Implementation Plan (USFWS 2015b)
- The Species Status Assessment for the Endangered Lost River Sucker and Shortnose Sucker (USFWS 2019c)
- The BO on the Effects of the Proposed Interim Klamath Project Operations Plan on the Lost River sucker and the shortnose sucker[4] (USFWS 2020)
- The formal Intra-service Section 7 Consultation on the issuance of a Section 10(a)(1)(B) Incidental Take Permit for PacifiCorp's Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for the Lost River and shortnose suckers (USFWS 2013a)

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[2] This is the reach of the Klamath River that encompasses the four dams and their associated facilities.

[3] Term that describes fish born in freshwater, who spend most of their lives in saltwater and return to freshwater to spawn.

[4] Alterations to the natural hydrologic system in the Upper Klamath Basin began in the late 1800s and expanded in the early 1900s, including water diversions by private water users, Reclamation's Klamath Irrigation Project, and several hydroelectric dams operated by a private company, currently known as PacifiCorp, a subsidiary of Berkshire Hathaway Energy. PacifiCorp operated the Klamath Hydroelectric Project under a 50-year license issued by the FERC until the license expired in 2006. Until FERC makes a decision either to surrender/decommission or to issue a new license the Klamath Hydroelectric Project, PacifiCorp continues to operate the Klamath Hydroelectric Project under annual licenses based on the terms of the previous license.

CONSULTATION HISTORY

During the consultation for the project, which extended from April 2017 through December 22, 2021, the Renewal Corporation and its contractors worked collaboratively with federal and state agencies. Numerous meetings, phone calls, and site visits occurred. Proposed action documents, technical construction plans, and aquatic and terrestrial management plans were developed and reviewed.

This section provides a summary of prior consultation considered relevant to the project and a summary of recent consultation proceedings. The full consultation history is included in Appendix A.

Relevant Prior Consultation Documents

- December 3, 2007, Biological Opinion for the Proposed Relicensing of the Klamath Hydroelectric Project, FERC Project No. 2082, Klamath River, Klamath County, Oregon, and Siskiyou County, California – Formal consultation that addressed relicensing, PacifiCorp's decommissioning of the Eastside and Westside Powerhouses at Link River Dam, and the continued operation of Keno Dam. See Chapter 5-section 5.9 for additional information.
- November 19, 2012, Joint Preliminary Biological Opinion for the Proposed Removal of Four Dams on the Klamath River – Formal consultation prepared by NMFS and the Service in response to a request from the Bureau of Reclamation (USBR) on October 31, 2012, for a preliminary Biological Opinion on the removal of Iron Gate, Copco No. 1 and No. 2, and J.C. Boyle Dams.
- April 10, 2020, Biological Opinion for the Proposed Interim Klamath Project Operations Plan, effective April 1, 2020 through September 30, 2022 – Interim consultation on the continued operation of the Klamath Project by the USBR in Klamath County in Oregon and Siskiyou and Modoc Counties in California. See Chapter 5-section 5.9 for additional information.

Recent Consultation History

- April 28, 2017, through December 21, 2021, numerous meetings, field reviews, and technical plan reviews. See Appendix A for details.
- The Service received a request for formal consultation from FERC on August 2, 2021, for the Lost River sucker, shortnose sucker, and bull trout.
- The Service requested additional information on August 11, 2021, regarding FERC's critical habitat determination for the Lost River sucker and shortnose sucker. Included in our request was a clarification regarding conferencing on Franklin's bumble bee (*Bombus franklini*).
- The Service received an erratum to the BA on August 16, 2021, from the Renewal Corporation regarding Lost River sucker and shortnose sucker critical habitat. We then received a response from FERC on August 31, 2021, that clarified their determination that

the project *may affect, but is not likely to adversely affect* Lost River sucker or shortnose sucker critical habitat. As described in the BO transmittal letter and Letter of Concurrence, the Service concurs with this determination. The Service sent a letter to FERC on September 3, 2021, informing them all the information required to initiate formal consultation had been received as of August 31, 2021.

- Between December 9 and December 15, 2021 – The Service reviewed updated versions of the Aquatic Resources Management Plan (ARMP), the Reservoir Area Management Plan (RAMP), and the Terrestrial and Wildlife Management Plan.

- December 13, 16, and 21, 2021, Section 7 Formal Consultation – The Service met with Renewal Corporation staff via Microsoft TEAMS virtual meetings, to review the Reasonable and Prudent Measures and the Terms and Conditions for the Lost River and shortnose sucker. We also reviewed and discussed the Conservation Recommendations for Pacific lamprey and freshwater mussels.

- December 22, 2021, Section 7 Formal Consultation – The Service signed and transmitted to the FERC our Biological Opinion for the Lower Klamath Project through electronic filing. The transmittal includes our concurrence for project actions that *may affect, but are not likely to adversely affect*, listed species or their critical habitat, and the Conservation Recommendations for Pacific lamprey and freshwater mussels.

The project files for this consultation are available, upon request, by contacting the Fish and Wildlife Service Field Office in Yreka, California.

1. DESCRIPTION OF PROPOSED ACTION

1.1. Location of Proposed Action

The proposed action extends from Iron Gate Dam in California to the upstream extent of J.C. Boyle Reservoir in Oregon (BA pp. 6-7), and includes areas in Siskiyou County, California and Klamath County, Oregon (see Figure 1). Most of the proposed action will occur at the four hydroelectric reach reservoirs and dams, centered approximately 50 miles northeast of Yreka, California. Additional project actions will occur at suitable locations as agreed upon by agencies that may include the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility near Chiloquin, Oregon, the Tule Lake National Wildlife Refuge, or another agreed-upon location.

The project area and limits of work is approximately 57,684 acres. The action area (see Chapter 2) assessed for the analysis in this BO is approximately 138,470 acres and includes 962 mainstem Klamath River and tributary miles.

1.2. Proposed Action

This section of the BO is based on information in the March 2021 BA. The purpose of the project is to facilitate large-scale fisheries restoration (BA p. 1). The project addresses limiting factors in the hydroelectric reach of the Klamath River such as a lack of fish passage, warm water temperatures, blue-green algae blooms, decreased sediment supply, sediment transport disruptions, and other factors. The outcome in the hydroelectric reach between Iron Gate Dam and J.C. Boyle Dam will be a free-flowing river with restored ecological function that provides for anadromous fish passage (addressed in NMFS' project BO), improved instream habitat quality and complexity, and improved water temperatures for threatened coho salmon (BA p. 2, NMFS 2021). The four reservoirs between Iron Gate Dam and J.C. Boyle Dam will cease to exist and the conditions in this reach are expected to be similar to the historic conditions in the Klamath River, prior to dam construction.

As described in the BA (p. 2), the proposed action is likely to:

- Provide anadromous fish with access to their historical habitat upstream of Iron Gate Dam to the headwaters of the Klamath Basin through the existing fish passage facilities at Keno Dam and Link River Dam.[5]
- Restore gravel recruitment, and the natural process of gravel transport and deposition, in both the hydroelectric reach and downstream of Iron Gate Dam.
- Create a more mobile streambed, which is expected to reduce fish disease by decreasing the population of annelid worms that serve as an alternate host for *Ceratonova shasta* (*C. shasta*), a deadly fish disease that causes significant juvenile coho salmon and Chinook salmon (*Oncorhynchus tshawytscha*) mortality in some years.
- Improve water quality.

The proposed action includes the removal of the four dams and their associated hydroelectric generation facilities and support structures over an 18 to 21-month period. This includes a 6 to 9-month period for site preparation, and a subsequent 12-month period for full reservoir drawdown and the removal of the four dams. To restore a free-flowing river in the hydroelectric reach, the proposed action includes:

1. Removal of the dams and their foundations
2. Removal of the power generation facilities
3. Removal of the water intake structures, canals, pipelines, and ancillary buildings
4. Partial removal of transmission lines

Restoration of the areas currently inundated by the four reservoirs includes reconnecting stream channels to the river channel and stabilizing lands disturbed during the removal of the dam facilities. The proposed action and project activities are described in the BA (pp. 17-91). The analysis in this BO focuses on the effects of the action and associated project activities that may affect Lost River sucker, shortnose sucker, and bull trout (see Table 1).

[5] The proposed action does not include any improvements at Keno Dam or Link River Dam.

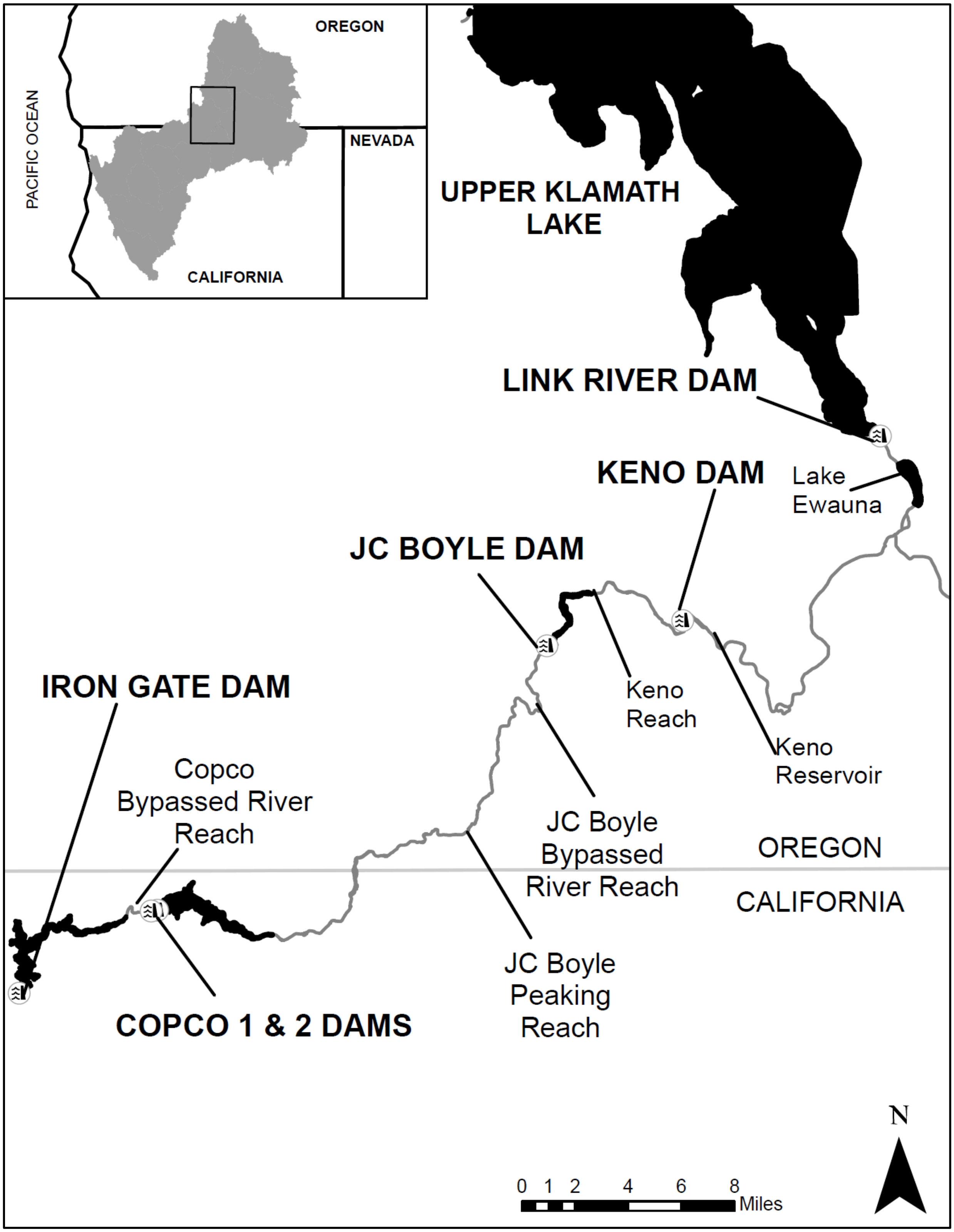

Figure 1. Lower Klamath Project Area.

The phases and timeline are as follows:

- The Renewal Corporation will begin pre-drawdown construction activities in the pre-drawdown year. (Year 0)
- Reservoir drawdown will begin in January after the pre-drawdown year. This is considered Year 1 or the drawdown year.
- The Construction Period, including dam removal and restoration construction, begins in the pre-drawdown year (Year 0), includes the drawdown year (Year 1) and extends through the post-drawdown year (Year 2).
- The restoration maintenance and monitoring period begins in Year 3 and extends for a total of five years (Years 3-7).
- The term of the proposed action is eight years (Y0-Y7)

1.2.1. Reservoir Drawdown and Diversion

Prior to reservoir drawdown, PacifiCorp will use the facilities' existing structures to lower each reservoir's water surface level to an elevation that is at, or near, their minimum allowable operating level. Then, starting on January 1 of the drawdown year (Year 1), drawdown and associated sediment passage through the dams will be accomplished with regulated releases. At each reservoir, drawdown will continue until the water level stabilizes at the elevation of the historical cofferdams,[6] though the approach may differ for Copco No. 2, as described in section 1.2.1.3 below. Then, the river will be connected to its historic channel by removing the cofferdams.

The reservoir drawdown and diversion approach are described below (Kiewit 2020) (BA p. 18). Facilities are as follows:

- At J.C. Boyle, drawdown facilities include the spillway and diversion culverts beneath the dam.
- At Copco No. 1, drawdown facilities include the power generation facilities, the spillway, one constructed outlet tunnel through the base of the dam, and a re-established historical diversion tunnel after the reservoir is substantially drawn down.
- At Copco No. 2, drawdown will occur through the existing power conveyance system and over the spillways.
- At Iron Gate, drawdown will occur initially through the power facilities and then via a modified diversion tunnel.

The penstocks (large pipes) at Copco No. 1 and Iron Gate provide only a minor amount of potential additional diversion. PacifiCorp and the Renewal Corporation will initially use these penstocks to lower water surface levels to the minimum operating level, and then will only use the power facilities as needed to keep water levels lowered until their use is no longer feasible.

To maintain compliance with the current BO (USFWS 2020) for interim operations of the Klamath Project, the Renewal Corporation will coordinate closely with the Bureau of Reclamation (USBR) as Upper Klamath Lake refills during the fall, winter, and spring months prior to and during drawdown (NMFS 2019 and USFWS 2020). The process of refilling Upper Klamath Lake affects

[6] A watertight enclosure that can be pumped dry to permit construction work below the waterline.

the discharge rates from Keno Dam down to J.C. Boyle Reservoir.

The Upper Klamath Basin's freshet (flooding from heavy rain or melted snow) from springtime runoff and precipitation will follow reservoir drawdown. Depending on the river basin's hydrology and reservoir inflows for the year, partial refilling of each reservoir may result throughout the drawdown period and be followed by subsequent periods of drawdown. Historically, the freshet ends by early June. The ability to control the water surface level (WSL) drawdown to a target of 5 feet per day are dictated by the actual river flows during the drawdown period. The exception to this is at Iron Gate Dam, where flows may be controlled by the existing gate and downstream orifice in the diversion tunnel.

The proposed action is a large multidimensional construction project subject to changing conditions that may affect the timeline. Alternative measures may be needed to facilitate anadromous fish passage around the Iron Gate construction site. Alternative measures will involve different drawdown scenarios and post-dam removal restoration actions based on the water year. The Aquatic Technical Working Group (ATWG) will meet frequently during project implementation, to guide actions and help with decision making and any alternative measures for anadromous fish passage, based on observed conditions. The projected water year, evaluated drawdown scenario, and projected schedule based on "year-of" conditions will be communicated by the ATWG to resource agencies including the FERC, the Division of Safety of Dams (DSOD), NMFS, the Service, and other agencies.

1.2.1.1. J.C. Boyle Reservoir

Drawdown of J.C. Boyle Reservoir will not require any new diversion structures. The existing power intake, spillway, and two low-level diversion culverts through the concrete portion of the dam under the spillway will be used. The existing earth-fill dam embankment and historical cofferdam will divert water into the diversion culverts during drawdown. At the beginning of drawdown, the intake gates will be gradually opened all the way and then low-level diversion culverts will be re-opened. The water conveyance system (pipeline and power canal) will be isolated from the reservoir as the water level drops, allowing for the decommissioning and selective removal of various components of the water conveyance system, powerhouse and substation.

The initial drawdown stages (Stages 1 and 2) will use the power facilities and spillway gates to bring the reservoir to minimum operating levels, depending on the Klamath River flow rates or conditions. The initial drawdown stages will achieve a target WSL rate of 5 feet per day. After initial drawdown, the power intake will be used as needed to divert water until the diversion culvert is opened. During this phase, the anticipated WSL drawdown rate may exceed 10 feet per day for a short period of time (BA p. 20).

The final stages of drawdown will be initiated by removing one of the two diversion-culvert concrete stoplogs (Stage 3), followed by the second stoplog (Stage 4). The stoplogs will be removed with controlled blasting. The drawdown process for J.C. Boyle Reservoir is considered complete when both diversion culverts are fully open and operating. Reservoir levels will continue to subside through the spring and summer months as flow rates in the Klamath River decrease. The diversion culverts will remain open and the entire river will flow through them until the embankment dam and historical cofferdam are deconstructed, channel restoration is complete, and volitional fish passage is established.

The design analysis for the 100% Design Report Revision C (Kiewit 2020) compared steady-state inflows to culvert rating curves to determine the maximum flow allowable for crews to safely access the downstream side of the diversion culverts.

The USBR controls the releases at the Link River Dam, and therefore has the capacity to regulate flows into J.C. Boyle Reservoir. For the safety of working crews during Stages 2 and 3, flow coordination with USBR will be finalized when climate information is available, and flow forecasts are prepared by USBR to keep the reservoir below its spillway crest (BA p. 20).

1.2.1.2. Copco No. 1 Reservoir

The drawdown of Copco No. 1 Reservoir will occur through a new low-level outlet tunnel in the dam. Prior to drawdown, in-water sediment and debris upstream of the dam will be dredged. This will help ensure the low-level outlet tunnel remains unobstructed during drawdown while river flows and sediment move through the tunnel. The approach channel for the historical diversion tunnel will be dredged prior to Year 1 to facilitate use of the tunnel during dam demolition and removal (BA p. 20).

Approximately 4,800 cubic yards of cobble, boulders, and fine sediment will be dredged from an area of approximately 0.5 acre from the upstream side of the dam. Dredged material will be transferred to a dredge barge and disposed of in-water, or on land. For the in-water disposal site, the disposal area will be approximately 2.25 acres, and located in water deeper than 50 feet (see the Appendix 2, Figure 2-7, Sheet 1 of the BA). The in-water disposal is pending approval from the United States Army Corps of Engineers (USACE). If this is not approved, the dredged material will be disposed of on land.

Dredging and other construction activities before final drawdown and dam removal will be completed during California’s in-water work period of June 15-October 15 (BA pp. 20-21). The dredge and disposal areas will not be isolated from the water.

The low-level outlet tunnel will be built by drilling and blasting from the downstream side of the dam and a steel pipe will then extend from the tunnel outlet to the downstream plunge pool, to convey reservoir water during drawdown. The tunnel will not be connected to the reservoir until drawdown is initiated in Year 1. In the interim, a concrete “tunnel plug” will remain in place to separate the tunnel from the reservoir until drawdown is initiated. The tunnel plug will be removed in Year 1 by blasting to initiate final drawdown through the steel pipe (BA p. 21).

1.2.1.3. Copco No. 2 Reservoir

Project activities at Copco No. 2 Reservoir before drawdown include modifying the downstream side of the dam. These modifications will allow the river to flow through a channel and the existing dam structure. These modifications will avoid the use of cofferdams or other structures in the river channel.

The modifications before drawdown will occur during the low-flow and in-water work period of June 15-October 15. A portion of the downstream face of the left-side spillway bay will be removed to create a downstream channel. The spillway gates will be closed and all river water will be passed through the power intake. Diversion through the power intake during the low-flow period will also allow for the construction of a temporary work platform on the downstream side of the existing dam in dry conditions.

When drawdown commences January 1 of the drawdown year, flows will be passed through the power conveyance system and over the spillways. The reservoir may be drawn down through the power intake when the final 17 feet of the dam's concrete is removed by a controlled blast. The concrete rubble will be removed with a long-arm hydraulic excavator and disposed of in the Copco concrete disposal area. Once the river flows are routed through Spillway Bay No. 1, the power intake gate will be permanently closed and reservoir drawdown will be complete. After drawdown, the diversion dam and historical cofferdam will be deconstructed, and river channel restoration will begin.

PacifiCorp's current approved operations plan for Copco No. 1, Copco No. 2, and Iron Gate allow for the river channel between the Copco No. 1 and No. 2 dams to be dewatered for short periods of time. Iron Gate Reservoir provides the required downstream flows during this period. Given this, the Copco No. 1 facility may be used to fully dewater the Copco No. 2 head pond, allowing for the removal of the Copco No. 2 dam and historical cofferdam without the need for a diversion. The viability of this alternate option will depend on approval from relevant agencies. This alternate approach would occur during the year prior to drawdown and could be used to dewater the Copco No. 2 Reservoir over a 5- to 10-day period (BA p. 21). If this option is approved, the Renewal Corporation will remove the entire concrete diversion dam, a portion of the intake structure to the final excavation limits, and historical cofferdam in the year prior to drawdown. Final channel restoration would also be completed at this time.

1.2.1.4. Iron Gate Reservoir

Beginning in July of the year before drawdown, the installation of the new control gate on the Iron Gate Dam outlet tower will require a platform (for crane work) be constructed on the upstream side of the dam. Construction of the work platform will take approximately 10 days and will occur after the reservoir is lowered to an elevation of 2,340.5 feet. This will allow rock and fill to be placed in dry conditions. The work platform will be constructed in dry conditions. Because of the unpredictability of river flows and a WSL that may vary based on weather and snowmelt, the work platform base could be inundated by subsequent flow increases and be subject to erosion (BA pp. 220-221).

Modifications will occur on the downstream side of the dam before drawdown (BA pp. 22). A temporary access road will be constructed across the spillway and tunnel outlet to provide access to the existing outlet of the diversion tunnel. The existing diversion tunnel will be partially lined with concrete and reinforced for drawdown use. Once drawdown begins on January 1, the existing diversion tunnel gate and downstream opening will be used to control the target drawdown WSL rate of 5 feet per day. The objective for drawdown is to safely achieve a reservoir level below the historical cofferdam at the upstream dam toe. At the final stage of dam deconstruction, a controlled breach of the cofferdam will be conducted to connect the mainstem river through the dam site.

The controlled breach will help regulate flows to the river and avoid flood impacts and public risk.

Prior to the final breach, the river channel through the dam embankment area will be constructed so when the cofferdam is breached, the river will be free flowing through this reach and volitional fish passage conditions will be met (BA p. 22).

1.2.2. Drawdown Rates of All Reservoirs

Drawdown in Year 1 will be controlled using gates and other controls (e.g., tunnel opening size) to maintain a safe drawdown rate that also provides embankment and reservoir rim stability. Reservoir water level simulations from January 1 through the freshet period have been developed based on the proposed controlled drawdown methods. Drawdown at the J.C. Boyle and Copco No. 1 dams will be restricted by the size of the openings through the dams, with no gates for drawdown modulation. Drawdown of Iron Gate Reservoir will be controlled by the gate in the diversion tunnel. During drawdown, the dams and critical portions of the reservoir rims will be monitored for signs of instability (BA p. 22).

Copco No. 2 Dam does not impound a significant volume of water or sediment (as described in Chapter 5 of this BO and BA p. 22). While this dam may be removed during the same year as the three larger dams, removal could occur prior to drawdown as described in section 1.2.1.3 above.

Reservoir drawdown rates at J.C. Boyle, Copco No. 1, and Iron Gate will target a WSL of 5 feet per day. However, as the reservoirs approach their maximum storage levels and there is limited storage remaining, there may be short periods when the target WSL rate is exceeded. This will depend on reservoir inflows from the upstream Klamath River and when more rapid lowering at the bottom of the reservoir is desired for sediment evacuation. Actual drawdown rates may be lower (or result in filling) during storms because of increased inflows to the reservoirs.

The time necessary to complete drawdown will depend on the hydrology during the drawdown year. Drawdown to the initial elevation (defined as the top of the historical coffer dams) is expected to be achieved between mid-January and mid-April in most water years. This elevation will then be held (and the reservoirs will be allowed to refill, depending on inflows) until the high inflows have ended for the season.

The diversion tunnels at the historical cofferdams will be connected to achieve final drawdown to the historical river channel elevation in June or July, depending on the water year hydrology. This approach will result in two peaks of suspended sediment concentrations in the Klamath River, one in winter/spring and one in summer.

During dry periods, the reservoirs can be drawn down more quickly, which will result in higher flows into the river. Because the WSL rates are within or just above the traditional power operation flows (or average freshet river flows), the magnitude of the drawdown-related flows is not necessarily greater. During wet periods, the reservoirs may partially refill and drain multiple times before the spring freshet ends. Each refilling and subsequent draining may mobilize additional sediment. Following the spring freshet, there will be a final flow and sediment release that occurs in summer, corresponding to the opening of the diversion tunnel at the Copco No. 1 dam.

1.2.3. Dam and Facilities Removal

This project activity consists of removing the four dams (except for buried features), the power generation facilities and some transmission lines, the water intake structures, canals, pipelines, and ancillary buildings. Hazardous materials will be removed from each dam site, and from any structural components left in place, per the Abatement Specifications provided by Entek for each of the four developments (Entek 2020a, b, c, d). If hazardous materials are not friable and are attached to a structure that will be buried, they will be buried in place. These standard practices will be followed: 1) make a detailed assessment of the material, 2) identify the required abatement needs and special handling needs (if required) for each type of hazardous material, and 3) assure compliance with legal disposal and transportation rules per local, state, and federal regulations. Any remaining structures will not impact the Klamath River's flow characteristics below the 100-year flood elevation (BA p. 23).

The quantity estimates for all features to be removed, including earth-fill volumes, concrete volumes, and weights of mechanical and electrical equipment, have been prepared using detailed engineering drawings provided by PacifiCorp. These are believed to represent current, as-built conditions.

A "Waste Disposal and Hazardous Materials Management Plan" identifies the disposal sites, materials, and best management practices (BMPs). The waste disposal actions will not affect instream or water resources in the hydroelectric reach, or any upstream habitat.

1.2.3.1. J.C. Boyle Dam

J.C. Boyle Dam is in a relatively narrow canyon. The minimum requirements for a free-flowing river and volitional fish passage include partial removal of the dam embankment and concrete cutoff wall. This will ensure long-term stability of the site and prevent potential development of a future fish barrier.

Once the reservoir is drawn down, the spillway gates and hoisting equipment will be removed prior to Oregon's in-water work period from July 1 to September 31. The spillway bays will remain open to discharge flood flows. Active dam deconstruction will begin in June of the drawdown year, and a volitional fish passage channel will be constructed by October 1 of the drawdown year, depending on river flows and conditions (BA p. 27).

After drawdown, the concrete spillway aprons will be partially demolished, and the area will be mechanically graded to construct a 20-foot-wide access road from the embankment excavation to the left bank. The deconstruction plan is designed to allow for removal of the dam removal in dry conditions. The deconstruction work will be isolated from river flows by leaving the upstream portion of the embankment and historical cofferdam in place as work platforms while the downstream dam section is removed (BA p. 27).

The remaining work platform will be demolished, and the historical cofferdam will be breached to establish volitional fish passage in this reach by the end of September. Additional channel restoration work will take place afterward (BA p. 27). The cofferdam will be removed by excavating the small embankment back towards the right bank. It is anticipated once the structure is breached, flows will naturally erode portions of the historical cofferdam during excavation. After excavation of the left embankment and historical cofferdam, the left bank access road will be rehabilitated. This will involve placing soil and grading this area to match the contours of the left bank disposal.

Embankment, work platform, historical cofferdam, and soft sediments will involve removing embankment soils to pre-dam channel elevations appropriate for volitional fish passage (BA p. 28). The final work platform breach and fill removal process is planned to occur in August and September of the drawdown year, when river levels are at seasonal lows (BA p. 28). The exact timing of the breach will be in accordance with low flow conditions and the breach may be delayed if high flows occur. Once the embankment dam and historical cofferdam are removed, a volitional fish passage channel will be established. Some in-water work will be necessary immediately upstream of the historical cofferdam to establish this channel. The completed channel will include fringe roughness (i.e., placement of boulders to aid fish passage) and slope protection to stabilize soils.

1.2.3.2. Copco No. 1 Dam

Copco No. 1 Dam is in a narrow canyon on the Klamath River. Minimum requirements for a free-flowing condition and volitional fish passage through this reach include removing the concrete gravity-arch dam between the left abutment rock contact, and the concrete intake structure on the right abutment. The elevation required for volitional fish passage is approximately 2,474.1 feet, to ensure future scour and ensure migration of the riverbed does not expose foundational concrete that could create a fish passage barrier.

The concrete dam will be removed to an elevation of 2,472.1 feet during the drawdown year. The concrete rubble will be pushed onto the spillway work platform at the base of the dam and hauled to the right bank disposal area.

The removal of the concrete foundation is targeted for completion in August or September, during the in-water work period when water surface levels will be at their lowest. This work will depend on the river’s hydrologic conditions and flows. The existing historical cofferdam will be left in place to direct flows into the diversion tunnel and allow for the removal of the concrete dam foundation in dry conditions. The concrete dam foundation will be removed to an elevation of 2,472.1 feet so future scour and migration of the riverbed does not expose foundational concrete and create a barrier for fish passage.

After the dam foundation is removed, the historical concrete cofferdam upstream of the main dam will be removed by drilling and blasting, or any other means necessary. Concrete and other spoils will be hauled to the disposal area. After the dam and historical cofferdam are removed, the diversion tunnel will be blocked by backfilling and burying the inlets. A grate will be installed at the outlet end to prevent human access while still allowing for groundwater drainage.

1.2.3.3. Copco No. 2 Dam

Copco No. 2 Dam is in a narrow canyon on the Klamath River approximately 0.4 mile downstream of Copco No. 1 Dam. All dam removal work here is expected to occur during the in-water work period.

The concrete at Spillway Bay No. 1 will be removed from between its two piers using blasting or mechanical demolition. In addition, a temporary channel may be excavated to route flows through

Spillway Bay No. 1 below the dam during the pre-drawdown period. The remainder of Spillway Bay No. 1 demolition will occur after January 1 of the drawdown year.

Dam deconstruction will consist of demolishing the concrete structure and spillway apron. Deconstruction will most likely begin at the left bank and move toward the right bank, removing all concrete down to an approximate elevation of 2,453.5 feet. The earth-fill embankment, historical diversion dam, and intake structure will be removed (BA p. 36).

1.2.3.4. Iron Gate Dam

Iron Gate Dam is in a relatively narrow canyon on the Klamath River. Minimum requirements for a free-flowing condition and volitional fish passage through this reach require the removal of the earth-fill embankment, the concrete cutoff walls, and the fish trapping and holding facilities that are downstream of the dam.

Following drawdown, the diversion tunnel gate will be open while the dam embankment is removed. At the conclusion of dam removal, and after breaching, the gate will be closed to backfill the opening and conform the river channel to final grade. Excavation of the embankment section will begin in early summer of the drawdown year and will be completed by early October. Earth-fill material from the embankment will be disposed of and buried.

Flow rates in the Klamath River are anticipated to decrease during each year, throughout the dam removal period (Year 1 and Year 2; see section 1.2) as part of the river's normal hydrologic cycle. Flow rates will increase from March to April, regardless of the water year based on the current Klamath Project operations (USFWS 2020). The lowest river flows should occur close to the time of final dam breach in early fall. The remaining embankment will be notched using heavy equipment and flows will progressively downcut the embankment to provide a controlled release of the remaining reservoir water.

The Renewal Corporation expects peak releases from final dam breach to be less than 6,000 cubic feet per second (cfs), if the WSL at the time of the breach is at or below 2,183 feet. Then the embankment will be removed, and the inlet and outlet of the diversion tunnel will be buried and permanently blocked off using coarse rockfill or concrete rubble. Using coarse material will help facilitate the drainage of any water accumulating in the tunnel after the river channel is restored. The features associated with the powerhouse penstock will be removed last. Most of the concrete thrust blocks will be deconstructed, but the final thrust block nearest to the powerhouse will be buried (BA p. 41).

1.2.4. Additional Actions

There are additional project activities associated with the proposed action that will affect the Lost River sucker or shortnose sucker (expected effects addressed in Chapter 6). These activities are described below and include road and bridge improvements to maintain a level of service comparable to existing conditions, as well as invasive exotic vegetation (IEV) management. These additional activities will not affect bull trout since the only project activity that affects this species is restoring access for anadromous salmonids to the upper Klamath Basin, through dam removal and channel restoration.

1.2.4.1. Copco Road Culverts at Scotch Creek, Camp Creek and Fall Creek

Corrugated metal pipes measuring 120 inches in diameter pass beneath Copco Road at both Scotch and Camp Creeks, adjacent to and just upstream of their confluences with Iron Gate Reservoir. Erosion is anticipated at both locations after reservoir drawdown. This erosion will lead to perched culvert outlets and non-passable fish barriers. Therefore, the culverts will be replaced with box culverts prior to drawdown (BA p. 67). These modifications at the Scotch and Camp Creek crossings will provide suitable erosion protection. The design, construction and placement of the new box culverts will meet anadromous fish passage requirements (NMFS 2001).

Daggett Road crosses the mouth of Fall Creek at Iron Gate Reservoir. As with Scotch and Camp Creeks, erosion after reservoir drawdown will likely result in a perched culvert outlet and a barrier to fish passage. Therefore, the existing culvert will be replaced with an arch culvert prior to drawdown and will provide protection from erosion during the drawdown year's summer months (BA p. 67). The arch culvert will meet anadromous fish passage requirements (NMFS 2001).

1.2.4.2. Temporary In-Water Bridge Upstream of Daggett Road Bridge

A temporary bridge will be constructed in the water immediately upstream of the Daggett Road bridge crossing on the Klamath River at the upstream end of Iron Gate Reservoir. Construction will include placing rock abutments on either side of the river channel/reservoir and spanning the channel with a 140-foot-long by 18-foot-wide bridge. These abutments will extend approximately 100 feet and 40 feet into the channel from the river-left and river-right banks, respectively. Constructing the abutments will require the excavation of vegetation, soil, and loose channel bed materials; the placement of rock fill and riprap; and the construction of cast in-place or pre-cast concrete structures in the wetted channel. Due to the anticipated volume of river flow, it will not be feasible to pump turbid water from the construction site (BA p. 220).

1.2.4.3. Invasive Exotic Vegetation Management

Control and containment will be the primary strategies for invasive exotic vegetation (IEV) treatment. Efforts will focus on invasive species that are found everywhere (ubiquitous) on the landscape, those near restoration areas, and those that cannot be realistically eradicated or contained for long periods (BA p. 55). A combination of methods will be used including mechanical treatment (grubbing, which is shallow digging in the soil, or mowing) and chemical treatments. Chemical treatments will be minimized and used only on those invasive species that are not effectively treated mechanically.

Herbicides will be used for species that cannot be removed mechanically. Only herbicides approved for use by the Bureau of Land Management, the California Department of Fish and Wildlife (CDFW), the Oregon Department of Fish and Wildlife (ODFW), the Regional Water Quality Control Boards, the Service and NMFS, the Renewal Corporation, and Native American Tribes will be considered. Herbicides will be applied in fall, winter, and early spring and will be rotated when possible, to reduce the plant's resistance to the herbicide. Spot spraying will be primarily used. All herbicides will be applied according to label specifications and by a California Licensed Qualified Applicator and approved by the U.S. Environmental Protection Agency (EPA). Application timing and location will minimize chemical contamination into waterways. Invasive plant populations near the water will only be treated with AquaNeat®. AquaNeat® is an herbicide designed for use in aquatic environments and is approved by EPA for use in or near water.

The IEV treatments will require a multi-year approach to ensure containment or eradication goals are achieved. Treatment will begin during pre-drawdown site preparation activities, will continue through facility demolition, and will extend 2-3 years after drawdown and into the monitoring period. Although the total eradication or prevention of IEV in the de-watered reservoir footprint areas is not possible, the strategy will be to minimize IEV presence during the critical early phases of native plant establishment (BA Appendix C p. 69).

The strategies for controlling IEV will differ for each revegetation period. Prior to dam removal, restoration staff will work at the watershed scale to eradicate and contain populations of IEV to limit the opportunity for propagules (a bud or spore) to disperse into the dewatered reservoirs (Von Holle and Simberloff 2005). The highest priority sites for IEV management will be the future access points for equipment and staging areas. A 50- to 100-foot buffer will be established around all future staging areas. All invasive, exotic vegetation will be removed from this buffer, and it will be maintained as such throughout the use of the temporary access sites.

During demolition, IEV management will continue at the watershed scale, but the priority will shift to evaluating and eradicating pioneer populations of IEV in newly exposed areas within the de-watered reservoir footprint areas (Moody and Mack 1988). Preventing the introduction of invasive, exotic vegetation can be achieved by focusing management on roads and access points. New trails and roads that are established in the dewatered reservoir footprints will act as pathways for invasive species introduction (seeds and roots). Therefore, the Renewal Corporation will maintain a 50-foot buffer around the access trails and roads that is free of IEV, during and after dam demolition (BA p. 82).

1.2.5. Summary and Schedule of Proposed In-Water Work Activities

Much of the dam removal work will occur during dry conditions following reservoir drawdown. Table 1 summarizes the proposed in-water work activities.

Table 1. Summary of In-Water Activities for the Lower Klamath Project that will affect Lost River sucker or shortnose sucker.

Location	Description of Work	Approximate Schedule
J.C. Boyle, Copco No. 1 and Iron Gate Reservoirs	Implement Action 2 of the Conservation Measure: Capture and Translocation of adult Lost River suckers and shortnose suckers	Prior to Final Drawdown
J.C. Boyle Dam and Reservoir	In-water blasting of concrete stoplogs	Drawdown Year (Year 1)
Open water disposal site in Copco No. 1 Reservoir, shown on Figure 2-7, Sheet 1.	Removal of sediment upstream of dam using clamshell or suction dredging from barge and in-water or on-land disposal.	July-August of pre-drawdown year (Year 0)
Copco No. 1 Dam	Drilling and blasting to excavate low-level tunnel through dam	July-August of pre-drawdown year (Year 0)
Copco No. 1 Dam	Remove last parts of dam and in-water work; may include in-water blasting.	August to September of Year 1
Daggett Road near upstream section of Iron Gate Reservoir	Install temporary bridge in-water, just upstream of existing Daggett Road bridge. Embank abutments.	July-August of pre-drawdown year (Year 0)
Camp Creek – downstream of existing stream crossing culvert	Install new box culverts (BA p. 67).	Prior to Drawdown and Year 1
Scotch Creek – downstream of existing stream crossing culvert		
Fall Creek at Daggett Road	Install new arch culvert (BA p. 67).	Prior to Drawdown
In-water work pad upstream of Iron Gate dam	Construct in-water work pad on upstream side of dam to allow access for crane and other equipment.	July to August of the year before drawdown (Year 0)
Dam removal – final breach and removal	Blasting and Mechanical Breach, Concrete Debris Removal and Disposal; will consist of some in-water work.	August to mid-October/mid-November Year 1

1.3. Conservation Measures

As described in the ESA Consultation Handbook (USFWS and NMFS 1998), conservation measures benefit or promote the recovery of listed species and are an integral part of the proposed action. These measures serve to minimize or compensate for project effects. They may occur prior to the initiation of consultation, or are those measures that the Federal action agency, or applicant, commits to complete in a biological assessment or similar document (USFWS and NMFS 1998 pp. xii, E-8). Conservation measures are reasonably specific, certain to occur, capable of implementation, subject to deadlines, or are otherwise enforceable.

Conservation measures represent actions pledged in the project description that the action agency or applicant will implement to further the recovery of the species under review. They are closely related to the action and should be achievable within the authority of the action agency or applicant. Since conservation measures are part of the proposed action, their implementation is required under the terms of this consultation (USFWS and NMFS 1998 p. 4-19).

As described in the BA, conservation measures are included for listed species and their habitats (BA pp. 75-84, and the Aquatic and Terrestrial Management Plans). The conservation measure specific to Lost River sucker and shortnose sucker is summarized below. There are no conservation measures for bull trout.

One conservation measure was developed to reduce impacts to Lost River sucker and shortnose sucker in the hydroelectric reach. Lost River sucker and shortnose sucker are lake-type suckers and will not persist in the Klamath River below Keno Dam after drawdown, dam removal, and the restoration of the hydroelectric reach. Any Lost River suckers or shortnose suckers that are entrained[7] or have drifted from Upper Klamath Lake into the Klamath River and the hydroelectric reach below Keno Dam do not migrate back upstream because of the natural high-gradient channel reach between Keno Dam and J.C. Boyle Reservoir (BA p. 80).

The conservation measure consists of two parts or two actions. Action 1 has been completed. Action 2 will reduce mortality and adverse effects to listed suckers in the hydroelectric reach reservoirs, prior to drawdown activities.

1) Action 1 (completed) – Under a recovery permit per ESA section 10(a)(1)(A) Lost River suckers and shortnose suckers were captured and released by the Renewal Corporation during the fall of 2018, both the spring and fall of 2019, and the spring of 2020 (USFWS 2018, 2019, 2020). Each sampling effort spanned 5-7 days, with a total effort of 24 days for the entire sampling period.

   For each capture, field crews identified, measured, evaluated body condition, photographed, tagged, fin clipped, and then released the fish. The passive integrated transponder (PIT) tags were used to mark listed suckers with unique identifications, and the information from re-captured suckers helped generate the population estimates in J.C. Boyle, Copco No.1, and Iron Gate Reservoirs (BO Table 2) (BA-Appendix D).

   The 2018-2020 sampling effort was designed to help the Service understand sucker demographics and population sizes in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs. These sampling efforts will be used to identify where to focus capture efforts to complete Action 2, described below. Both efforts may help inform the genetic makeup of suckers in the reservoirs. The Service compiled genetic libraries for four Klamath sucker species including Lost River sucker, shortnose sucker, Klamath largescale (*Catostomus snyderi*), and Klamath smallscale (*Catostomus rimiculus*) based on sampling efforts before 2018 (Smith *et al*. 2020). Preliminary results suggest the genetic variation within each of these

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[7] When fish are transported along with the flow of water and out of their normal river, lake or reservoir habitat into and through a canal, dam, or other facility.

four species is partitioned among the Mid and Upper Klamath River subbasins, and there are potentially thousands of genetic markers for species and population differentiation that could be conserved to enhance recovery efforts for Lost River and shortnose suckers (Smith *et al*. 2020).

2) Action 2 – Using the information from the 2018-2020 sampling efforts, adult Lost River and shortnose suckers will be captured from J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs prior to final drawdown activities. These suckers will be translocated to the Klamath Falls National Fish Hatchery near Klamath Falls, Oregon; the Klamath Tribes' sucker rearing facility near Chiloquin, Oregon; the Tule Lake National Wildlife Refuge (NWR) near Tulelake, California; or other translocation sites that may be identified based on further planning and agreement between the Service, ODFW, CDFW, and the Renewal Corporation. All actions associated with this conservation measure shall comply with all other Federal, State, and local laws and regulations. This includes any permits associated with transporting fish across State lines between California and Oregon.

   The capture and translocation effort will occur prior to final reservoir drawdown. These efforts will be conducted for up to a total of 14 days. If safely feasible, suckers may also be captured during the drawdown of J.C. Boyle Reservoir, because it is the most accessible of the three reservoirs. The methods for capture and translocation are described below. It is estimated that approximately 600 listed suckers will be captured and translocated during the 2-week period (BA p. 81). It is possible that additional suckers may be captured and translocated. If so, the capture and translocation will be in accordance with the BA, BA-Appendix D, and the methods described below.

1.3.1. Methods and Timing

The methods for salvaging and translocating listed adult suckers will follow the guidelines from the "Aquatic Resource Measure – Sucker Adaptive Management Plans." The plans were developed for suckers inhabiting J.C. Boyle Reservoir in Oregon (the Oregon Plan), and Copco No. 1 and Iron Gate Reservoirs in California (the California Plan). These plans are summarized in Appendices B and F of BA-Appendix D.

Action 2 will occur before final reservoir drawdown. This action will be more effective during spring, when water temperatures exceed 10 °C and 12 °C, respectively (Renewal Corporation 2021, Hewitt *et al*. 2017). Lost River suckers and shortnose suckers also congregate in shallower habitats at this time of year (Hewitt *et al*. 2017). If a spring capture can occur, it will be completed between mid-April and early May, this is when suckers congregate near the surface (Renewal Corporation 2021, Hewitt *et al*. 2017). If occurs in the fall, it will occur after water temperatures decrease to less than 16 °C, this is when the microcystin (an algal toxin that can affect the liver) levels decline to concentrations below the human-health advisory levels. Therefore, if a fall capture occurs, it will take place between late October and early November.

1.3.2. Water Quality Assessment

Prior to completing Action 2, water quality conditions in the reservoirs, and the agreed-to translocation sites, will be assessed. Data on water temperature, dissolved oxygen, salinity concentrations, and pH levels will be collected. Acquiring this information in advance will assure water conditions in the live wells (used for transporting suckers) are consistent with the reservoirs and translocation sites. It will also help plan for an appropriate water-acclimation period at the translocation sites.

1.3.3. Capture

Locations for the Action 2 capture effort in Copco No. 1 and Iron Gate Reservoirs will occur at successful sampling locations, specifically shallower habitats associated with coves and tributary confluences. During a spring capture, the one-mile reach of the Klamath River upstream of Copco Road Bridge will be prioritized.

In the J.C. Boyle Reservoir, capture locations will also occur at successful sampling areas, including shallow habitats associated with reservoir margins and deeper habitats associated with the historical Klamath River channel (Evans *et al*. 2016, Banish *et al*. 2007, 2009, Markle and Dunsmoor 2007). The deeper habitats will be targeted because suckers inhabit deeper habitats in Upper Klamath Lake (Reiser *et al*. 2001). The upper 0.25 mile where the Klamath River enters the J.C. Boyle reservoir will be the focus of the capture effort.

Suckers will be captured over a 14-day period. This includes five days on Copco No. 1 Reservoir, two days on Iron Gate Reservoir, and seven days on J.C. Boyle Reservoir. Adult suckers will be primarily captured at night using electrofishing and trammel nets from boats. Tangle nets may be used in riverine reaches if congregations of suckers are encountered here during electrofishing. Tangle nets or a resistance board weir may be used to capture suckers from the upstream extent of Copco No. 1 or J.C. Boyle Reservoirs, or in the riverine reaches upstream of all three reservoirs. Larval and juvenile Lost River and shortnose suckers will not be captured because they are too difficult to tell apart from Klamath small-scale sucker. When Action 2 is implemented, agency biologists will coordinate and communicate with the Renewal Corporation to ensure that approved methods for fish capture, and translocation, are followed and are being used correctly.

Lost River and shortnose suckers that are captured will be identified to species and sex, measured, fin clipped, photographed, and PIT tagged. Each captured sucker will be scanned to detect any existing PIT tags. The time to complete these actions per fish is an average of two minutes (M. Shaffer, personal communication, July 27, 2021). Pulling nets in and selecting fish from nets can take 10-30 minutes, or longer if there is a large amount of bycatch of other species. Individuals will be placed in aerated live wells on the boats and periodically transferred to net pens near the boat access sites, where they will be held until transport.

1.3.4. Transport

When ready for transport, Lost River and shortnose suckers will be moved from net pens to aerated live wells on trucks or trailers. Each sucker will be scanned and weighed to record the PIT tag identification prior to loading into the live well. Live wells will hold approximately 200-300 gallons of water and will be constructed of fiberglass, steel or polyethylene. The live wells will also be baffled to limit sloshing during transport, reducing potential impacts to suckers.

For safe and humane transport, fish density should be roughly 1 lb. of fish per gallon of water. Sucker weight varies by species and habitat, among other factors. Suckers will be stocked into the live wells at densities appropriate to their size and species. No more than 165 lbs. of Lost River or shortnose suckers will be held in a 160-gallon tank (Reclamation 2008). Following these guidelines is expected to reduce stress on or impacts to individuals during transport.

The travel time between the reservoirs and the translocation sites ranges between 1-2 hours. Water temperature in the live wells will be monitored during transport and will need to remain within 4 °C of the initial ambient water temperature.

During transport, water temperatures in the live wells will be monitored, and regulated by chillers or heaters. Dissolved oxygen concentrations will be monitored and maintained at approximately 100 percent saturation. If needed, a portable aeration system will be used to regulate and maintain dissolved oxygen levels to reduce impacts to suckers during transport. All actions will occur in accordance with state and federal permit requirements for translocating fish.

1.3.5. Translocation Sites

Captured suckers will be translocated to the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, the Tule Lake NWR, or other translocation sites that may be identified based on further planning and agreement between the Service, ODFW, CDFW, and the Renewal Corporation.

As a first priority, individuals will be translocated to the Klamath Falls National Fish Hatchery to support the Sucker Assisted Rearing Program. The hatchery currently has capacity for 100 adult suckers. Approximately 60-70 shortnose suckers will be delivered to the hatchery; estimated at 30-35 from J.C. Boyle and 30-35 from Copco No. 1 Reservoirs. Approximately 30-40 Lost River suckers from J.C. Boyle Reservoir will be delivered to the hatchery. Before being integrated into hatchery groups as brood stock,[8] suckers will be held in isolation and receive an external parasite treatment. The genetics of translocated suckers will also be analyzed.

Any Lost River or shortnose suckers that are captured in J.C. Boyle Reservoir that exceed the hatchery's capacity will be translocated to the Klamath Tribes' sucker rearing facility in Oregon. This facility has two ponds, and three additional 0.5-acre ponds will be developed prior to translocation. The total capacity is expected to hold 2,000 adult suckers (A. Gonyaw, personal communication, August 26, 2021). Translocated suckers will also receive an external parasite treatment before release into the rearing ponds. Rearing pond effluent will be discharged to a dry basin, so no pond effluent will discharge to the Sprague River. The Klamath Tribes, ODFW, or the Service will genetically test these fish and conduct fish health investigations before they are released from the hatchery.

The Klamath Tribes anticipate holding the translocated suckers for 3 to 5 years before they are released either into Upper Klamath Lake, or another location to be determined in the future with approval and coordination with the Service. If another location (e.g., Upper Klamath Lake, Indian Tom Lake, or others) is agreed upon by the Service, the Klamath Tribes, ODFW and CDFW, then any translocated suckers will also be held in isolation (a net pen) and receive an external parasite

[8] Brood stock is a small population of any animal that is maintained as a source of population replacement, or for the establishment of a new population(s) in suitable habitats.

treatment prior to their release at another site.

To acclimate Lost River and shortnose sucker adults at translocation sites, the reservoir water in each live well will be replaced with water from the recipient waterbody over a 1-hour timeframe. Approximately one-quarter to half of the reservoir water will be drained from the live well and replaced with recipient waterbody water to "temper" the live well and help acclimate suckers to the recipient waterbody's water quality conditions.

1.4. Best Management Practices

1.4.1. Herbicide Application

A comprehensive list of best management practices (BMPs) describing minimization of herbicide drift, leaching, and runoff, as well as herbicide application methods, is included in BA-Appendix C. The following information is included here to address herbicide application near or that could enter water occupied by Lost River and shortnose suckers.

Herbicide application that consists of a combination of approved products will use the most conservative buffer for the included herbicides. Buffer widths are measured as a mapped distance perpendicular to the bankfull width for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Herbicides that are safe for aquatic use such as AquaNeat® will have "no-application" buffer of 100 feet for broadcast spraying but can be used up to the waterline for spot spraying or manual application. Other herbicides (Dicamba and Metsulfuron-methyl) with a low risk to aquatic organisms will be used with a buffer of 100 feet for broadcast spraying, and 15 feet for spot spraying and hand application.

The following BMPs will protect aquatic resources, including Lost River and shortnose suckers and water quality conditions:

1. Obtain National Pollutant Discharge Elimination System (NPDES) permit from California Environmental Protection Agency (CalEPA) and Oregon Department of Environmental Quality (ODEQ).
2. Use local historical weather data to choose the month of treatment. Considering the phenology of the invasive exotic vegetation, schedule treatments based on the condition of the water body and existing water quality conditions.
3. Review hydrogeologic maps of proposed treatment areas. Note depths to groundwater and areas of shallow groundwater and areas of surface water and groundwater interaction.
4. Minimize treating areas with high risk for groundwater contamination.
5. Minimize the potential effects to surface water quality and quantity by stabilizing terrestrial areas as quickly as possible following treatment.
6. Minimize treatments near fish-bearing water bodies during periods when fish are in life stages most sensitive to the herbicide(s) being used and utilize spot treatments rather than broadcast or aerial treatments during this time.
7. For treatment of aquatic vegetation:
    a. Treat only that portion of the aquatic system necessary to achieve acceptable vegetation management.
    b. Use the appropriate application method to minimize the potential for injury to

desirable vegetation and aquatic organisms.
c. Follow water use restrictions presented on the herbicide label.

1.4.2. Erosion and Equipment Operation BMPs

Best management practices will also help minimize erosion and sediment runoff, and thereby protect water quality, during ground and soil disturbance. The following BMPs are included:

1. Maintain an adequate supply of materials necessary to control erosion at the construction site.
2. Deploy compost berms, impervious materials, or other effective methods during rain events or when stockpiles are not moved or reshaped for more than 48 hours (stockpile erosion should not occur).
3. Inspect erosion control measures and maintain erosion control measures as often as necessary to verify continued effectiveness of the BMP until exposed soil is stabilized.
4. Make repairs, install replacements, or install additional controls, as necessary, if monitoring or inspections show the erosion and sediment controls are ineffective.
5. Remove sediment to its original contour if it has reached 1/3 of the exposed height of a sediment or erosion control.
6. Use removable pads or mats to reduce soil compaction at construction access points through, and staging areas in, riparian or wetland areas.
7. Flag or fence off wetlands that are not authorized for impacts, to protect them from disturbance and/or erosion.
8. Place dredged or other excavated material on upland areas with stable slopes to reduce materials from eroding back into waterways or wetlands.
9. Place clean aggregate and utilize other BMPs at construction entrances, including but not limited to, washing vehicle wheels when earth-moving equipment is leaving the site and traveling on paved surfaces.

Additional BMPs are described in the Oregon and California NPDES General Permits and includes temporary and permanent BMPs and monitoring to regulate stormwater runoff to surface waters.

1.5. Conservation Measures and Best Management Practices Summary

Action 2 of the conservation measure described above will help promote the recovery of Lost River and shortnose suckers by translocating individuals that would otherwise die, and having them available as future brood stock, or to eventually release into Upper Klamath Lake. It will help minimize the adverse consequences of the proposed action on adult Lost River and shortnose suckers in the hydroelectric reach reservoirs by removing a portion of the population before drawdown and dam removal (see Chapter 6). The sampling information from Action 1 will help the Renewal Corporation determine where to focus their capture efforts during Action 2 in the reservoirs to help achieve higher capture rates.

Our analysis of the impacts to and the determinations for Lost River sucker, shortnose sucker, and bull trout are based on the implementation of the project as described in the BA. This includes the conservation measures committed to in the BA and described above, and the BMPs for equipment operation, dust abatement, herbicide application, and erosion as described in both the BA and BA

Appendices C, D, E; and the Reservoir Area, Aquatic Restoration, and Terrestrial Wildlife Management Plans.

2. Purpose and Organization of this Biological Opinion

Because the FERC and the Renewal Corporation determined the proposed action "*may affect, and is likely to adversely affect*" the Lost River sucker, shortnose sucker, and bull trout, it has requested formal consultation with the Service. For formal consultation, the Service issues a BO that evaluates the consequences of a proposed action and determines whether it is likely to jeopardize the continued existence of the species. If there are adverse effects to critical habitat, the Service also evaluates if the proposed action will destroy or adversely modify designated critical habitat. The requirement for all Federal actions to not jeopardize the continued existence of listed species, or destroy or adversely modify critical habitat, is described in Section 7(a)(2) of the ESA. The regulatory definition of jeopardy and a description of the formal consultation process can be found at 50 CFR § 402.02 and § 402.14.

For this BO:

- The Status of the Species is described in Chapter 3, as well as Appendices B and C.
- The threats, species needs, and species recovery plans and recovery objectives are described in Chapter 4.
- The environmental baseline for the 138,470-acre action area, as well as 962 miles of the Klamath River (226 miles) and tributary streams (736 miles), is described in Chapter 5.
- The effects of the action are described in Chapter 6.
- Cumulative effects are described in Chapter 7.
- Chapters 8 and 9 include our Summary and Synthesis of the proposed action, and our Section 7(a)(2) conclusion regarding jeopardy, using the information from Chapters 3-7, and Appendices B and C.

2.1. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area for the project consists of the geographic extent anticipated for potential effects of the dam removal activities, and the resulting free-flowing river condition in the hydroelectric reach on all evaluated listed species (BA p. 92). Specific to this BO, it also includes the current proposed translocation areas for the Lost River and shortnose sucker.

The Action Area (see Figure 2) for our effects analysis includes the following:

- Upper Klamath Lake and its fish-bearing tributaries, up to the limit of anadromy as defined by ODFW (2020) which includes the area expected to be recolonized by Chinook salmon and steelhead after implementation of the proposed action.

- The Klamath River from Upper Klamath Lake downstream to the mouth of the Klamath River estuary.

All fish-bearing tributaries of the Klamath River upstream of Iron Gate Dam, up to the limit of anadromy. For those tributaries in Oregon, the limit of anadromy is defined by ODFW (2020).

- The area within 1.5 miles of the project's construction limits in the hydroelectric reach, which contains the four dams and reservoirs to be removed and encompasses the extent of fish passage actions on the main tributaries as well as the entire construction footprint. This 1.5-mile buffer is conservative and encompasses the area of potential effects related to noise from construction activities including blasting activities at the dams, restoration work in tributaries, work at disposal sites, road work, and hauling.
- The 100-year floodplain from the Link River Dam to the mouth of the Klamath River.
- The Tule Lake National Wildlife Refuge, including Tule Sump 1A and Sump 1B to account for the effects of translocated suckers or any existing suckers in these locations. Suckers translocated to the Tule Lake National Wildlife Refuge will be subject to protections under existing and future ESA consultations on the Klamath Project operations.
- The Klamath Falls National Fish Hatchery near Klamath Falls, Oregon and the Klamath Tribes' sucker rearing facility near Chiloquin, Oregon to account for translocation. Once the captured suckers arrive at these facilities, any injury, harm, or death will be covered by existing permits to operate these facilities.

2.1.1. Historic Range of Anadromous Salmonids Under NMFS Jurisdiction

Klamath River Chinook salmon and steelhead historically used tributaries throughout the Klamath Basin, including streams and rivers upstream of Upper Klamath Lake (Hamilton *et al*. 2005). Spring-run and fall-run Chinook salmon migrated throughout the Klamath Basin prior to the construction of the historical Klamathon Dam (near Iron Gate Dam) and Copco No. 1 Dam (Hamilton *et al*. 2016). Prior to the construction of Iron Gate Dam, Chinook salmon spawned in Jenny, Fall, Shovel, and Spencer Creeks (Hamilton *et al*. 2005). Historical accounts and summaries of these accounts document Chinook salmon in the tributaries above Upper Klamath Lake, including the Williamson, Sprague, and Wood rivers prior to dam construction (Lane and Lane Associates 1981, Nehlsen *et al*. 1991, Moyle 2002).

Prior to the construction of Iron Gate dam, steelhead spawned in Scotch Creek, Camp Creek, and Fall Creek (Fortune *et al*. 1966, King *et al*. 1977, Hamilton *et al.* 2005). Additionally, steelhead were documented in Spencer Creek, as well as the Wood River, the Sprague River, and the Williamson River in the Upper Klamath Basin before dam construction (Fortune *et al*. 1966, Moyle 2002).

The project is likely to restore access to approximately 81 miles of suitable riverine, side channel, and tributary habitat in the hydroelectric reach, and restore access in 49 tributaries accounting for over 420 miles of historical aquatic habitat throughout the Klamath Basin

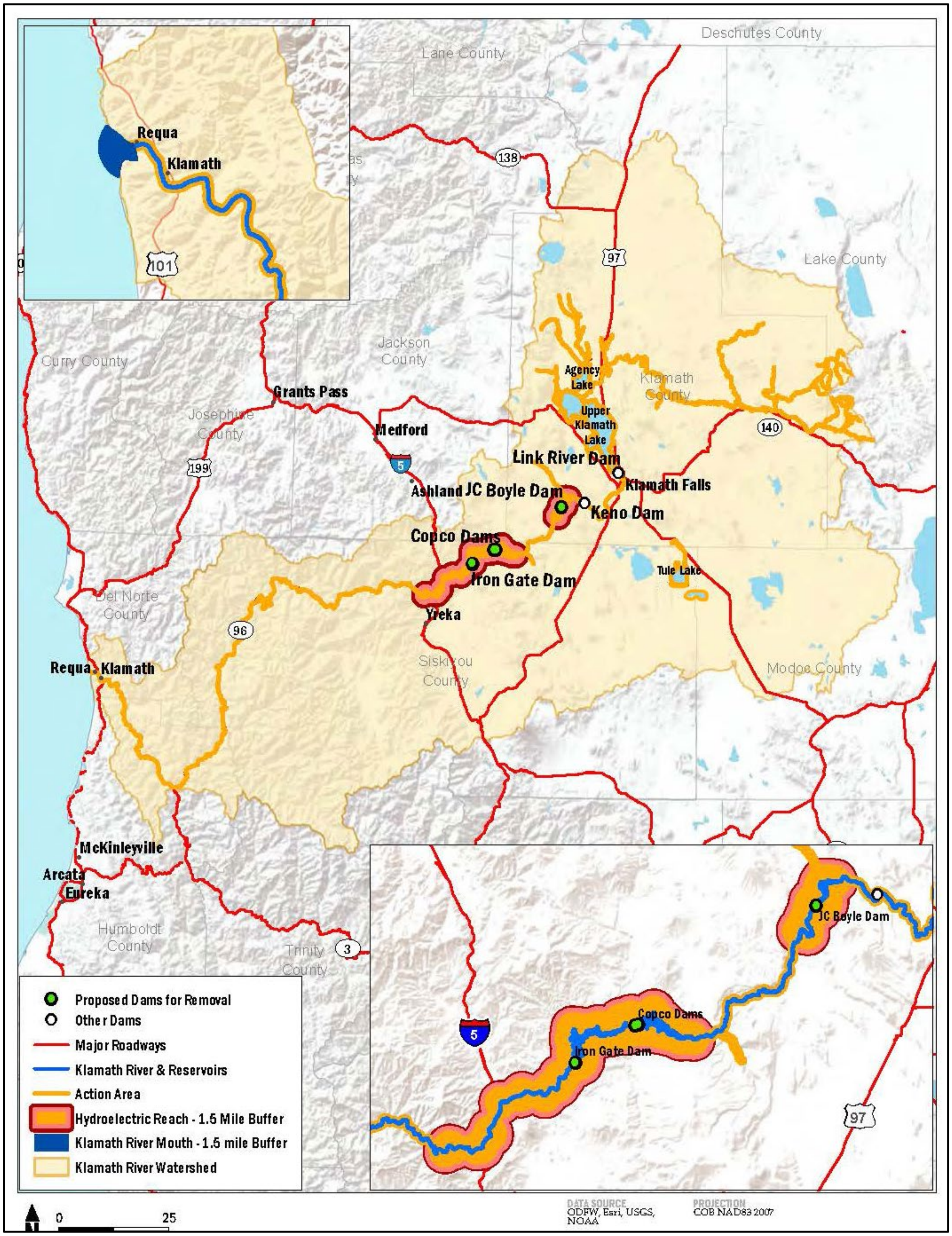

Figure 2. Lower Klamath Project Action Area

upstream of Iron Gate Dam. This includes approximately 300 miles for Chinook salmon (Huntington 2004), and 420 miles for steelhead (Huntington 2004, 2006).

2.2. Analytical Framework for the Jeopardy Determination

The main purpose of this BO is to examine whether the proposed action will jeopardize the continued existence of threatened or endangered species as described in Section 7(a)(2) of the ESA or result in the adverse modification or destruction of designated critical habitat. Because the Service concurs critical habitat for any listed species will not be adversely affected by the proposed action, an adverse modification analysis is not required (see instead our BO transmittal letter).

In accordance with 50 CFR § 402.14(g)(2) and (3), the jeopardy determination in this BO relies on the following four components (USFWS 2019 p. 45017; 84 FR 44976):

1. The *Status of the Species* evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; the species survival and recovery needs; and explains if the species' current range-wide population is likely to persist and if recovery of the species will remain viable.
2. The *Environmental Baseline* evaluates the current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the consequences of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species.
3. The *Effects of the Action* evaluates all future consequences to the species that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action, in the action area; and how those impacts are likely to influence the survival and recovery of the species.
4. *Cumulative Effects* evaluates the consequences of future, non-Federal activities reasonably certain to occur in the action area on the species, and how those impacts are likely to influence the survival and recovery the species.

In accordance with policy and regulation, the jeopardy determination is made by adding the Effects of the Action and Cumulative Effects to the Environmental Baseline and evaluating it in light of the Status of the Species. This formulates our opinion as to whether the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species.

Recovery units are management subsets for listed species that are created to establish recovery goals or carry out management actions. To lessen confusion in the context of Section 7 and other ESA activities, a subset of an animal or plant species that needs to be identified for recovery management purposes is called a "recovery unit" instead of a "population" (USFWS and NMFS 1998). Management units may be identified and designated within a recovery unit to compartmentalize distinct portions of the recovery unit so specific management approaches can be applied to these areas. The designation of a management unit does not imply an inherent recovery value of the individuals within that specific area; this occurs at the recovery unit level.

- The Revised Recovery Plan for the Lost River sucker and shortnose sucker identifies two recovery units for both species, the Upper Klamath Lake Unit and the Lost River Basin Unit (USFWS 2013 pp. 40-41). See Figure 3 in Chapter 4. It also identifies eight management units, four in each recovery unit (see Figure 5).

- The final Recovery Plan for the Coterminous Bull Trout Population formalized six recovery units (USFWS 2015a). Specific to the action area, the Klamath Recovery Unit in southern Oregon and northwestern California contains three core areas and eight local populations (USFWS 2015a, USFWS 2015b). See Figure 4 in Chapter 4.

Recovery units can be useful for informing the effects of a proposed action and our jeopardy determination. When an action appreciably impairs or precludes the capacity of a *recovery unit* from providing for both the survival and recovery, the action may also represent jeopardy to the species as a whole. When using this type of analysis, a BO should describe how the consequences of the proposed Federal action not only affects the recovery unit's capability, but the relationship of the recovery unit to both the survival and recovery of the listed species as a whole (USFWS and NMFS 1998 p. 4-36).

- The description of the affected Recovery Units for Lost River sucker, shortnose sucker, and bull trout, is included in Chapter 4.
- The analysis of the consequences of the action to these Recovery Units is included in Chapter 6.
- The jeopardy analysis for all three species, which relies on the status of the species, the environmental baseline, the effects of the action, and the cumulative effects, is included in Chapter 8 with conclusion statements in Chapter 9.

3. STATUS OF THE SPECIES

3.1. Status of Lost River Sucker and Shortnose Sucker

The Lost River sucker and shortnose sucker are federally listed as endangered throughout their entire range (USFWS 1988). A final revised recovery plan for both species was published in 2013 (USFWS 2013). Refer to Appendix B for additional detailed information on the legal status, physical description, biology, and threats to the Lost River sucker and shortnose sucker. Appendix B also includes information concerning range-wide habitat and population trends and incorporates the effects of all past human activities and natural events that have led to the present-day status of the species and its habitat.

The Lost River and shortnose sucker are large-bodied, long-lived species. The oldest individuals are an estimated 57 years for Lost River sucker and 33 years for shortnose sucker (Buettner and Scoppettone 1991 p. 21, Terwilliger *et al*. 2010 p. 244).

Information summarized below for both species includes the historical and current ranges, adult population estimates, and conclusions from a 2019 status review and a separate 2019 Species Status Assessment. Refer to Appendix B for additional information on the species status and life history needs.

3.1.1. Historical Range

The historical range of the Lost River sucker and shortnose sucker has been significantly altered by the drainage of Lower Klamath Lake and Tule Lake, wetland losses around Upper Klamath Lake, and the alteration of river and spring habitats in the Upper Klamath Basin. Both species are endemic to the Upper Klamath Basin, including Upper Klamath Lake and its tributaries, and the Lost River and its tributaries.

Lost populations include those formerly associated with Lower Klamath Lake (including Sheepy Lake), Lake of the Woods, and at spring systems in Upper Klamath Lake, including Barkley Spring and springs along the northwestern shoreline near Pelican Bay (USBR 2019). In general, the quantity of suitable lake, tributary streams and rivers, and wetland habitat has been reduced to approximately 25 percent of pre-settlement extents (USFWS 2007b, c). Prior to the construction of Keno Dam, as well as the dams in the downstream hydroelectric reach that led to the reservoirs, any Lost River sucker or shortnose sucker that drifted downstream out of Upper Klamath Lake and Lake Ewauna were presumed to be lost.

3.1.2. Current Range

Both Lost River and shortnose sucker are currently present in Upper Klamath Lake and its tributaries, Clear Lake and its tributaries, the Lost River, and Tule Lake. Shortnose suckers also occupy Gerber Reservoir.

Both species are known to move from Upper Klamath Lake into Lake Ewauna and Keno Reservoir and back into Upper Klamath Lake (Kyger and Wilkens 2011). Lake Ewauna probably functions as a subpopulation to Upper Klamath Lake, to some degree. Hundreds of listed suckers (both species) have been captured, tagged, and translocated to Upper Klamath Lake from Lake Ewauna since 2010 (Kyger and Wilkens 2011, USBR 2018b). There is a fish ladder at the Link River Dam that provides connectivity between Lake Ewauna and Upper Klamath Lake.

Larvae, juveniles or adults of both species can drift downstream, or they are entrained,[9] at Keno Dam into the Klamath River. Once in the river, they drift or move into J.C. Boyle and Copco No. 1 Reservoirs (Beak Consultants 1987, Buettner and Scoppettone 1991, Desjardins and Markle 2000, Renewal Corporation 2021). Adult Lost River and shortnose suckers are not known or expected to occur in Copco No. 2 Reservoir (USFWS 2013, 2013a) and only the shortnose sucker is known to be present in Iron Gate Reservoir (Desjardins and Markle 2000, Renewal Corporation 2021). See Figure 3. The Lost River and shortnose suckers that are below Keno Dam are there because they have drifted downstream from, or were entrained at, Keno Dam. They are sourced from the Upper Klamath Lake spawning populations.

The overall distribution of the Lost River sucker and shortnose sucker has not changed substantially

[9] When fish are transported along with the flow of water and out of their normal river, lake or reservoir habitat into and through a canal, dam, or other facility.

at the sub-basin scale from what it was when the species were listed as endangered (USFWS 1988).

3.1.3. Adult Population Estimates

The Service estimates the rangewide adult populations of Lost River and shortnose suckers is approximately 92,960 individuals. This is based on recapture rates and spawning estimates (USFWS 2020). In the Upper Klamath Lake Recovery Unit, there are an approximate combined 48,000 adult Lost River and shortnose suckers in Upper Klamath Lake; 1,000 adults in Lake Ewauna/Keno Reservoir (USFWS 2013a, J. Rasmussen, personal communication, September 10, 2021); and 5,540 adults in the hydroelectric reach reservoirs (Renewal Corporation 2021).

In Clear Lake, shortnose sucker are more abundant than Lost River sucker. Approximately 5,100 tagged shortnose suckers were detected during the 2016 spawning run; slightly more than 800 tagged Lost River sucker were detected during the same period (D.A. Hewitt, personal communication, September 14, 2017). Although reliable estimates of the total population numbers are unavailable, the best available data suggests it is unlikely that more than 25,000 adult shortnose sucker and 10,000 adult Lost River sucker occur in Clear Lake (USFWS 2020).

In Gerber Reservoir, and based on mark-recapture data from 2004 (Leeseberg *et al*. 2007), 2005, and 2006 (Barry *et al*. 2007a), the population of shortnose sucker may have been as high as 42,000 adults. In 2015, drought conditions reduced water levels within Gerber Reservoir to approximately one percent of the maximum storage, which undoubtedly reduced shortnose sucker numbers because of the limited available habitat. The Service does not have specific data to accurately estimate the extent of this reduction (USFWS 2020).

3.1.4. Summary of Recent Status Review and Species Status Assessment

In 2019, the status of both species was reviewed by the Service (USFWS 2019a, 2019b). A species status assessment (SSA) was also prepared in 2019 (USFWS 2019c).

Lost River sucker – There are three distinct spawning populations of this species: Upper Klamath Lake-springs, Upper Klamath Lake-river, and Clear Lake Reservoir. Two of the remaining populations (Clear Lake Reservoir and Upper Klamath Lake-springs) have very low numbers and are at a high risk of localized catastrophic events. The Clear Lake Reservoir population is separated from the others. As a species, the Lost River sucker appears to be genetically distinct from the other sucker species in the Upper Klamath Basin.

The status reviews and SSA concluded the Lost River sucker would continue to decline if conditions in Upper Klamath Lake remain unchanged. The species may persist over the next 50 years but would have critically fewer individuals. Given the only other spawning population of this species in Clear Lake Reservoir is extremely small, a substantial reduction in the number of individuals in Upper Klamath Lake would put the Lost River sucker close to extinction (USFWS 2019c p. 65). This conclusion assumes adult survival rates similar to the recent past. On average, approximately 90 percent of adult Lost River (and shortnose) suckers survive from year to year, though survival may vary among populations. This long-term survival of adults enables populations to persist through periods of unfavorable spawning or recruitment (Hewitt *et al*. 2018 pp. 17, 21) (USFWS 2019c p. 65).

For both the Lost River and shortnose sucker, there is an overall lack of recruitment of juveniles into the adult population (USFWS 2019 p. 42). The primary limiting factor for both species appears to be juvenile survival, because successful reproduction occurs annually, and adult survival is relatively high (USFWS 2019 c p. 42).

Shortnose sucker – There are three known spawning populations (Upper Klamath Lake, Clear Lake Reservoir, and Gerber Reservoir). There are high levels of genetic introgression[10] with Klamath largescale sucker (*Catostomus snyderi*) in Clear Lake and Gerber Reservoir.

The status reviews and SSA concluded the shortnose sucker could become extinct within the next 30 to 40 years. If current conditions persist, the population in Upper Klamath Lake would decline by 78 percent over the next 10 years to contain fewer than 5,000 individuals and could become extirpated within the next 30 to 40 years. This would result in the Clear Lake and Gerber Reservoir populations remaining for the species; both of which are highly genetically introgressed with the Klamath largescale sucker and geographically isolated behind dams in the Lost River Basin that do not have fish passage (USFWS 2019c p. 65).

Both the Lost River and shortnose sucker are likely to realize greater stability from the Klamath River Basin Sucker assisted rearing program. See Chapter 5-section 5.9.2.1 for additional information on this program. Landscape-scale improvements that reduce nutrient loads in Upper Klamath Lake are necessary to achieve full recovery of both species (USFWS 2019c p. 65).

3.2. Status of Bull Trout

All populations of bull trout within the coterminous United States are listed as a threatened species (64 FR 58910; November 1, 1999). Bull trout 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 (63 FR 31647; 64 FR 58910; 75 FR 2269, January 14, 2010, USFWS 2015a). There are six recovery units for bull trout (75 FR 63898, October 18, 2010).

Appendix C provides further detailed information on the legal status, physical description, biology, and threats to the bull trout. It also includes information on range-wide habitat and population trends and incorporates the effects of all past human activities and natural events that lead to the present-day status of the species and its habitat.

The action area for this project is wholly within the Klamath Recovery Unit for bull trout (see Chapter 4 and Figure 4). Of the five recovery units, bull trout in this unit are the most imperiled because of lost or reduced populations, reduced connectivity and dispersal barriers, reduced genetic diversity, and nonnative brook trout (USFWS 2015a). An SSA for bull trout is underway and is targeted for completion in July 2022.

The Klamath Recovery Unit consists of three core areas and eight local populations (USFWS 2015a, b). All three core areas have been isolated from other bull trout populations for the past

[10] Hybridization occurs when individuals of two species interbreed and genetic introgression is the subsequent incorporation of genetic materials, resulting from numerous hybridization events (i.e., back crossing).

10,000 years (USFWS 2015b). Within the recovery unit, bull trout have been adversely impacted by climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices (UFWS 2015b).

4. THREATS AND RECOVERY PLANS

4.1. Reasons for Listing – Lost River Sucker and Shortnose Sucker

The Lost River and shortnose suckers were listed as endangered because of population declines, a lack of recruitment, and habitat loss (USFWS 1988). The remaining populations are restricted in distribution and some lack the ability to successfully reproduce (Figure 3 displays their current range and the two recovery units for both species).

Suitable habitat for the Lost River sucker and shortnose sucker is reduced in extent and functionality because of the historical conversion of wetlands to agricultural use, and the construction of irrigation and hydroelectric facilities. The conversions 1) drained lakes and wetlands, 2) created barriers to spawning habitat, and 3) caused mortality by entraining fish. See Appendix B for more information.

Overharvesting of adult suckers may have contributed to declining numbers in Upper Klamath Lake, especially for the Lost River sucker, but harvest has not been authorized since 1987 (USFWS 1988). Entrainment of larval and juvenile suckers into irrigation and hydroelectric structures threatens both species, though several major improvements to key structures in the range have been implemented.

Nonnative fish are a threat to both species because of potential competition and predation. This threat continues to persist across their range to varying degrees, and little is known about the effects of specific nonnative species.

Lastly, die-off events caused by blue-green algae (*Aphanizomenon flos-aquae*; AFA) blooms and subsequent water quality degradation contributed to population declines (USFWS 1988). Since AFA increasingly dominates the system, the frequency of extreme fish die-off events has also increased (NRC 2004). Although water quality conditions are worse in Upper Klamath Lake and Keno Reservoir, listed suckers throughout the Klamath Basin are vulnerable to water quality-related mortality (USFWS 2007a, b). Degraded water quality conditions can negatively influence the species needs, weaken fish, and increase their susceptibility to disease, parasites, and predation (Holt 1997, Perkins *et al*. 2000b, ISRP 2005). See Appendix B for additional information on species needs.

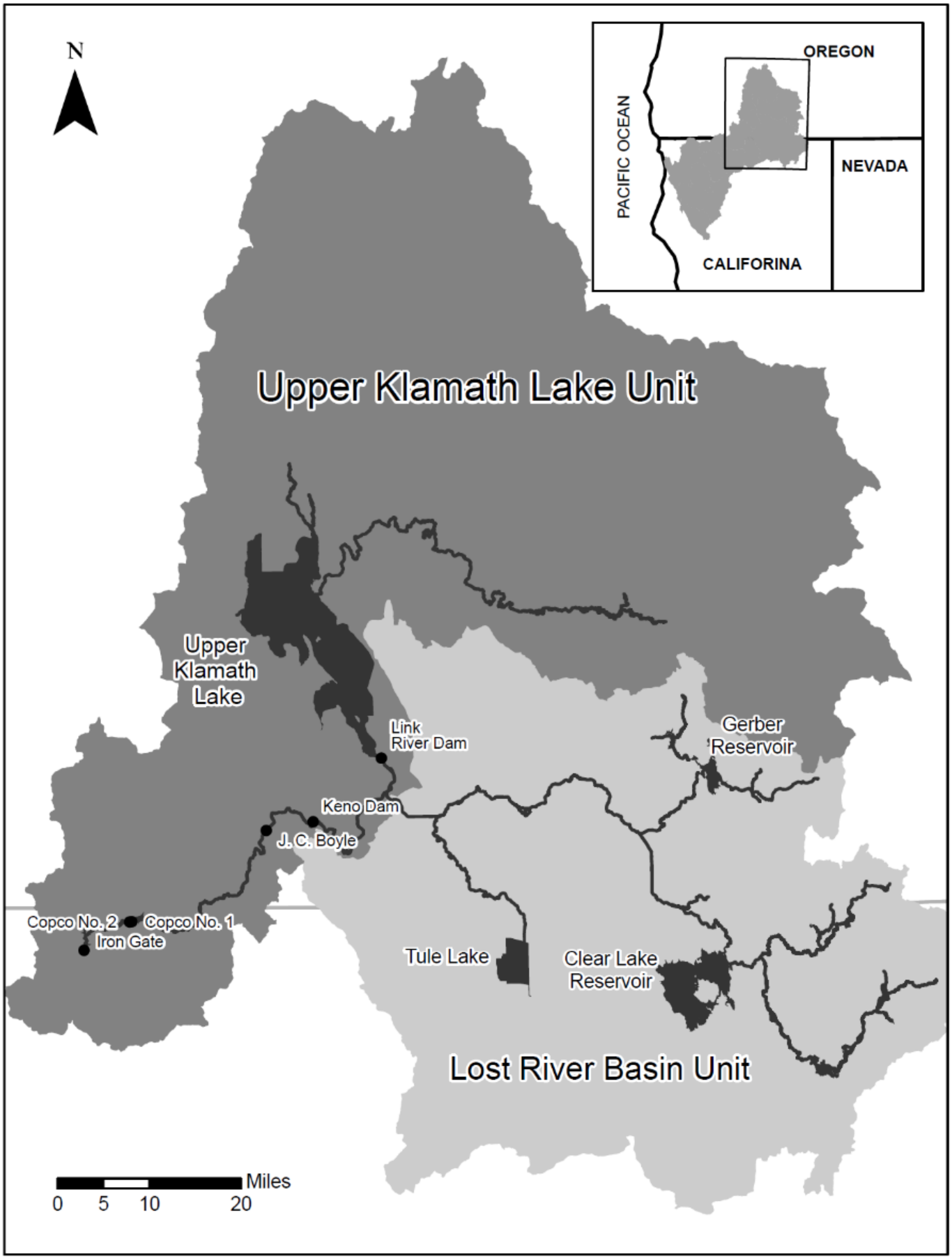

Figure 3. Current Range and Recovery Units for the Lost River and Shortnose sucker.

4.2. New Threats Since Listing – Lost River Sucker and Shortnose Sucker

The rangewide status of the species for the Lost River sucker and shortnose sucker was last updated on April 10, 2020 (see BO Appendix B, and USFWS 2019a,b,c, 2020). These documents describe the existing condition across both species' range.

New threats since listing include genetic introgression, climate change, parasites, and disease (USFWS 2013, 2019a,b,c).

4.2.1. Hybridization and Introgression

Hybridization occurs when individuals of two species interbreed. Introgression is the subsequent incorporation of genetic materials, resulting from numerous hybridization events (i.e., back crossing). Introgression is common among suckers in general and is well documented among all four Klamath sucker species; Lost River, shortnose sucker, Klamath largescale, and Klamath smallscale (Smith *et al*. 2020, Dowling *et al*. 2016, Smith *et al*. 2015, Tranah and May 2006).

Introgressive hybridization affects rarer species more than common ones because it can reduce genetic diversity of the rarer species, and lead to declines as individuals are replaced by genes of the alternate species. Additionally, this process may reduce fitness if the hybrid individuals are less adapted to exploit specific habitat niches in their environment. Depending on the degree of reduction, introgressive hybridization can result in lower survival rates and reduced population resiliency, resulting in lower numbers, reproduction and distribution.

It is also possible that introgression can increase diversity by introducing new and beneficial mutations into species genomes. This could possibly increase diversity both within and among populations (Dowling *et al*. 2016), but for rare species it is more likely that introgression results in a reduction of the integrity of the genome as genes from more common species overwhelm the rare species (Rhymer and Simberloff 1996).

Hybridization and introgression between shortnose sucker and Klamath largescale sucker are well documented and evidenced by intermediates in morphology (Markle *et al*. 2005) and a lack of discrimination among molecular markers (Dowling *et al*. 2016). However, morphological distinctiveness of the species varies by location (Markle *et al*. 2005) and spawning for each of the species is partially isolated both in time and space (Markle *et al*. 2005).

In contrast to the situation with the shortnose sucker, hybridization and introgression do not appear to be extensive in Lost River suckers (Dowling *et al*. 2016). At present, both of the endangered suckers in Upper Klamath Lake have population sizes large enough to maintain genetic diversity and prevent the negative effects of inbreeding. We cannot make similar conclusions in Clear Lake for both species, or Gerber Reservoir for the shortnose sucker because these populations are smaller and subject to more threats.

The historical draining of Tule Lake and Lower Klamath Lake, and the construction of dams and irrigation structures, have isolated both the Lost River and shortnose sucker populations. Suckers can no longer move between Upper Klamath Lake, Gerber Reservoir, and Clear Lake; the system no longer functions as a metapopulation.

For recovery of both suckers, the Upper Klamath Lake and Clear Lake populations are needed for long-term persistence. These two water bodies are the largest and most stable within the species' range. Recovery and stability cannot occur without viable populations in each of these water bodies.

In general, the Lost River and shortnose suckers require genetic diversity at the population and species scale to ensure species viability and adaptability. This requires access to diverse habitats throughout the landscape, appropriate levels of introgression and reproductive isolation, and connectivity among populations that will promote genetic and ecological diversity through adaptation (USFWS 2019c).

4.2.2. Climate Change

Climate variability, such as fluctuations between wet and dry periods, is part of natural processes; however, climatic models suggest that much of the recent trends in climate are driven by anthropogenic causes (Barnett *et al*. 2008). Annual average temperatures in the Upper Klamath Basin are expected to rise 2.1-3.6 °F from the 1960-1990 baseline by the decade of 2035-2045 due to climate change (Barr *et al*. 2010, Risley *et al*. 2012). Presently, the lethal temperatures for suckers are uncommon, but stressful temperatures occur with regularity. Climate change is likely to increase the frequency and duration of these stressful temperature events and make high stress events more common.

Future changes in precipitation are uncertain. Annual precipitation may increase or decrease overall under climate change (Barr *et al*. 2010, Risley *et al*. 2012). Climate models predict a larger proportion of annual precipitation and run-off will occur as rain events in the winter (Barr *et al*. 2010, Risley *et al*. 2012).

Warmer temperatures during the winter will reduce the proportion of precipitation falling as snow. Snow acts as a buffer for hydrologic systems, providing more gradual and manageable input into the lakes than rain. It is difficult to predict the effects of precipitation changes to suckers, but these changes will alter the dynamics of spring flows and reduce snowmelt runoff during the spawning season. This restricts access to spawning areas in smaller watersheds, such as those entering Clear Lake and Gerber Reservoir, and reduces reproductive success.

4.2.3. Predation, Parasitism, and Disease

Since listing, several bird species have been observed to prey on Lost River and shortnose suckers. The ultimate effect to the status of the species from avian predators is currently unknown. See section 5.1 in Appendix B for a detailed discussion of avian predation. Similarly, new information on parasites suggests they are also a threat. See section 5.1 in Appendix B for a detailed discussion of parasitism.

Microcystin (produced by blue-green algae) and other algal toxins are another threat to both species that was not specifically considered during the listing process. Microcystin can cause netpen liver disease[11] (Andersen *et al*. 1993), which can cause high mortality rates in fish, particularly salmonids (Kent 1990). In Upper Klamath Lake, microcystin concentrations tend to be highest in

[11] A severe liver disease that can develop in fish that are reared in net pens.

August and September but show substantial variation across sites and among years (Caldwell Eldridge *et al*. 2012, 2013).

In 2007, 49 percent of juvenile suckers (n = 47) collected at 11 shoreline sites exhibited symptoms of microcystin exposure (VanderKooi *et al*. 2010). One hypothesis is the toxin is indirectly ingested when suckers consume midge larvae (Chironomidae), which feed on the algae (Burdick and Martin 2017).

With the available data, the Service and NMFS understand the deleterious effects of microcystin on salmonids and water quality. The Service is not as certain of the effects to Lost River or shortnose suckers as laboratory trials completed for both species are not conclusive.

The influence of blue-green algae throughout an ecosystem can be substantial (Karjalainen *et al*. 2007). These organisms strongly affect physical properties of water (temperature and turbidity, for example) and chemical properties (dissolved oxygen and pH, among others), as well as toxin inputs. Organic matter associated with a massive blue-green algae bloom can also affect turbidity and potentially disrupt the ability of juveniles to feed by disrupting their vision (Engström-Öst *et al*. 2006, Engström-Öst and Mattila 2008).

4.3. Recovery Plan for Lost River and Shortnose Suckers

The Revised Recovery Plan for the Lost River sucker and shortnose sucker outlines a strategy to recover the species (USFWS 2013). It describes recovery objectives based on threats and demographics (USFWS 2013 p. 43). See section 4.3.2 below for additional information and Appendix B-Table 2, for a summary of actions completed to date.

The objectives to reduce threats include:

1. Restore or enhance spawning and nursery habitat in Upper Klamath Lake and Clear Lake Reservoir systems.
2. Reduce negative impacts of poor water quality.
3. Clarify and reduce the effects of non-native organisms on all life stages.
4. Reduce the loss of individuals to entrainment[12], and
5. Establish a redundancy and resiliency enhancement program.

The objectives to address demographics such as small population size and genetic diversity that can contribute to recovery include:

1. Maintain or increase larval production.
2. Increase juvenile survival and recruitment to spawning populations.
3. Protect existing and increase the number of recurring, successful spawning populations.

[12] Entrainment is a process by which aquatic organisms are pulled through a diversion or other device

4.3.1. Recovery Units

Two recovery units are designated for both species, the Upper Klamath Lake Unit and Lost River Basin Unit (USFWS 2013 pp. 40-41). Refer to both Figures 2 and 3 to see the relationship of these Recovery Units to the action area.

The Upper Klamath Lake Recovery Unit is subdivided into four management units:

1. Upper Klamath Lake-River: Individuals residing in Upper Klamath Lake and areas associated with tributary spawning (current and future).
2. Upper Klamath Lake-Spring: Individuals residing in Upper Klamath Lake associated with shoreline spring spawning locations (current and future). This management unit applies only to Lost River sucker because shortnose sucker do not spawn at shoreline springs.
3. Keno Reservoir: Individuals residing between Link River Dam and Keno Dam (including Link River, Lake Ewauna, and Keno Reservoir).
4. Klamath River: Individuals residing in flowing water or reservoirs between Keno Dam and Iron Gate Dam, known as the Klamath River management unit.

The Lost River Basin Unit (designated for each species separately) includes all individuals residing in lakes, sumps, reservoirs, or flowing waters found in the Lost River sub-basin. Four specific management units have been designated:

1. Clear Lake Reservoir: Individuals residing in Clear Lake Reservoir and tributaries.
2. Tule Lake: Individuals residing in Tule Lake, and the Lost River downstream from the Anderson-Rose Diversion Dam.
3. Gerber Reservoir: Individuals residing in Gerber Reservoir and tributaries; this includes only shortnose sucker because Lost River sucker do not occur here.
4. Lost River: Individuals residing in Lost River proper downstream of Clear Lake Dam to Anderson Rose Dam, including Miller Creek downstream of Gerber Dam.

The criteria for assessing whether each species has been recovered focuses on the reduction or elimination of threats, and demographic evidence that sucker populations are healthy (USFWS 2013 pp. 43-47).

The threats-based criteria for downlisting the species include:

1. Restoring and enhancing habitats, including water quality.
2. Reducing adverse effects from nonnative species.
3. Reducing losses from entrainment.

To meet population-based criteria for delisting, each species must exhibit an increase in spawning population abundances over a sufficiently long period, to indicate resilience. Spawning subpopulations of both species must be established in the Upper Klamath Lake recovery unit; and Oregon, California, and the Klamath Tribes, collaboratively or separately, should prepare and finalize population management plan(s) for the Lost River sucker (USFWS 2013 pp. 46-47).

4.3.2. Conservation and Recovery Efforts for Lost River and Shortnose Suckers

4.3.2.1. Klamath Basin Sucker Rearing Program

We started an assisted rearing program for the Lost River and shortnose sucker in 2015 to supplement populations in Upper Klamath Lake. The primary target species of this effort is shortnose sucker, but because of problems telling larvae and juveniles apart, both species are collected and reared. In 2013, the USBR agreed to fund this program to improve the environmental baseline of the species and minimize impacts to suckers from Klamath Project operations with a 10-year target of releasing a total of 8,000 to 10,000 suckers with lengths of at least 200 mm. The Service is funding an expansion of the program and the current goal is to release 60,000 suckers by 2025; the estimated number to stabilize populations in Upper Klamath Lake.

The program is designed to maximize genetic diversity and maintain natural behaviors after release (Day *et al*. 2017). Larvae are collected as they drift downstream in the Williamson River, so no brood stock are currently maintained. Collection efforts are spread across the drift season to maximize genetic variability. Juveniles are stocked in ponds and fed natural and artificial food.

The first release of reared suckers into Upper Klamath Lake occurred in spring 2018. The assisted rearing program is likely to be a source of recruitment for both species in Upper Klamath Lake, but the effect on population trajectories is uncertain until further information on survival and recruitment of released individuals is available. Preliminary information shows released fish have been detected at PIT tag arrays in spawning areas.

4.3.2.2. Habitat Restoration

Numerous agencies and organizations have restored habitat to reduce threats to Lost River and shortnose sucker over the last 20 years. It takes time to understand the success and effects of restoration efforts for sucker recovery. For example, actions to increase reproduction and recruitment requires at least five years for shortnose sucker and nine years for Lost River sucker. Hundreds of on-the-ground restoration projects, wetland, riparian, in-stream, upland, and fish passage projects have been implemented in the Upper Klamath Basin that directly or indirectly benefit suckers.

Major recovery projects that have been completed include: 1) screening of irrigation diversions, 2) eliminating fish passage barriers, and 3) restoring rearing and spawning habitat (see Appendix B, Table 3). Refer to section 5.9.2 for additional detail on these actions and the environmental baseline.

4.4. Reasons for Listing – Bull Trout

Refer to Appendix C for a full accounting of the rangewide status of bull trout, last updated in February 2020. When listed, and throughout its range, threats consisted of the combined effects of habitat degradation, fragmentation, and alterations. Dewatering, road construction and maintenance, mining, grazing, and the blockage of migratory corridors by dams or other diversion structures impacted and fragmented habitat. Poor water quality, incidental harvest by anglers, entrainment into diversion channels, and introduced non-native species were additional threats (63 FR 31647, 64 FR 58910).

Bull trout were once widespread in the Klamath River basin (Gilbert 1897, Dambacher *et al*. 1992, Ziller 1992, USFWS 2002). Habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, and fisheries management practices have greatly reduced their distribution and abundance. The remaining populations are highly fragmented and vulnerable to natural or manmade factors that place them at a high risk of extirpation (USFWS 2002).

The presence of nonnative brook trout (*Salvelinus fontinalis*), which compete and hybridize with bull trout, is a particular threat to bull trout persistence throughout the Klamath Recovery Unit.

4.5. New Threats Since Listing – Bull Trout

The final Recovery Plan for the Coterminous Bull Trout Population (USFWS 2015a) describes new or emerging threats that were not addressed under the listing rule (USFWS 1999).

The 2015 Recovery Plan summarizes the threat from climate change and acknowledges some local populations and core areas may not persist into the future due to small populations, isolation, and climate change effects (USFWS 2015a). Climate change effects include rising air temperature, changes in the timing of streamflow related to changing snowmelt, increases in extreme precipitation events, lower summer stream flows, and other changes (Mote *et al.* 2014).

All salmonids are likely to be affected by climate change, but bull trout are especially vulnerable because spawning and rearing occurs in upper elevation watersheds and requires cold water temperatures (Battin *et al*. 2007, Rieman *et al*. 2007). See Appendix C for additional information on climate change threats to bull trout.

Effects from large high severity wildfires, as part of climate change, are considered a new threat (see Appendix C). Chapter 5, action area environmental baseline) discusses a portion of the 2021 Bootleg Fire relative to two of the three core areas for bull trout recovery in the action area.

Poaching and incidental mortality of bull trout are also identified and described as additional threats (USFWS 2015a).

4.6. Recovery Plan for Bull Trout

The 2015 Recovery Plan for bull trout outlines a Recovery Program strategy (USFWS 2015a) describing recovery objectives based on threats and demographics. The plan includes four categories of recovery actions that should:

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.

3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Result in actively working with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities.
5. Be consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

The final Recovery Plan formalized six recovery units, one of which is the Klamath Recovery Unit (USFWS 2015a). The Klamath Recovery Unit is in southern Oregon and northwestern California (see Figure 4). Its three core areas overlap with the action area. Of the six recovery units, this unit is the most imperiled because populations have shrunk or been lost, low population size and reduced genetic diversity, dispersal barriers and nonnative brook trout (USFWS 2015a).

Bull trout in the Klamath Recovery Unit have been isolated from other populations for the past 10,000 years and are recognized as evolutionarily and genetically distinct. There is no opportunity for bull trout in another recovery unit to naturally re-colonize this recovery unit if it were to become extirpated (USFWS 2015b). The three core areas consist of 1) Upper Klamath Lake, 2) the Sycan River, and 3) the Upper Sprague River (Figure 4).

Bull trout in each core area face:

1. Threats from nonnative salmonids (*i.e.*, brook trout and, in some instances, brown trout).
2. Small population size, as low numbers of local populations within the three core areas place them at increased risk from genetic threats.
3. Degraded instream and riparian habitat.
4. Impaired connectivity.

Conservation measures or recovery actions that have been implemented or are ongoing include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culvert replacement, and habitat restoration (USFWS 2015b).

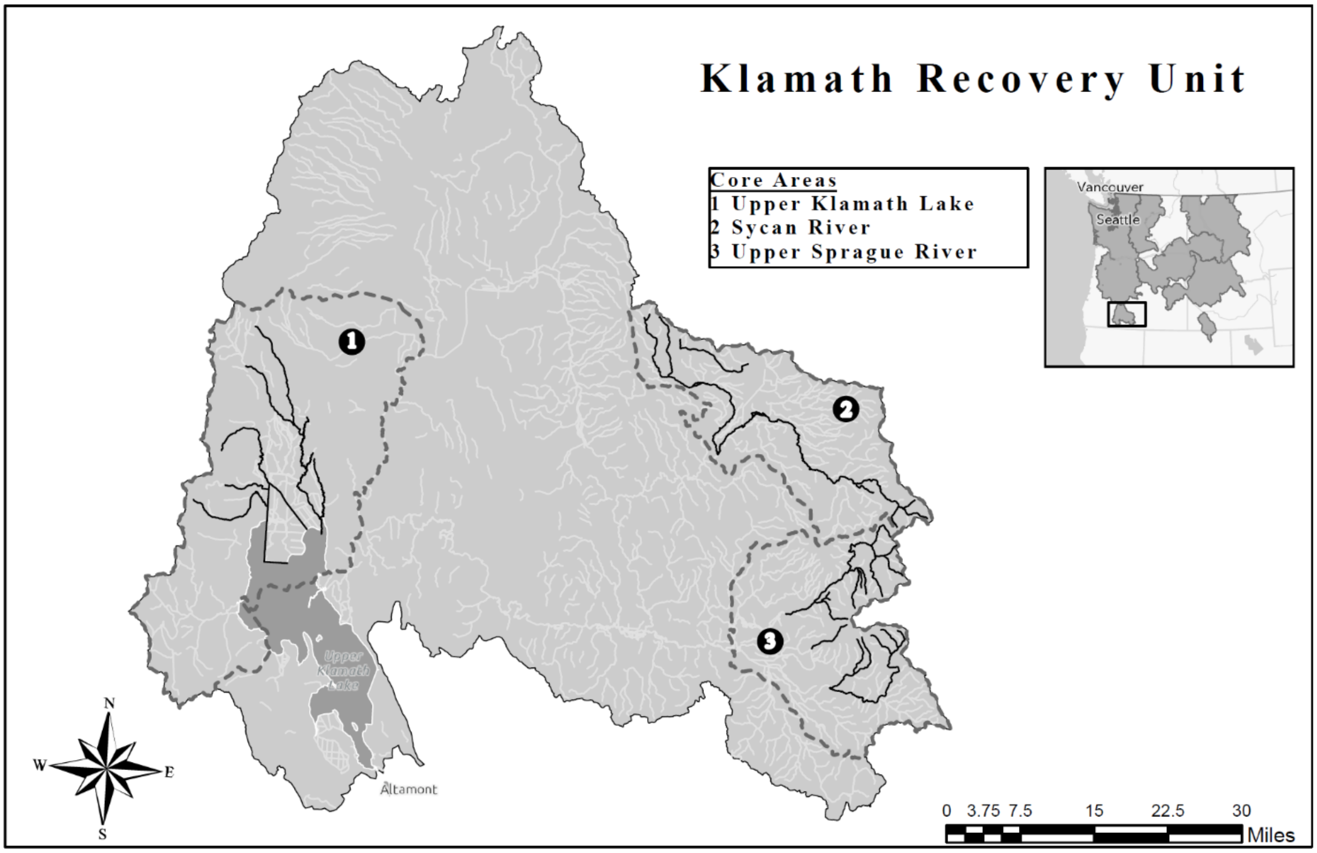

Figure 4. Klamath Recovery Unit and Core Areas in the Action Area for Bull Trout

4.6.1. Upper Klamath Lake Core Area

This core area comprises the northern portion of Upper Klamath Lake and its immediate major and minor tributaries. Major tributaries are the Williamson and Wood rivers. This core area includes two existing local bull trout populations: Threemile Creek and Sun Creek. Sun Creek originates in Crater Lake National Park, and currently supports the largest population in the Upper Klamath Lake core area.

4.6.2. Sycan River Core Area

This core area comprises Sycan Marsh, the Sycan River, and their tributaries. It includes the waters that drain into Sycan Marsh, including Long, Calahan, and Coyote Creeks on the west side. On the east side of the marsh are the upper Sycan River, Chocktoot Creek, Shake Creek, and their tributaries. The only existing bull trout population in the Sycan River core area is in Long Creek.

4.6.3. Upper Sprague River Core Area

This core area is comprised of drainages of the North Fork and South Fork of the Sprague River upstream of their confluence, including Deming, Boulder, Dixon, Brownsworth, and Leonard creeks. Deming Creek is believed to support the largest local population of bull trout in this core area.

The Klamath Recovery Unit implementation plan describes site-specific management actions necessary for the recovery of bull trout in the unit (USFWS 2015b). There are no specific recovery actions for the Klamath Recovery Unit that will be met by the proposed action.

However, the implementation plan for the Klamath Recovery Unit includes a Conservation Recommendation to "Support actions to reintroduce anadromous species". It describes that anadromous species, such as Chinook salmon and steelhead, were historically present in the upper Klamath River basin and that their reintroduction and recolonization will support the recovery of bull trout by increasing prey base and providing marine derived nutrients (USFWS 2015b p. B-23).

5. Environmental Baseline for the Lost River Sucker, Shortnose Sucker, and Bull Trout in the Action Area

The preamble to the 1986 implementing regulations for section 7 of the ESA provides context for understanding the meaning of the term "Environmental Baseline." The preamble (51 FR 19926) states: "[i]n determining the "effects of the action," the Director first will evaluate the [rangewide] status of the species or critical habitat at issue. This will involve consideration of the present environment in which the species or critical habitat exists, as well as the environment that will exist when the action is completed, in terms of the totality of factors affecting the species or critical habitat. The evaluation will serve as the baseline for determining the effects of the action on the species or critical habitat."

The 2019 Revised Regulations implementing the ESA updated the definition of environmental baseline (USFWS 2019; 84 FR 44976, 45016) to refer to "the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action." 50 CFR §402.02.

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities, or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline. 50 CFR § 402.02.

For existing section 7 consultations that include ongoing actions within the environmental baseline, such as the interim Klamath Project operations for irrigation (USFWS 2020) as well as PacifiCorp's Habitat Conservation Plan (USFWS 2013a), separating baseline effects from anticipated effects of the proposed action is difficult. The existing structures associated with these actions, such as the dams, canals, and associated infrastructure, are already present and are thus considered part of the environmental baseline.

5.1. Existing Conditions in the Action Area for Lost River Sucker and Shortnose Sucker – Upper Klamath Lake Recovery Unit

Because of the vast action area, our discussion of the environmental baseline and existing conditions is separated into various sections.

For the Upper Klamath Lake Recovery Unit, which is wholly encompassed in the action area, our discussion of the existing conditions is organized into four main sections. This includes the description of the four management units in the recovery unit, and the Klamath River downstream of Iron Gate Dam (section 5.1); a description of water quality conditions in Upper Klamath Lake and its tributaries, and Lake Ewauna/Keno Reservoir (section 5.2); a description of water quality conditions in the hydroelectric reach (section 5.3); and a description of the population estimates for Lost River and shortnose suckers (section 5.4).

5.1.1. Upper Klamath Lake Management Units

As described in Chapter 4, two management units are designated within the Upper Klamath Lake Recovery Unit; the Upper Klamath Lake-River and the Upper Klamath Lake-Spring (Lost River sucker only, as shortnose sucker do not use shoreline springs for spawning) (see Figure 5 below). These two management units are the most important for recovery of the Lost River and shortnose suckers in the Upper Klamath Lake Recovery Unit, and for both species across their range. These two management units support the largest populations and have the highest amount of larval production. See Appendix B for additional detail.

These two management units also include the most extensive spawning habitat, the Sprague River, and the only known populations that use shoreline springs. These two management units also include unoccupied areas where suckers could someday reside, such as the Wood River drainage or other springs. Protection of Lost River and shortnose suckers in these two management units is of the "utmost importance for long-term survival of [listed suckers] in the upper Klamath basin as a whole" (NRC 2004). These two management units are designated as critical habitat for the Lost River and shortnose sucker (USFWS 2012; 77 FR 73740).

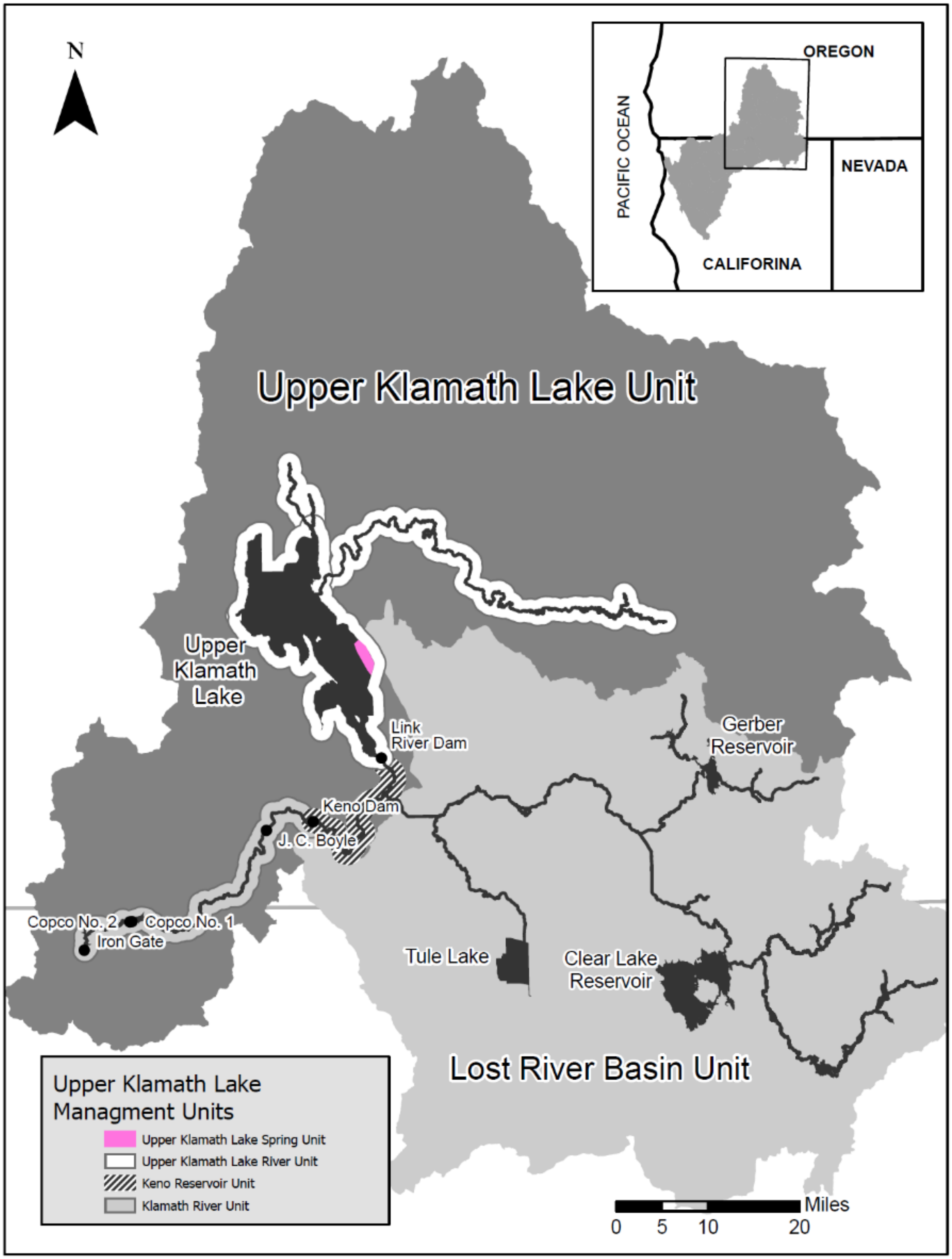

Figure 5. Management Units in the Upper Klamath Lake Recovery Unit for Lost River and Shortnose Sucker.

The Upper Klamath Lake watershed encompasses about 9,800 square kilometers (3,800 square miles), ranges in elevation from 1,250 meters (4,100 feet) to over 2,700 meters (9,000 feet), and has an average annual precipitation of approximately 68 centimeters (27 inches; Boyd *et al*. 2002).

The lake's three major contributing drainages are the Sprague, Williamson, and Wood Rivers. The Williamson River flows into the lake from the north shortly after receiving the Sprague River, which is the larger of the two streams. The Wood River flows into Agency Lake, also from the north. The lake itself is relatively shallow throughout, but the Eagle Ridge trench on the west side can reach depths of 12 meters (40 feet). Approximately 10,000 hectares (25,000 acres) of wetlands remain connected to the lake. Areas of concentrated Lost River sucker spawning in the Williamson and Sprague Rivers include the lower Williamson River, the lower Sprague River below the Chiloquin Dam area, and the Beatty Gap area of the upper Sprague River (Buettner and Scoppettone 1990, Tyler *et al*. 2004, Ellsworth *et al*. 2007). Lost River suckers may spawn in the lower Sycan River and Sprague River near the Nine Mile area (Ellsworth *et al*. 2007).

A smaller but significant number of Lost River sucker also spawn over gravel at shoreline springs along the margins of Upper Klamath Lake (Buettner and Scoppettone 1990, NRC 2004). Significant spawning aggregations currently occur at Sucker Springs, Cinder Flats, Silver Building Springs, and Ouxy Springs. Spawning by Lost River suckers at these springs is very sensitive to lake levels. As lake levels decline, much of the spawning habitat quickly becomes unavailable.

Shortnose suckers from Upper Klamath Lake spawn primarily in the lower Williamson and Sprague Rivers (Tyler *et al*. 2004, Ellsworth *et al*. 2007). However, some shortnose sucker spawning is likely occurring along shorelines (Hayes *et al*. 2002, Barry *et al*. 2007a, b).

Both the Keno Reservoir and Klamath River management units (described below) contain adult, juvenile and larval Lost River and shortnose suckers that drift down or are entrained[13] from the two Upper Klamath Lake management units. Without the populations in the two upstream management units, the listed suckers would not exist in the Keno Reservoir or Klamath River management units (USFWS 2013).

A number of factors affect the environmental baseline of the Klamath River in the action area downstream of the two Upper Klamath Lake management units. This includes injury and mortality associated with turbines and spillways around the dams, migration barriers, stranding and ramp rate effects from daily flow fluctuations in the river and the reservoirs, degradation and loss of habitat, water diversions, and water quality problems.

Appendix B addresses the detailed environmental baseline for the range of the Lost River and shortnose sucker. Figure 5 above displays the portion of the action area in the Klamath River, downstream of the outlet of Upper Klamath Lake.

5.1.2. Keno Reservoir Management Unit

The Keno Reservoir management unit includes the area between the Link River Dam and Keno Dam (including Link River, Lake Ewauna, and Keno Reservoir). Like the two upstream

[13] When fish are transported along with the flow of water and out of their normal river, lake or reservoir habitat into and through a canal, dam, or other facility.

management units, the Keno Reservoir management unit is designated as critical habitat for the Lost River and shortnose sucker (USFWS 2012; 77 FR 73740).

Prior to the major anthropogenic changes to the lakes, river, and wetlands in the Upper Klamath Basin that began in the early 1900s, there large spawning runs of suckers were observed in the Link River. These runs were described as "immense congregations" of fish weighing two to six pounds (Klamath Republican March 21, 1901). The origin of these runs is not recorded, but they were presumably coming from the Lower Klamath Lake area and were likely headed to Upper Klamath Lake's tributaries to spawn. Before major agricultural development began in the early 1900s, there were thousands of acres of open water and emergent wetland habitat in the Lower Klamath Lake and Klamath River area above the basalt reef at Keno (Akins 1970). These areas likely provided good rearing habitat for all life stages of Lost River and shortnose suckers.

The Keno Reservoir management unit is designated as critical habitat because it contains the physical and biological features necessary for the conservation of the species (USFWS 2012; 77 FR 73740). This management unit has conservation value because of the presence of adult suckers and connectivity with the Upper Klamath Lake populations.

The Keno Reservoir management unit includes the following components – Link River Dam and Link River, Lake Ewauna and Keno Reservoir.

5.1.2.1. Link River Dam and Link River

The Link River is a one-mile-long segment of the Klamath River that extends from the outlet of Upper Klamath Lake to the beginning of Lake Ewauna, and then Keno Reservoir. The Link River is relatively steep with several cascades or "falls". During low flows, the river breaks into smaller braided channels.

Fish species composition is dominated by blue chub (*Gila coerulea*), tui chub (*Siphateles bicolor bicolor*), and fathead minnows (PacifiCorp 2004c, Kyger and Wilkens 2010, USFWS 2020).

The Link River is a corridor where large numbers of larval and juvenile suckers are entrained in the downstream flows through the Link River Dam (Gutermuth *et al*. 2000, Foster and Bennetts 2006, Tyler 2007). The dam is 16 feet high and includes a fish ladder. The fish ladder was rebuilt in 2004 to improve upstream passage for both sucker species, but individuals move upstream in low numbers (Piaskowski 2003). Each year, the number of detections of PIT-tagged Lost River and shortnose suckers using the fish ladder averages around 25 individuals. The Service estimates up to 2.33 million larvae, 31,627 juveniles, and 111 adult suckers could be entrained through the Link River Dam annually and move into Lake Ewauna and Keno Reservoir (USFWS 2020).

In addition, the screening facilities at the A-Canal near the Link River Dam allow fish to be returned via pipeline to Upper Klamath Lake. The screen was designed to particularly protect suckers longer than 30 mm and was constructed in 2002.

The Link River also provides refugia for juvenile and adult suckers. They can move upstream into the Link River from Lake Ewauna/Keno Reservoir when dissolved oxygen levels in the lake and reservoir are low (Piaskowski 2003, Kyger and Wilkens 2010). Spawning by either species has not been observed in the Link River (USFWS 2013). Adult redband trout have been documented migrating through the Link River dam fish ladder (B. Ramirez, ODFW, personal communication, November 10, 2021).

5.1.2.2. Lake Ewauna

Lake Ewauna is a naturally occurring lake, but it has become functionally indistinguishable from the downstream impoundment of the Keno Reservoir. To some degree, Lake Ewauna functions as a subpopulation of Upper Klamath Lake. Hundreds of listed suckers (both species) have been captured, tagged, and translocated to Upper Klamath Lake from Lake Ewauna since 2010 (Kyger and Wilkens 2011, USBR 2018b, USFWS 2020).

As described above, the fish ladder at the Link River Dam provides some connectivity between Lake Ewauna and Upper Klamath Lake. Although water quality conditions are consistently poor during late summer and early fall, small numbers of Lost River and shortnose suckers do persist in Lake Ewauna.

5.1.2.3. Keno Reservoir

Keno Reservoir is the first of five reservoirs downstream of Upper Klamath Lake. It is a widened, low gradient area that extends 20 miles from the terminus of the Link River to Keno Dam. The most upstream portion of the Keno Reservoir is Lake Ewauna (described above).

The average depth of Keno Reservoir is 7.5 feet with a maximum depth of 20 feet. Water levels are normally maintained within a 0.5-foot range by the Keno Dam. Summer water quality is generally poor, with high temperatures, high pH, and low dissolved oxygen (Sullivan *et al*. 2008, 2009, 2011, Kirk *et al*. 2010, Sullivan and Rounds 2011, USFWS 2020). Dissolved oxygen levels of less than 1 mg/L, well below levels generally recognized as harmful to fish, occur regularly (Kirk *et al*. 2010). Water quality is also degraded in the reservoir by nutrient-rich agricultural return flows entering the reservoir at the Straits Drain, and from the Lost River Diversion Channel in winter and spring (Kirk *et al*. 2010).

Fish species composition is similar to the Link River (PacifiCorp 2004c, Kyger and Wilkens 2010, USFWS 2020). Multiple survey efforts and radio-tagging for Lost River and shortnose suckers in Lake Ewauna/Keno Reservoir have occurred (Hummel 1993, Piaskowski 2003, PacifiCorp 2004c, Terwilliger *et al.* 2004, Banet *et al.* 2019).

Larvae and juveniles younger than a year are generally most abundant in the upper part of Keno Reservoir and decrease downstream. Several hundred adults from both species (predominantly shortnose sucker) have been captured and tagged in Lake Ewauna near the confluence of the Link River (Kyger and Wilkens 2010). There are no firm population estimates for Keno Reservoir, but the combined population of both species is estimated at 1,000 adults (USFWS 2013a, J. Rasmussen, personal communication, September 10, 2021).

Few larvae and juveniles survive to become adults in Keno Reservoir. The poor water quality conditions likely restrict year-round use to the upper portion of the reservoir, near the Link River where water quality is better (USFWS 2007a, 2008, 2020). And, poor water quality in July and August results in stressful and lethal dissolved oxygen levels (Piaskowski 2003, Kirk *et al*. 2010) affecting juvenile sucker survival.

There is little wetland habitat for use by rearing larvae and juveniles in Keno Reservoir because of past diking and draining, and the water management operations that result in stable reservoir water levels. The lack of wetland habitat increases competition between larval and juvenile suckers. It also increases competition between, and predation risk from, the large numbers of non-native fish including fathead minnows (USFWS 2020).

The loss of larval and juvenile suckers also occurs through entrainment at irrigation diversions in Keno Reservoir. Major diversions include the Lost River Diversion Channel, North Canal, and Ady Canal (refer to Appendix B for more information). In addition, there are numerous smaller irrigation diversions in Keno Reservoir and the drains that enter the reservoir, including the Klamath Straits Drain (USBR 2001, USFWS 2020).

The Lost River and shortnose suckers in Keno Reservoir are from the upstream source populations in Upper Klamath Lake. They have drifted downstream from, or were entrained at, the Link River Dam. The Klamath River contains no known spawning habitat between the mouth of the Link River and Keno Dam (Buchanan *et al*. 2011). Spawning has not been documented in Keno Reservoir.

Upon entering Lake Ewauna/Keno Reservoir, there are three possible outcomes for surviving suckers: 1) they remain in the Lake or reservoir, 2) they drift or are entrained[14] downstream past the Keno Dam, or 3) on rare occasions they return to the Link River and possibly back upstream to Upper Klamath Lake.

Keno Dam does not include power-generating equipment, but it has a 24-pool weir and orifice-type fish ladder that gains 19 feet in elevation over a length of 350 feet. This fish ladder was designed to pass trout and other resident fish species; however, it does not meet the Service and ODFW criteria for passage of suckers (USFWS 2007a). The fishway slope is too steep for suckers and the automated weirs (weir # 25-28) lack adequate openings, so any fish using this ladder have to jump over the last four weirs to move upstream into Keno Reservoir (USFWS 2007a). Lost River and shortnose suckers will pass through the openings, but they are not known to jump over weirs. Adult redband trout have been documented migrating through the Keno Dam fish ladder (B. Ramirez, ODFW, personal communication, November 10, 2021).

5.1.3. Klamath River Management Unit

The Klamath River management unit is directly downstream of the Keno Reservoir management unit. It extends from the downstream side of Keno Dam to Iron Gate Dam (USFWS 2013). This management unit includes the Keno Reach, J.C. Boyle Reservoir, the J.C. Boyle Bypassed Reach and Peaking Reach, Copco No. 1 and No. 2 Reservoirs, and Iron Gate Reservoir. See Figure 5.

The Klamath River below the basalt reef at Keno, Oregon, is a high-gradient system with shallow, swift flowing water that is too steep to provide suitable habitat for suckers, or passage back to Upper Klamath Lake. Any suckers that historically drifted into this section of the Klamath River from Upper Klamath Lake were immediately lost from the population.

[14] When fish are transported along with the flow of water and out of their normal river, lake or reservoir habitat into and through a canal, dam, or other facility.

The range of the Lost River and shortnose suckers, which prefer lakes, was artificially expanded by the construction of J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs. These reservoirs capture the suckers that drift downstream, or those entrained at Keno Dam, from Upper Klamath Lake.

The suckers that drift or are entrained downstream at the Keno Dam are not able to re-access the three upstream management units and interact with the populations in Lake Ewauna/Keno Reservoir or Upper Klamath Lake. There is no connectivity with upstream populations because of both the steep channel gradient in the river between J.C. Boyle and Keno Dam, and the lack of fish passage for suckers at Keno Dam. Therefore, the Lost River and shortnose suckers in the Klamath River management unit are considered a sink population (USFWS 2013).

Additionally, spawning by Lost River and shortnose suckers is not known to occur in the management unit or its reservoirs, and there is no access to suitable spawning habitat (USFWS 2013 p. 5, NRC 2004, Moyle 2002). Since they are not known to reproduce in the management unit, they are unable to contribute to population growth. Their distribution is also limited. While anecdotal spawning behavior by unknown sucker species has been observed in the lower section of the J.C. Boyle peaking reach, we have no documentation or evidence that shortnose or Lost River suckers spawn in this reach, in the reservoirs, anywhere in the Klamath River management unit, or anywhere downstream of Iron Gate Dam.

Therefore, the individuals downstream of Keno Dam are considered a sink population[15] that are not considered viable, self-sustaining populations that are actively managed for recovery (USFWS 2013 pp. viii). If they are relocated, the individual fish in the Klamath River management unit can provide genetic support to the populations in the upstream management units, but not in their current location (USFWS 2013 pp. viii).

As described above, the two Upper Klamath Lake management units and the Keno Reservoir management unit are designated as critical habitat for the Lost River and shortnose sucker (USFWS 2012; 77 FR 73740). This is because those areas have the primary constituent elements, and physical and biological features, that are necessary for the conservation of the species. Those areas are also considered important to both species' recovery (USFWS 2012, 2013).

The Klamath River management unit is not designated as critical habitat. The Lost River and shortnose sucker populations here are not self-sustaining, there is severe habitat degradation, there is a very low potential for conservation or restoration, and the area does not contribute to connectivity among populations. The Service did not designate areas as critical habitat where Lost River and shortnose sucker populations are not viable; are not connected to spawning habitat; occur in low densities or abundances in very isolated populations; occur only as sink populations; or are greatly impacted by nonnative species (USFWS 2012 pp. 73752-73753; 77 FR 73740). Considering these criteria, we did not designate critical habitat for two occupied areas because they do not contain the primary constituent elements or physical and biological features that are essential to the conservation of the species. These two areas are the Klamath River management unit, below Keno Dam, and Tule Lake (USFWS 2012 p. 73743; 77 FR 73740).

[15] A population in a low-quality habitat in which the birth rate is generally lower than the death rate and population density is maintained by immigrants from "source populations," which are generally more robust.

The following sections describe general conditions and fish presence and species composition in the Klamath River management unit. A description of water quality conditions and the Services' population estimates for Lost River and shortnose suckers are included in sections 5.2, 5.3, and 5.4.

5.1.3.1. Keno Reach

Downstream of Keno Dam and the fish ladder, the Klamath River flows for 4.7 miles through a steep-gradient canyon until it enters the J.C. Boyle Reservoir. This stretch is known as the Keno Reach. The reach has a high gradient of 50 feet/mile, or about one percent. The river channel is generally broad with rapids, riffles, and pocket water among the rubble and boulders (ODFW 1997). Water quality in the Keno Reach is influenced by the water quality in Keno Reservoir, but it typically has higher levels of dissolved oxygen because of turbulence.

Fish sampling conducted by PacifiCorp in 2001 and 2002 found only a few suckers in the Keno Reach. The fish population is dominated by marbled sculpins (*Cottus klamathensis*), fathead minnows, blue chubs, speckled dace (*Rhinichthys osculus*), and tui chubs.

As described above, any Lost River or shortnose suckers in the Keno Reach originated from the Upper Klamath Lake populations. They are in the reach because of drift or entrainment at Keno Dam (Henriksen *et al*. 2002, USFWS 2020). Spawning by Lost River and shortnose suckers has not been observed or documented in the Keno Reach, and is not possible in the reach because of the high gradient and the lack of spawning gravel (Fortune *et al.* 1966).

5.1.3.2. J.C. Boyle Reservoir

J.C. Boyle Reservoir is approximately 3.6 miles long has a surface area of 420 acres, an average depth of 8.3 feet, a maximum depth of 53 feet, and a total storage capacity of 3,500 acre-feet. Based on valley morphology and geomorphic features, it consists of two sections. The 2-mile upstream reach extends from the upper part of the reservoir down to the Highway 66 bridge. This portion of the reservoir is shallow and surrounded by a low-gradient, gently sloping shoreline. Water depths are near zero for all but the historical river channel location, where depths are typically 10-15 feet, with maximum values of 20 feet in the deep pool at the river right bedrock control. Wetland conditions support an extensive marsh of bulrush in the wide, shallow reservoir margins that experience seasonal water level fluctuations. The upper portion contains a large amount of macrophytes[16] during the summer and several large shoreline wetland areas.

For the next lower one-mile extent where the canyon narrows, the reservoir deepens. Water depths increase from approximately 10 feet at the Highway 66 bridge to maximum values around 35 feet at the unnamed tributary junction 1,000 feet upstream from the dam. The lowest portion is 3.6 miles long and has an average depth of 8.3 feet with a maximum depth of 53 feet. Like the upstream Keno Reservoir, water quality is often degraded in the J.C. Boyle Reservoir, particularly during the summer.

Water levels are normally maintained within 5.5 feet of full pool, and daily fluctuations are typically between one and two feet. These fluctuations influence predation of and habitat

[16] Macrophytes are aquatic plants that grow in or near water. They may be either emergent (i.e., with upright portions above the water surface), submerged or floating.

availability for the listed suckers. If water level fluctuations force larval and juvenile suckers to abandon the refuge of littoral areas, they are more vulnerable to predators.

All four Klamath Basin sucker species have been observed or captured in the J.C. Boyle Reservoir (Desjardins and Markle 2000). Shortnose suckers and Klamath smallscale suckers (*Catostomus rimiculus*) are found more often than Klamath largescale sucker, and Lost River sucker is rarely found (Ziller and Buettner 1987, Piaskowski 2003, Desjardins and Markle 2000).

Larval and juvenile suckers have been collected in J.C. Boyle Reservoir, but their species identity is unknown (Desjardins and Markle 2000). This is the only reservoir where sampling has captured juveniles. Klamath smallscale suckers are the only sucker species documented and known to spawn in Spencer Creek, a tributary to the J.C. Boyle Reservoir (USFWS 2013a).

The listed suckers in J.C. Boyle Reservoir are limited by the amount of available rearing habitat and by competition and predation from non-native fish. Non-native fish include fathead minnows, yellow perch (*Perca flavescens*), bullheads (*Ameiurus* spp.), and largemouth bass (*Micropterus salmoides*) (NRC 2004). See Section 5.4 for a summary of the sucker population estimates in the J.C. Boyle Reservoir.

Upon entering J.C. Boyle Reservoir, there are two possible outcomes for surviving suckers: 1) they remain in the reservoir, or 2) they drift or are entrained downstream past J.C. Boyle Dam. Similar to Keno Dam, J.C. Boyle Dam has a fish ladder that does not accommodate sucker passage (ODFW OAR 412, FishPro 2000) and impedes upstream access for the Lost River and shortnose sucker to Upper Klamath Lake (PacifiCorp 2013). When suckers are entrained downstream through the J.C. Boyle Dam, there is some mortality associated with passing through turbines and spillways (USFWS 2013a).

5.1.3.3. J.C. Boyle Bypassed Reach

The J.C. Boyle Bypassed Reach is 4.3 miles long and extends from the J.C. Boyle Dam downstream to the J.C. Boyle Powerhouse. The reach is steep and the river channel is approximately 100 feet wide. It consists primarily of rapids, runs, and pools among large boulders with some large cobble interspersed. Gravel is scarce, in part because gravel recruitment from upstream areas is blocked by the dam. When spill from the dam is substantial, habitat in the bypassed reach consists of a series of rapids and fast runs.

Based on sampling, fish populations in the Bypassed Reach are dominated by rainbow trout, speckled dace, and marbled sculpin (PacificCorp 2004). Only one juvenile shortnose sucker has been captured in this reach (PacifiCorp 2004).

5.1.3.4. J.C. Boyle Peaking Reach

The J.C. Boyle Peaking Reach is 17.3 miles long and extends from the powerhouse downstream to the upper end of Copco No. 1 Reservoir. The upstream 11.1 miles of this reach are in Oregon and the downstream 6.2 miles are in California. In the Oregon portion of the reach, habitat includes cascades, deep and shallow rapids, runs, riffles, and occasional deep pools. It is steep with numerous rapids that impede any upstream movement by suckers. The substrate primarily consists of boulders and large cobbles, with a few small pockets of gravel behind the boulders. The

California segment of the peaking reach is wider, lower in gradient, contains more riffles and runs, and has infrequent pools and quiet water. Substrate is primarily bedrock, boulders, and cobbles, with a few gravel pockets behind boulders.

Fish composition in the Peaking Reach are primarily speckled dace, marbled sculpin, and rainbow trout (PacifiCorp 2004c). Klamath largescale sucker and Klamath smallscale sucker and a small number of shortnose suckers have been captured in the reach (PacifiCorp 2004c). As with the other reaches and reservoirs, any listed suckers in the Peaking Reach are individuals from Upper Klamath Lake (Henrickson *et al.* 2002).

Suckers (of unknown species identity) from the Copco No. 1 Reservoir have been documented spawning in the lower section of the Peaking Reach (Beak Consultants Incorporated 1988). A key tributary to the Peaking Reach is Shovel Creek, an important spawning tributary for rainbow trout. There are no records or observations of Lost River and shortnose suckers spawning or rearing in the Peaking Reach or Shovel Creek (D. Maria, CDFG, pers. comm., as cited in USFWS 2007).

5.1.3.5. Copco No. 1 Reservoir

The Copco No. 1 Reservoir was formed when the Copco No. 1 Dam was constructed in 1918. The reservoir is approximately 972 acres and has been described as two sections, based on valley morphology and geomorphic features. Its downstream reach extends for six miles from the dam to the upstream extent of the historical floodplain, upstream of Beaver Creek. The upstream reach extends approximately three miles from the upper extent of the historical floodplain to the upstream extent of the reservoir.

The reservoir is in a canyon and has an average depth of 34 feet with a maximum depth of 108 feet; it is deeper than Keno and J.C. Boyle Reservoirs (USFWS 2013a). The Copco No. 1 Reservoir's width and water depths decrease with distance upstream from the dam, with maximum depths occurring in the historical river channel at the dam site.

In the downstream reach, shallower depths occur on terraces located on the insides of the meander bends. In the upstream reach, depths are relatively uniform at 10 feet or less. Water levels are normally maintained within 6.5 feet of full pool, and daily fluctuations are typically 0.5 feet.

Bedrock cliffs, some of which were exposed by erosion after dam construction, line portions of the reservoir. The reservoir has several coves with more gradual slopes, and large areas of thick aquatic vegetation are common in shallow areas. Nearshore riparian habitat is largely lacking because of the cliff shorelines but there are small patches of emergent wetland and riparian vegetation scattered around the shoreline that can provide refugia for listed suckers. Larger patches of wetland and riparian habitat occur where tributaries enter the reservoir.

Fish species include yellow perch, unidentified larval sucker, and golden shiner (*Notemigonus chrysoleucas*) (Desjardins and Markle 2000). Adult shortnose suckers have been captured in Copco No. 1 Reservoir during several studies over the last two decades (Beak Consultants Incorporated 1988, Buettner and Scoppettone 1991, Desjardins and Markle 2000, Renewal Corporation 2021). Between 1976 and 2018, five Lost River sucker adults were captured in the reservoir (Desjardins and Markle 2000, USFWS 2007a). In the recent sampling efforts between 2018 and 2020, one Lost River sucker was captured (Renewal Corporation 2021). See Section 5.4 for a summary of the sucker population estimates in Copco No. 1 Reservoir.

There is anecdotal data of sucker spawning in the J.C. Boyle Peaking Reach (see above), but species verification is lacking (Beak Consultants 1987, 1988). If listed suckers swim into the Peaking Reach from downstream, there is no data to show they spawn there, nor is there data that any larvae survive in the reservoir and recruit into the population. There is a low likelihood of survival for any Lost River or shortnose sucker larvae or juveniles that reach Copco No. 1 Reservoir from drift or entrainment at J.C. Boyle Dam (from the Upper Klamath Lake source populations). This is because of the poor summertime water quality and large populations of predatory and non-native fish in Copco No. 1 Reservoir (NRC 2004).

Upon entering Copco No. 1 Reservoir, there are two possible outcomes for surviving suckers: 1) they remain in the reservoir, or 2) they drift or are entrained, downstream. If the suckers drift or are entrained downstream through the Copco No. 1 Dam, there is some mortality associated with passing through the turbines and spillways (USFWS 2013a).

5.1.3.6. Copco No. 2 Reservoir

The Copco No. 2 Reservoir is approximately 0.25 mile in length and was formed by the construction of the 33-foot high Copco No. 2 Dam in 1925. There are no fish passage facilities at this development, and no fish monitoring has occurred in this reservoir. Its small size and high rate of water exchange makes it is unlikely to support shortnose or Lost River sucker (USFWS 2013a).

Upon entering the reservoir surviving suckers either drift or are entrained downstream past the Copco No. 2 Dam. There is mortality associated with suckers passing through the turbines and spillways as they go downstream (USFWS 2013a).

5.1.3.7. Iron Gate Reservoir

Iron Gate Reservoir is 6.8 miles long, and has an average depth of 62 feet, with a maximum depth of 167 feet. It was formed when Iron Gate Dam was constructed in 1962 and is in a relative uniform, deep, narrow canyon. The 173-foot-high dam does not include any fish passage facilities. The reservoir is approximately 942 acres and has been described as two sections, based on the location of primary tributaries and geomorphic features.

The downstream reach extends two miles from the dam to just upstream of the Camp Creek confluence and the Mirror Cove arm of the reservoir. At this location, it transitions to the upstream reach, which extends four miles to the upstream extent of the reservoir. The reservoir’s width and water depth decrease upstream from the dam, except at tributary valleys where the reservoir widens into coves.

It is the deepest of the three reservoirs, with water depths of 150-167 feet near the dam. Water levels in Iron Gate Reservoir are normally maintained within 4 feet of full pool, and daily fluctuations from peaking operations at the upstream J.C. Boyle and Copco dams are typically 0.5 feet.

It is in a canyon with generally steep shorelines, except for a few coves with more gradual slopes. Due to the cliff-like nature of the shorelines, areas of aquatic vegetation occur in shallow areas in small, isolated pockets around the reservoir's perimeter. There are small patches of willow and emergent vegetation along the shoreline, with larger areas of riparian habitats at tributary confluences.

Fish composition includes golden shiners, tui chubs, pumpkinseed (*Lepomis gibbosus*), unidentified chubs, yellow perch, unidentified sucker larvae, and largemouth bass (Desjardins and Markle 2000). See section 5.4 for a summary of the population estimates in Iron Gate Reservoir.

Upon entering Iron Gate Reservoir, there are two possible outcomes for surviving suckers: 1) they remain in the reservoir, or 2) they drift or are entrained downstream into the mainstem Klamath River, past Iron Gate Dam. If suckers go downstream through the Iron Gate Dam, there is some mortality associated with passing through the turbines and spillways (USFWS 2013a).

5.1.4. Iron Gate Dam to Mouth of Klamath River

This portion of the action area in the Klamath River is not part of a recovery unit or management unit for the Lost River and shortnose sucker (USFWS 2013). Downstream of Iron Gate Dam, the Klamath River flows unobstructed for 190 miles before entering the Pacific Ocean. The river basin downstream of Iron Gate Dam supports a variety of species of anadromous fish including fall and spring Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey.

Although information on non-anadromous species downstream of Iron Gate Dam is limited, Klamath smallscale sucker, speckled dace, and sculpin are common (USFWS 2007, 2012). It is likely some listed suckers drift into the downstream Klamath River via passive transport through the dam. There is no documentation of Lost River or shortnose suckers, which are lake-dwelling species, below Iron Gate Dam (USFWS 2007) and there is no opportunity for suckers to return to Iron Gate Reservoir. Any individuals that drift through Iron Gate Dam are considered lost to the population (USFWS 2007, 2012).

5.2. Water Quality Conditions in the Action Area – Portion of Upper Klamath Lake Recovery Unit

This section discusses water quality conditions throughout the Upper Klamath Lake Recovery Unit portion of the action area, excluding the hydroelectric reach reservoirs (see section 5.3). Species needs in terms of water quality are fully described in Appendix B. Water quality is a complex and important factor for sucker survival and vigor. Many elements contribute to water quality in the action area, including temperature, dissolved oxygen, ammonia toxicity, pH, algae, and nutrient loading.

Most water bodies currently occupied by Lost River and shortnose suckers do not meet water quality standards for nutrients, dissolved oxygen, temperature, and pH (Boyd *et al*. 2002, Kirk *et al*. 2010). Poor water quality conditions during the summer in Upper Klamath Lake have led to several mass adult mortality events, which appear to be a consequence of inadequate amounts of dissolved oxygen (Perkins *et al*. 2000b). Water quality in the reservoirs below Upper Klamath Lake and Lake Ewauna/Keno Reservoir is likely worse, and so water quality effects to suckers in the Klamath River management unit are also likely worse. See section 5.3 for a summary of general water quality conditions in the hydroelectric reach reservoirs.

5.2.1. Blue-Green Algae

Populations or communities of blue-green algae are often able to exploit the favorable conditions of Upper Klamath Lake, and downstream areas, to produce rapid and widespread blooms during the summer (Hoilman *et al*. 2008). Large annual blooms and subsequent crash dynamics are the primary driver of most water quality dynamics in Upper Klamath Lake during the high-stress period of summer, and this has implications to the downstream areas and management units.

Summertime blooms of AFA dominate Upper Klamath Lake phytoplankton communities, due to excessive phosphorus loading linked to watershed development. Similar phytoplankton dynamics in Lake Ewauna/Keno Reservoir are due to large populations and associated nutrients of blue-green algae imported into the system from Upper Klamath Lake in summer. These nutrient and algae exports influence all four reservoirs in the Klamath River management unit, particularly Copco No. 1 and Iron Gate (see section 5.3).

The algal toxins from blue-green algae can exert a direct effect on listed suckers, in particular microcystin (VanderKooi *et al*. 2010). This is a liver toxin produced by the cyanobacterium *Microcystis aeruginosa*. Microcystin enters suckers through their gut as they consume midge larvae containing the toxin (Burdick and Martin 2017). Due to the limited capacity of fish to detoxify microcystin, fish can suffer from sub-lethal effects or succumb to the toxic effects of elevated microcystin concentrations. Because microcystin is relatively stable, persisting in place for months, it potentially could accumulate in fish tissues and in aquatic life. See section 5.3 for a summary of blue-green algae in the hydroelectric reach reservoirs.

5.2.2. Dissolved Oxygen

Concentrations of dissolved oxygen in Upper Klamath Lake range annually from near 0 mg/L to greater than 10 mg/L (Morace 2007), with notable spatial and temporal variation (Morace 2007). Larval and juvenile suckers require levels of at least 2.1 mg/L or higher before mortality starts to occur (Saiki *et al.* 1999, USFWS 2019c). In Upper Klamath Lake, high nutrient loading (particularly phosphorus) causes the massive, widespread blooms of AFA referenced above. As the bloom crashes, bacterial decomposition of the large quantities of organic matter consumes dissolved oxygen, which produces hypoxic (oxygen deficiency) and rarely anoxic (lack of oxygen) (0 mg/L of DO) conditions in some locations of the lake (Helser *et al*. 2004, Lindenberg *et al*. 2008). The severity of the dissolved oxygen depletion in Upper Klamath Lake varies, depending on the size and timing of the bloom, the wind mixing the water column, and temperature (Laenen and LeTourneau 1995, Helser *et al.* 2004, Kann and Welch 2005).

For many weeks during the summer, dissolved oxygen levels in Upper Klamath Lake are continuously below the criterion that is set by the Oregon Department of Environmental Quality; a level of at least 5.5 mg/L (Kann 2017 p. 35). Hypoxic dissolved oxygen concentrations (generally < 4 mg/L) occur most frequently in late July and August (Morace 2007). Decomposition of blue-green algae from Upper Klamath Lake through the Link River is the primary reason for low oxygen in the Lake Ewauna/Keno Reservoir (Sullivan *et al*. 2010).

The dissolved oxygen levels in Upper Klamath Lake and downstream of the Lake Ewauna/Keno Reservoir during the summer are sometimes at or below the lethal levels described for dissolved oxygen in Appendix B. However, the duration and extent of when these conditions occur varies, in both depth and location, and is influenced by other factors including water stratification, bloom decline, and wind-driven circulation (Wood *et al.* 2006). Like the upstream Keno Reservoir, water quality is often degraded at J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs, particularly during the summer (ODEQ 2010, Renewal Corporation 2021).

Within Upper Klamath Lake, low dissolved oxygen concentrations occur most frequently in August, the period of declining algal blooms with associated decomposition and warm water temperatures in the lake. Downstream in Keno Reservoir, dissolved oxygen typically reaches very low levels from July through October as algae transported from the lake settle out of the water and decay; these low- dissolved oxygen events can last for extended periods.

Organic matter and nutrient inputs, which promote primary productivity, from the Lost River basin via the Klamath Straits Drain and the Lost River Diversion Channel also contribute to low dissolved oxygen levels in this reach. See section 5.3 for a summary of dissolved oxygen levels in the hydroelectric reach reservoirs.

5.2.3. Ammonia Toxicity

Low dissolved oxygen events are often associated with high levels of un-ionized ammonia, which can be toxic to fish. Ammonia toxicity is complex because it is a function of total ammonia nitrogen concentration, pH, and temperature. The toxic form, ammonia, is most prevalent at higher pH levels. Ammonia concentrations in Upper Klamath Lake can be high enough to threaten suckers (Burdick *et al*. 2015). Total ammonia nitrogen concentrations in the Keno Reservoir frequently exceed Oregon's chronic criteria from June to September and can exceed the acute criteria in both June and July. These degraded conditions can occur throughout much of the 20-mile long reservoir, with better conditions only in the uppermost and lowermost reaches of Keno Reservoir. See section 5.3 for a summary of ammonia toxicity in the hydroelectric reach reservoirs.

5.2.4. pH Levels

In the Upper Klamath Basin, summertime pH levels are elevated above neutral. Extended periods of higher pH are associated with large summer algal blooms in Upper Klamath Lake. Generally, pH in the reach from Link River Dam through the Keno Reservoir increases from spring to early summer and decreases in the fall. See section 5.3 for a summary of pH levels in the hydroelectric reach reservoirs.

5.2.5. Water Temperature

Water temperatures in the Upper Klamath Basin vary seasonally and by location. They are typically very warm during summer months as ambient air temperatures heat surface waters. Both Upper Klamath Lake and Lake Ewauna/Keno Reservoir have periods of intermittent, weak summertime stratification, but water temperatures here are predominantly similar throughout the water column.

Although maximum water temperatures do not typically exceed the acute thermal tolerance of listed suckers, they can cause stress to listed suckers in the hottest months leading to reduced growth or increased susceptibility to other stressors. Increasing temperature has many potential indirect effects, including reducing dissolved oxygen concentrations, increasing total ammonia-nitrogen, increasing growth rates of pathogens, and requiring greater energy demands from fish, and thus is an exacerbating factor. See section 5.3 for a summary of water temperature in the hydroelectric reach reservoirs.

5.2.6. Nutrients

Concentrations of primary plant nutrients, including nitrogen and phosphorus, in lakes are affected by the geology of the surrounding watershed, upland land uses, and physical processes in the lakes and their tributaries. The ability of riparian and floodplain habitats to retain or alter nutrients throughout the system in Upper Klamath Lake is degraded as a result of ditches, dikes, and levees that promote drainage or prevent overbank flows (ODEQ 2002). The relatively high levels of phosphorus present in the Upper Klamath Basin's young volcanic rocks and soils are a major contributor to phosphorus loading to the lake. Land use within the watershed increases inputs through soil erosion, pasture runoff, and irrigation return flows (ODEQ 2002). Upper Klamath Lake is a major source of nitrogen and phosphorus loading to the Klamath River; nitrogen exported from Upper Klamath Lake is primarily derived from nitrogen fixation by AFA (Walker *et al.* 2012).

Upper Klamath Lake was eutrophic prior to settlement by Anglo-Americans (Eilers *et al*. 2004) but is now hypereutrophic[17] due in large part to human modifications to the environment (ODEQ 2002, Eilers *et al*. 2004).

Nutrient and organic matter inputs from the Lost River Basin via Klamath Straits Drain and the Lost River Diversion Channel are also an important source of nutrients to the downstream Keno Reservoir and Klamath River. The annual phosphorus inputs into Upper Klamath Lake are approximately 124 metric tons (137 tons) from its tributaries, and there is no current input from anadromous salmonids. See section 5.3 for a summary of nutrients in the hydroelectric reach reservoirs.

5.2.7. Die Off Events

Large die-off events, though uncommon, can have a pronounced effect on a population by killing individuals. Documented die-offs of suckers in Upper Klamath Lake are for adults only, but it is likely any juveniles present would also be impacted but remain undetected because of their smaller body size (USFWS 2020).

For example, three consecutive die-offs in Upper Klamath Lake (1995-1997) possibly involved tens of thousands of adult suckers (Perkins *et al*. 2000a). Multiple factors likely contributed, but low dissolved oxygen concentrations and high total ammonia-nitrogen concentrations were the likely greatest factors (Perkins *et al*. 2000a). During the die-off in 1996, there was concurrent *Microcystis aeruginosa* bloom which likely contributed to sub-optimal water quality conditions and the die-off.

Other reported die-offs in Upper Klamath Lake include 1986 (Coleman *et al*. 1988). Since the die-offs of the late 1990s, similar events have been relatively rare with observations of sucker die-offs in 2003 and 2017. During August and September of 2017, 490 Lost River and nine shortnose sucker carcasses were observed, predominantly in the northwest area of Upper Klamath Lake (M. Buettner, The Klamath Tribes, personal communication, January 2, 2018). The data are not

[17] Resulting from high algal productivity, intense algal blooms, fish kills due to oxygen depletion in bottom water.

sufficient to conclusively implicate low dissolved oxygen concentrations as the primary factor, but the highest numbers of carcass detections were coincident with the lowest dissolved oxygen levels of the summer; similar to each of the late-1990s events. It is possible that other die-off events went undetected or are under-reported. Nevertheless, it seems that widespread die-offs in Upper Klamath Lake have occurred in roughly one out of 10 years.

The Service does not have monitoring data for die-off events in the Klamath River management unit and hydroelectric reach reservoirs. Similar conditions are likely to occur in Copco No. 1 and Iron Gate Reservoirs, due to reduced water quality conditions throughout summer months, and algal blooms.

5.3. Water Quality Conditions in the Hydroelectric Reach Reservoirs

During the summer, the reservoirs in the hydroelectric reach exhibit varying degrees of dissolved oxygen super-saturation at their surface (due to high rates of internal photosynthesis by algae) and oxygen depletion in bottom waters (due to microbial decomposition of dead algae).

The J.C. Boyle Reservoir experiences weak intermittent temperature stratification, and seasonal variations in dissolved oxygen are observed. Stratification and dissolved oxygen in J.C. Boyle Reservoir are influenced by the upstream reach from Link River Dam through Keno Reservoir (including Lake Ewauna).

Upper Klamath Lake, and Copco No. 1 and Iron Gate reservoirs, thermally stratify beginning in April and May and do not mix again until October and November (FERC 2007). Dissolved oxygen in the Copco No. 1 and Iron Gate reservoirs, and surface waters during summer months, is generally at, or in some cases greater than, saturation, while deeper waters reach minimum values near 0 mg/L by July (Raymond 2008, 2009, 2010).

In the hydroelectric reach, pH levels are seasonally variable, with levels near neutral during the winter, and increasing in the spring and summer. Peak values (8 to 9.2) have been recorded during May and September, with lower values documented for June through August (7.5 to 8) (Raymond 2010). The lowest pH values are downstream of J.C. Boyle Reservoir, and the highest pH values occur in Copco No. 1 and Iron Gate reservoirs (Raymond 2008, 2009, 2010). High pH levels coincide with high algal photosynthesis rates at or near the water surface during periods of thermal stratification and high nutrient concentrations in the reservoirs (Raymond 2008).

The nutrient and algae exports from upstream influence all four reservoirs in the Klamath River management unit, particularly Copco No. 1 and Iron Gate Reservoirs. Water quality in Copco No. 1 Reservoir is degraded during the summer months, and algae blooms occur as temperatures warm, including AFA. Similarly, summertime water quality in Iron Gate Reservoir is generally quite poor; with large annual blooms of AFA and warm surface water temperatures. This can exert a direct effect on listed suckers, in particular the liver toxin microcystin (VanderKooi *et al*. 2010). Fish can suffer from sub-lethal effects or succumb to toxic effects of elevated concentrations.

In addition, no formal evaluations of parasites or disease that can arise from changes in water quality have been done for the Lost River and shortnose suckers in the hydroelectric reach reservoirs. Body surface afflictions were recorded during the 2018-2020 sampling effort and between 11-33 percent of sampled suckers had body surface afflictions. This included worn fins, caudal fin deformities, parasites, wounds from lamprey attachment, growths or tumors and parasites (Renewal Corporation 2021).

In summary, water quality conditions of water temperature, pH, dissolved oxygen, and blue-green algae in the hydroelectric reach reservoirs are poor overall in the summertime, exerting stress and sometimes lethal effects on Lost River sucker and shortnose sucker.

5.4. Population Estimates for Hydroelectric Reach Reservoirs

As described in Chapter 3 (section 3.1.3), the rangewide adult population estimate for Lost River sucker and shortnose sucker is approximately 92,960 adults (USFWS 2020, Renewal Corporation 2021, J. Rasmussen, personal communication, September 10, 2021). Population estimates for the hydroelectric reach reservoirs are discussed below.

5.4.1. Prior Sampling and Adult Population Estimates

Based on historic and more recent sampling efforts in the hydroelectric reach, shortnose sucker is captured more often than other species of sucker below Keno Dam. Adult shortnose suckers (SNS) have been captured in three of the four hydroelectric reach reservoirs (Beak Consultants 1987, Desjardins and Markle 2000, Renewal Corporation 2021), with Lost River sucker (LRS) only captured in the J.C. Boyle and Copco No. 1 Reservoirs.

Prior population estimates for these fish in the reservoirs were based on sampling data from 1998-1999 as well as 2000-2001 (Desjardins and Markle 2000, Desjardins and Markle, unpublished data, USFWS 2012, 2009).

- Between 1998 and 1999 in J.C. Boyle Reservoir, 44 adult SNS and 2 adult LRS adults were captured (Desjardins and Markle 2000). And in 2000 and 2001, 65 adult SNS were captured (Desjardins and Markle, unpublished data). Based on this sampling, the Service estimated there were 500 adult shortnose sucker in J.C. Boyle Reservoir.
- Between 1998 and 1999 in Copco No. 1 Reservoir, 165 adult shortnose suckers and one Lost River sucker were captured. Based on this sampling, the Service estimated there were 2,000 adults in the Copco No. 1 Reservoir (USFWS 2012).
- In 2000 and 2001, 40 SNS were captured in Copco No. 1 Reservoir (Desjardins and Markle, unpublished data). No LRS were captured. Three juvenile suckers were observed in Copco No. 1 Reservoir.
- While Lost River suckers were detected in extremely low numbers (2 in J.C. Boyle and 1 in Copco No. 1 Reservoir), the Service estimated approximately 50 Lost River suckers throughout the entire hydroelectric reach, given the probable low capture efficiencies and the large size of the reservoirs.
- In 1998 and 1999, 22 adult SNS were captured in Iron Gate reservoir (Desjardins and Markle 2000) with no Lost River suckers captured. In 2000 and 2001, five adult shortnose suckers and no adult Lost River suckers were captured (Desjardins and Markle, unpublished data). Based on this sampling, the Service estimated there were 200 adult shortnose suckers

in the reservoir (USFWS 2009, 2012).

In the 2012 Preliminary Biological Opinion for the Lower Klamath Project (USFWS and NMFS 2012), information was included from the Service's prior 2007 and 2009 analyses, which was based on listed sucker population estimates from the 1998-1999 sampling (Desjardins and Markle 2000). It was estimated there were 500, 2,000, and 200 adult shortnose suckers in J.C. Boyle, Copco No.1, and Iron Gate Reservoirs, respectively. It was estimated there were 50 adult Lost River suckers throughout the hydroelectric reach. These prior analyses also estimated approximately 543,100 larvae, 1,114 juveniles, and one sub-adult or adult listed sucker, drift or are entrained downstream into the reservoirs annually (USFWS 2009).

5.4.2. Current Sampling and Adult Population Estimates

Additional sampling for listed suckers was completed over four periods between fall 2018 and spring 2020 in J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs (Renewal Corporation 2021). Individuals with intermediate morphological characteristics were found during these recent sampling efforts, suggesting hybridization with other sucker species is occurring. Using the information from the recent sampling efforts, the Renewal Corporation roughly estimated the mean population estimates for each sampled reservoir (Table 2).

- In J.C. Boyle Reservoir the 2018-2020 sampling effort was focused at the upper extent, where the Klamath River enters the reservoir. See Table 2 for the results. During this sampling effort, five potential hybrid suckers were captured in J.C. Boyle Reservoir (Renewal Corporation 2021, BA-Appendix D).
- Sampling efforts in Copco No. 1 Reservoir captured 96 SNS, one LRS and two potential hybrids. The sampled shortnose suckers are likely older fish. However, fifteen of the SNS caught here in spring 2020 were less than 15 inches (390 mm), suggesting a cohort of younger fish that was not sampled during the 2018 and 2019 sampling efforts (Renewal Corporation 2021).
- Sampling efforts in Iron Gate Reservoir captured 25 adult SNS, zero Lost River suckers, and five potential hybrids.

Mark-recapture data based on the PIT tags was used to produce abundance estimates for listed suckers (Renewal Corporation 2021). Due to the relatively low recapture rates, the mark-recapture data for shortnose sucker, Lost River sucker, and the potential hybrid suckers were combined. All listed sucker mark-recapture data were aggregated to determine total population estimates. Any listed sucker recaptured at least one day (or longer) after initial capture, tagging, and release was considered a recapture for determining population estimates.

To calculate mean population estimates for each reservoir where sampling occurred, a non-parametric bootstrap method[18] was used (Efron and Tibshirani 1986, Manly 2007) (BA-Appendix D, sub-Appendices B and F). The Renewal Corporation also calculated mean population estimates using the Chapman method (Chapman 1951, Johnson *et al.* 2007) and the super-population parameterization of the Jolly-Seber model (Schwarz and Arnason 1996) (BA-Appendix D).

[18] Resampling method used to estimate the sampling variance of an estimate of a parameter of a population, from a set of observations.

Because the bootstrap method has the least assumptions, it represents the best estimate of adult suckers in and across the three reservoirs.

Under the bootstrap method, the mean population estimates for listed suckers across the three reservoirs is 5,540 adults without differentiation by species. Population estimates for each reservoir show the total number of adult listed suckers is highest in Copco No. 1 Reservoir, slightly less in J.C. Boyle Reservoir, and lowest in Iron Gate Reservoir (Table 2).

Table 2. Population Estimate attributes and estimates for listed and potential hybrid suckers in the Lower Klamath Project Hydroelectric Reach Reservoirs.

Population Estimate Attributes	J.C. Boyle	Copco No. 1	Iron Gate	Combined
Total Initial Suckers Captured – Fall 2018 through Spring 2020	95	98	29	222
Total Target Suckers PIT-tagged and Available for Recapture – Fall 2018, Spring 2019, Fall 2019, Spring 2020)[1]	71	83	27	181
Total Tagged Suckers Recaptured – Fall 2018 through Spring 2020)	3	3	2	8
Recapture Efficiency (# Recaptured / # Tagged	4.2%	3.6%	7.4%	4.4%
Bootstrap Method – Mean Population Estimate	2,766	3,371	399	5,540

[1] Although all target suckers captured on the final night of sampling at each reservoir were PIT-tagged, they were not available for subsequent recapture, and therefore, they were excluded from the total number of target suckers PIT-tagged and released for the mark-recapture estimate.

Based on the 2018-2020 sampling and population modeling, there are an estimated 2,766 adult listed suckers in J.C. Boyle Reservoir, and 3,371 adult listed suckers in Copco No. 1 Reservoir. It is estimated there are 399 adult shortnose suckers in Iron Gate Reservoir (Table 2). The total modeled population estimate is 5,540 adult listed suckers.

5.4.3. Juvenile and Larval Estimates in the Hydroelectric Reach Reservoirs

Assessing the number of larvae and juveniles in the hydroelectric reach through capture and re-capture is challenging, especially since sampling efforts target adults and the gear used rarely captures juveniles. Estimating larvae and juveniles is also problematic because they are tough to catch in sufficient numbers to obtain robust estimates. And telling larvae and juvenile sucker species apart is difficult and can only be done in a laboratory.

The intra-Service consultation for PacifiCorp's Habitat Conservation Plan (USFWS 2013a) provides the best available information for larval and juvenile estimates in the hydroelectric reach. The USBR's Klamath Project and interim operations plan does not include Keno Dam and we do not have current entrainment estimates for this location (USFWS 2020). The Habitat Conservation Plan estimates 402,000 larvae and 3,169 juveniles drift downstream through Keno Dam alive (USFWS 2013a pp. 65, 67, 72-Table A3). The estimated annual mortality of each life stage at the hydroelectric reach facilities is approximately 36,771 larvae and 344 juveniles. Mortality occurs from turbines, spillways, flow lines, ramping rate effects, and reservoir fluctuations that can strand suckers (USFWS 2013a p. 72-Table A3).

These estimates support an annual population of 365,229 larvae and 2,825 juveniles in the hydroelectric reach. These individuals are from drift or entrainment at Keno Dam (USFWS 2013a) and originated from the spawning populations in Upper Klamath Lake.

5.5. Relationship of the Klamath River Management Unit to the Upper Klamath Lake Recovery Unit

As discussed in section 5.1.3, the portion of the action area from Keno Dam to Iron Gate Dam encompasses the Klamath River management unit of the Upper Klamath Lake Recovery Unit (USFWS 2013). See Figure 5. The hydroelectric reach reservoirs in the Klamath River management unit contain shortnose and Lost River suckers. They are considered a sink population,[19] with no reproduction and no ability to change their distribution and move back upstream. Any new individuals in this reach are spawned upstream in Upper Klamath Lake and drift or are entrained downstream. This sink population does not contribute to maintaining and recovering Lost River and shortnose suckers in its current location because of the restricted access to suitable spawning habitat (Desjardins and Markle 2000 pp. 14-15, Hodge and Buettner 2009 pp. 4-6, Kyger and Wilkens 2011 p. 3).

As described earlier, both the Service (USFWS 2012, 2013) and the National Research Council (NRC 2004) concluded that the sucker populations in the Klamath River hydroelectric reach reservoirs (and Klamath River management unit) do not contribute to the survival and recovery of the species. The individual fish from the reservoirs could serve as "backup" to replace fish lost in other populations if a catastrophic event occurred (NRC 2004). However, the conservation value of the sucker populations in these reservoirs is low because:

1. The listed suckers in the reservoirs are not self-sustaining. There is no opportunity for spawning and reproduction is not known to occur.
2. There are relatively low numbers of individuals and without spawning habitat, they cannot increase their numbers.
3. There is not adequate fish passage and the gradient of the river is too steep for listed suckers to return to Upper Klamath Lake, where suitable spawning habitat exists, and therefore they cannot increase their distribution.
4. The suckers are residing in low quality habitat with frequent algae outbreaks and poor water quality.

In the final critical habitat rule for the Lost River and shortnose sucker (USFWS 2012; 77 FR 73740), both the Upper Klamath Lake and the Keno Reservoir management units were designated as critical habitat. The Klamath River management unit was not proposed or designated because it does not include the physical and biological features necessary for the conservation of the species (see section 5.1.3). The area downstream of Keno Dam is considered a population sink for both

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[19] A population in a low-quality habitat in which the birth rate is generally lower than the death rate and population density is maintained by immigrants from "source populations," which are generally more robust.

species.

5.6. Existing Conditions in Action Area for Lost River Sucker and Shortnose Sucker – Lost River Recovery Unit

The environmental baseline for this portion of the action area is specific to the Tule Lake National Wildlife Refuge (NWR). The Tule Lake NWR is identified as a translocation site for Lost River and shortnose suckers under Action 2 of the conservation measure.

5.6.1. Existing Conditions in the Tule Lake Portion of the Action Area

Tule Lake is a closed or endorheic basin, with different hydrology from the other wetland and inner-wetland lake basins in the Upper Klamath Basin. Historically the lake covered between 40,000 to 120,000 acres, depending on precipitation accumulations (J. Vradenburg, personal communication, September 29, 2021).

Tule Lake was extensively diked, and its volume has been greatly reduced through evaporation as well as water retention above dams and irrigation. Water diversions to the Klamath River and Lower Klamath National Wildlife Refuge through the D Pump also influence the lake levels. The remaining lake habitat which is referred to as Sump 1A and Sump 1B, is approximately 9,081 acres and 3,259 acres, respectively.

Drought conditions in 2020 and 2021 resulted in a reduction in water quantity and quality in the two sumps. Despite these reductions, the Service was able to work with our partners to ensure that adequate habitat was provided for the sucker populations in the sumps. Existing and future protections for these populations will allow for the continued maintenance of habitat for resident and translocated suckers in this area, and these areas need to be managed for the suckers, regardless of the use of Tule Lake NWR as a translocation site (USFWS 2021).

The Tule Lake sumps are maintained by agricultural return flow. For Sump 1A, the main source of inflow is from the Lost River. Until 2018, the Service used Sump 1A as a release site for Lost River and shortnose suckers that are captured from canals in the basin. However, since 2018, the Service has transferred suckers from other areas of the basin to the Klamath Falls National Fish Hatchery rather than to Sump 1A. Adults of both species are known to occupy Sump 1A and have been relocated to Upper Klamath Lake in the past (Courter *et al.* 2010). Management of the sumps is complicated by multiple user groups, a periodic need to draw down the reservoirs for sediment maintenance, and the need to maintain emergent and submergent wetland habitat for fish and wildlife benefits (1964 Kuchel Act). These management considerations will not undermine either sumps' ability to support habitat for adult suckers and the Service will continue to manage the Tule Lake sumps for multiple uses.

Hundreds of individuals of both species were captured in Sump 1A during a 3-year effort in March and April 2006, 2007, and 2008 (Hodge and Buettner 2009). Spawning aggregations have been observed in the Lost River below Anderson Rose Dam, but the habitat is not high quality. Locations in the Lost River where historical spawning was documented, such as Olene, are inaccessible from Tule Lake because of multiple dams and the inundation behind them. Thus, the populations in Tule Lake are not self-sustaining (they are also considered a sink) and are composed of offspring from other populations that found their way through the Lost River or the irrigation system into Tule Lake, or were brought there from other salvage efforts (USFWS 2013).

Return flows to the sumps are influenced by water use for agriculture and water availability in the basin. During drought periods, flows to the sumps diminish and habitat for the suckers decreases. Water quality is also impacted by agricultural inputs, algal blooms, and reduced dissolved oxygen levels. Drought conditions likely exacerbate water quality issues as agricultural nutrients are concentrated in lower return flows.

Non-native predatory fish species in the sumps may prey on juvenile suckers. Adults are large enough that non-native fish cannot prey on them. Fish-eating birds including American white pelicans (*Pelecanus erythrorhynchos*) and double-crested cormorants (*Phalacrocorax auratus*) prey on suckers in Upper Klamath Lake and in Clear Lake east of the Tule Lake NWR (Evans *et al.* 2016).

The effects of pesticides and herbicides on lands around Tule Lake was evaluated in previous section 7 consultations (USFWS BOs: 1-7-95-F-26 and 1-10-07-F-0056, dated February 9, 1995 and May 31, 2007, respectively). In both consultations, the Service determined that the prescribed use of pesticides and herbicides will not jeopardize the continued existence of Lost River and shortnose suckers. And, monitoring of pesticides in Tule Lake indicate pesticides are not present in concentrations that will adversely affect suckers (USFWS 2019a). In addition, an ecological risk assessment specific to soil fumigants (e.g., Vapam) used on federal lease lands within the Tule Lake NWR analyzed the toxicity, environmental fate, transport, and exposure pathways, finding there is "sufficient information that ecological risks to terrestrial, aquatic, and invertebrate species are negligible" for the majority of exposure scenarios (USFWS 2019a).

Despite the challenging environmental conditions in aquatic areas at the Tule Lake NWR, including Sump 1A and Sump 1B, listed suckers have persisted here for decades.

5.7. Existing Conditions in Action Area for Bull Trout

As described in Chapter 4, the Klamath Recovery Unit for bull trout wholly encompasses the project's action area for this species. The current condition of bull trout in the action area is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, water diversions for agriculture, nonnative species, and past fisheries management practices (USFWS 2015b).

Conservation measures or recovery actions implemented or ongoing include the removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culvert replacement, and habitat restoration (USFWS 2015b).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2015b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. The three core areas in the action area are Upper Klamath Lake, Sycan River, and Upper Sprague River (Figure 4).

5.7.1. Upper Klamath Lake Core Area

This core area comprises the northern portion of Upper Klamath Lake and its immediate major and minor tributaries. Major tributaries are the Williamson and Wood rivers. Numerous small streams fed by springs and surface water originate along the rim of the basin. It includes waters draining from Crater Lake National Park south of Scott Peak (8,927 feet) and from the area west of, and including, the Williamson River below Klamath Marsh. The west side of the Fremont-Winema National Forest, from Crater Lake National Park south into the Varney Creek drainage on the west side of Klamath Lake, is also included.

The core area includes two existing local bull trout populations: Threemile Creek and Sun Creek. These populations are isolated and not interconnected with each other. They are genetically distinct from populations in the other two core areas in the Recovery Unit. Genetic variation in this core area is the lower than the other two core areas.

Threemile Creek and Sun Creek have been isolated by habitat fragmentation and have experienced population bottlenecks. Unoccupied habitat is needed to restore connectivity between the two populations and to establish additional populations. This unoccupied habitat includes canals, which now provide the only means of connectivity as migratory corridors. Providing full volitional connectivity for bull trout, however, can also introduce the risk of invasion by nonnative brook trout, which are abundant in the Upper Klamath Lake core area.

The populations in Sun Creek and Threemile Creek have received focused attention. This includes the removal of nonnative brook trout from bull trout-occupied reaches, with intentional isolation of the reaches to prevent access. Because of this work, these populations have become stable and their distribution and abundance is increasing.

The most recent abundance estimates for Threemile Creek are 577 age-1+ fish (ODFW 2016, 2012). In Sun Creek, abundance is estimated at 1,606 age-1+ fish) and distribution has increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica *et al.* 2013).

5.7.2. Sycan River Core Area

The Sycan River core area comprises Sycan Marsh and River, and their tributaries. The Sycan River originates from springs at an elevation near 7,000 feet on the eastern edge of the Klamath River basin and flows through high-elevation meadows and forest lands for 46 miles, and through Sycan Marsh for 9.3 miles. It then flows for 35 miles until it joins the Sprague River. This core area is composed of waters that drain into the Sycan Marsh, including Long, Calahan, and Coyote creeks on the west side of the marsh. On the east side of the marsh is the upper Sycan River, Chocktoot Creek, Shake Creek, and their tributaries.

The only local bull trout population in the Sycan River core area occurs in Long Creek. Long Creek is driven by a snow melt hydrograph, but base flow is largely spring fed. Bull trout, including a fluvial[20] life-history form (up to 20 inches); Light *et al.* 1996), are distributed throughout most of Long Creek.

The local population here is also genetically distinct from those in the other two core areas and bull trout here exhibit both resident and fluvial life histories, which are important for representing diverse life history expression in the overall Recovery Unit. The fluvial, or migratory bull trout grow larger than their resident counterparts, resulting in greater fecundity and higher reproductive potential (Rieman and McIntyre 1993). Fluvial life history forms are important for population persistence and resilience (Dunham *et al.* 2008).

Like Sun and Threemile Creeks, the Long Creek local population has received focused attention to ensure it is not lost. The amount of occupied foraging, migratory, and overwintering (FMO) habitat has been increased through restoration efforts. Bull trout currently occupy approximately two miles of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek. They also use approximately 16 miles of foraging, migratory, and overwintering habitat. Brook trout do inhabit Long Creek and periodic removal efforts have occurred.

The abundance estimate for Long Creek and this core area is 855 individuals (Ziller 1992, Buchanan *et al*. 1997). The Service and USGS have an agreement for making structured decision-making on projects that assist with recovery planning of bull trout populations in the Sycan River core area.

5.7.3. Upper Sprague River Core Area

The Upper Sprague River core area is comprised of drainages of the North Fork and South Fork of the Sprague River upstream of their confluence, including Deming, Boulder, Dixon, Brownsworth, and Leonard creeks. The North and South Fork Sprague rivers originate mostly from small, spring-fed streams near 6,900 feet elevation on the north and southeast sides of Gearhart Mountain. The upper reaches of each river meander through high-elevation meadow and forest lands before being confined by narrow forested canyons (Buchanan *et al.* 1997). The lower reaches of both rivers meander through the broad, low-gradient Sprague River valley and have been heavily modified for agriculture.

This core area comprises five bull trout local populations in Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. Deming Creek likely supports the largest local population in the core area. Like the Sycan River cover area, bull trout here exhibit resident and fluvial life histories that are important for conserving genetic diversity in the Recovery Unit (USFWS 2015b).

Nonnative brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats. Although brook trout are widespread in the core area, they are not known to overlap with the bull

[20] Bull trout exhibit four distinct life history patterns: anadromous, adfluvial, fluvial and resident. Anadromous populations spend the early portion of their life in streams, grow to adulthood in the ocean, and eventually return to the tributaries in which they were born to spawn. Adfluvial populations spend between one and four years growing in their natal stream and then migrate to lakes. Fluvial populations spend about the same amount of time in their natal streams as their adfluvial siblings but migrate to larger rivers and streams instead of lakes. Resident populations spend their entire lives in small, high elevation streams and generally do not grow very large.

trout populations here (USFWS 2015b). Numerous projects have occurred in this core area to replace culverts that had blocked fish passage with crossings that allow for bull trout passage and increased connectivity. Because of this work, the local populations here have likely been stable and increased in distribution.

5.7.4. Competition and Hybridization

Competition and hybridization with nonnative brook trout is ongoing in all three core areas. We continue to work with partners to support brook trout control efforts and re-establish bull trout populations (USFWS 2015b).

Nonnative brown trout, which occur in the Upper Klamath Lake and Upper Sprague River core areas, may also threaten bull trout. The effects of brown trout on bull trout are not well understood and much remains to be learned; however, they may directly compete with bull trout (USFWS 2002) and superimpose their redds[21] over bull trout redds (Lockard and Carlson 2005).

5.7.5. Livestock Grazing

Cattle grazing has had a strong influence on riparian vegetation and stream bank stability in the Klamath River basin. Livestock grazing increases sediment and nutrient loading rates by accelerating erosion (USFWS 2015b, USFWS 2002, McCormick and Campbell 2007). Cattle can heavily graze floodplains, wetlands, forests, rangelands, and riparian areas, resulting in the degradation of these areas. Poorly managed grazing operations alter streamside riparian vegetation and compact soil surfaces, increasing groundwater runoff, lowering streambank stability, and reducing fish cover.

While livestock grazing has been reduced along most stream reaches occupied by bull trout, impacts still occur upstream and downstream of known habitat and in historically occupied drainages that could be restored. Different grazing techniques could be used, and in some areas are used, to reduce impacts to bull trout habitat. This includes fencing and the temporary removal or a significant reduction in the number of permitted cattle on priority stream reaches.

5.7.6. Timber Harvest

Timber harvest and associated activities such as 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 2015b, 2002b, NRC 2004). Past logging and road-building practices did not often utilize adequate soil stabilization and erosion control. There is a high density of forest roads in the upper Klamath River basin with many located near streams where the roads likely erode and contribute sediment (USFWS 2015b, USFS 2010). While road management practices have improved, these sediments can result in an increase of fine soil particles that can cover spawning substrates.

[21] A redd is a spawning nest made by a fish, especially a salmon or trout.

5.7.7. Water Management

Water control structures and agricultural diversions contribute to bull trout declines in the Klamath Recovery Unit. Without ensuring adequate water flow, screens at diversions, and passage at water control structures, these structures continue to impede recovery. Unscreened irrigation diversions exist in each of the three core areas and there are recent and ongoing restoration efforts to screen priority diversions. Providing passage at water control structures and ensuring sufficient water quantity for bull trout are improving existing conditions.

5.7.8. Genetics

Most local populations of bull trout within the Klamath Recovery Unit have small population sizes and are isolated from one another, which has genetic risks and reduces the likelihood of population persistence over time. Isolated populations may show signs of inbreeding depression[22] after a few generations with an effective population size of less than 50 individuals. Over longer time scales isolated populations can lose genetic variation due to random effects of genetic drift when effective population sizes fall below 500 (Rieman and Allendorf 2001, Whitesel *et al.* 2004).

Populations of bull trout benefit from management actions that increase the number of spawning adults and increase gene flow. This includes actions that improve habitat capacity, remove threats such as brook trout, and establish new populations (USFWS 2015b). Genetic variability is low, particularly in the Upper Klamath Lake core area. Because population sizes have been substantially reduced and many local populations are isolated, inbreeding depression is a concern (USFWS 2015b).

5.7.9. Conservation Actions

In the Upper Klamath Lake core area, suitable habitat for bull trout in Sun and Threemile Creeks has been expanded by removing nonnative brook trout, bull trout/brook trout hybrids, and nonnative brown trout [Sun Creek only] through recent piscicide and electrofishing treatments, and by installing exclusion barriers to prevent re-invasion by nonnative fish (Buktenica *et al.* 2013). Within Threemile Creek, additional actions include adding large woody debris to increase pool habitat, channel restoration, and channel enhancement in downstream reaches for improved connectivity. In Sun Creek, conservation work includes reconnecting Sun Creek to the Wood River, connecting foraging, migratory, and overwintering habitat (mainstem Wood River and Agency Lake) to additional spawning and rearing habitat. In addition to these two streams, ongoing conservation actions in the core area include acquiring water rights for additional instream flow, replacing diversion structures, installing fish screens, constructing bypass channels, and installing riparian fencing.

These conservations actions have been conducted by or are being undertaken by multiple entities, including Crater Lake National Park, Oregon Department of Forestry, ODFW, Klamath Tribes, Fremont-Winema National Forest, Klamath Basin Rangeland Trust, the Service, and private landowners.

[22] The reduced survival and fertility of offspring of related individuals

In the Sycan River core area, changes in land management restored historic forest structure, species composition, and function to reduce the risk of catastrophic wildfire. Removing water control structures in the Sycan Marsh also restored the historic hydrology. Eliminating these structures allowed streams to access their floodplains. Additional restoration activities include increasing riparian vegetation to reduce channel width and improve instream habitat conditions, and restoring hardwoods in riparian areas to provide shade (Lawler *et al.* 2010, Wong and Bienz 2011). Barrier removal has also established connectivity from Long Creek to Upper Klamath Lake.

Brook trout control efforts in Long Creek are ongoing (USGS 2019). The goal is to achieve long-term viability of bull trout populations in the Sycan River core area through expanding and maintaining existing populations, establishing new populations, and improving stream and riparian habitats.

Additional restoration actions in the Sycan River core area include realignment of the Sycan River within the Sycan Marsh reconnecting the river to Long Creek. This will open 60 miles of Sycan River and tributary habitat to bull trout. Cooperators in recovery actions include the Nature Conservancy, the Fremont-Winema National Forest, ODFW, the Klamath Tribes, Green Diamond Resource Company, U.S. Geological Survey and the Service.

In the Upper Sprague core area, habitat restoration includes culvert replacements, removals, or modifications in multiple streams to allow for migratory behavior and genetic exchange. Bull trout in Leonard and Brownsworth creeks have full volitional access to the entire drainage network. Large woody debris has also been added to these two creeks to improve instream habitat.

Within Deming Creek, culvert replacement occurred, and plans are in place to replace or modify additional culverts to improve passage for bull trout. Habitat restoration includes the installation of riparian fencing to exclude livestock, the addition of instream large woody debris, the planting of riparian species, and improvements in grazing management practices.

Additional actions include large woody debris additions to the South Fork Sprague River and installing a fish screen on the North Fork Sprague River to prevent entrainment. Cooperators in recovery actions include the Fremont-Winema National Forest, ODFW, the Klamath Tribes, the Klamath Basin Rangeland Trust, Green Diamond Resource Company, Deming Ranch Land and Cattle, the Service and private landowners.

The state of Oregon has also taken extensive actions to address bull trout conservation since 1990 in the action area. This includes: (1) Establishing bull trout working groups in the Klamath, Deschutes, Hood, Willamette, Odell Lake, Umatilla and Walla Walla, John Day, Malheur, and Pine Creek river basins for the purpose of developing conservation strategies; (2) establishing more restrictive timber harvest regulations; (3) reducing stocking of hatchery-reared rainbow trout and brook trout into areas where bull trout occur; (4) conducting angler outreach and education efforts; and (5) researching life history, genetics, habitat needs, and limiting factors. In addition, the ODEQ established a water temperature standard where surface water temperatures may not exceed 50 °F in waters that support or are necessary to maintain bull trout viability.

5.7.10. Effects of the 2021 Bootleg Fire

The 2021 Bootleg Fire (Fire) burned significant portions of the Upper Sprague and Sycan River core areas (see Figure 4).

In the Upper Sprague River core area, entire reaches of streams occupied by bull trout were within the Fire perimeter, including Boulder Creek, Dixon Creek, and Leonard Creek. The total acreage of these three watersheds that burned at moderate and high severity was 92, 97, and 81 percent, respectively (R. Pyzak, personal communication, 2021).

Other occupied streams in the Upper Sprague River core area were mostly within the fire perimeter as well, including Brownsworth Creek and Deming Creek. The percent burned at moderate and high severity was 78 and 61 percent, respectively (R. Pyzak, personal communication, 2021).

A thermograph deployed by the USDA Forest Service (USFS) on Leonard creek recorded a maximum water temperature of 20 °C during the fire (Terry Smith, personal communication, 2021). While this temperature is not acutely lethal, it is greater than the chronic thermal temperature limit for bull trout, 16 °Celsius.

While western salmonids are known to show high resiliency to fire events, the high severity and extent of fire within these occupied reaches is concerning for the persistence of the Upper Sprague River core area’s bull trout population. Wildfire can negatively affect water quality by causing ash flows, increasing sedimentation, reducing large woody debris that provides instream habitat complexity, and decreasing stream bank stability with subsequent erosion. These impacts can influence changes in the hydrologic regime, leading to severe flooding and decreases in base stream flow because of sedimentation that clogs the stream channels. These conditions are likely to persist over the next 2 to 5 years as riparian vegetation recovers.

Several rain events have already occurred since the Bootleg Fire was extinguished, creating turbulent water that may be lethal because ash particles can lead to trout suffocation by lodging in their gills. Initial surveys by ODFW have found a 90 percent reduction in fish abundance in Boulder Creek, Dixon Creek, Leonard Creek, and Brownsworth Creek. Deming Creek and Long Creek have not yet been surveyed.

In larger systems, fish can escape wildfire effects by migrating into other reaches of those larger systems. However, bull trout in the Klamath Basin rarely return from downstream migration, presumably due to high competition with non-native brook trout (USFWS 2015b).

In the Sycan River core area, only the lower reach of Long Creek was within the Fire perimeter and the bull trout populations here were not likely to have been affected.

Several bull trout-occupied streams within the Fire perimeter occur on lands that are owned by Green Diamond Resource Company (GDRC) and these lands are managed as commercial timberlands. This includes Boulder Creek, Dixon Creek, Leonard Creek, Brownsworth Creek and Long Creek. Unoccupied critical habitat for bull trout within the Fire perimeter occurs on GDRC property, including reaches of the North Fork Sprague River, South Fork Sprague River and Coyote Creek.

The Oregon Department of Forestry has approved the GDRC to conduct salvage logging operations surrounding Boulder Creek and Dixon Creek. These salvage logging activities allow merchantable trees to be removed from the riparian management area. While the GDRC has been conducting salvage logging, they are also assuring that large woody debris remains or will be introduced into affected streams (see below).

No other timber harvest plans or proposals have been approved to date, but it is expected GDRC will pursue salvage opportunities for other areas encompassing other bull trout-occupied streams within the next year and a half (see Chapter 7, cumulative effects). The GDRC is coordinating with the Service and other restoration and conservation partners to ensure their work protects bull trout and its habitat. This includes contour felling to retain sediment (falling trees across the hillslope so they are on the ground at an angle), leaving slash material, and felling trees within streams and riparian areas to retain large down wood. These actions are expected to minimize further impacts to fire-affected bull trout habitat and contribute to the restoration of bull trout in the future.

Other streams with bull trout within the Bootleg Fire perimeter mostly transect USFS lands. Emergency actions to control the fire were consulted on independently of this BO but have included logging along roads near streams occupied by bull trout to create buffers for containment and intrusion of aerial fire retardant into Deming Creek. The actions taken by the USFS to date are not expected to have significantly altered the environmental baseline for bull trout on their lands.

5.8. Relationship of the Action Area to the Klamath River Recovery Unit for Bull Trout

The action area for the project includes the entire Klamath Recovery Unit for bull trout and its three core areas (see Figure 4, see section 4.6). The Upper Klamath Lake core area contains two local populations of bull trout: Sun Creek and Threemile Creek. The Sycan River core area contains the Long Creek local population. The Upper Sprague River core area contains five local populations; Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek and Brownsworth Creek.

5.9. Previous and Current Activities Affecting Lost River Sucker, Shortnose Sucker and Bull Trout in the Action Area

The environmental baseline in the action area includes past and ongoing management actions on Federal lands that affect the Lost River sucker, shortnose sucker, and bull trout.

The Klamath Basin's hydrologic system is a complex of interconnected rivers, lakes, marshes, dams, diversions, wildlife refuges, wilderness areas, other federal and state lands, and private lands. Alterations to the natural hydrologic system began in the late 1800s and accelerated in the early 1900s. There is now a complex network of water uses in the Basin, including the operation of several hydroelectric dams by the privately owned PacifiCorp, the United States Bureau of Reclamation (USBR), and additional diversions by private users.

5.9.1. Consulted on Effects included in the Environmental Baseline for Lost River and Shortnose Sucker

Consulted-on effects are an important component of characterizing the existing condition of a species and the environmental baseline in the action area. Although there are numerous actions in the Klamath River Basin where section 7 consultation has been completed, here we address only the key projects most closely tied to the environmental baseline in the action area and the proposed action.

The most significant action currently affecting the endangered suckers is the continued operation of the USBR's Klamath Project (section 5.9.1.1). Additional actions associated with the hydroelectric reach reservoirs and dam facility operations include PacifiCorp's Habitat Conservation Plan (section 5.9.1.2). Additional conservation actions are described in section 5.9.1.3.

5.9.1.1. The Klamath Project

Located above Keno Dam and separate from the Lower Klamath Project and PacifiCorp's Klamath Hydroelectric Project is the USBR's 250,000-acre Klamath Project. The USBR manages several reservoirs, canals and water diversions in the upper Klamath Basin that supply irrigation water for agricultural uses in the Upper Klamath Basin. It also supplies water to the Tule Lake and Lower Klamath National Wildlife Refuges. The Klamath Project includes the major habitats for the listed suckers including Upper Klamath Lake, Gerber Reservoir, Clear Lake Reservoir and Tule Lake (USFWS 2020).

The Klamath Project was established in 1905 as the second federal water project in the nation. The Service and NMFS (collectively the Services) have issued several biological opinions regarding the effects of the Klamath Project operations on ESA-listed species and their critical habitat over the past 20 years. Among other biological opinions, in 2001 and 2002 the Service concluded the Klamath Project operations would jeopardize the continued existence of the endangered Lost River sucker and the shortnose sucker in Upper Klamath Lake (USFWS 2001), and that it would result in the adverse modification of proposed critical habitat.

The Service identified reasonable and prudent alternatives to the proposed action in its 2002 biological opinion, which allowed the Klamath Project to continue operating without jeopardizing the continued existence of both species (USFWS 2002a).

The reasonable and prudent alternatives, and the substantive measures set in place, included water quality improvement measures, entrainment reduction, fish passage improvements, habitat enhancement, and supporting research and monitoring to evaluate the factors that were limiting recovery.

The Service has authorized lethal and non-lethal take for all life stages of Lost River and shortnose sucker as a result of past and ongoing activities associated with the Klamath Project through numerous section 7 consultations. The most recent formal consultation was completed in April 2020 for the USBR's interim operations plan (08EKLA00-2020-F-0059).

There are three elements of USBR's interim operations plan:

- Element 1: Water Storage. The USBR operates three reservoirs for the purpose of storing water for delivery to the Klamath Project's service area – Upper Klamath Lake, Clear Lake Reservoir and Gerber Reservoir.
- Element 2: Water Delivery. The USBR directs operations to deliver water for irrigation purposes, as well as the National Wildlife Refuge needs. Operations are subject to water availability, and consistent with flood control purposes, while maintaining Upper Klamath Lake and Klamath River hydrologic conditions that avoid jeopardizing the continued existence of listed species and adverse modification of designated critical habitat.
- Element 3: The USBR performs the operation and maintenance activities necessary to maintain Klamath Project facilities to ensure proper long-term function and operation.

The Klamath Project has two distinct service areas: the east side and the west side. The east side includes lands served primarily by water from the Lost River, and Clear Lake and Gerber Reservoirs, which are not part of the Lower Klamath Project's action area.

The west side includes lands served primarily by water from Upper Klamath Lake and the Klamath River. The west side may use return flows from the east side. The project was designed based on the reuse of water and therefore, water diverted from Upper Klamath Lake and the Klamath River for use on the west side may be reused several times before it discharges back into the Klamath River via the Klamath Straits Drain. Return flows from water delivered from the reservoirs on the east side may also be reused several times.

The physical structures that are part of the Klamath Project (e.g., dams, canals, diversion points) have altered Lost River and shortnose sucker habitat both upstream and downstream of the structures. For example, habitat below Clear Lake Dam no longer functions as a migration corridor for spawning individuals because impassable barriers exist, and because the water course does not provide optimal habitat for out-migrating larvae given unnatural flow patterns through the system. Conversely, the habitat above the dams has been altered from systems with large, vegetated wetlands, intermixed with open water areas that historically provided spawning and rearing habitat for the listed suckers to a nearly homogenous open-water system with few wetlands.

The Service's 2020 BO assessed the environmental baseline. Current conditions and past actions adversely affecting the listed suckers include:

- Negative effects of water quality (e.g., low dissolved oxygen, high ammonia, high pH, algal toxins, and urban and agricultural run-off) to suckers in Upper Klamath Lake, Keno Reservoir, the Lost River, Tule Lake, and the Klamath River.
- Native and introduced pathogens, parasites, and predators.
- Injury and mortality associated with entrainment into irrigation canals, turbines, and spillways at water control structures and dams.
- Migration barriers such as dams that prevent access to upstream spawning habitats in the Lost River and adverse water quality and low flows that could also act as seasonal barriers.

- Diversion of water for agriculture and drought that can reduce access to and availability of spawning and rearing habitats throughout both species range, especially during droughts when water use increases (USFWS 2020).

Numerous conservation efforts and restoration activities have been implemented and are ongoing to improve the environmental baseline for the listed suckers, either directly or indirectly. This includes 1) enforcement of State water-quality criteria and State water rights upstream of the Klamath Project's reservoirs that contain suckers, 2) implementation of management plans associated with nutrient Total Daily Maximum Loads, and 3) ongoing restoration and enhancement of sucker habitat that should improve the environmental baseline.

Furthermore, the Service's assisted rearing program will have beneficial effects by increasing survival above observed rates in Upper Klamath Lake, which are close to zero. This will enable recruitment of some individuals into the adult sucker populations in Upper Klamath Lake by stocking individuals in size classes that should have a higher success of survival. Overall, the environmental baseline for the species in the action area is highly degraded and is contributing to their current endangered status and the ongoing and future conservation efforts and restoration activities are anticipated to provide benefits to suckers and their habitats.

The Service's non-jeopardy determination for the effects of operating the Klamath Project on the Lost River and shortnose sucker described that survival of both species will continue to be influenced by project activities such as entrainment; however, larval and juvenile survival is expected to increase due to assisted rearing and conservation measures.

The interim operations plan for the Klamath Project includes higher lake elevations for Upper Klamath Lake, particularly in summer and fall, and greater certainty that expected elevations will be met. These higher elevations provide habitat for larval, juvenile and adult suckers during critical parts of the year. Additional conservation measures to reduce entrainment effects at the Link River Dam are included. Assisted rearing is also expected to increase the survival of larvae and juveniles brought into captivity. Based on preliminary results, we expect some of the large juvenile suckers that are released from the program are also likely to survive and recruit into the adult populations in Upper Klamath Lake (USFWS 2020).

5.9.1.2. PacifiCorp's Klamath Hydroelectric Project and Habitat Conservation Plan

PacifiCorp's Klamath Hydroelectric Project (FERC Project No. 2082; KHP) was constructed between 1911 and 1962. The project included eight developments: East and West Side power facilities (at the Link River Dam), Keno, J.C. Boyle, Copco No. 1, Copco No. 2, Fall Creek and Iron Gate. A 50-year FERC license for the project was issued in 1954, prior to enactment of the ESA. Beginning in 1956, Iron Gate Dam flow releases were generally governed by guidelines outlined in the FERC license, commonly referred to as "FERC minimum flows." In 2004, PacifiCorp filed an application with FERC for a new 50-year license (FERC 2007, USFWS 2007). PacifiCorp's application did not include provisions for volitional fish passage. PacifiCorp operated the project under the 50-year license issued by FERC in 1954 until the license expired in 2006.

The FERC consulted with the Services in 2007 on PacifiCorp's Klamath Hydroelectric Project, and its effects to listed species (USFWS 2007). The Federal nexus for the 2007 consultation was the

FERC's action on an application for a new long-term license for the project's operations. However, the license was never authorized by the FERC. The FERC also chose not to consult on the annual licenses issued to PacifiCorp after the expiration of the original license and PacifiCorp has continued to operate the Klamath Hydroelectric Project under annual licenses, based on the terms of the previous license.

Consequently, the full extent of the actions assessed in the 2007 consultation were never implemented and as a result, PacificCorp was left without incidental take authorization for the endangered Lost River and shortnose sucker and the threatened coho salmon. Because of this, PacificCorp applied for an incidental take permit under Section 10(a)(1)(B) of the Act, which required the development and analysis of a Habitat Conservation Plan (HCP). PacifiCorp finalized their HCP for the Lost River and shortnose sucker in November 2013 (PacifiCorp 2013). The HCP addresses effects to the suckers and their critical habitat (PacifiCorp 2013 pp. 43-58). The Service conducted an intra-Service consultation (08EKLA00-2013-F-0043) on the effects to suckers and issued an incidental take permit to PacificCorp for a period of 10 years (USFWS 2013a).

The HCP addresses direct effects to suckers, including entrainment at project diversions, false attraction at project tailraces, ramp rates, lake level fluctuations, migration barriers, loss of habitat, and water quality. The HCP also proposed and has completed the shutdown of the East Side and West Side facilities to reduce sucker mortality resulting from entrainment into the canals. These two facilities are upstream of the hydroelectric reach at the Link River Dam, which is owned and operated by the USBR. PacifiCorp ceased operation of the East Side and West Side facilities in March 2014.

As part of the HCP, PacifiCorp established a Sucker Conservation Fund to support conservation goals and objectives, and as part of this, committed to continue support of the Nature Conservancy's Williamson River Delta Restoration Project (PacifiCorp 2013 p. 67). This funding has contributed to numerous conservation efforts since 2013, including the Williamson River Delta Restoration Project (USFWS 2020).

The annual lethal take the Service estimated to be reasonably certain to occur as a result of authorization of the Incidental Take Permit, associated with the HCP, were approximately: 10,000 sucker eggs, 66,000 larvae, 500 juveniles, and up to five adults; and an annual harassment take of approximately 1,400,000 larvae, 6,700 juveniles, and 25 adults (USFWS 2013a-Table 5.2). Much of this take was eliminated in March 2014 when PacifiCorp ceased operation of the East Side and West Side facilities at the Link River Dam (USFWS 2020).

The Service determined the issuance of the Incidental Take Permit for the HCP was not likely to jeopardize the continued existence of the Lost River sucker and shortnose sucker for the following reasons:

1. The amount of take under the proposed HCP is reduced substantially (90 percent) from historic levels.
2. Most of the take is of sucker eggs and larvae that are produced in large numbers annually.
3. Sucker populations in the hydropower reservoirs are not self-supporting and are likely dependent on upstream source populations to maintain themselves.

4. Were it not for the reservoirs that are part of the Klamath Hydropower Project, habitat for the Lost River sucker and shortnose sucker would likely not exist below Keno Dam.
5. Lost River sucker and shortnose sucker occurring in the reservoirs below Keno Dam do not have adequate upstream access, and therefore these fish do not contribute to the reproducing upstream populations that are considered essential for recovery.
6. Adverse effects to designated critical habitat by the Klamath Hydropower Project are confined to Keno Reservoir, which represents a small fraction (one percent) of the total amount of designated critical habitat for the two species (USFWS 2007 pp. 49-50).

5.9.2. Conservation Efforts

5.9.2.1. Klamath Basin Sucker Rearing Program

As described in section 4.3.2, the Service began an assisted rearing program for Lost River and shortnose sucker in 2015 to supplement populations in Upper Klamath Lake through augmentation. The primary target of the effort is shortnose sucker, but the lack of an effective way to identify live larvae and juveniles means both species are collected and reared.

In 2013, the USBR funded the rearing program to help improve the environmental baseline and minimize impacts to suckers that may result from their Klamath Project operations. The Service funded expansion of the program and has collected thousands of larval suckers for assisted rearing.

The program seeks to maximize genetic diversity and maintain natural behaviors after fish are released (Day *et al*. 2017). Larvae are collected as they drift downstream in the Williamson River, so no brood stock are maintained, and the effects of artificial breeding are avoided. Collection efforts are currently spread across the drift season to maximize the genetic variability. Juveniles are stocked into semi-natural ponds and growth depends on a combination of natural and artificial feed.

The first release of reared suckers into Upper Klamath Lake occurred in spring 2018 and continues annually. Thus, the assisted rearing program is likely to be a source of recruitment for both species in Upper Klamath Lake. Support for the ongoing operation of the rearing program is a component of the USBR's Klamath Project, described above.

5.9.2.2. Habitat Restoration

Numerous agencies and organizations have restored important components of habitat to reduce threats to both species over the last 20 years. In most instances, considerable time is necessary to determine the efficacy of such recovery actions because habitat restoration takes time and effects to a long-lived species take time to realize. For example, actions to increase reproduction and recruitment into adult populations require at least five years for shortnose suckers and nine years for Lost River suckers.

Hundreds of wetland, riparian, in-stream, and upland restoration projects have been implemented in the Upper Klamath Basin that directly or indirectly benefit suckers. This also includes improving fish passage to allow for increased access to spawning habitat. Many take a holistic or ecosystem approach that assumes restoration of natural ecosystem functions will benefit multiple species.

Important projects that contribute to recovery include screening of irrigation diversions, eliminating fish passage barriers, and restoring rearing and spawning habitat.

For example, restoration of the Williamson River Delta by The Nature Conservancy, with substantial support from PacifiCorp and other organizations, has provided approximately 2,500 hectares (6,000 acres) of rearing habitat for the largest spawning populations of Lost River and shortnose suckers. The removal of Chiloquin Dam in 2008 allowed access to approximately 120 kilometers (75 miles) of potential spawning and migration habitat. Additionally, screening the A-canal at the Link River Dam in 2002 reduced entrainment of fish larger than 30 millimeters (1.2 inches) into the Klamath Project's irrigation system canals. Prior to placement of the screen, up to hundreds of thousands of juveniles were entrained annually (Gutermuth *et al.* 2000). Private landowners, ODFW, USBR, the Natural Resources Conservation Service (NRCS), and the Service have each implemented many other smaller projects that benefit Lost River sucker and shortnose sucker populations and habitat.

5.10. Tribal Actions

5.10.1. In-River Fish Harvest

Tribal in-river harvest activities occur in areas known to support Lost River sucker, shortnose sucker, and bull trout. These activities include the Klamath Tribes' harvesting sucker larvae from the rivers for rearing in the Hatchery. This has occurred over the last five years to date; and both the Klamath Falls National Fish Hatchery and the Klamath Tribes' Aquatic Research station have collaborated to collect wild spawned larvae from the Williamson River.

5.10.2. Other Tribal Projects and Programs

The Klamath Tribes have conducted water quality monitoring in Upper Klamath Lake since 1990 (Kann 2017). They have also engaged in stream restoration and fish passage improvement projects on the Wood River and its tributaries that benefitted bull trout, Lost River suckers, and shortnose suckers. The Klamath Tribes, in cooperation with the Klamath Basin Rangeland Trust, USFWS, Trout Unlimited, landowners, and other groups were part of an effort to reconnect Sun Creek to the Wood River. This project will aid bull trout populations in Sun Creek by improving connectivity and habitat (USFWS 2015b p. B-2).

These ongoing tribal programs and activities have long-term beneficial effects on federally listed species in the action area, such as localized improvements to aquatic habitats where stream restoration or enhancement activities are conducted and watershed level improvements to erosion and nutrient loading.

6. Consequences of the Project on Lost River Sucker, Shortnose Sucker and Bull Trout and their Habitat in the Action Area

This chapter presents an analysis of the expected consequences of the project activities described in Chapter 1 and Table 1 of this BO on Lost River sucker, shortnose sucker, and bull trout.

The Service revised portions of its regulations that implement section 7 of the ESA, including a revised definition of "effects of the action." 50 CFR § 402.02 (84 FR 44976; August 27, 2019). The "effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. The effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action" (see 50 CFR § 402.17).

This effects analysis relies on information presented in the Status of the Species and Environmental Baseline sections of this BO for Lost River sucker, shortnose sucker, and bull trout. The analysis specifically addresses the species' numbers or abundance, reproduction, and distribution for the jeopardy analysis. Using the information and data from the BA; additional information from the Renewal Corporation; conversations and personal communications with other Service biologists, NOAA's NMFS and USBR staff, and River Design Consultants; and the Service's own analysis, we assess the consequences of the proposed action to Lost River sucker, shortnose sucker, and bull trout individuals, as well as their habitat, and prey.

Effects to listed species can be discountable, insignificant, wholly beneficial, or adverse. To make this determination, an assessment of the individual's expected exposure to a stressor[23] is made, along with the species expected response, based on its biology. Effect determinations for individuals, or their habitat, are based on survey data, assumptions regarding occupancy by various life stages (based on their life history), the best available scientific data, or direct experience with and observations of similar activities and observed effects.

An effect is considered insignificant if it cannot be meaningfully measured, detected, or evaluated. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not be able to meaningfully measure, detect, or evaluate insignificant effects or expect discountable effects to occur (USFWS and NMFS 1998 p. 3-12). Beneficial effects are contemporaneous positive effects without any adverse effects to the species (USFWS and NMFS 1998 p. 3-12). An effect is adverse when the effect cannot be clearly demonstrated as insignificant, discountable, or wholly beneficial.

6.1. Actions Affecting Lost River Sucker and Shortnose Sucker

Based on the Service's review of the proposed action as described in the BA, project maps and diagrams, and our knowledge of the species and their habitat, the following project activities will likely affect Lost River and shortnose suckers:

1) Sediment dredging and in-water blasting at Copco No. 1 Dam
2) Disposal of dredged material in open water in Copco No. 1 Reservoir (or on land)
3) Construction of a work pad on the upstream side of Iron Gate Dam
4) Implementation of Action 2 of the Conservation Measure (capture and translocation of listed adult suckers)

[23] A change that can result in a negative effect

5) In-water blasting at J.C. Boyle Reservoir
6) Improvements to the Copco Road culverts at Scotch Creek and Camp Creek near Iron Gate Reservoir
7) Construction of a temporary bridge upstream of Daggett Road near Iron Gate Reservoir
8) Reservoir drawdown and removal of the four dams

6.1.1. Effects to Lost River and Shortnose Sucker

Individual Lost River and shortnose suckers will be variously affected by project implementation. Effects will occur through several mechanisms that reduce fitness, increase stress, or lead to injury or death (e.g., water quality and quantity impairment, noise disturbance, introduction of pathogens and disease, resource competition). Effects, including stressors and benefits, are summarized below.

Effects and Stressors to Lost River and shortnose suckers:

1. Injury or mortality from project activities before final drawdown and dam removal
2. Injury or mortality from chemical spills or concrete dust
3. Mortality during reservoir drawdown and dam removal
4. Injury or mortality from adult fish trapping and relocation activities during the capture and translocation effort under Action 2 of the Conservation Measure
5. Disease and pathogens from anadromous salmonids in the Upper Klamath Basin
6. Interspecific competition with anadromous salmonids for food and space in the Upper Klamath Basin
7. Predation from anadromous salmonids on different life stages in the Upper Klamath Basin

Beneficial Effects to Lost River and shortnose suckers:

1. Translocated adult suckers are expected to provide an additional source of genetic brood stock[24] and contribute to the existing populations in Upper Klamath Lake and the Upper Klamath Lake Recovery unit. They will contribute to improved opportunities for adults to spawn and successfully reproduce in these areas, contributing to increased numbers and reproduction.
2. Increases in primary productivity from marine-derived nutrients in a hypereutrophic[25] system in the Upper Klamath Basin

6.1.2. Key Assumptions for the Effects Analysis

The Service assumes the proposed action will occur as described in the BA. This includes all activities in the hydroelectric reach reservoirs, and within the Klamath River channel reach in the reservoir footprints, to create conditions for volitional fish passage. This assumption frames the basis of our analyses in terms of the temporal and spatial separation of likely effects.

[24] A group of mature individuals used for breeding purposes. Brood stock can be a population of animals maintained in captivity, as a source of replacement for, or enhancement of, seed and fry numbers. They are generally kept in ponds or tanks where environmental conditions such as photoperiod, temperature and pH are controlled.
[25] Resulting from high algal productivity, intense algal blooms, fish kills due to oxygen depletion in bottom water

The timing and implementation of Action 2 of the conservation measure is critical to our analysis. The capture and translocation of adults will occur in spring, or fall, of the pre-drawdown year, *prior* to drawdown and dam removal (see section 1.3). As described in section 1.3, conservation measures under the ESA are reasonably specific, certain to occur, capable of implementation, subject to deadlines, or are otherwise enforceable. This conservation measure is part of the proposed action and will be completed during either the spring or fall of the year prior to drawdown (BA p. 81).

6.2. Effects of Proposed Action to Lost River and Shortnose Suckers

The following description of project activities and resulting effects is organized chronologically. Effects from project activities that will occur prior to drawdown and dam removal are discussed first, followed by the effects of full drawdown and dam removal. Lastly, the expected effects on Lost River sucker and shortnose sucker from Chinook salmon and steelhead returning to the Upper Klamath Basin are described.

While Coho salmon are expected to recolonize the Klamath River above Iron Gate Dam, after dam removal and channel restoration is completed (Renewal Corporation 2021, NMFS 2021), historical limit of anadromy for coho salmon was Spencer Creek. After the Spencer Creek confluence, the Klamath River's gradient is too steep for coho salmon to move upstream (Hamilton *et al*. 2005). Spencer Creek is located downstream of where any suckers are expected to be present after the removal of the hydroelectric reach reservoirs and dams and therefore there are no expected effects between coho salmon and the listed suckers.

The project will result in a range of effects to individual Lost River and shortnose suckers in the hydroelectric reach reservoirs, at the Tule Lake National Wildlife Refuge (NWR), and in the Upper Klamath Basin. The Service does not have reasonable estimates on the number of individuals that may be adversely affected by each project activity. We currently have estimates on the total number of adult listed suckers in the reservoirs based on sampling and population modeling from 2018 to 2020 and estimates on the number of larvae and juveniles from the Intra-service consultation on PacifiCorp's Habitat Conservation Plan (Renewal Corporation 2021, USFWS 2013a) (see Chapter 5, section 5.4).

For the purpose of this analysis, the Service estimates all Lost River and shortnose suckers in the reservoirs, of any life stage, will experience a range of insignificant, discountable, or adverse effects, including injury or mortality, during pre-drawdown activities. This includes effects during Action 2 of the conservation measure (capture and translocation of adults). During and after drawdown and dam removal, any individuals remaining in the reservoirs and the Klamath River will die.

Table 3 summarizes the life stages of Lost River and shortnose suckers that are expected to be present, and possibly exposed, to each project activity and associated stressors.

Table 3. Life Stages of Lost River Sucker (LRS) and Shortnose Suckers (SNS) Likely to be Present[26] During Project Activities

Project Activity or Stressor	Eggs	Larvae[1, 2] LRS Mar-Jul	Larvae[1, 2] SNS Apr-Jul	Juveniles[3]	Adults
IEV Management and Herbicide Use	N	Y	Y	Y	Y
Chemical Spills	N	Y	Y	Y	Y
Concrete Dust (increased pH)	N	Y	Y	Y	Y
Erosion and Suspended Sediment Impacts (decreased dissolved oxygen)	N	Y	Y	Y	Y
Sediment Dredging at Copco No. 1 (decreased dissolved oxygen, increased pH)	N	N	N	Y	Y
Upstream Work Pad at Iron Gate (decreased dissolved oxygen, increased pH)	N	N	Y	Y-SNS	Y
Drilling and Blasting in pre-Drawdown Year and In-Water Blasting at Copco No. 1 (acoustic shock, increased pH)	N	Y	Y	Y	Y
In-Water Blasting at J.C. Boyle (acoustic shock, increased pH)	N	Y	Y	Y	Y
Stream Crossing Upgrades near Iron Gate Reservoir (increased turbidity, noise impacts)	N	N	Y	Y-SNS	Y
In-Water Construction of Temporary Bridge at Iron Gate (increased turbidity, noise impacts, decreased dissolved oxygen, increased pH)	N	N	Y	Y-SNS	Y
Action 2 of Conservation Measure: Capture and Translocation of Adult Suckers (spring or fall prior to drawdown)	N	Y	Y	Y	Y
Final Reservoir Drawdown and Dam Removal	N	Y	Y	Y	Y

[1] Reiser *et al*. 2001

[2] Larvae transform into juveniles in mid-July between 20 and 30 mm (0.8-1.2 in) total length, and then transition from predominantly feeding at the surface to feeding near the bottom of lakes (Markle and Clauson 2006).

[3] Desjardins and Markle 2000

[26] Denotes if the life stage is expected to be present, based on biology, not if or how the life stage will be affected.

6.2.1. Effects of Project Activities Prior to Full Drawdown and Dam Removal

Activities are proposed at all four reservoirs prior to full reservoir drawdown and dam removal. The activities at Copco No. 2 Dam are not expected to have any effect on Lost River and shortnose suckers because none of the activities will occur in-water, and therefore will not impact individuals, or their habitat.

Project activities at the other three reservoirs and stream crossings in the hydroelectric reach where listed suckers occur will result in a range of effects to these two species. A substantial amount of in-water work will occur in the vicinity of individual suckers or in their habitat. There will be insignificant, discountable, or adverse effects to fish, including mortality. Suckers will be exposed to detrimental noise from drilling and blasting, or other water quality impairments such as increased turbidity, low dissolved oxygen, toxic sediments, pH changes, potential chemical spills, herbicide application, or concrete dust. Effects include direct injury, reduced fitness, or increased energy expenditure from swimming away from a disturbance and stressor. This range of effects will occur to individual suckers of all life stages present in the reservoirs both before and after capture and translocation of adult suckers (see Table 3). Ultimately, aside from the suckers that are captured and translocated, all suckers in the hydroelectric reach will be lost when the dams are removed, and their habitat is removed.

For the remainder of Chapter 6 effects on Lost River and shortnose sucker, we use the term "sucker" or "suckers" to address effects to these two listed species, unless effects are only expected to one of the species (e.g. effects at Iron Gate Dam or near Iron Gate Reservoir).

6.2.1.1. Chemical Spills

The use of heavy equipment in and around the waterways and the removal of concrete and other materials from the existing dams increases the potential for contaminants to enter affected stream channels and reservoirs. Accidental releases of fuel, lubricants and other construction-related chemicals from equipment or hazardous materials in the dam structures will negatively affect water quality, and subsequently sucker health, and the habitats they use.

The project includes BMPs to maintain all fuel storage and refueling sites in an upland location, distant from stream channels, bypass channels, and the reservoirs. Petroleum-powered equipment will be used in a way that prevents potential release of petroleum materials into the water. Fuel storage, refueling, and servicing of construction equipment will occur at upland locations (BA-Appendix D p. 10). Vehicles and construction equipment will be in good working condition with no signs of fuel or oil leaks. Before any equipment enters the reservoirs or stream channels, it will be checked for leaks and repaired (BA p. 53).

The Service expects these BMPs, and rapid responses to address any accidental spill of toxic materials, to be sufficient to restrict the effects to the immediate area and prevent toxic materials from entering the waterway. Because of the minimization measures, larval, juvenile and adult suckers are unlikely to be exposed to chemical spills and effects are expected to be discountable.

6.2.1.2. Concrete Dust

In-water blasting prior to full drawdown, blasting after drawdown, and the removal of the concrete dams and associated concrete facilities, will impact water quality for suckers in wetted areas of the reservoirs. Concrete dust has a high pH and may enter waterways during in-water blasting at J.C. Boyle or Copco No. 1, causing a short-term, localized spike in pH levels (Falter and Cech 1991). For example, during the removal of the Dinner Dam in the Row River Basin in the Southern Willamette Valley, pH rose above 9 during the deconstruction, and this level was maintained for several hours after deconstruction stopped (Stewart 2006).

While the Klamath River is predisposed to higher pH levels in response to algal photosynthesis (see sections 5.2.4 and 5.3), further elevated pH levels for any extended period will result in damage to gills, eyes, skin, or equilibrium;[27] or possible mortality of suckers. In-water blasting will occur at J.C. Boyle and Copco No. 1 prior to full drawdown and dam removal, exposing individuals to elevated pH levels when concrete dust enters the reservoirs.

Therefore, project activities that result in concrete dust entering the waterways will have adverse effects on individual larvae, juvenile, and adult suckers from elevated pH levels.

Project activities that do not result in concrete dust entering the water column will have a discountable effect on suckers. This includes removal of the four dams as this activity will occur when channel conditions are dry. Concrete debris will be removed before the breaching of the cofferdams and therefore we do not expect any concrete dust to enter the water column when or where suckers are present.

6.2.1.3. Invasive Exotic Vegetation Management

Herbicide application will occur during pre-drawdown activities and will be focused at future equipment access points and staging areas. The BMPs for herbicide application (section 1.4.1) will reduce any potential impacts to water quality, and the timing and location of herbicide application will be designed to minimize chemical contamination of waterways. Therefore, effects to suckers from herbicide application are discountable.

Herbicide application after final drawdown and dam removal will not affect suckers because they will no longer be present in the hydroelectric reach.

6.2.1.4. Erosion

Erosion is likely to occur during all project activities from heavy equipment operations near the reservoirs. As described in the BA and section 1.4.2 above, BMPs will help limit erosion and control sediment, thereby eliminating the potential for any water pollution to occur from heavy equipment operations near the reservoir shorelines (BA p. 81). Because the standard BMPs that are included have been observed in the past to avoid sediment inputs, the effects to suckers from any potential nearshore erosion are discountable. The effects from reservoir bank erosion and increases in suspended sediments in the water column during drawdown are addressed below in section 6.2.3.

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[27] Balance and orientation. The sense of equilibrium plays an extremely important role during orientation in three-dimensional space and disruptions to this sense can cause fish to lose their ability to orient their body correctly.

6.2.1.5. Sediment Dredging at Copco No. 1 Reservoir

Two in-water areas immediately upstream of Copco No. 1 Dam will be dredged between August and September during the pre-drawdown year (BA p. 219). Sediment will be dredged using a clamshell excavator, or suction dredging from a barge. It will then be disposed in-water, upstream of the dam. The in-water disposal of these materials is pending permit approval from the USACE (BA p. 32). If approved, the approximately 4,800 cy of material that will be dredged, consisting of cobble, boulders and fine sediment, will be placed in the in-water disposal site. If not approved, the material will still be dredged, but will be disposed on land.

Juvenile and adult suckers present in the dredging areas can swim away from disturbed areas to cleaner water, thereby limiting their exposure (Table 3). The proposed location of the in-water spoils site in deeper water is also likely to reduce effects on suckers, because of their preference for shallower habitats. When not aggregating for spawning, adults are found at depths of 2-4 m in Upper Klamath Lake (Banish *et al*. 2007). Past sampling (Desjardins and Markle 2000, Renewal Corporation 2021) and tracking of radio tagged shortnose suckers (Beak Consultants 1987) found suckers use the shallower areas of Copco No. 1 Reservoir.

The disposed sediments will be distributed over a broad surface area of the reservoir and will expand out as the material sinks. Juveniles and adults will be present in Copco No. 1 Reservoir when this project activity occurs, between August and September (see Table 3). Given the large surface area of the reservoir and the small area impacted, interactions between juveniles and adults, the barge, and in-water spoils disposal have a limited potential to occur, because these life stages can swim away. Additionally, the disposal site will be approximately 400 feet offshore, away from the preferred littoral habitat of most juveniles (Bottcher and Burdick 2010, Burdick and Vanderkooi 2010). The potential interaction will be limited to individuals that do not seek areas of better water quality or those that do not find areas with less disturbance from boat or machine noise.

Despite their mobility, there could be direct physical impacts (injury or harm) to juveniles or adults from the barge, dredging equipment, or noise disturbance, or from the rapid dumping of dredged material into the water. If juvenile or adult suckers are in the vicinity of the in-water dredging sites or disposal area, they could be exposed to contaminated sediments and further reduced dissolved oxygen levels or incur increased energy expenditures to move away from the disturbance. Larval stages are not highly mobile or able to swim from a disturbance; however, larvae will not be present, given the timing of the dredging and disposal (Table 3).

The capture and translocation of adult listed suckers under Action 2 of the conservation measure is currently planned for spring of the pre-drawdown year. If done at this time, it will reduce the numbers of adult suckers that experience effects. However, this effort may occur during fall of the pre-drawdown year.

Because of their mobility, we anticipate most adults and juveniles will be able to move away from the disturbance from the sediment dredging and in-water disposal and not experience effects that are meaningfully measurable or detectable. However, some individuals will be exposed in the short-term to reduced dissolved oxygen levels from contaminated sediments, and impaired water quality. Juveniles or adults that are exposed are likely to experience adverse effects from increased breathing stress, increased energy expenditures to rapidly move away, and reduced fitness.

Therefore, the effects to juvenile or adult suckers from this project activity may be either insignificant, or adverse. Effects to larval suckers are not expected.

6.2.1.6. Iron Gate Reservoir Work Pad Construction

To construct a new control gate on the Iron Gate Dam outlet tower, a platform or work pad will be constructed upstream of the dam near the spillway. This project activity is planned for July during the year before drawdown when larval, juvenile, and adult shortnose suckers will be present in Iron Gate Reservoir (BA pp. 157, 220-221, Table 3). Past sampling efforts have not detected Lost River sucker in Iron Gate Reservoir (Beak Consultants 1987, Desjardins and Markle 2000, Renewal Corporation 2021). Construction is expected to take approximately 10 days (BA p. 221). Because of the unpredictability of river flows that vary based on weather and snowmelt, the work pad base may need to be constructed in the water, where erosion is likely (BA p. 221).

Larval shortnose suckers are unlikely to be immediately adjacent to the work pad construction area near the dam and spillway, based on their preferred habitats of near-shore and emergent vegetation (Cooperman 2004, Cooperman and Markle 2004). However, some individuals may be in the water, directly near or in the work pad construction area and adversely affected by increased turbidity, lower dissolved oxygen levels, or increased pH levels. While their preference for nearshore habitats means most shortnose sucker larvae are not likely to be exposed to the disturbance. However, some individuals could be exposed since larvae are not able to swim away from disturbance and some larvae may be adversely affected.

Similarly, juvenile or adult shortnose suckers are not expected to be in the area immediately adjacent the dam, spillway, and work pad area. Water quality impacts during construction or subsequent erosion will occur, and juveniles and adults are expected to be able to swim away from the disturbance given their mobility. While we expect effects on juvenile and adult shortnose suckers from any increased energy expenditures to not be meaningfully measurable, detectable, or evaluated, given both the smaller area of the in-water work, and its location, some individuals could be adversely affected. If the work pad erodes, there could be a short-term, localized increase in suspended sediment that lowers dissolved oxygen in direct proximity to the work pad.

Therefore, the effects to juvenile or adult shortnose suckers from this project activity may be either insignificant, or adverse. Effects to larval shortnose suckers, should they be present, will be adverse.

6.2.1.7. In-Water Blasting at J.C. Boyle Reservoir

Two concrete stoplogs[28] at the diversion-culverts in the J.C. Boyle Reservoir will be removed through in-water blasting during the drawdown year (Year 1). Reservoir water levels will drop throughout the spring and summer months, as upstream flow rates in the Klamath River decrease. The pool depth is expected to be approximately 17 feet (from the bottom of the power intake pipe to the bottom of the diversion culverts) when in-water blasting occurs. With this water depth, it is unlikely suckers will be near the blasting, since they typically prefer depths shallower than 13 feet (4 meters) (Banish *et al*. 2007, Desjardins and Markle 2000, Renewal Corporation 2021, Beak

[28] A stoplog is a structure (steel, concrete, wood, or other material) used in channels or control structures to adjust the water level or discharge in a stream, river, canal, or reservoir, or stop flow.

Consultants 1987). However, if water levels in the reservoir are lowered so there is no water elsewhere, there could be a concentration of all age classes of suckers (and other fish and aquatic organisms) in this area.

The blasting of the stoplogs, combined with the concrete dust (see section 6.2.1.2), is likely to adversely affect larval, juvenile, and adult suckers (Table 3). Hydrostatic pressure changes (acoustic shock) produced from blasting or other sudden impacts under water can be lethal or sublethal to fish (Hastings and Popper 2005, Yelverton 1975, Coker and Hollis 1950). The capture and translocation of adult suckers (currently approximated at 300 from J.C. Boyle Reservoir; BA-Appendix D) will be completed prior to the in-water blasting; thereby reducing the number of adults adversely affected by this activity.

When in-water blasting occurs, the Service anticipates impaired water quality conditions directly upstream of the dam from increased turbidity and decreased dissolved oxygen levels, because of the rapid drawdown rate. Since in-water blasting will occur during the latter stages of drawdown, water quantity in the overall reservoir is expected to be significantly lower than during normal operations, with mostly poor water quality throughout the reservoir. Any larval, juvenile, or adult suckers in the reservoir that are in proximity to in-water blasting are likely to be adversely impacted by the hydrostatic pressure changes and reduced fitness, injury or death; and eventual death as the reservoir level is drawn down.

6.2.1.8. Drilling and In-Water Blasting at Copco No. 1 Reservoir

During the year before drawdown, an outlet tunnel will be constructed through the center of Copco No. 1 Dam by drilling and blasting. A concrete plug will remain in the tunnel until it is removed through blasting the following year, when drawdown begins (BA pp. 20-22).

The use of air-track or hydraulic track drills, and blasting, can produce hydrostatic pressure changes (acoustic shock) under water that can be lethal or sublethal to fish (Hastings and Popper 2005, Yelverton 1975, Coker and Hollis 1950). This project activity, combined with concrete dust impacts (section 6.2.1.2), will affect suckers of all life stages that are near the dam in the reservoir.

The timing for the capture and translocation of adult suckers during the pre-drawdown year is not certain. If it occurs in spring of the pre-drawdown year, it will reduce the number of adult suckers that experience adverse effects during this initial blasting. However, it may occur in the fall of the pre-drawdown year after the initial drilling and blasting. Adults, juveniles, and larvae will be adversely impacted from the exposure to the initial drilling and blasting, with reduced fitness, injury, or death.

The capture and translocation of adult suckers (currently approximated to range from 150-300 in Copco No. 1 Reservoir; BA-Appendix D) will be completed prior to the final blasting, reducing the number of adult listed suckers adversely affected. Any larval, juvenile, or adult suckers in the reservoir that are in proximity to in-water blasting are likely to be adversely impacted from the hydrostatic pressure changes with reduced fitness, injury, or death, and eventual death as the reservoir water is drawn down and flows through the outlet tunnel.

6.2.1.9. Stream Crossing Upgrades

The BA describes culvert replacements that will occur on Scotch, Camp, and Fall Creeks before reservoir drawdown. These actions will occur during the in-water construction window from June 15 to October 31 prior to reservoir drawdown (BA pp. 52, 67).

Both Scotch and Camp Creek are intermittent streams that dewater where they cross under Copco Road during summer months (Ramos 2020). The average active channel width of each creek is 15 feet, with depths averaging less than 3 feet. The Scotch and Camp Creek corrugated metal pipes are 0.14 and 0.05 river miles upstream of their confluence with Iron Gate Reservoir, respectively. The crossing on Fall Creek, which is a perennial stream and is not expected to dewater during summer months, is approximately 0.06 miles upstream from its confluence with the reservoir.

Both sucker species prefer lacustrine (lake-type) habitat. Since Lost River suckers do not occur below Copco No. 1 Reservoir (Desjardins and Markle 2000, Renewal Corporation 2021), no life stages of this species will be affected by this project activity (Table 3).

The three crossings are near each stream's confluence with Iron Gate Reservoir, where turbidity and noise disturbance from culvert replacement could affect reservoir-dwelling shortnose suckers. Shortnose sucker do not occur in the instream reaches of these three creeks, but any life stage could be inhabiting areas just downstream of the current corrugated metal pipes, within the coves and stream confluences with the reservoir (see Table 3).

While sampling of adult suckers has targeted tributary confluences and coves, it usually occurs in the spring and fall when water levels are higher. The culvert replacements are expected to occur between June 15 and October 31 prior to drawdown (BA pp. 52. 67). This is the time of year when reservoir water quality is the most diminished, and water levels are lowest.

The Camp Creek confluence is one of the PacifiCorp monitoring sites in Iron Gate Reservoir for cyanobacteria and microcystin. Extremely high concentrations have been measured in the reservoir across multiple years (Watercourse Engineering, Inc. 2016, 2017). Wind concentrates harmful algal blooms into coves, including the three stream confluences. Extensive cyanobacteria (blue-green algae) blooms typically result in large fluctuations over a 24-hour period (diel fluctuations) in dissolved oxygen and pH, high concentrations of the hepatotoxin microcystin, and toxic levels of un-ionized ammonia during bloom decomposition.

Together, these conditions create a suboptimal environment for fish. Therefore, it is unlikely for any life stage of shortnose sucker to be near the three crossings before, during, or immediately after they are replaced. For these reasons, the effects of replacing the Scotch, Camp, and Fall Creek stream crossings are considered discountable to all life stages of shortnose sucker.

6.2.1.10. Temporary Bridge Placement

A temporary bridge will be constructed over Iron Gate Reservoir, just upstream of the Daggett Road bridge, between July and August before drawdown (BA pp. 86, 220). The temporary bridge will require the construction of rock abutments on either side of the reservoir. The abutments will extend approximately 30 m (100 ft) and 12 m (40 ft) into the channel (BA p. 220). Vegetation, soil, and loose channel-bed materials will be excavated to construct the abutments. Heavy equipment will operate from the reservoir banks to place rock fill and riprap, and then a concrete bridge will be constructed (or a pre-cast concrete structure will be placed) in the wetted channel (BA p. 220). The BA describes the anticipated volume of river flow will make it infeasible to pump turbid water from the construction site (BA p. 220).

Based on past sampling, adult shortnose suckers are expected to be in this part of the reservoir when construction occurs. Juveniles or late-stage larvae that have drifted downstream, or been entrained, from Upper Klamath Lake could be present, given the project activity will occur between July and August (see Table 3). There is a lower potential for larval shortnose suckers to be affected, however, given that larvae transform into juveniles in late July (Markle and Clauson 2006, Table 3).

Effects from this project activity will occur in the wetted channel, and per the BA, it will not be feasible to pump turbid water from the construction site due to the volume of anticipated river flows (BA p. 220). As a result, shortnose suckers of any life stage are likely to be impacted by noise disturbance, as well as increases in suspended sediments and turbidity from vegetation removal, bank erosion, and large rock placement. Concrete dust entering the water will result in a short-term localized increase in pH levels. We expect that most adult or juvenile suckers will be able to swim to other areas of the reservoir where less disturbance is occurring, but some individuals may be adversely affected, and larvae are not mobile or able to move away on their own.

For these reasons, the installation of the temporary bridge upstream of the Daggett Road bridge will result in either insignificant, or adverse, effects to juvenile or adult shortnose suckers; and adverse effects to larval shortnose suckers, should they be present.

6.2.1.11. Summary of Project Activity Effects Prior to Full Drawdown and Dam Removal

Larval, juvenile, and adult suckers are expected to be present in the reservoirs when the six project activities discussed above occur (Table 3).

Larvae – Despite the large surface area of the reservoirs and the apparent preference of larvae for vegetated shore (littoral) areas, larval suckers may be exposed to the effects from in-water dredging and disposal in Copco No. 1 Reservoir (Desjardins and Markle 2000, Banish *et al*. 2007, Renewal Corporation 2021) or the in-water work pad construction and erosion upstream of Iron Gate Dam. These effects include localized, short-term increases in turbidity, decreased dissolved oxygen, and elevated pH levels. These activities, as well as drilling and in-water blasting, may result in either insignificant, or short- or long-term adverse effects to larval suckers.

Replacing the corrugated metal pipes on Scotch, Camp and Fall Creek is considered discountable to all life stages of shortnose sucker and will have no effect on the Lost River sucker. Constructing the temporary bridge upstream of Daggett Road will result in adverse effects to shortnose sucker larvae, should they be present.

Juveniles and Adults – The in-water spoils disposal, other in-water activities, drilling, or blasting may result in either short-term insignificant, discountable, or adverse effects. Juvenile and adult suckers are likely to swim away from disturbances caused by most project activities that will occur before final drawdown, and will likely avoid areas of disturbance and poorer water quality. If they can move away from a disturbance, effects are considered discountable and insignificant. There could be short-term impacts from increased energy expenditure from these movements. Adverse effects will occur from hydrostatic pressure changes and underwater acoustic shock during drilling or in-water blasting, from increased suspended sediments that can decrease dissolved oxygen, or from the introduction of concrete dust that can increase pH levels which may injure or kill juveniles or adults.

6.2.2. Effects of Sucker Capture and Translocation Prior to Drawdown

The level of effort and number of listed suckers targeted for capture and translocation was established through coordination with ODFW, CDFW and the Renewal Corporation. Action 2 of the conservation measure will occur over a 2-week period and is expected to capture and move 600 listed adult suckers from the J.C. Boyle, Copco No. 1 and Iron Gate Reservoirs. This level represents a reasonable effort to capture adult fish based on the prior sampling efforts. It is possible that additional fish beyond the 600 may be captured, and if so, the same capture and translocation methods would be used.

The following sub-sections summarize the effects of conducting Action 2. The methods are described in section 1.3. This conservation measure will result in a range of effects to adult listed suckers in the three reservoirs, and individuals at translocation sites.

6.2.2.1. Water Quality Conditions Assessment

Assessing water quality conditions in the three reservoirs and at the translocation sites will not have any effect on any life stages of suckers, or their habitat.

6.2.2.2. Capture Effects

Captured adults will be identified to species and sex, measured, fin clipped, photographed and PIT tagged. Each captured sucker will be scanned to detect any existing PIT tags. Individual fish will be stressed during capture, measurements, fin-clipping and PIT tagging. The estimated time to complete these actions, per fish, is an average of two minutes. However, pulling nets in and selecting fish from nets can take 10-30 minutes, or longer if there is a large amount of bycatch. Individuals will be placed in aerated live wells on the boats and periodically transferred to net pens near the boat access sites. They will be held in the net pens until transport. These actions will stress individual fish and it is possible that some individuals could die.

While electrofishing is an effective means of salvaging individual fish, it can also increase fish stress, and injury or mortality levels may be higher than other methods if not adhering to certain guidelines. Immobilization thresholds for fish vary based on species, body form, and size. Larger bodied fish can be more vulnerable to voltage due to larger muscles, body length, and total surface area (Dolan and Miranda 2003). Effects can include changes in behavior, physiological stress, or mechanical injury. Physiological stress can include harmful changes in blood chemistry attributes, such as cortisol and oxygen saturation, and changes in physical movements such as gilling rate and cardiac output (Emery 1984).

The following methods, which are integrated into Action 2 of the conservation measure, will be adhered to when electrofishing in the reservoirs:

1. Electrofishing settings shall be selected to minimize potential injury or mortality to suckers.

2. Only direct current or pulsed direct current may be used.
3. Egg deposition areas will be avoided during electrofishing if any are present.

As in previous sampling efforts, the Renewal Corporation will set the Smith-Root 1.5 KVA electrofisher to DC current and set the voltage to the lowest setting. The electrofisher will be activated to determine the amount of current (amperage) drawn at the lowest voltage setting. Test electrofishing will be conducted, and the voltage will be increased in a stepwise manner until the desired level of electrotaxis[29] to facilitate capture is exhibited by suckers, while also minimizing injury and mortality of target and non-target species. The effective DC voltage for the Klamath Reservoir surveys was approximately 150 volts, which drew about 5 amps. During electrofishing, two people using fish nets will be stationed in the boat's bow to control the electrofisher via a foot switch (BA-Appendix D).

Because standard electrofishing best management practices will be used, the low capture rate of listed suckers in previous sampling events, and no previous mortality of listed suckers during electrofishing sampling, we consider the effects of electrofishing on suckers insignificant.

6.2.2.3. Transport Effects

The density of transported fish will be the equivalent of approximately 1 lb. of fish per gallon of water. Sucker weight varies by species and habitat, among other factors. Suckers will be placed in tanks at densities appropriate to their size and species. No more than 165 lbs. of shortnose or Lost River suckers will be held in a 160-gallon tank (Reclamation 2008). Following Reclamation's guidelines should reduce stress or impacts on individuals during the transport of the live wells.

The travel time between the reservoirs and translocation sites ranges between 1-2 hours. Water temperature in the live wells will be monitored during transport and will be maintained by chillers or heaters to stay within 4 °C of the initial ambient water temperature. Dissolved oxygen concentrations will also be monitored during transport and maintained at approximately 100 percent saturation using a portable aeration system. Transport is expected to result in discountable effects to adult suckers, given the measures to monitor and maintain water temperature and dissolved oxygen levels. It is possible that individuals may be stressed and die, however. Based on past translocation efforts completed by the Service, 95 percent of the translocated individuals survived during the capture and transport efforts (Z. Tiemann, personal communication, October 21, 2021).

6.2.2.4. Translocation Sites and Effects

If additional translocation sites beyond the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, or the Tule Lake National Wildlife Refuge (NWR) are determined to be suitable, effects to individual suckers moved to these other sites will be as described here because the same methods will be used. If a different method is proposed, reinitiation may be warranted. If translocation to any other recipient waterbody occurs, and that waterbody contains other listed species or critical habitat, a separate effects analysis of potential impacts on those other listed species or critical habitats in that recipient waterbody will need to be completed.

[29] Electrotaxis is the phenomenon whereby application of a low voltage, direct current electrical field provides a cue to direct a cell to move of its own volition.

The measures to conduct fish health investigations and external parasite treatments will result in neutral effects to other individuals at the Klamath Falls National Fish Hatchery and the Klamath Tribes' sucker rearing facility. An introduction of parasites or other diseases from captured adult suckers to these facility's stock is considered discountable because of the treatment.

6.2.2.5. Acclimation Effects

Tempering[30] the live wells will result in no meaningfully measurable effect on the captured suckers. Both species can tolerate a 0.5 °C temperature change every 15 minutes when tempering, and overall tempering should not exceed a greater than 4 °C change (BA-Appendix D). In some instances, more time is required to not exceed the tolerated degree change, and optimal tempering is preferred such as up to a 4 °C change over an hour, with a less than 10 °C change in an hour. Having a temperature and dissolved oxygen meter to constantly monitor water quality will help assure minimal impacts (M. Yost, personal communication, September 17, 2021).

At the Tule Lake NWR translocation site, releasing fish after dusk is expected to maximize their overall survival (M. Yost, personal communication, September 17, 2021).

The acclimation effects are expected to be insignificant to individuals because of the water tempering and releasing fish after dusk.

6.2.2.6. Hybridization

Spawning by Lost River and shortnose suckers does not occur at the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, or in the Tule Lake NWR sumps. The Service does not expect hybridization impacts to other populations or management units in the Lost River Basin Recovery Unit[31] from using the Tule Lake NWR as a holding location for translocated individuals. This is because the sumps have no connectivity to the other populations and the fish at the Tule Lake NWR cannot interact with the other populations in the Lost River Basin Recovery Unit (USFWS 2013).

Any translocated adults that are eventually moved from the Tule Lake NWR to the Klamath Falls National Fish Hatchery, the Klamath Tribes' rearing facility, or directly to Upper Klamath Lake, would remain in their source Upper Klamath Lake Recovery Unit (J. Rasmussen, personal communication, September 10, 2021). A genetics analysis will also be completed for any fish before it is moved to any other location in the Upper Klamath Lake Recovery Unit.

Because of these reasons, we expect no effects from hybridization with the other Lost River and shortnose sucker populations in the Lost River Basin Recovery Unit.

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[30] Adding water from the recipient waterbody to the live wells in order to acclimate the suckers to the recipient waterbody's water quality constituents (pH, dissolved oxygen, temperature).
[31] The Tule Lake NWR is within the Tule Lake management unit of the Lost River Basin Recovery Unit for Lost River sucker and shortnose sucker.

6.2.2.7. Effects in Tule Lake National Wildlife Refuge

Translocated suckers from Copco No. 1 and Iron Gate Reservoir that exceed the capacity of the Hatchery will be translocated to the Tule Lake National Wildlife Refuge (NWR). The effects assessed here will occur in the Tule Lake management unit of the Lost River Basin Recovery Unit.

Predation

Based on the sucker sizes and measured fork lengths of sampled Lost River and shortnose sucker adults in the reservoirs (Chapter 5), there is a potential for translocated adults to be eaten by birds at the Tule Lake NWR. This includes the American white pelican and double-crested cormorant which are known to prey on suckers in Upper Klamath Lake and Clear Lake, that may also prey on adult suckers in the Tule Lake NWR's sumps. Avian predation can be responsible for an annual mortality of at least 8.4 percent of juveniles and 4.2 percent of adults in Clear Lake (Evans *et al*. 2016). There could be adverse effects to translocated adults from predation.

Non-native predatory fish in the Tule Lake NWR may also prey on juvenile suckers, but adult suckers are large enough that they will not be preyed on by non-native fish. Therefore, predation of translocated adults by non-native fish is not expected to occur and effects are discountable.

Parasites and Disease

Translocating adult suckers from the three reservoirs to the Tule Lake NWR could introduce parasites and diseases to the area. Conversely, translocated individuals may be exposed to parasites or diseases that are already present. Past studies in the Tule Lake NWR show high rates of parasites and deformities in juvenile suckers (Sutton *et al*. 2014). In addition, the fish health investigations completed by the Service prior to the 2010 relocation of listed suckers from the Tule Lake NWR to Upper Klamath Lake found similar diseases and parasites in both areas (Courter *et al*. 2010). Based on these studies, translocated adults may be exposed to parasites or diseases, but effects from parasite or disease introduction from translocated individuals to individuals already present are considered insignificant, given the existing conditions. We expect insignificant effects to translocated suckers from parasites and disease as they will receive an external parasite treatment before they are released at the translocation site.

Pesticides

The proposed action does not involve pesticide use, but translocated adults could be exposed to pesticides at the Tule Lake NWR. Investigations and monitoring of pesticides and soil fumigants at the NWR indicate they are not present in concentrations that will adversely affect suckers (USFWS 2019a). The ecological risks to terrestrial, aquatic, and invertebrate species are considered negligible (USFWS 2019a). Based on these findings, any effects from pesticide exposure to translocated adults are discountable.

Water Quality and Quantity

Based on a 2019 evaluation of Lost River sucker and shortnose sucker at the Tule Lake NWR, the Service found that conditions, including predation risk, parasite and disease levels, water quality, and entrainment were not likely to impact sucker populations there. Since the 2019 evaluation, extreme drought conditions in 2020 and 2021 reduced water quantity and quality in the sumps. The Service was able to work with our partners to ensure adequate habitat was provided for the sucker populations in 2020 and 2021, and existing and future protective measures in similar drought conditions will allow for the continued maintenance of habitat. Therefore, we expect suckers that are translocated to the Tule Lake NWR will continue to persist.

Using the Tule Lake NWR as a recipient waterbody for translocated adults and as a holding area for brood stock for the Upper Klamath Lake Recovery Unit will provide the Service with management flexibility for both species. This will lead to long-term beneficial effects. The shallow depths and known locations where suckers congregate in the Tule Lake NWR sumps allows for an easier recapture of adults than capturing them from Upper Klamath Lake or the hydroelectric reach reservoirs.

6.2.2.8. Summary of Effects from Sucker Capture and Translocation

Capturing adult Lost River and shortnose suckers from the reservoirs and translocating them to the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, the Tule Lake NWR, or another agreed-upon location will provide beneficial effects to the overall populations in the Upper Klamath Lake Recovery Unit and contribute to the recovery of both species. Capture and translocation will result in neutral to adverse effects to individuals. While it will reduce the number of adult suckers that will die from dam removal, the capture and translocation more importantly helps to retain genetic diversity and provides additional suckers to the upstream populations in Upper Klamath Lake and Lake Ewauna/Keno Reservoir.

It is expected that translocated adults will increase the numbers and reproduction of the sucker populations in the Upper Klamath Lake Recovery Unit. Any future reintroduction of translocated individuals into Upper Klamath Lake will provide opportunities for adult listed suckers to contribute to the spawning populations there, compared to their current location in the hydroelectric reach reservoirs where spawning is not known to occur (USFWS 2012, 2013, Hamilton *et al*. 2011, Buettner *et al.* 2006).

Suckers will be stressed during the capture and translocation activities. We estimate a 95 percent survival rate which means that some of the captured suckers could perish during capture and actual translocation (Z. Tiemann, personal communication, October 21, 2021). The stress from capture, handling, water quality changes, and possible exposure to parasites or diseases may result in reduced fitness, direct injury, or immediate or delayed mortality.

The effects from fish health investigations and external parasite treatments at the Klamath Falls National Fish Hatchery and Klamath Tribes' sucker rearing facility are expected to be beneficial to treated individuals. These same beneficial effects are expected to extend to any individuals that are already in the recipient facilities, or in Upper Klamath Lake, since they will not be exposed to new parasites or diseases from translocated fish. We do expect a higher survival rate for the individuals translocated to the Klamath National Falls Fish Hatchery and Klamath Tribes' sucker rearing facility, given that water quality conditions here are more controlled.

For those fish that are translocated to the Tule Lake NWR, there may be additional delayed mortality of individual suckers (USGS 2019, Courter *et al*. 2010). The use of the Tule Lake NWR as a translocation site poses some risk to translocated adult suckers from impaired water quality and quantity during future extreme drought conditions, or from predation. Existing and future protections such as assuring adequate water quality and quantity conditions for the populations in the Tule Lake NWR are likely to allow for the continued maintenance of habitat for resident and translocated suckers in this area.

6.2.3. Effects of Reservoir Drawdown and Dam Removal

6.2.3.1. Activities

As described in Chapter 1, prior to removing the dams and hydropower facilities, the water surface in each reservoir will be simultaneously drawn down to an elevation that is as low as possible, while also facilitating evacuation of accumulated sediment to create a dry work area for dam removal activities (BA p. 43).

In general, reservoir drawdown will begin on January 1 of the drawdown year and will extend until reservoir levels have stabilized at or below the level of the historic cofferdams. The remaining reservoir sediments will be considered stabilized after this drawdown, and dam and hydropower facility removal will begin (BA p. 7).

Drawdown will be controlled with gates and other controls (e.g., tunnel opening size) to maintain a safe rate, and to help ensure embankment and reservoir rim stability. Drawdown rates at J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs will target a water surface level drop of 5 feet per day. If actual rates are lower, the reservoir pools may re-fill during storms or from increased inflows.

The time required for drawdown will vary and will be dependent on the drawdown year's hydrology. It is expected drawdown to the top of the historical coffer dams will be achieved between mid-January and mid-April in most water years. This elevation will be held, and the reservoirs will be allowed to refill depending on inflows, until high flows end for the season. When flows subside, the diversion tunnels will be connected at the historical cofferdams to implement the final drawdown to the historical elevation of the Klamath River channel. It is expected final drawdown will occur in June or July, but timing is dependent on the drawdown year's hydrology. This approach will result in two peaks of suspended sediment concentrations: one in winter/spring and one in the summer.

6.2.3.2. Effects of Drawdown and Dam Removal

The accumulated sediments in each reservoir and along the reservoir banks, will erode during drawdown and be transported downstream through the hydroelectric reach. The accumulated sediments are highly erodible; predominantly silt, clay, and organic material that is more than 80 percent water. One- and two-dimensional sediment transport models predict approximately 50 percent of the stored sediment in the reservoirs will be eroded during drawdown during a median water year, with 41 to 65 percent during dry and wet years, respectively (USBR 2011).

The erosion of reservoir deposits during drawdown, including the slumping of saturated sediment and water drainage from deposit pore spaces, will increase suspended sediment levels in the reservoir pools. As drawdown proceeds and water quantity decreases and water temperature increases, the increases in suspended sediment concentrations will result in toxic chemical accumulation.

As described in Chapter 5, the USBR collected sediment samples from the J.C. Boyle, Copco No. 1, and Iron Gate Reservoirs in 2009 and analyzed them for chemical constituents (USBR 2011a). A screening-level human health and ecological risk evaluation of the sediment data concluded that the chemicals detected in the reservoir sediments are at concentrations unlikely to cause adverse effects when humans or animal life are exposed (CDM 2011). The Service has reviewed similar data in Upper Klamath Lake and did not find a connection between human health and pet risks, and risks for fish (USFWS 2020). Based on these results and information, the Service expects that effects to sucker will not be meaningfully measurable, detectable, or evaluated from sediment chemical exposure.

In 2017 and 2018, arsenic concentrations were compared to sediment and soil ecological screening levels (CDM Smith 2018). The range of arsenic sediment concentrations (4.3-15 milligrams per kilogram [mg/kg]) in both 2009 and 2017 are lower than most soil and sediment screening levels.

Based on the arsenic level testing, any effects to any life stages of listed suckers from an increase in chemical concentrations in suspended sediments during drawdown will not be meaningfully measurable, detectable, or evaluated and are therefore insignificant. However, decreased dissolved oxygen concentrations can make suspended sediment toxic, when chemical oxygen demand generated from the conversion of ammonium and other nitrogenous compounds in reservoir sediments are changed to nitrate under anoxic conditions (e.g., when dissolved oxygen levels are 0 mg/L or greater).

The increases in suspended sediment in the pools will exacerbate a decrease in dissolved oxygen levels, resulting in increased stress and likely lethal effects to suckers. When dissolved oxygen levels decrease, suckers start to swim up to the surface of the water column and ventilate (or gasp and experience increased stress) at the top layer of the water where it contains higher levels of dissolved oxygen (USFWS 2020). In general, suckers are relatively tolerant of degraded water quality conditions. They tolerate higher pH, temperature, un-ionized ammonia concentrations, and lower dissolved oxygen concentrations than many other fish (Saiki *et al*. 1999, Meyer and Hansen 2002, NRC 2004). During the final drawdown stage, the increased movement of water may increase oxygen levels in the immediate term of exposure, but the rapid influx of suspended sediments and nutrients into the water column from reservoir banks, combined with lowered water levels, will deplete oxygen and exert lethal effects on all life stages of listed suckers in the reservoirs.

The Service expects that throughout final drawdown, suckers will have increasingly less available habitat. This will occur from a loss of water, increases in suspended sediment, lowered dissolved oxygen levels, increased pH levels, higher water temperatures, and overall reduced water quantity and quality. Mortality starts to occur when dissolved oxygen levels drop below 1.58 mg/L, or the pH exceeds 10, or when water temperatures exceed 31-32 °C (USFWS 2019c, BO Appendix B-Table 1).

Any individuals that are not captured and translocated under Action 2 of the conservation measure are not expected to persist once the reservoirs and dams are removed. This is because there will be no habitat available for them (they are both lake-type dependent species). The final drawdown of the reservoirs and removal of the four dams will remove an approximate 107,470 acre-feet of sink habitat for these two species (USFWS 2013a p. 11, PacifiCorp 2000, Chapter 5).

Adults, larvae, and juveniles will be adversely affected by increased stress, injury, or mortality during the pre-drawdown activities discussed in section 6.2.1. After the capture and translocation of adult suckers, any remaining adults, and all larvae and juveniles, are expected to be killed as they are not expected to survive the final stage of reservoir drawdown and dam removal. If some individuals survive through drawdown and dam removal, they will not be self-sustaining or reproduce in the downstream reaches of the Klamath River (USFWS 2007, 2012).

6.2.3.3. Summary of Effects of Final Drawdown and Dam Removal

The Service expects the decreases in water quantity and quality during the final drawdown stage, and subsequent dam removals, will result in injury and mortality to an estimated 4,940 adult Lost River and shortnose suckers, as well as 2,825 juveniles, and 365,229 larvae. The juveniles and larvae originated upstream of Keno Dam, as spawning by listed suckers below Keno Dam is not known or documented to occur. These numbers are based on the population estimates in the reservoirs, and implementation of Action 2 of the conservation measure (USFWS 2013a, Chapter 5-section 5.4). Because they lack spawning habitat, the Lost River and shortnose suckers currently inhabiting the reservoirs do not represent self-sustaining populations. Reservoir habitat will disappear once the project activities of the proposed action occur. The remaining occupied habitat in the Upper Klamath Recovery Unit, and the range of the species, will not be impacted by this project and will remain available for the foreseeable future. These upstream habitats provide suitable conditions and opportunities for spawning and rearing that contributes to the survival and recovery of the Lost River and shortnose suckers.

6.2.4. Effects in the Upper Klamath Basin from Anadromous Salmonids

For this analysis, the Service is reasonably certain the upper Klamath Basin will be accessed by anadromous salmonids after dam removal and completion of the associated channel restoration activities in the hydroelectric reach. See Chapter 2, section 2.1.1 for a summary of historical occurrence by anadromous salmonids in the Upper Klamath Basin.

Currently, there are no estimates of when Chinook salmon or steelhead will reach the Upper Basin and areas occupied by Lost River and shortnose suckers. After removal of the Elwha Dam, it took approximately 31 months for Chinook salmon, coho salmon, steelhead, Pacific lamprey and other anadromous species to move upstream and access portions of their historical reaches (Duda *et al.* 2021). We expect it will take longer for anadromous salmonids to reach the Upper Klamath Basin and areas occupied by Lost River and shortnose suckers. This is due to several complex challenges that involve navigating the Keno and Link River Dam fish ladders to reach Upper Klamath Lake, longer migration distances, and other potential barriers related to water quality and water temperatures (N. Hetrick, personal communication, Dec 20, 2021).

Fish passage facilities for anadromous salmonids are in place at the Link River Dam and no modifications are required to improve volitional fish passage for anadromous salmonids at this facility. Upstream passage by anadromous salmonids is also probable at Keno Dam, based on observations of adult redband trout using the ladder (B. Ramirez, ODFW, personal communication, November 10, 2021). Some updates at the Keno Dam may occur when the USBR takes title of the facility (KHSA, as amended April 2016). If any future action to alter fish passage conditions at Keno Dam are proposed, the Services (USFWS and NMFS) would evaluate any effects on listed species or their critical habitat through a separate section 7 consultation.

The return of Chinook salmon and steelhead to the Upper Klamath Basin is expected to result in both short- and long-term effects, stressors, or benefits to the Lost River sucker or shortnose sucker. This may occur from:

1. Introduced diseases and pathogens
2. Interspecific competition for food and space in the Williamson and Sprague Rivers
3. Predation
4. Trophic cascades[32] of the food web within the Upper Klamath Basin
5. The restoration of marine-derived nutrients to the Upper Klamath Basin

The effects, stressors, or benefits will occur in the Upper Klamath Lake-river spawning and Upper Klamath Lake-spring spawning management units, and the Keno Reservoir management unit of the Upper Klamath Lake Recovery Unit.

6.2.4.1. Disease and Pathogens

The possibility that pathogens will be reintroduced to suckers by anadromous salmonids is low. Historically, anadromous fish (and their associated pathogens) migrated to the upper Klamath Basin. The best available information suggests the likelihood of introducing new pathogens that would affect existing populations is minimal (Stocking and Bartholomew 2007, Hamilton *et al.* 2011, USDI 2013).

Columnaris disease, or "gill rot", and Ich (*Ichthyophthirius multifiliis*), are ubiquitous in freshwater systems, and both are already present throughout the Klamath River system above and below Iron Gate Dam (BA pp. 116, 120, 226). Removal of the dams will reduce or eliminate populations of warmwater fish that live in the existing reservoirs that are hosts to columnaris disease and Ich (Hamilton *et al*. 2011) and will reduce the exposure paths to anadromous salmonids and suckers.

While the viral pathogen, Infectious Hematopoietic Necrosis (IHN), and the bacteria *Renibacterium salmoninarum*, have been documented in Chinook salmon in the lower Klamath River basin, IHN is rare and not virulent to trout and current resident fish in the upper Klamath system. *Renibacterium salmoninarum* is present in low levels in juvenile and adult Chinook salmon in the Klamath River basin but does not appear to induce significant disease (S. Foott, personal communication, as cited in Hamilton *et al*. 2011). Except for columnaris disease and Ich, pathogens associated with anadromous salmonids, such as *C. shasta* and IHN*,* do not impact non-salmonids, including the federally listed suckers (USDI 2013).

[32] A trophic cascade can be triggered by the addition or removal of top predators and changes in the relative populations of predator and prey through a food chain, this can result in dramatic changes in ecosystem structure and nutrient cycling.

Given all this, the risk is low for anadromous salmonids to introduce diseases and pathogens to listed suckers in the Upper Klamath Basin. This effect, should it occur, will not be meaningfully measurable, detectable, or evaluated and these effects are insignificant.

6.2.4.2. Competition for Food and Space

Chinook salmon and steelhead will likely interact with suckers in both Upper Klamath Lake and their spawning tributaries such as the Williamson and the Sprague Rivers. Competition for food resources may occur but will likely be minimal. This is because of the varying diets between the four species and the presence of a hypereutrophic system with high levels of primary productivity from nutrients and organic matter.

Juvenile Chinook salmon and steelhead primarily feed on zooplankton, benthic (bottom) and terrestrial macroinvertebrates, crustaceans, and small fish (Merz 2002). Juvenile and adult suckers also feed on zooplankton, benthic macroinvertebrates, and small crustaceans (USFWS 2019c), so there could be overlap during feeding.

Suckers transition from their surface feeding larval stage to bottom-feeding juveniles in late July and early August (Table 3). Juvenile salmonids are primarily drift feeders that feed higher up in the water column. Because Upper Klamath Lake has high productivity, it is unlikely that food resources will be a limiting factor for the suckers, Chinook salmon juveniles, or steelhead juveniles or adults. Primary productivity is also high in the Sprague and Williamson Rivers, though it is higher in the Sprague River due to larger phosphorous inputs (USFWS 2020, Rabe and Calonje 2009).

Adult Chinook salmon do not feed during their spawning migrations. Adult steelhead do not typically feed during their spawning or upstream migrations (Penney and Moffitt 2014, Quinn *et al*. 2016, Jenkins 2019), but do resume feeding after spawning (J. Boyce, personal communication, September 3, 2021). Because of this, competition for food resources between listed suckers and adult Chinook salmon and steelhead, is not expected to occur when Chinook salmon and steelhead are migrating and spawning in the Upper Basin. Therefore, this effect is discountable to any life stages of sucker when Chinook salmon or steelhead are migrating and spawning.

Suckers reside in lakes for most of their life and only leave lakes during their spawning migrations. Spatial overlap with Chinook salmon and steelhead is likely to be minimal within the rivers when adult suckers are spawning in the Williamson and Sprague Rivers. We have no expectation that the species will compete for food or space in Upper Klamath Lake or Lake Ewauna/Keno Reservoir when Chinook salmon and steelhead are migrating through the lakes to reach spawning habitat.

Suckers spawn in lake tributaries and lake shorelines in late February to mid-June. Klamath River fall Chinook salmon spawn from October through December; and spring Chinook salmon begin spawning in early September. In the Klamath River, peak spawning for Summer and Winter steelhead occurs in January and March, respectively (Busby *et al*. 1996). Based on the timing, there is no spawning overlap expected between adult Chinook salmon and listed suckers and the effects of competition for resources such as space or dissolved oxygen when spawning are considered discountable. There may be competition for spawning areas between steelhead and suckers between February and March.

Another overlap may occur when juvenile Chinook salmon and steelhead are rearing in tributaries, and larval suckers are drifting downstream. In the Williamson and Sprague Rivers, sucker larvae drift downstream from spawning grounds from April to early July. Chinook salmon and steelhead eggs hatch and alevins[33] and fry grow from February to June. Although there could be temporal overlap, spatial overlap will be minimal since sucker larvae spend little time in rivers after they swim up to the surface. Then the larvae quickly drift downstream to the lakes where no spatial overlap or competition for food or space is expected. Some evidence suggests low numbers of juvenile suckers rear in the Sprague River but this is likely a small component of the overall population (Hayes and Rasmussen 2017).

Given the minimal likelihood of spatial interactions because of habitat preferences of each of the species during differing life history stages, the effects from any spatial overlap and competition for food and space between Chinook salmon, steelhead, and suckers will not be meaningfully measurable, detectable, or evaluated. Larval suckers drift along the shallow edges of the river, and during this phase, juvenile Chinook salmon and steelhead are holding in deeper pools and faster moving water in the tributaries (NRC 2004). Therefore, the Service considers these potential effects to be insignificant.

6.2.4.3. Predation

Predation by anadromous salmonids on sucker eggs, larvae, and juveniles is likely to be limited, but may occur. Predation may occur when suckers are spawning, or when larval suckers emerge in the spring, since this timing overlaps with steelhead and Chinook salmon alevins[33] emerging from their redds and rearing (holding and maturing) in tributaries. Predation on sucker eggs and larvae may occur during juvenile salmon outmigration, or after adult steelhead have spawned.

As described above, adult Chinook salmon and steelhead do not feed during their upstream migrations and are not expected to prey on sucker eggs or larvae. Adult steelhead are known to resume feeding after spawning (J. Boyce, personal communication, September 3, 2021).

Suckers evolved in a system where predation on eggs and larval fish is high. This is evident in their reproductive strategy. Female Lost River suckers typically produce 44,000 to 236,000 eggs per spawning season, while female shortnose suckers produce 18,000 to 72,000 eggs (Houde 1989, Houde and Bartsch 2009). For comparison, female steelhead will lay 200 to 12,000 eggs depending on body weight (Moyle 2002). Once suckers are sexually mature, they likely spawn every year in Upper Klamath Lake (USFWS 2019c).

Steelhead can spawn in smaller tributaries, but juvenile steelhead distribute themselves widely, and move into main stem rivers as they rear and mature (NRC 2004). Juvenile steelhead will likely be present during sucker spawning and emergence in the Williamson and Sprague rivers, and predation of sucker eggs may occur during this time. However, since the adult suckers produce many eggs and larvae, and are already sympatric with native redband trout, egg and larvae predation by steelhead is expected to remain at its natural background levels.

While adverse effects are likely from potential steelhead predation, the magnitude of the potential effect is not be meaningfully measurable or detectable. This is because of the high numbers of

[33] A newly spawned salmon or trout

larvae produced on an annual basis and the limited potential for overlap in habitat use, estimated at 20 days:

- Progeny of spring-run and fall-run Chinook salmon will rear in river habitats for up to a year before migrating to the ocean. Juvenile Chinook salmon begin to move downstream when still small (<150 millimeter) and feed exclusively on aquatic and terrestrial insects (Healy 1991).

- Progeny of summer and winter steelhead will rear in river habitats for up to three years before migrating to the ocean. Juvenile steelhead may prey on sucker eggs and small larvae, which emerge at about 7-10 mm in total length.

- In the Williamson and Sprague Rivers, sucker larvae drift downstream to Upper Klamath Lake from the adult spawning grounds from April to July, with the peak in mid-May (Scoppettone *et al*. 1995).

- Sucker larvae spend little time in the rivers and lake tributaries after their immediate emergence; drifting downstream to lakes when they are about 14 mm (0.55 in) in length, around 20 days after hatching (Cooperman and Markle 2003).

Once they drift downstream, larval suckers inhabit near-shore areas in the lake with emergent vegetation. In mid-July, they transform into juveniles and transition to benthic (bottom) feeding. Other fish species including dace, minnows, sculpins, redband trout, and many non-native species (including fathead minnows and yellow perch) are more abundant than the listed sucker juveniles in Upper Klamath Lake and its associated tributaries. These species reside higher in the water column and are more likely to be preyed on by steelhead.

There may be adverse effects to Lost River and shortnose sucker eggs and larvae from steelhead predation. Given, 1) the large numbers of eggs and larvae that suckers produce, 2) the expected minimal spatial overlap between larval and juvenile suckers and juvenile steelhead, and 3) the large non-native and native prey base available for steelhead, the Service finds these potential effects will not be measurable or detectable.

6.2.4.4. Marine-Derived Nutrients

The recolonization of the Upper Klamath Basin by anadromous salmonids will result in beneficial impacts to water quality conditions in portions of the Upper Klamath Basin from the reintroduction of marine-derived nutrients. This effect will occur through an increase in primary productivity, in an already productive system, through the input of salmon carcasses. As described in Chapter 5, the annual phosphorus inputs into Upper Klamath Lake are approximately 124 metric tons (137 tons) from its tributaries. This number will be higher with input from anadromous salmonids.

The increase in marine-derived nutrients will likely increase aquatic invertebrate biomass, thereby increasing the forage base for juvenile anadromous salmonids and other native fish. Marine-derived nutrients are expected to provide benefits to many other species in the Upper Klamath Basin, including bull trout (section 6.6.4) that inhabit tributary headwaters where the system is not as productive or nutrient rich.

While the enrichment of the freshwater ecosystem by marine-derived nutrients may have far-reaching benefits throughout the food web, effects to the Lost River and shortnose suckers will not be meaningfully measurable, detectable, or evaluated. The additional nutrients and effects from marine-derived nutrients will either be too small to have a measurable beneficial impact each year, or any effects they may have on annual water quality conditions will be too small to detect or evaluate in a hypereutrophic system. The annual impacts from marine-derived nutrients will depend on the level of upstream migration and spawning by Chinook salmon and steelhead each year. Based on past dam removals and research regarding marine-derived nutrients, we expect the long-term effects to be either insignificant, or beneficial to the Upper Klamath Basin.

6.2.4.5 Summary of Anadromous Salmonid Recolonization on Lost River and Shortnose Suckers

Chinook salmon and steelhead are likely to recolonize portions of the Upper Klamath Basin because of the proposed action. They may introduce diseases and pathogens, compete for food and space, or prey on larval suckers. They will also contribute marine-derived nutrients to a hypereutrophic system. The effects from introduced diseases and pathogens, competition for space and food, and potential predation will not be meaningfully measurable, detectable, or evaluated; and marine-derived nutrients could have an insignificant or beneficial effect on water quality conditions in the lower reaches of the Upper Klamath Basin.

6.3. Effects of Proposed Action to the Upper Klamath Lake Recovery Unit

The Revised Recovery Plan identifies numerous actions for Lost River sucker and shortnose sucker recovery in the Upper Klamath Lake Recovery Unit (USFWS 2013 pp. 48-62). Project effects will occur in all four management units.

6.3.1. Upper Klamath Lake Recovery Unit

The Revised Recovery Plan (USFWS 2013) describes that the two Upper Klamath Lake management units possess the highest conservation value for the Lost River and shortnose sucker. The Keno Reservoir management unit provides conservation value, because of the connectivity that both species in this management unit have back to Upper Klamath Lake. The Klamath River management unit possesses low conservation value. The only value is that the fish in the reservoirs could be used to repopulate other parts of the species' range (NRC 2004). The fish here do not reproduce, and their distribution is limited; they are a sink population.

Removing the hydroelectric reach reservoirs will not impede the recovery actions, or overall recovery, of suckers in the Upper Klamath Lake Recovery Unit, or across their range.

The effects in the hydroelectric reach and its reservoirs will occur on approximately 10 percent of the estimated adult population in the Upper Klamath Lake Recovery Unit (USFWS 2020, Hewitt *et al*. 2018, 2014). The project's effects will occur to approximately six percent of the rangewide adult population. These effects include those from capture and translocation, pre-drawdown, drawdown, and dam removal.

For the effects to eggs, larvae, and juveniles across the Recovery Unit, and at the range-wide scale, we do not have estimates. Given both species' high egg and larval output, the effects are considered minimal. Eggs will not be affected in the hydroelectric reach, because spawning by listed suckers is not known to occur downstream of Upper Klamath Lake. In addition, any larvae and juveniles in the hydroelectric reach, or Klamath River below Keno Dam, are from the source population in Upper Klamath Lake. Effects to eggs or larvae from possible predation in Upper Klamath Lake's tributaries from steelhead will not be meaningfully measurable or detectable.

The Service considered whether the Lower Klamath Project will create a condition that precludes the survival and recovery of the Lost River sucker or the shortnose sucker. Given the individuals in the hydroelectric reach and its reservoirs are considered a sink population, with no connectivity to Upper Klamath Lake and suitable spawning habitat, and no ability to interact with other individuals in the Upper Klamath Lake Recovery Unit, the effects from the proposed action on these individuals will not preclude the survival and recovery of the species.

After the project is completed, the remaining occupied habitat in the Upper Klamath Recovery Unit, and across both species' range, will remain available for the foreseeable future. These other management units provide better conditions and opportunities for spawning, rearing, or contributing to both species' persistence than the hydroelectric reach reservoirs. The captured and translocated adult shortnose and Lost River suckers will help contribute toward each species' survival and recovery in the Upper Klamath Lake Recovery Unit by contributing to additional numbers and reproduction and therefore, an increased abundance.

6.3.1.1. Upper Klamath Lake Management Units and Keno Reservoir Management Unit

Upon removal of the dams and restoration of volitional fish passage in the hydroelectric reach, Chinook salmon and steelhead are expected to migrate upstream and access Upper Klamath Lake and its tributaries. As a result, various consequences may occur to Lost River and shortnose suckers in these three management units. As described above in section 6.2.4, effects may occur from the introduction of diseases and pathogens, interspecific competition for food resources and space, potential predation by steelhead, and water quality impacts from marine-derived nutrients.

The Service has determined the effects from disease and pathogens are likely to be insignificant because Pacific Northwest fish pathogens are already present in the resident native fish populations in the upper Klamath Basin, including both listed sucker species. Given that these diseases and pathogens are already present in the Basin and these three management units, the Service does not anticipate any changes, including climate change effects, will exacerbate or minimize the presence or distribution of these diseases and pathogens. The three management units will continue to function for the conservation and recovery of the Lost River and shortnose sucker by providing spawning and rearing habitat; contributing to reproduction and numbers.

While effects from interspecific competition and possible predation by native steelhead may result in a loss of sucker eggs or larvae, the function of these three management units and what they contribute to the Recovery Unit will not be impeded. These management units will continue to provide for conservation and recovery. The effects of egg or larval predation will not be meaningfully measurable, detectable or evaluated, given both species' high fecundity and the environmental baseline conditions of ongoing egg and larval predation that occurs from other native and non-native fish species. There is minimal potential for spatial overlap between larval and juvenile suckers and juvenile Chinook salmon and steelhead, due to the differing habitat preferences of vulnerable life stages. These potential impacts are not expected to impede Lost River or shortnose sucker recovery or survival within the three management units.

The long-term effects of marine-derived nutrients will contribute toward the recovery of listed suckers in all three management units because of beneficial impacts to the food web. The existing hypereutrophic conditions in Upper Klamath Lake will make it difficult to detect any water quality changes from marine-derived nutrients. These effects will not further degrade the recovery potential within these three management units and will be beneficial overall.

6.3.1.2. Klamath River Management Unit

The Service anticipates all listed suckers which remain in the reservoirs behind the dams, after capture and translocation of adults, will not survive after final drawdown and dam removal. Any individuals in the Klamath River management unit will not survive after full implementation of the proposed action because all the reservoir-lake habitat will be removed downstream of Keno Dam and the Klamath River does not provide habitat for the listed suckers (USFWS 2013, 2012, Hamilton *et al.* 2011, Buettner *et al.* 2006).

While the Klamath River management unit will no longer support Lost River and shortnose suckers, and the geographic distribution of listed suckers will be reduced after implementation of the proposed action, the project will attempt to capture genetic diversity through individual fish that can either serve as brood stock (USFWS 2013 p. 58) or eventually be moved into Upper Klamath Lake. The contribution to future numbers and reproduction from the translocated adults, or their brood stock, in the other management units of the Upper Klamath Lake Recovery Unit will directly aid the survival and recovery of these species. Capturing and translocating adults to the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, the Tule Lake NWR or other agreed-upon locations will provide the Service with the ability to use these adults to help accomplish recovery goals in the Upper Klamath Lake Recovery Unit.

The remaining Lost River and shortnose suckers of all age classes in the reservoirs during drawdown and dam removal are not expected to survive. But with no successful reproduction (Buettner *et al.* 2006), and no connection to upstream populations, individuals downstream of Keno Dam currently do not contribute to additional reproduction or numbers:

1) Within the hydroelectric reach reservoirs,
2) Within the Upper Klamath Lake Recovery Unit, or
3) Within the range of both species (USFWS 2012, 2013, Hamilton *et al.* 2011).

The reservoir populations are sink populations, with any new individuals being spawned upstream in Upper Klamath Lake and its tributaries. Any new individuals drift down from, or are entrained at, Keno Dam (USFWS 2020, USFWS 2013 p. 5).

The Klamath River management unit possesses some conservation value because individual fish "residing in flowing water or reservoirs between Keno Dam and Iron Gate Dam reservoirs" can provide support to help repopulate other areas of the Upper Klamath Lake Recovery Unit (USFWS 2013). However, this conservation value is considered low because: 1) the listed fish in the reservoirs lack spawning habitat and are not self-sustaining because of poor summertime water quality and large populations of non-native predatory fish that hinder recruitment into the adult populations in the reservoirs, 2) there are relatively low numbers of individuals, 3) the Service has limited ability to capture fish in these reservoirs, and 4) there is not adequate fish passage for listed suckers to return to their source populations in Upper Klamath Lake and its tributaries where suitable spawning habitat exists (Desjardins and Markle 2000, Hodge and Buettner 2009, Kyger and Wilkens 2011).

Therefore, the Klamath River management unit functions as a population sink for the two species; the individuals that are there are from the source population in Upper Klamath Lake (USFWS 2013, 2020). They cannot directly contribute to additional numbers and abundance, or reproduce, in their current location and they are not able to directly contribute to the survival and recovery of the species in the Klamath River management unit. The loss of this management unit will not impede the survival and recovery of the Lost River sucker or shortnose sucker in the Upper Klamath Lake Recovery unit, and its three other important management units.

6.4. Effects of Proposed Action to the Lost River Basin Recovery Unit

The Revised Recovery Plan identifies numerous recovery actions within the Lost River Basin Recovery Unit (USFWS 2013 pp. 48-62). Actions specific to the Tule Lake management unit, include: (1) prepare emergency response protocols for Upper Klamath Lake, Clear Lake Reservoir, Gerber Reservoir, and Tule Lake populations (USFWS 2013 p. 49), and (2) facilitate successful spawning for the Tule Lake population (USFWS 2013 p. 50).

6.4.1. Tule Lake Management Unit

Project consequences in the Lost River Basin Recovery Unit and the Tule Lake management unit are limited to the translocation of captured adult suckers to the Tule Lake National Wildlife Refuge (NWR) and its existing sumps. The neutral and adverse effects to translocated individuals, and any individuals in the recipient waterbodies, along with the beneficial effects described in Chapter 6 will not impede recovery goals or objectives for the Lost River Basin Recovery Unit, or the Tule Lake management unit.

Adults that are translocated to the Tule Lake management unit will not be released, or utilized as future brood stock, for any portion of the Lost River Basin Recovery Unit outside of the Tule Lake NWR. As described in Chapter 5, the Tule Lake populations of Lost River and shortnose sucker are also considered sinks, entirely composed of the offspring of other populations that found their way through the Lost River, or the irrigation system into Tule Lake. They have no sufficient means to be self-sustaining (USFWS 2020).

While no recovery actions in the Lost River Basin Recovery Unit will be directly met by the Lower Klamath Project, the project will not impede recovery goals or objectives specific to this Recovery Unit. Fish that are captured and translocated to the Tule Lake NWR will be used as broodstock for the Upper Klamath Lake Recovery Unit.

6.5. Actions Affecting Bull Trout

Based on the review of the proposed action in the BA, project maps and diagrams, and our knowledge of the species and their habitat, the following action will affect bull trout:

1) The removal of the four dams in the hydroelectric reach will allow for subsequent upstream fish passage of anadromous salmonids into the Upper Klamath Basin, namely Chinook salmon and steelhead, based on their historic distribution.

There are no other project activities that will affect bull trout and there are no conservation measures for this species.

6.5.1. Effects to Bull Trout in the Upper Klamath Basin

Effects, including stressors and benefits, for bull trout, are summarized below.

<u>Effects and Stressors for bull trout:</u>

1. Introduction of disease and pathogens from Chinook salmon and steelhead
2. Interspecific competition between Chinook salmon and steelhead, and bull trout, for food resources and space
3. Predation by steelhead on different life stages of bull trout

<u>Beneficial Effects for bull trout:</u>

1. Restored marine-derived nutrients that provide increased food availability to juvenile and adult bull trout in the form of carcass flesh, eggs, fry, and juveniles from Chinook salmon and steelhead reoccupying historical habitat in the Upper Klamath Basin.

From the best available information that the Service has at this time, Chinook salmon and steelhead are likely to overlap the current distribution of bull trout in all parts of the three core areas with the exception of Threemile Creek and Sun Creek, though they may be able to access these areas over time if the ODFW or Service physically move fish to these areas. For the purposes of this analysis, we are assuming that Chinook salmon and steelhead may occupy all areas that are occupied by bull trout over time. In addition, one of the recovery goals for bull trout in the Klamath Recovery Unit is to improve fish passage throughout the range to encourage fluvial life histories (USFWS 2015b pp. B-18 to B-21).

6.6. Effects of Proposed Action to Bull Trout Individuals

The project will result in both adverse and beneficial effects to bull trout in the Upper Klamath Basin from anadromous salmonids that recolonize this portion of the action area. The effects of the proposed action may result in adverse effects to bull trout individuals over the long-term because of predation by steelhead. Insignificant effects are expected from resource competition and diseases and pathogens. Chinook salmon and steelhead are expected to provide beneficial effects over the short and long term from additional marine-derived nutrients and increased bull trout prey resources.

We are not certain how long it will take for anadromous salmonids to reach the areas where bull trout reside. After removal of the Elwha Dam, it took approximately 31 months for Chinook salmon, coho salmon, steelhead, Pacific lamprey and other anadromous species to move upstream and access portions of their historical reaches (Duda *et al*. 2021). We expect it will take longer than this for anadromous salmonids to reach the Upper Klamath Basin because of the further migration distances, the number of potential barriers, and the poorer water quality and increased water temperatures.

6.6.1. Disease and Pathogens

The BA discusses the presence and potential for multiple diseases and pathogens to affect many fish species (BA pp. 225-226). A common salmonid parasite, *Ceratonova shasta* (formerly *Ceratomyxa shasta*), is a significant source of salmonid mortality in the lower Klamath Basin (Stocking *et al.* 2011). However, the geographic distribution of *C. shasta* in the Klamath Basin already includes the headwaters of the Klamath River and is known to infect native Klamath redband trout (*Oncorhynchus mykiss newberri*) (Stocking *et al.* 2011, Atkinson and Bartholomew 2010).

Redband trout are known to exist in sympatry with bull trout in the Klamath Basin and bull trout have likely been exposed to *C. shasta*. Based on the presence of the same diseases and pathogens upstream and downstream of Iron Gate Dam, and the evolution of bull trout in the presence of these pathogens, the potential for recolonizing Chinook salmon and steelhead to facilitate the reintroduction of new or unknown diseases and pathogens to bull trout is not meaningfully measurable or detectable and is therefore insignificant.

6.6.2. Interspecific Competition for Food and Space

Since the construction of the dams and resulting blockage of anadromous fish passage upstream on the Klamath River, bull trout have lost a major food source (see, for example, the discussion of Snake River effects, 69 FR 59996). Bull trout are piscivorous (they prey on other fish), and are considered voracious nocturnal predators of steelhead, redband, and Chinook salmon eggs, fry, and juveniles (Lowery and Beauchamp 2015, Thurow *et al*. 2020).

In the Klamath Recovery Unit, dam removal will allow for the recolonization of Chinook salmon and steelhead into areas occupied by bull trout. The actual degree of potential overlap is uncertain at this time because of current fish passage obstacles. However, fish passage is expected to continue to improve throughout the Upper Klamath Basin and eventually reconnect all streams within bull trout designated critical habitat. Therefore, our effects analysis is based on Chinook salmon and steelhead recolonizing all three of the bull trout core areas. Exceptions include natural barriers such as waterfalls on Fourmile Creek and Annie Creek, both of which are unoccupied bull trout critical habitat.

The recolonization by Chinook salmon and steelhead will increase the prey base for bull trout through salmon eggs, fry, juveniles, and carcasses. Another effect will be increased productivity from marine-derived nutrients (section 6.6.4 below). These nutrients will lead to a greater abundance and richness of insects and aquatic macroinvertebrates (Cederholm *et al.* 1999) that also serve as food for bull trout. These effects will be beneficial to bull trout.

Adult Chinook salmon and steelhead do not feed during their spawning migrations and there will be no competition with bull trout for food resources during migration. Adult steelhead are known to resume feeding after their upstream migration, however, and there may be competition for food resources amongst juvenile bull trout and steelhead. In most streams, juvenile bull trout generally do not occupy the same microhabitat as Chinook salmon. For example, in the Yakima River Basin, reintroduced spring Chinook salmon rarely overlapped spatially with bull trout in tributaries (Pearsons and Temple 2007). Furthermore, the diets of juvenile bull trout and Chinook salmon are not likely to overlap, as seen in the Elwha river basin in which no piscivorous behavior was documented (Duda *et al*. 2011). Steelhead fry are associated with a benthic feeding strategy however, similar to bull trout (Johnson 2007).

While steelhead and bull trout rely on similar habitats to rear and feed, they primarily do so at different times of the day. Steelhead are sight feeders and therefore most active during daylight hours versus bull trout which are primarily nocturnal (Thurow *et al.* 2020). And, because we expect food resources to be abundant for bull trout, steelhead, and Chinook salmon, any effects from competition for food resources are considered discountable.

Chinook salmon migrate upstream in the spring and spawn in the fall like bull trout. However, bull trout spawn in colder headwater locations than Chinook salmon and are known to use stream gradients greater than four percent, whereas Chinook salmon prefer gradients less than four percent (Davies *et al.* 2007), and spawn in larger, deeper streams. Steelhead do not spawn at the same time as bull trout and therefore do not pose a risk of competition for available spawning grounds. Bull trout juveniles also typically rear in colder streams compared to Chinook salmon or steelhead. Therefore, we expect any effects from competition for spawning and rearing habitat between bull trout, Chinook salmon or steelhead to be insignificant and discountable.

If sub-adult and adult bull trout and anadromous salmonids do spatially overlap, it would most likely occur in habitats used by bull trout for feeding, migration, and overwintering, rather than spawning or rearing. Interspecific competition for space may occur between fall run Chinook salmon and bull trout fry (juveniles). This effect is likely discountable, as bull trout fry are cryptic, nocturnal, and associated with the interstitial (in-between) spaces of gravel and cobble more than other salmonids (Rieman and McIntyre 1993, Goetz 2006, Thurow *et al.* 2020). Bull trout fry also stay in, or close to, the redd until they reach the juvenile stage. As described above, spawning habitats between fall run Chinook salmon and bull trout are not likely to overlap, and there will be no overlap between spawning steelhead and bull trout fry, thereby limiting competitive interactions for space at the fry stage.

The spatial preference of both the fry and adult populations of Chinook salmon and bull trout is such that the two species' foraging and spawning habitat should not substantially overlap. In addition, the microhabitat separation and different spawning timeframes would cause insignificant competition for space between steelhead and bull trout.

6.6.3. Predation

Juvenile Chinook salmon begin to move downstream at small sizes (<150 mm) and appear to feed exclusively on aquatic and terrestrial insects (Healy 1991). Therefore, if predation on bull trout eggs or fry were to occur, it would be from juvenile steelhead. Adult steelhead spawn in the spring and fry emerge from the substrate later that same year, after bull trout fry have emerged. As discussed above, steelhead spawn in slightly different stream gradients than bull trout and feed during the day. Upon emergence, steelhead fry are also too small to feed on small bull trout that emerged earlier in the year (i.e., they are gape-limited, or have too small a mouth).

Juvenile steelhead can spend one to three years in freshwater prior to outmigrating to the ocean. Although adult steelhead may spawn in small tributaries such as Long Creek, juvenile steelhead distribute themselves widely and many migrate into main stem rivers as they rear and mature (NRC 2004). This behavior limits the spatial overlap and potential for predation by steelhead juveniles on small bull trout (NRC 2004). However, one to three-year-old juvenile steelhead are likely to eat bull trout eggs and fry (subyearlings) to some degree. Bull trout's coloration and cryptic behavior also make them difficult to detect and they use areas with complex instream cover and coarse substrate (Pratt 1984, Thurow and Schill 1996, Thurow 1997).

The magnitude of steelhead predation on bull trout eggs and fry is difficult to estimate given their unknown future overlap in the Upper Klamath Basin. There is no available literature or local information regarding predation rates of juvenile steelhead on bull trout subjuveniles. However, an analysis of juvenile steelhead predation on Chinook salmon suggests approximately 0.6 percent of total subyearling Chinook salmon were eaten (Sharpe *et al.* 2008). While bull trout were not among the species investigated in this study, the predation rate is likely an accurate description of will occur in areas where juvenile steelhead overlap in bull trout spawning habitat. The uncertainty about the future extent of overlap and the lack of bull trout consideration in the predation study suggests that, while significant predation is highly unlikely, it is not entirely discountable.

6.6.4. Marine Derived Nutrients

The return of anadromous salmonids to the Upper Klamath watershed will have an indirect benefit to bull trout by restoring marine-derived nutrients into the Long Creek drainage and a portion of Boulder Creek, and other areas where the species will overlap. The Upper Klamath watershed historically supported anadromous fish species before the dams were built and it is assumed the range of anadromy will be similar to the historical range, including Long Creek, because no biological or physical barriers will prevent their access (Fortune *et al*. 1966, Lane and Lane Associates 1981, Nehlsen *et al*. 1991, Moyle 2002, Hamilton *et al*. 2005).

The enrichment of the freshwater ecosystem from the input of salmon carcasses may have far reaching benefits throughout the food web by increasing primary productivity (Wipfli *et al.* 2003). The increase in marine-derived nutrients in the upper tributaries of the watershed that are not as high in nutrients as Upper Klamath Lake will likely increase the aquatic invertebrate biomass, thereby increasing the prey base for bull trout and other native fish. In fact, transporting anadromous salmonids above barrier dams has been intentionally undertaken in other parts of Oregon to increase primary productivity through marine-derived nutrients as well as elevate the forage base for native species (Keefer *et al.* 2011).

The primary benefit for a piscivore like bull trout will stem from increased food availability to juvenile and adult bull trout in the form of carcass flesh, eggs, fry, and juveniles of salmon and steelhead reoccupying their historical habitats in the Upper Klamath Basin. Therefore, the indirect effect of restoring marine-derived nutrients into bull trout occupied streams is expected to be beneficial.

6.7. Summary of Effects to Bull Trout in the Upper Klamath Basin

Bull trout, Chinook salmon, and steelhead have co-existed and evolved together in the Klamath Basin and throughout most of the bull trout's range (USFWS 2004). Nonetheless, it will take time to reach equilibrium between these populations that have been separated for nearly a century. This equilibrium may be different than what existed prior to dam construction because of changes in habitat type and availability in the watershed.

In addition, climate change may affect interactions between bull trout and anadromous salmonids. As stream temperatures warm, the coldest stream reaches, typically headwater areas, will become increasingly important for bull trout (Isaak *et al.* 2010). This, in turn, may require longer migrations by anadromous salmonids to reach areas occupied by bull trout, thus lessening potential interactions.

As discussed above, the risk of bull trout exposure to pathogens or disease from, or interspecific competition with, recolonizing Chinook salmon and steelhead is considered insignificant and discountable. The return of anadromous salmonids to the upper Klamath Basin will result in beneficial effects to bull trout by providing marine-derived nutrients that increase their prey base.

Potential steelhead predation of bull trout eggs and subyearlings may adversely affect bull trout in the long term. Fry and juvenile bull trout upstream of Upper Klamath Lake may be preyed on by steelhead, and bull trout will also prey on Chinook salmon and steelhead. The loss of bull trout eggs and fry is likely to be offset by the increase in food availability provided by carcass flesh, eggs, fry, and juveniles of Chinook salmon and steelhead (Hamilton *et al*. 2010).

This is consistent with the finding of Moyle *et al*. (2017) who reported that the eventual extirpation of bull trout from the McCloud River in California was due to the construction of Shasta Dam and the subsequent elimination of juvenile salmon and steelhead as key prey for bull trout. They report, "*Salmon were a major driving force in the McCloud River ecosystem, so their depletion and loss undoubtedly had a major impact on the piscivores in the river, including bull trout.*" Similarly, Buchanan *et al*. (2011) reports that the reintroduction of anadromous salmonids to the Upper Klamath Basin "provides promise for preventing extinction of bull trout and for increasing the overall population abundance and distribution of the species in the basin."

6.8. Effects of Proposed Action to the Klamath River Recovery Unit

The project is expected to result in the recolonization of the Upper Klamath Basin by Chinook salmon and steelhead. The effects of this recolonization on interspecific competition for food or space, and disease and pathogens, are insignificant or discountable to bull trout. There may be adverse effects to bull trout eggs and fry from steelhead predation, and beneficial effects are expected from the reintroduction of marine-derived nutrients.

The final Recovery Plan for bull trout (USFWS 2015a) defines four categories of recovery actions that, when implemented and effective, should:

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Result in actively working with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

The Klamath Recovery Unit's implementation plan describes threats to bull trout and site-specific management actions necessary for recovery of the species in the recovery unit (USFWS 2015b). The proposed action will not implement any management actions from the implementation plan. However, the proposed action will also not impede implementation, or the expected effectiveness, of any of the management actions.

The proposed action will directly meet a conservation recommendation from the Implementation Plan that supports actions to reintroduce anadromous species. It describes, "Chinook salmon and steelhead were historically present in the upper Klamath River basin and their recolonization is expected to support bull trout recovery by increasing prey base through marine derived nutrients" (USFWS 2015b p. B-23).

To address demographic threats to bull trout in all three core areas, management action 2.3.2 from the Klamath Recovery Unit's bull trout implementation plan is intended to implement actions that increase the number of spawning adults and improve gene flow (USFWS 2015b p. B-18). Actions that improve habitat capacity, remove demographic threats, and establish additional local populations can help meet management action 2.3.2. While the project effects would not be immediate, the long-term effects from Chinook salmon, steelhead, and marine-derived nutrients will be beneficial to bull trout recovery, helping to meet the intent of this management action (USFWS 2015b p. B-18).

This is because the enrichment of the freshwater ecosystem from the input of salmon carcasses will have far reaching benefits throughout the food web by increasing primary productivity (Wipfli *et al.* 2003). The increase in marine-derived nutrients will increase aquatic invertebrate biomass. And the anadromous salmonids will provide salmon carcasses, eggs, fry, and juveniles, thereby increasing the forage base for bull trout. The proposed action's effects will not impede the conservation role the Klamath Recovery Unit provides for the survival and recovery of bull trout.

The Service considered whether the Lower Klamath Project will create a condition that precludes the survival and recovery of bull trout. Given the insignificant and discountable effects, the minor scale of potential predation effects from steelhead at the rangewide and local scales, and the beneficial effects, the effects from the proposed action on bull trout in the Klamath Recovery Unit will not preclude the survival and recovery of the species.

7. CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal Activities, that are reasonably certain to occur in the action area of the Federal action subject to consultation (50 CFR § 402.02). Future Federal actions are subject to the consultation requirements established in Section 7 of the ESA and, therefore, are not considered in this BO as cumulative effects. This includes, but is not limited to, hatcheries, water projects, or instream restoration activities with a federal nexus, or timber harvest on federal lands. These actions will require separate Section 7 consultation and are not considered in this analysis.

In addition, actions not considered include those carried out by non-federal entities that have a federal nexus. Because projects on private or state lands often involve multiple parties and may include federal funds or permitting, it can be difficult to distinguish between projects with a federal nexus and those that can be properly described as having cumulative effects.

Cumulative effects in this analysis are the changes to the existing condition for the Lost River sucker, shortnose sucker, and bull trout in California and Oregon from future non-federal activities that are reasonably certain to occur. The BA discusses cumulative effects (pp. 236-240). Since receipt of the BA, there are few additional projects or actions reasonably certain to occur in the action area that may affect the Lost River and shortnose sucker, or bull trout.

7.1. State Actions

The Service is not aware of any actions on state lands in the action area, including road work or timber harvest, that are reasonably certain to occur and have effects on Lost River and shortnose suckers or bull trout (CDFW and ODFW 2020).

The Oregon Department of Transportation (ODOT) is planning to widen US Highway 140 along the western side of Upper Klamath Lake, near Howard Bay area. This action will occur in direct proximity to Lost River and shortnose sucker habitat. Some state transportation projects occur near areas adjacent to jurisdictional waters. While not certain, they may have a federal nexus and may be covered under programmatic agreements for section 7 under the ESA. We consider the effects from them here, however, due to this uncertainty. The effects from transportation actions (e.g., road maintenance, road reconstruction, road widening) are expected to be insignificant and discountable to Lost River and shortnose suckers. This is because these actions incorporate best management practices and resource protection measures to protect water quality from sediment inputs, increased turbidity and pollutants. Therefore, this action is not expected to contribute toward adverse effects to Lost River or shortnose suckers, and this action will not occur in or near bull trout habitat.

The ODFW and the Klamath Tribes prepared a "Draft Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin" (ODFW and Klamath Tribes 2021). To examine fish movement and survival, and prior to dam removal, ODFW and its partners will reintroduce spring-run Chinook salmon juveniles from the hatchery into areas upstream of the dams. The reintroduction of spring-run Chinook salmon hatchery juveniles will only occur in Oregon.

Information from the reintroduction will help guide restoration actions which can maximize the success of any future full-scale active reintroductions (see below). Given the progress that has already occurred on this project, it is the Service's view this action is reasonably certain to occur and will contribute to a more rapid increase of Chinook salmon abundance in the Klamath Basin.

Natural (volitional) repopulation is generally considered the approach with the lowest risk of failure or unintended consequences, because it minimizes the interruption or alteration of natural biological processes (George e*t al*. 2009, Anderson *et al*. 2014). Active reintroduction through transplanting adults, juveniles, or fertilized gametes has the benefit of immediately placing fish in a reintroduction area, but has increased ecological risks relative to natural repopulation.

Fall-run Chinook salmon, coho salmon, steelhead trout and Pacific lamprey are all found in the Klamath River immediately below Iron Gate Dam. When the dams are removed, the Service and NMFS are confident individuals of these species will repopulate newly available upstream habitat on their own. However, because the timing and extent of volitional repopulation is uncertain, ODFW plans to allow three generations (estimated at nine years for coho salmon and 12 years for Chinook salmon) to pass following restored passage, after which an assessment will be conducted to determine if, where, and when any additional active reintroduction is needed to help establish populations.

The effects from reintroducing Spring Chinook salmon hatchery juveniles are considered discountable to interspecific competition with bull trout and Lost River and shortnose suckers. As discussed in Chapter 6, juvenile Chinook salmon are not expected to compete for resources or space with these three species. In addition, the recolonization by Chinook salmon is considered a beneficial effect to the suckers and bull trout in terms of providing increased prey resources and marine-derived nutrients.

7.2. Local and Regional Projects and Programs

The Klamath Falls Spring Street wastewater treatment plant (WWTP) and the South Suburban Sanitary District wastewater treatment facility discharge into Lake Ewauna, and the Upper Klamath River. The 2010 implementation of nutrient TMDLs[34] (nitrogen, phosphorus) for the Upper Klamath River prompted the City of Klamath Falls and the South Suburban Sanitary District to consider upgrades to these facilities (ODEQ 2010). Successful upgrades to wastewater treatment systems will benefit water quality in Lake Ewauna/Keno Reservoir and the Klamath River, and improve aquatic habitat.

1. The City of Klamath Falls is currently in the design phase for upgrading the 2.4-million-gallon-per-day (mgd) capacity Spring Street WWTP. The City approved contracts for these upgrades in May 2016 and additional funding for design work in February 2018 (Bassinger 2018). Improvements may include, but are not limited to, upgrading the facility headworks and nutrient removal system and repairing concrete structures. The City of Klamath Falls estimates completion of the Spring Street upgrade by late 2022 (Dillemuth 2021).
2. The South Suburban Sanitary District's wastewater treatment facility will be upgraded to comply with the nutrient TMDL requirements. The 2.1-mgd facility currently consists of 130 acres of facultative wastewater stabilization lagoons and a chlorine disinfection system.

[34] Total Maximum Daily Loads

Upgrades to this facility are reasonably certain to occur, but the implementation timeframe is uncertain.

As required by the 2014 Sustainable Groundwater Management Act (SGMA), Siskiyou County is developing Groundwater Sustainability Plans (GSP) for four basins (Shasta, Scott and Butte Valley Basins and the Tulelake Subbasin) (CDFW SGMA 2018). A GSP provides a roadmap for how groundwater basins will reach long-term sustainability. Per the SGMA, these GSPs must be developed by January 31, 2022. The Siskiyou County Flood Control and Water Conservation District is coordinating the GSP development for the three Basins. The Siskiyou County Board of Supervisors is coordinating with the City of Tulelake, Tulelake Irrigation District, and Modoc County to develop the GSP for the Tulelake Subbasin.

Expected Effects to Lost River and shortnose sucker: The aforementioned local and regional activities are expected to have beneficial effects on listed suckers in the action area. Benefits may include improved surface and groundwater management and improved aquatic habitat conditions from upgrades to wastewater infrastructure. The reduction of nutrient loads will benefit listed suckers in Lake Ewauna/Keno Reservoir by reducing harmful cyanobacterial bloom magnitudes and subsequent degraded water quality.

Expected Effects to bull trout: As the aforementioned local and regional activities will occur downstream of areas occupied by bull trout, they are not expected to affect bull trout or their habitat.

7.3. Private Actions

7.3.1. Commercial Timberlands

The action area includes expansive areas of private timberlands subject to commercial harvest in California and Oregon.

We reviewed private timber harvest plan (THP) data in CalTREES[35] in December 2021. Based on this review, there are no THPs reasonably certain to occur in the action area in California that may affect the Lost River or shortnose sucker. Timber harvest on private lands in California would have no effect on bull trout.

We reviewed the "Notifications to Operate" that are filed through the Oregon Department of Forestry's online notification process in December 2021. Based on this review, there are no private land timber harvest notifications for the action area in Oregon.

Timber harvest in both California and Oregon may occur in the action area during the pre-drawdown, drawdown, and post-drawdown years. Timber harvest plans in California are reviewed by the California Department of Forestry and Fire Protection and effects to water quality conditions and protected species are analyzed and mitigated during the THP permitting process.

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[35] CalTREES is the California Timber Regulation and Environmental Evaluation System. It is an online permitting system used by the California Department of Forestry and Fire Protection (CAL FIRE) staff and timber harvest review team agencies.

In Oregon, all timber harvest on private lands must comply with the Oregon Forest Practices Act. Oregon state law outlines a set of rules for private timber harvest aimed to protect soil productivity, water quality and wildlife habitat, and to ensure replanting after harvest. Aquatic or upland restoration activities may also occur on commercial timberlands and are reviewed during the permitting process.

The required compliance with state and federal guidance for water quality and listed species protections reduces the potential for adverse effects to listed species from timber harvest on private lands, but it may occur in short duration, area or magnitude. Protections include stream and riparian area setbacks or requirements to leave, or place, large wood within streams to provide habitat complexity. We expect most effects from timber harvest on private lands to Lost River or shortnose suckers, and bull trout, to be insignificant or discountable.

7.3.2. Conservation and Restoration Actions on Private Lands

Numerous restoration and conservation activities are planned on private lands in the Upper Klamath Basin that will result in beneficial effects to bull trout and listed suckers. The majority of these actions are likely to receive federal funding and or require federal permitting, and therefore they are likely to have a federal nexus. They include, but are not limited to, installing fish screens to reduce entrainment, installing stock water systems to mitigate water diversion impacts, improving fish passage, adding large wood and boulders to create roughness and pools in streams or rivers, restoring floodplain connectivity, and other riparian area restoration.

Actions reasonably certain to occur on private lands over the next five years include restoration in the Wood River Valley, Sycan River, and the North and South Fork Sprague River watersheds. Additional actions on private lands near Upper Klamath Lake include numerous small water quality improvement projects and the "Running Y and Caledonia Farms" project. These projects are expected to help reduce phosphorus inputs into the lake (C. Erdman, personal communication, August 23, 2021).

In the Wood River Valley, actions to improve riparian habitat and restore channel locations and stream gradients will occur in Threemile Creek, Crane Creek, and Annie Creek that will benefit bull trout. In Annie Creek, two dams that block passage for bull trout will also be removed. An additional four barriers in Annie Creek will be remediated over the next five years which may also benefit bull trout.

Additional restoration actions will occur in the Sycan River and Brown Springs; Lost River sucker have been observed in Brown Springs. This includes riparian planting and fencing to protect the river and springs habitat. A fish passage barrier for listed suckers and bull trout will also be removed on the Sycan River, allowing for additional upstream access to spawning and rearing habitats.

Within the North Fork Sprague River watershed and Bailey Flat area, instream restoration using beaver dam analogues[36] and placement of large wood is planned for 2022. After this restoration, we expect bull trout will be able to access and use these areas, and the upstream reaches. Anadromous

[36] Beaver dam analogues (BDAs) simulate natural beaver dam functions including modifying stream hydrology and enhancing stream-riparian connectivity.

salmonids that recolonize this area would also be able to access these areas and overlap with bull trout (C. Erdman, personal communication, August 23, 2021). Within the South Fork Sprague River watershed, actions to remediate fish passage barriers for bull trout will occur in Leonard Creek, Brownsworth Creek, the South Fork Sprague River, Corral Creek and Camp Creek. The barriers on Leonard and Brownsworth Creek where bull trout already occur would be removed by the end of 2023, with the remaining four barriers being remediated by 2025.

Restoration and conservation projects on private lands can be planned and implemented at almost any time. Most of these projects on private lands are expected to have insignificant, discountable, or wholly beneficial effects to Lost River and shortnose suckers and bull trout in the action area. Where fish passage barriers are removed that allow steelhead to access streams and rivers occupied by bull trout, adverse effects are likely to occur on bull trout eggs and subyearlings from steelhead predation. Benefits include improved surface and groundwater management, improved riparian and instream habitats, improved access to upstream habitats, and the reduction of nutrient loads into Upper Klamath Lake.

7.4. Cumulative Effects Conclusion

State and private actions are likely to continue affecting listed species in the action area throughout and after implementation of the proposed action. The cumulative effects of non-federal actions in the action area are difficult to analyze considering the geographic landscape of this Biological Opinion and the uncertainties associated with State and private actions. Whether cumulative effects will increase or decrease is a matter of speculation, as is determining whether future effects will be adverse. Future cumulative effects are wholly dependent on the activity affecting the species, and the non-federal entity regulating the activity.

We expect State and private actions will continue at similar magnitudes and intensities as in the recent past including timber harvest, cattle grazing, and habitat restoration. Any future restoration and recovery actions would likely help lessen the effects of non-federal land and water-use actions on Lost River and shortnose suckers and bull trout.

The majority of the reasonably certain future actions on State and private lands in the action area will have insignificant, discountable, or wholly beneficial effects on Lost River and shortnose suckers and bull trout. Restoration actions that remove fish passage barriers are likely to result in adverse effects to bull trout from steelhead predation. The Service is not aware of any other specific future State or private actions that would contribute to adverse effects on these three species.

8. Summary and Synthesis of the Proposed Action

This chapter is the final step for assessing the risk posed to the listed species as a result of implementing the proposed action. Here, we add the effects of the action, environmental baseline and the cumulative effects to the status of each species, to help formulate our Biological Opinion. We do this to determine whether the proposed action is likely to jeopardize the continued existence of the Lost River sucker, the shortnose sucker, and bull trout, by reducing appreciably the likelihood of both the survival and recovery of each species in the wild, by reducing their reproduction, numbers, or distribution. Chapter 9 provides our conclusion regarding jeopardy for all three species.

First, we will assess the effects of the proposed action at the entire rangewide scale, then the scale of the recovery units, and then the action area scale.

8.1. Lost River Sucker and Shortnose Sucker

8.1.1. Effects at the Scale of the Entire Range of the Species and Action Area

The action area includes the majority of the Lost River and shortnose sucker's range. The range is described by Recovery Units; the Upper Klamath Lake Recovery Unit and the Lost River Basin Recovery Unit.

The effects of the proposed action will occur in the entire Upper Klamath Lake Recovery Unit. Effects will also occur in the two sumps within the Tule Lake National Wildlife Refuge (NWR), which is located in the Lost River Basin Recovery Unit. Any Lost River or shortnose suckers that are captured and translocated to the Tule Lake NWR will have no connectivity or potential to interact with any other listed suckers in the Lost River Basin Recovery Unit. This is because listed suckers that may already be in the sumps when translocation occurs are from the Upper Klamath Lake Recovery Unit. In addition, none of the translocated suckers will be used to augment any of the sucker populations in other parts of the Lost River Recovery Unit. Therefore, the proposed action will not affect any individuals in Gerber Reservoir or Clear Lake, or any other areas within the Lost River Basin Recovery Unit.

In our *Status of the Species* section and Appendix B, the Service describes the factors that led to listing the Lost River and shortnose sucker as endangered under the ESA, throughout their range: dramatic population declines and the loss of important habitats and populations (USFWS 2013, 2019 a,b, 2020).

Regularly spawning populations only occur in Upper Klamath Lake, Clear Lake Reservoir, and Gerber Reservoir (shortnose sucker only). Furthermore, populations in Upper Klamath Lake are characterized by low recruitment and low juvenile survival. These are limiting factors for these species when combined with periodic reduced survivorship of adult fish and reduced age-class diversity.

The environmental conditions that influence the survival and recovery of Lost River and shortnose suckers at the range-wide scale include injury and mortality associated with turbines and spillways around each of the dam structures, entrainment in water diversions and canals, and stranding and ramp rate effects from daily flow fluctuations. Habitat degradation and loss because of excessive nutrients, water diversions, migration barriers, lack of access to spawning habitat and poor water quality also exert a negative influence on both species' survival and recovery.

The specific factors limiting their recovery include higher than natural mortality of juveniles due to minimal rearing habitat, entrainment in water management structures, poor water quality, and negative interactions with introduced species. Adult populations are limited by negligible recruitment into the population, as well as high levels of stress and mortality associated with impaired water quality.

At the range-wide scale, the species are also limited by a lack of connectivity (USFWS 2013, 2019a,b,c, 2020). If the restoration actions identified in the Revised Recovery Plan are successfully implemented, Lost River sucker and shortnose sucker could recover in five to seven generations. A generation is considered the average time it takes for a female to become reproductive. This is typically seven years for Lost River sucker and five years for shortnose suckers. Therefore, the Service expects it will take roughly 30 to 50 years to achieve recovery for both species (USFWS 2013 pp. ix, 63).

A long-term consequence of the proposed action in the Upper Klamath Lake Recovery Unit is recolonization by Chinook salmon and steelhead within their historical range and distribution. As assessed in sections 6.2.4 and 6.3, this recolonization is expected to have discountable, insignificant, and beneficial effects to the Lost River sucker and shortnose sucker.

Chinook salmon and steelhead may introduce diseases and pathogens or compete for food resources and space. Steelhead may eat sucker eggs or larvae. Chinook salmon and steelhead will also contribute marine-derived nutrients. For the listed suckers:

- The risk associated with the potential reintroduction of diseases or pathogens is low and is considered insignificant.

- Potential competition for food resources may occur, but it is likely to be minimal due to the varying diets between the species and their presence in a hypereutrophic system.

- There is minimal potential for spatial overlap between larval and juvenile suckers and juvenile Chinook salmon and steelhead, due to the differing habitat preferences of these life stages.

- Predation on Lost River and shortnose sucker eggs or larvae may occur and result in adverse effects. The effects will not be measurable, detectable, or evaluated, however, because both species produce large numbers of eggs and larvae. Spawning Lost River sucker females produce 44,000 to 236,000 eggs and spawning shortnose sucker females produce 18,000 to 72,000 eggs (see section 6.2.4.3). In addition, the environmental baseline conditions of ongoing egg and larval predation by other native and non-native fish species in the action area make it impossible to measure, detect or evaluate what proportion of predation may occur by juvenile Chinook salmon, or steelhead.

- The enrichment of the freshwater ecosystem in the action area from marine-derived nutrients may have far-reaching benefits throughout the food web. The effects to Lost River and shortnose suckers, however, are not measurable. This beneficial effect will also only be realized in a portion of both species range.

    - Additional nutrients will either have a minor beneficial impact each year in terms of providing for additional prey base for suckers. Or any additive effects on annual water quality conditions will be too small to detect in a hypereutrophic system.

    - The annual impacts from marine-derived nutrients will depend on the number of Chinook salmon and steelhead that reach the upper basin each year.

Based on the discussion above, in relation to Chinook salmon and steelhead, we find the effects from introduced diseases and pathogens, competition for space and food, and potential predation will not be meaningfully measurable, detectable, or evaluated. The effects from marine-derived nutrients will be neutral, insignificant or beneficial to water quality conditions at the range-wide and action area scales.

While the numbers of Lost River and shortnose sucker will be reduced through the pre-drawdown, drawdown, and dam removal activities, the effects of the proposed action will not affect any known spawning habitat for either species. The Lost River and shortnose sucker are not known to spawn in the hydroelectric reach reservoirs, or anywhere downstream of Upper Klamath Lake. Thus, they provide no contribution to future population growth at the range-wide scale.

While their numbers and distribution will be somewhat reduced through the loss of the four dams and reservoirs; the Klamath River downstream of Keno Dam to Iron Gate Dam, including the hydroelectric reach, is considered a population sink. Reproduction by both species will not be affected. We estimate that 4,940 adult listed suckers will perish during drawdown and dam removal, based on the total estimate of 5,540 adult listed suckers in the reservoirs minus 600 captured and translocated adults. The loss of the 4,940 adults represents approximately nine percent of the Lost River and shortnose sucker adult population in the Upper Klamath Lake Recovery Unit. This loss represents approximately five percent of the estimated range-wide adult population.

While we do not have range-wide estimates of larval or juvenile populations for either species, the effects of the proposed action are considered insignificant given their high egg and larval output. Eggs will not be affected in the hydroelectric reach because spawning by listed suckers is not known to occur downstream of Upper Klamath Lake. In addition, any larvae and juveniles in the hydroelectric reach, or Klamath River below Keno Dam, are from the source population in Upper Klamath Lake. The effects to eggs or larvae in Upper Klamath Lake's tributaries from possible predation by anadromous salmonids will not be meaningfully measurable or detectable.

8.1.2. Effects at the Scale of the Klamath River Management Unit

The Klamath River management unit represents a population sink for the Lost River and shortnose sucker. Spawning is not known to occur in this management unit and there is no ability for these fish to access suitable upstream spawning habitat or reconnect with their source populations above Keno Dam. Therefore, these suckers provide no contribution to reproduction or additional numbers or abundance in their current location.

In terms of species distribution, the loss of individuals in the Klamath River management unit will not appreciably impair or preclude the conservation role provided by the Upper Klamath Lake Recovery Unit to the survival and recovery of both species as a whole.

8.1.3. Effects at the Scale of the Hydroelectric Reach Reservoirs

The four hydroelectric reach reservoirs are part of the Klamath River management unit and represent the area where substantive effects will occur to Lost River and shortnose suckers.

There are an estimated 5,540 adult listed suckers across the hydroelectric reach reservoirs (Renewal Corporation 2021). Under Action 2 of the conservation measure, approximately 600 of these adults will be captured from J.C. Boyle, Copco No. 1 and Iron Gate Reservoirs during the 2-week capture and translocation effort. Additional adults may also be captured during the 2-week effort, or when drawdown occurs at J.C. Boyle Reservoir. Any captured adults will be translocated to the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, the Tule Lake National Wildlife Refuge (NWR), or additional agreed-upon locations.

We expect this conservation measure will help contribute to recovery goals in the Upper Klamath River Recovery Unit, through additional brood stock. This brood stock will be used to create more individuals, adding to the species' survival and recovery through additional numbers and improved reproductive capacity. The conservation measure will also minimize the number of adult suckers that will be killed during final drawdown and dam removal.

The final drawdown of the four reservoirs and subsequent removal of the four dams will remove an approximate 107,470 acre-feet of sink habitat for the two species (PacifiCorp 2000, USFWS 2013a p. 11, Chapter 5).

The proposed action will have adverse effects on all 5,540 adult Lost River and shortnose suckers. These effects consider the potential negative impacts to adults during the capture and translocation, as well as in-water sediment dredging and disposal, drilling and in-water blasting, in-water temporary bridge construction, reservoir drawdown, and dam removal.

A range of insignificant to discountable effects, as well as adverse effects, will occur to juveniles and larvae during pre-drawdown activities. As described below, all juveniles and larvae in the reservoirs will be lost during drawdown and dam removal. There will be no effects to eggs, as the Lost River and shortnose suckers are not known to spawn in this location, or anywhere below Upper Klamath Lake.

During the final stage of reservoir drawdown, an estimated 4,940 adult listed suckers, and 365,229 larvae and 2,825 juveniles, will remain in the reservoirs and hydroelectric reach and are expected to be injured or harmed, and eventually killed or lost downriver. All of these individuals will experience reduced fitness or die from exposure to increased water temperatures, reductions in dissolved oxygen, avian predation, toxin exposure and increased pH levels from suspended sediments, or direct physical injury as flows are drawn down. As drawdown progresses, individuals will also be swept or transported downstream through the dam outlet tunnels or other diversion channels used for final drawdown.

Individuals in the hydroelectric reach do not contribute to the survival and recovery of the species in their current location. Spawning by these two species is not known to occur in the hydroelectric reach, its reservoirs, or at any location below Upper Klamath Lake. Since the individuals in the reservoirs are not able to successfully migrate upstream and contribute to the spawning populations in Upper Klamath Lake and the Upper Klamath Basin, the reservoirs are a population sink for all age classes present; they do not contribute to increasing the species' numbers and abundance through reproduction.

The adults that are captured and translocated are expected to help contribute to recovery by functioning as brood stock at the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, the Tule Lake NWR or another agreed-upon location. Translocated adults may also be released into Upper Klamath Lake. Using the translocated adults as brood stock will better conserve the genetic material of both species. This material will be incorporated into future generations to help recover both species in Upper Klamath Lake, thereby contributing more significantly to the long-term survival of both species.

Based on this rationale, the effects of the proposed action to the Lost River sucker and the shortnose sucker will not appreciably impair or preclude the conservation role the Upper Klamath Lake Recovery Unit provides for the survival and recovery of these two species as a whole. The proposed action will not influence conditions that contribute to survival and recovery of both species in the Lost River Basin Recovery Unit.

8.2. Bull Trout

8.2.1. Effects at the Scale of the Entire Range of the Species

In our *Status of the Species* section and Appendix C, the Service describes the factors that led to the current listing of bull trout as threatened under the ESA, throughout their range. Historical habitat loss and fragmentation, interaction with nonnative species, and fish passage issues are widely regarded as the most significant primary threats affecting bull trout (USFWS 2015a p. iv). Additional threats include small populations, isolation and climate change (USFWS 2015a pp. vi, 48).

Since the listing, there has been very little change in the general distribution of bull trout in the coterminous United States (USFWS 2015a p. 7). Most threats currently affecting bull trout fall into three broad categories: (1) habitat threats, (2) threats to individuals and populations (demographic threats), and (3) threats from nonnative species. Habitat threats impact spawning, rearing, foraging, migratory, and overwintering habitats. Demographic threats impact individuals or local populations (such as wildfires, or disease outbreaks). Threats from nonnative species result from introduced fish species that negatively impact bull trout individuals or populations (USFWS 2015a p. 11).

Numerous conservation actions have and continue to be implemented across the species' range (USFWS 2015a p. iii). These include the removal of migration barriers to allow access to spawning, foraging, overwintering, or migrating habitats; screening of water diversions to prevent entrainment into unsuitable habitat in irrigation systems; nonnative fish suppression efforts; habitat improvements; instream flow enhancements; and water quality improvements to minimize impacts from sedimentation, agricultural chemicals, or warm temperatures (USFWS 2015a p. 10).

The estimated timeframes for recovery vary for the six Recovery Units and core areas (Figure 6). If the restoration actions and implementation schedules for the six Recovery Units are successfully implemented, recovery is estimated at 25 years for the Columbia Headwaters, Mid-Columbia, Coastal, and Upper Snake; 10-25 years in the Saint Mary; and 50-70 years in the Klamath Recovery Unit (USFWS 2015a pp. ix-x).

The effects of the proposed action will occur in the Klamath Recovery Unit, including all three of its core areas, over the long term (see section 6.6 and Figure 4). Threats to bull trout in this Recovery Unit are considered the most severe and many areas where bull trout have been lost will require reintroduction (USFWS 2015a p. ix, 2015b).

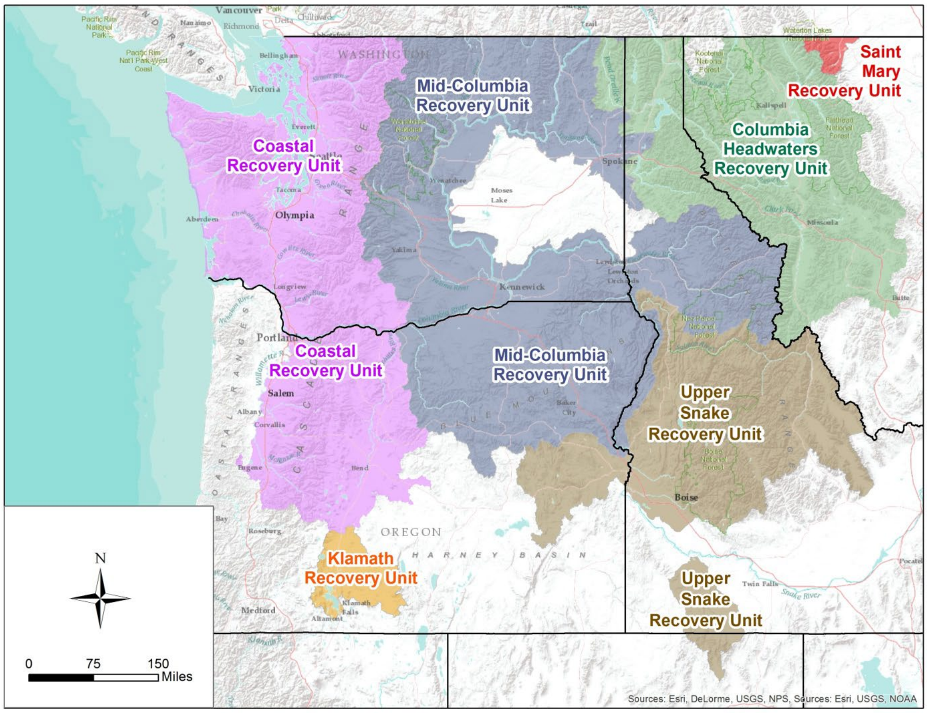

Figure 6. Locations of the six bull trout recovery units in the coterminous United States.

The proposed action will affect bull trout in all three core areas through the eventual recolonization of Chinook salmon and steelhead into their historic range and distribution in the Upper Klamath Basin. While Threemile Creek and Sun Creek are currently inaccessible by Chinook salmon and steelhead because of barriers that block brook trout, the ODFW may manually move Chinook salmon or steelhead upstream of these barriers (Z. Tiemann, personal communication, December 13, 2021). Hence, our analysis considers that all areas currently occupied by bull trout in the Klamath Recovery Unit will eventually be recolonized by Chinook salmon and steelhead.

The effects of the proposed action to bull trout include the introduction of diseases and pathogens, interspecific competition for food resources and space, predation of bull trout by steelhead, an increased availability in prey for bull trout, and the restoration of marine-derived nutrients. In our analysis of the project-level effects in sections 6.6 and 6.7, we determined these effects will be insignificant, discountable, or beneficial, with the exception of predation by steelhead on bull trout eggs and fry.

At the range-wide scale, the adverse effects from future predation by steelhead on bull trout fry will influence a small proportion of individuals. The proposed action will not adversely affect any spawning or rearing habitat; or any foraging, overwintering, or migration habitat. It will not change the distribution of bull trout at the rangewide scale.

8.2.2. Effects at the Scale of the Klamath Recovery Unit and Action Area

Because the action area wholly includes the Klamath Recovery Unit and its three core areas, we combine the action area and Recovery Unit here for our risk analysis.

Small population size is a primary threat in all three core areas (USFWS 2015 p. 17). This recovery unit is the most significantly imperiled. It has experienced the loss of several populations, the contraction of local populations, and declining abundance. Furthermore, natural recolonization is constrained by dispersal barriers and the nonnative brook trout (USFWS 2015 p. 39).

Nine of 17 local populations have already been extirpated and the remainder are significantly imperiled and require active management of threats in all three core areas (USFWS 2015 p. 112). The geographic range of bull trout in the Klamath Recovery Unit will need to be expanded through the reestablishment of extirpated local populations before recovery criteria can be met (USFWS 2015 p. 112).

The effects of Chinook salmon and steelhead recolonizing streams and rivers occupied by bull trout will not occur immediately after dam removal and Klamath River channel restoration. However, the long-term effects from their recolonization and the reintroduction of marine-derived nutrients are expected to benefit bull trout. This is because of the increases in food availability provided by salmonid carcass flesh, eggs, fry, and juveniles of Chinook salmon and steelhead (Hamilton *et al*. 2010).

Additional prey and additional forage for prey will contribute to bull trout recovery in the Klamath Recovery Unit. As discussed in section 6.8 above, management action 2.3.2 from the recovery unit's Implementation Plan recommends implementing actions that increase the number of spawning bull trout adults and improve gene flow in all three core areas (USFWS 2015b p. B-18). This includes actions to improve habitat capacity, removing threats such as brook trout, and establishing additional local populations. The additional food resources from recolonizing Chinook salmon and steelhead will positively contribute to individual bull trout health and survival, and their abundance.

The risk of bull trout being exposed to new pathogens or diseases from Chinook salmon or steelhead is considered discountable and insignificant. This is because of the presence of the same diseases and pathogens upstream and downstream of Iron Gate Dam, and the evolution of bull trout in the presence of these diseases and pathogens. The geographic distribution of *C. shasta* in the Klamath Basin also already includes the headwaters of the Klamath River and occupied bull trout streams (section 6.6.1).

Similarly, interspecific competition for resources such as space is considered insignificant and discountable. Food resources will be more abundant for bull trout and their prey, resulting in beneficial effects. The recolonization by Chinook salmon and steelhead will increase the number of salmon eggs, fry, juveniles, and carcasses that bull trout can eat. Marine-derived nutrients will lead to a greater abundance and richness of insects and aquatic macroinvertebrates that also serve as food for bull trout.

- We do not expect any competition for food resources when adult Chinook salmon and steelhead are migrating for spawning, though adult steelhead will resume feeding after their upstream migration. Competition for food resources amongst juvenile bull trout and steelhead subyearlings (fry) is likely because steelhead subyearlings are associated with a benthic feeding strategy similar to bull trout. However, steelhead are most active during the daylight hours and bull trout are primarily nocturnal. Because we expect food resources to be abundant for bull trout, Chinook salmon, and steelhead, any effects from competition for food resources are considered discountable.

- Because of their different spawning timeframes, we do not expect any competition for spawning habitat to occur between bull trout and steelhead. Chinook salmon and bull trout both spawn in the fall, but the separation of their spawning habitats, both in terms of elevation and stream gradient, will result in discountable effects. Bull trout juveniles typically rear in colder streams compared to Chinook salmon or steelhead.

- The spatial preferences of both the fry and adult populations of Chinook salmon and bull trout are such that the two species' foraging, spawning, and rearing habitats should not substantially overlap. In addition, the microhabitat separation and different spawning timeframes will result in insignificant competition for space between steelhead and bull trout.

As described above, and in section 6.6.3, steelhead predation of bull trout eggs or subyearlings is likely to occur and represents an adverse effect. Where this potential predation occurs in all three core areas, the numbers of bull trout that survive to a juvenile or adult life stage will be somewhat reduced. Conversely, bull trout are voracious predators of steelhead, redband, and Chinook salmon eggs, fry and juveniles (Lowery and Beauchamp 2015).

While there will be adverse effects to bull trout eggs and subyearlings, the proposed action will not adversely affect any spawning or rearing habitat; or any foraging, overwintering or migration habitat in the Recovery Unit or action area. Foraging habitat condition for bull trout will be benefitted through increases in their prey resources and from marine-derived nutrients. The effects of the proposed action will not influence the distribution of bull trout. As recolonization by steelhead occurs, there will be some predation on bull trout eggs or subyearlings, but the overall effect is not expected to meaningfully influence or appreciably reduce the numbers, reproduction, or distribution of bull trout in the Recovery Unit.

Based on this rationale, the effects of the proposed action to bull trout will not appreciably impair or preclude the conservation role the Klamath Recovery Unit provides for the survival and recovery of the species as a whole. Furthermore, because of the overall expected benefits, the reintroduction of anadromous fish is an important conservation recommendation identified in the Klamath Recovery Unit's Implementation Plan for bull trout (USFWS 2015b p. B-23).

9. CONCLUSION

Under section 7(a)(2) of the ESA, federal agencies must ensure the activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. Regulations implementing this section of the ESA define the phrase, "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR § 402.02).

A final rule revising the regulatory definition of "destruction or adverse modification of critical habitat" was published on February 11, 2016 (81 FR 7214) and revised August 27, 2019 (84 FR 45016). The revised definition states: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species." Because we concur with the action agency that critical habitat for any listed species will not be adversely affected by the proposed action, an adverse modification analysis is not required here.

As described in Chapter 2, the jeopardy analysis considers the effects of the proposed Federal action, and any cumulative effects, on the range-wide survival and recovery of the listed species. It relies on four components:

1. The Status of the Species, which evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; its survival and recovery needs; and explains if the species' current range-wide population is likely to persist while retaining the potential for recovery or is not viable;

2. The Environmental Baseline, which evaluates the current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the consequences of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species;

3. The Effects of the Action, which evaluates all future consequences to the species that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action, and how those impacts are likely to influence the survival and recovery of the species; and

4. The Cumulative Effects, which evaluates the consequences of future, non-Federal activities reasonably certain to occur in the action area on the species, and how those impacts are likely to influence the survival and recovery role of the species.

After reviewing the current status of the Lost River sucker, the shortnose sucker and the bull trout, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the Lower Klamath Project is not likely to jeopardize the continued existence of these three species. We reached this conclusion based on the information and analysis in Chapters 3-7, and the summary and synthesis in Chapter 8.

9.1. Lost River and Shortnose Sucker

Based on the stressors, exposure to the stressors, and the anticipated effects from the project activities described in Chapter 6 and summarized above in Chapter 8, the Service concurs the proposed action *may affect and is likely to adversely affec*t the Lost River sucker and shortnose sucker. This is based on the direct injury and mortality that will occur to individuals in the hydroelectric reach. We also find the project will have long-term insignificant, discountable, and beneficial effects to Lost River sucker and shortnose sucker in the Upper Klamath Basin.

9.1.1. Jeopardy Analysis for Lost River and Shortnose Sucker

Despite the adverse effects to these two species from the consequences of the proposed action, and after considering the best available scientific and commercial information, the current status of the two species, the environmental baseline, the effects of the action, and the cumulative effects, it is our biological opinion that implementation of the Lower Klamath Project is not likely to jeopardize the continued existence of the Lost River sucker or shortnose sucker. We reached this conclusion based on the following factors:

- The effects of the proposed action will not affect any documented spawning habitat for the two species.

- The removal of the four dams in the hydroelectric reach will reduce the current distribution of both species, and their current numbers and abundance. However, the effects of this activity are not reasonably expected, either directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of either species in the wild by reducing their reproduction, numbers, or distribution.

  This is because the impact of dam removal, and the subsequent loss of the reservoirs, is considered small relative to the currently available rangewide habitat and distribution for both species, including spawning habitats, and the estimated adult populations:

  - The hydroelectric reach reservoirs represent approximately 14 percent of the habitat available for and occupied by Lost River and shortnose suckers in the Upper Klamath Lake Recovery Unit, and eight percent of this habitat across their range-wide distribution.

  - The loss or mortality of adult Lost River and shortnose suckers from final drawdown and dam removal represents approximately nine percent of the estimated adult population for both species in the Upper Klamath Lake Recovery Unit, and approximately five percent of the estimated rangewide adult population.

  - More importantly, and as established in chapter 5 of this Biological Opinion, the Klamath River below Keno Dam and downstream, including the hydroelectric reach reservoirs, is considered a population sink for both species. Therefore the loss of this habitat is expected to have no impact to the reproduction of either species, and no meaningful impact to their numbers or distribution. Reproduction is not known to occur below Keno Dam and the listed suckers cannot access the three important upstream populations or spawning habitats. Therefore they cannot contribute to their survival and recovery in their current location.

- Juveniles and larvae in the hydroelectric reach and the reservoirs do not contribute to the other populations in the Upper Klamath Lake Recovery Unit, or the remainder of both species' range. The effects of the proposed action will not contribute to annual juvenile or larval losses, as juveniles and larvae in the reach have been entrained or drifted downstream from Upper Klamath Lake, and are thus also lost to the reproducing populations upstream.

- Action 2 of the conservation measure will, 1) help reduce the adverse impacts of drawdown and dam removal on adult Lost River and shortnose suckers, and 2) more importantly, help contribute toward additional numbers and future reproduction for the species' survival and recovery.
    - This conservation measure reduces the adverse impacts to adults by reducing their mortality during final drawdown and dam removal by 11 percent.
    - While the effectiveness of the capture and translocation effort will remain unknown until it is completed, the Service estimates 95 percent of the adults will survive during capture and translocation. We expect high survival rates at the Klamath Falls National Fish Hatchery and the Klamath Tribes' sucker rearing facility, but there may be some delayed mortality of adults that are translocated to the Tule Lake National Wildlife Refuge.
    - This conservation measure contributes to both species' survival and recovery because the translocated adults will be used as brood stock. They will become more accessible to the sucker rearing and hatchery operations, and any adults released into Upper Klamath Lake will become part of the adult spawning populations in the lake and its tributaries.

As described in sections 6.3, 6.4, and 8.1 of this Biological Opinion, the consequences of the proposed action are not expected to significantly influence the range-wide baseline or constitute an appreciable reduction in the "recovery support" function of the entire Upper Klamath Lake Recovery Unit, or the Lost River Basin Recovery Unit (as defined in USDI FWS 2013). The effects of the proposed action are not expected to accelerate the population decline of the Lost River sucker or shortnose sucker in an appreciable manner, because the hydroelectric reach and its reservoirs, and the Klamath River management unit, represent a population sink for the two species.

The cumulative effects of future non-Federal actions in the action area that are reasonably certain to occur are expected to result in neutral to beneficial effects to the Lost River and shortnose suckers. Specifically, increased screening should reduce entrainment into irrigation diversions, and habitat restoration is expected to improve habitat availability and water quality.

In this Biological Opinion, the Service reviewed the status of the Lost River sucker and the shortnose sucker, the relationship of the action area to both the survival and recovery of each species, the effects of the action on both species, and the cumulative effects. We conclude the change from the Lower Klamath Project to the numbers, reproduction, and distribution of both species does not appreciably reduce the likelihood of both survival and recovery of either species in the wild. Therefore, the Service concludes the Lower Klamath Project is not likely to jeopardize the continued existence of the Lost River sucker or the shortnose sucker.

9.2. Bull Trout

Based on the stressors, exposure to the stressors, and the anticipated effects from the project activities described in Chapter 6 and summarized above in Chapter 8, the Service concurs that the proposed action *may affect and is likely to adversely affec*t bull trout. This is based on the adverse effects to bull trout from likely predation by recolonizing steelhead. We also find the project will have long-term insignificant, discountable and beneficial effects to bull trout in the Upper Klamath Basin.

9.2.1. Jeopardy Analysis for Bull Trout

Despite the adverse effects from predation, after considering the best available scientific and commercial information, the current status of the species, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that implementation of the Lower Klamath Project is not likely to jeopardize the continued existence of bull trout. We reached this conclusion based on the following factors:

- The consequences to bull trout from removing the four hydroelectric dams and reservoirs are limited to the eventual upstream passage of anadromous salmonids, and the recolonization of their historical habitats in the Upper Klamath Basin.

- The effects of the proposed action will not affect any spawning or rearing habitat characteristics, nor any overwintering or migration habitat for bull trout. The proposed action will have beneficial effects on foraging habitat characteristics given the increases in prey resources and marine-derived nutrients. The proposed action will not alter the distribution of bull trout at the action area or range-wide scales.

- The Service expects long term adverse effects to bull trout from steelhead predation on bull trout eggs and subyearlings, but we do not expect adverse impacts from resource competition for space or prey, diseases, or pathogens. The predation will locally reduce bull trout numbers and their annual reproduction. However, the numbers, reproduction, and distribution of bull trout at the range-wide and action area scales will not be meaningfully influenced.

- The Service expects long-term beneficial effects in the tributary reaches where bull trout reside, from the marine-derived nutrients that recolonizing Chinook salmon and steelhead will provide. While the effects will not be immediate, the long-term effects will likely increase food availability for bull trout from salmonid carcass flesh, as well as eggs, fry, and juveniles of Chinook salmon and steelhead (Hamilton *et al*. 2010). These additional food resources are likely to contribute to an increase in bull trout numbers, including reproducing females.

- The cumulative effects of future non-Federal actions in the action area are expected to result in neutral to beneficial effects to bull trout. Specifically, the removal of migration barriers, increased screening at water diversions, and habitat restoration will improve spawning, rearing, overwintering, and migration habitat availability.

In this Biological Opinion, the Service reviewed the status of bull trout, the relationship of the action area to its survival and recovery, the effects of the action on bull trout, and the cumulative effects. We conclude that the change from the Lower Klamath Project to the numbers, reproduction, and distribution of bull trout does not reduce appreciably the likelihood of both survival and recovery of this species in the wild. Therefore, we conclude the Lower Klamath Project is not likely to jeopardize the continued existence of bull trout.

This jeopardy analysis includes consideration of future steelhead predation on bull trout eggs and subyearlings. At some point in the future, adverse effects may occur to bull trout from steelhead predation. As analyzed here, we do not anticipate that these prospective adverse effects are likely to jeopardize the continued existence of the species. Moreover, we do not consider the adverse effects rise to the level of take for the following reasons:

- Historically and prior to dam construction, bull trout, steelhead, and Chinook salmon overlapped in the Upper Klamath Basin; the three species co-evolved together. While it has been more than 100 years since they interacted in the Upper Klamath Basin, bull trout has survived here despite other natural predation from co-occurring redband trout which occurs currently and is expected to continue in the future. Predation caused by redband trout is indistinguishable from that caused by steelhead, and thus we cannot measure predation attributable to steelhead.

- Bull trout are cryptic, nocturnal predators and steelhead are day-time predators. This temporal separation during feeding is expected to reduce the impacts from steelhead predation.

- While adverse, we expect the predation of bull trout eggs and subyearlings by steelhead will be limited. Steelhead predation on bull trout eggs and subyearlings will be dependent upon steelhead returning to the Upper Klamath Basin:

    - We expect it may take many years before steelhead reach the areas where bull trout reside.

    - The timeframe and number of steelhead which access bull trout-occupied streams will likely be limited by 1) migration barriers in bull trout habitat (e.g., water diversions, impassable culverts), 2) decreased water quality compared to historic conditions, and 3) increased water temperatures compared to historic conditions.

    - Because of the existing predation from native fish that will continue into the future, and the gradual and likely limited return of steelhead to the Upper Klamath Basin, we determine that take incidental to the project is unlikely to occur at a level that can be measured.

INCIDENTAL TAKE STATEMENT

Introduction

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened animal species, respectively, without special exemption. Take is defined by the ESA as actions that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (ESA section 3(18)). Harm is further defined as an act that actually kills or injures fish or wildlife (50 CFR § 17.3). Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR §17.3). Incidental take is defined as takings that result from, but are not the purpose of, carrying out of an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR § 402.02).

The Service's regulatory definition of harass is constrained to "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" and therefore is not considered incidental take (50 CFR § 17.3). If intentional acts are determined to be a form of take (trap, capture, harass, etc.), when the Service analyzes those activities as part of the proposed action and includes them in an Incidental Take Statement, that is considered adequate to serve as the exemption for that take. Under the terms of Sections 7(b)(4) and 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking, provided that such taking is compliant with the terms and conditions of this Incidental Take Statement.

The reasonable and prudent measures, and terms and conditions, described below are non-discretionary, and must be undertaken by the action agency so that they become binding conditions of any grant or permit issued or authorization provided by the federal action agency to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The action agency has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the action agency (1) fails to include the terms and conditions in its authorizing decision or (2) fails to exercise oversight to ensure compliance that any applicant adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant or authorizing document, or (3) fails to retain discretion to ensure compliance with the terms and conditions through the extent of the project, the protective coverage and exemption provided in section 7(o)(2) may not apply. In order to monitor the effect of incidental take, the action agency must ensure that its grant, permit, or authorization includes all reporting requirements, including reporting the progress of the proposed action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR § 402.14(i)(3)].

Amount or Extent of Take Anticipated

As described in Chapters 6, 8 and 9 of the accompanying Biological Opinion, the proposed action will remove approximately 107,470 acre-feet of reservoir habitat currently occupied by the Lost River sucker and shortnose sucker. The proposed action will also create conditions that facilitate upstream migration and colonization by Chinook salmon and steelhead to the upper Klamath Basin, and areas occupied by the Lost River and shortnose sucker. The proposed action includes a conservation measure to capture and translocate adult Lost River suckers and shortnose suckers prior to reservoir drawdown activities (BA pp. 80-81).

ITS-1.1. Incidental Take of Lost River Sucker and Shortnose Sucker Adults

The proposed action will result in the incidental take of Lost River sucker and shortnose sucker adults in the form of capture, harm, and kill (Table 6).

The Service anticipates the proposed action is reasonably certain to take 5,540 adult listed suckers through 1) capturing and translocation, 2) harm due to injury from reduced fitness for sheltering or feeding, or 3) killing. This amount of take is based on the adult population estimates of listed suckers in the hydroelectric reach reservoirs that are likely to be exposed to toxic sediments, reduced dissolved oxygen levels, increased pH levels, acoustic shock, or direct mortality throughout the implementation of pre-drawdown, drawdown, and dam removal activities. It also includes those adults that will be harmed from injury or mortality during capture, handling, transport and translocation.

Action 2 of the Conservation Measure – Capture and Translocation of Adults

The Service is reasonably certain that 600 adult listed suckers would be taken through capture and translocation.

- Prior to drawdown, the Renewal Corporation (FERC's designated non-Federal representative), and its contractors and agents, will capture and translocate adult Lost River suckers and shortnose suckers from J.C. Boyle Reservoir, Copco No. 1 Reservoir, and Iron Gate Reservoir prior to final drawdown activities using trammel nets, tangle nets, or electrofishing equipment.

- As described in section 1.3 of the Biological Opinion, an approximate 600 adult listed suckers will be captured from the three reservoirs during a two-week sampling effort.

- Adult suckers will be physically handled in order to allow for identification to species and sex, to collect physical measurements and fin clips, and to receive passive integrated transponder (PIT) tags. They will be placed in net pens and aerated live wells and driven to the translocation sites where they will receive an external parasite treatment and be released.

- Captured individuals will be translocated to the Klamath Falls National Fish Hatchery, the Klamath Tribes' sucker rearing facility, or the Tule Lake National Wildlife Refuge. Individuals may be translocated to other suitable translocation sites, identified through further planning and agreement between the Service, the Klamath Tribes, Oregon Department of Fish and Wildlife, California Department of Fish and Wildlife, and the Renewal Corporation, if needed.

- All of these individuals will experience impairment of essential behavioral patterns resulting in harm. Any of these adults may also be injured or killed during the capture or translocation effort. The Service assumes, based on recent relocation efforts of adult listed suckers, that up to five percent may be killed during the capture and transport activities (Z. Tiemann, personal communication, October 21, 2021).

- Monitoring during the capture and translocation effort, and reporting after this effort, is part of the proposed action as a conservation measure. This monitoring and reporting is practicable and necessary to validate the Service's estimates of the number of listed suckers taken through the capture and translocation effort, and it is necessary to inform the reinitiation trigger regarding incidental take.

- Refer to the respective Reasonable and Prudent Measures, Terms and Conditions, and Monitoring and Reporting Requirements below.

Other Project Activities – Adults

The Service is reasonably certain the remaining 4,940 adult listed suckers not captured and translocated would be taken through direct injury, harm from reduced fitness for sheltering or feeding, or killing, throughout implementation of the other pre-drawdown activities, and during drawdown and dam removal.

- While additional adults beyond the 600 individuals described above may be captured and translocated, and not subject to this specific take, we have made a reasonable effort to estimate take as the maximum anticipated amount. Our estimate here, and for larvae and juveniles below, is based on the highest number resulting from the best information we have, rather than using the lowest number.

ITS-1.2. Incidental Take of Lost River Sucker and Shortnose Sucker Juveniles and Larvae

The proposed action will result in the incidental take of Lost River sucker and shortnose sucker juveniles and larvae in the form of harm and kill (Table 6).

The Service is reasonably certain that 2,825 juveniles and 365,229 larvae would be taken through harm due to injury from reduced fitness for sheltering or feeding, or killing. This take would result from juveniles and larvae being exposed to toxic sediments, reduced dissolved oxygen levels, increased pH levels, acoustic shock that impair essential behavioral patterns, or direct mortality throughout the implementation of pre-drawdown, drawdown, and dam removal activities. Juveniles and larvae will not be captured and translocated under Action 2 of the conservation measure.

Approximately 98 percent of the total anticipated take of Lost River suckers and shortnose suckers would be larvae, with approximately 0.76 percent as juveniles and 1.5 percent as adults.

Take Summary

The amount of take reasonably certain to occur for adults, juveniles and larvae is not quantifiable by species. The adult population estimates are based on sampling that did not clearly estimate the number of each adult species in the reservoirs. The Service is reasonably certain however, based on all prior and more recent sampling efforts, that only shortnose sucker occurs in Iron Gate Reservoir (see Table 6). Our juvenile and larval population, and reasonable estimates of incidental take, are based on the Service's prior estimates of these age classes that are expected to survive in the hydroelectric reach on an annual basis, from upstream entrainment or drift at Keno Dam (Service 2013a, see also the accompanying Biological Opinion, section 5.4).

Therefore, the number of listed suckers anticipated to be incidentally taken is estimated and cannot be precisely quantified by species. We have made a reasonable effort to estimate take as the maximum anticipated amount, based on the highest number resulting from the best information we have, rather than using the lowest number. This was done to ensure that we do not underestimate the effect of the taking in our Jeopardy analysis (see Table 6).

Adult Lost River and shortnose suckers will be taken during Action 2 of the conservation measure and those adults that are not captured and translocated will be injured or killed during the pre-drawdown activities, reservoir drawdown or dam removal. Juveniles and larvae will not be captured under Action 2 of the conservation measure. Juveniles and larvae of both species will be injured or killed during other pre-drawdown activities, reservoir drawdown or dam removal.

In summary, the Service anticipates the proposed action is reasonably certain to result in incidental take through capture, injury, or killing of up to a combined 373,594 Lost River sucker and shortnose sucker adults, juveniles and larvae (Table 6). Most of the incidental take will occur from the loss of larvae (98%), with approximately 0.76 percent from the loss of juveniles and 1.5 percent from the loss of adults.

The incidental take, which includes take from capture and translocation of adults that are expected to survive, as well as take that occurs during the other project activities where suckers will be injured or killed, will affect approximately six percent of the rangewide adult population of the Lost River sucker and shortnose sucker.

Table 4. Summary of incidental take of Lost River and shortnose sucker as a result of the proposed action.

Species	Cause of Take	Location of Take	Type of Take	Life Stage Affected	Incidental Take
Lost River and Shortnose Sucker	Pre-Drawdown Activities Drawdown Dam Removal	J.C. Boyle Reservoir Copco No. 1 Reservoir Copco No. 2 Reservoir Iron Gate Reservoir (shortnose sucker only)	Injure and/or Kill	Larvae Juveniles Adults	365,229 larvae injured *and* killed 2,825 juveniles injured *and* killed 4,940 adults injured *or* killed
	Conservation Measure Capture and Translocation of Adults	J.C. Boyle Reservoir Copco No. 1 Reservoir Iron Gate Reservoir (shortnose sucker only)	Capture, Injure or Kill	Adults	600 adults captured – Some proportion of this number may be injured or killed

Effect of the Take

In Chapter 9 of the Biological Opinion, the Service concluded that the effects of the proposed action, including this level of anticipated take, is not likely to jeopardize the continued existence of the Lost River sucker or shortnose sucker.

Reasonable and Prudent Measures

Pursuant to 50 CFR § 402.14(i)(1)(ii) and (iv), the incidental take statement specifies those reasonable and prudent measures (RPMs) that are considered necessary or appropriate to minimize the impact to such incidental taking on the species, and terms and conditions (including reporting requirements) that must be complied with by the action agency or applicant to implement the RPMs. These must be carried out for the exemption in section 7(o)(2) to apply.

For the established RPMs and Terms and Conditions below, both the FERC and the Renewal Corporation as the applicant are considered the responsible parties.

As part of the overall project design, the FERC and its designated non-federal representative, the Renewal Corporation, have taken steps to avoid and minimize impacts to listed species through the incorporation of numerous conservation measures (see section 1.3 of the accompanying Biological Opinion and BA pp. 75-84) and best management practices. The Service's evaluation of jeopardy and incidental take is premised upon implementation of the conservation measure specific to Lost River and shortnose sucker and the best management practices for (1) prohibiting herbicide application near water, and (2) implementing erosion control measures during drawdown. Any subsequent changes to the timing or application of the conservation measure or to the best management practices described in the BA may constitute a modification of the proposed action and may warrant reinitiating formal consultation, as specified at 50 CFR § 402.16 and in the Reinitiation - Closing Statement below.

The following RPMs and corresponding Terms and Conditions are intended to minimize the incidental take of the Lost River sucker and shortnose sucker. They also serve to clarify important steps of Action 2 of the conservation measure that is incorporated into the proposed action by the FERC and Renewal Corporation. The Service considers the conservation measure as incorporated into the proposed action and the RPMs and Terms and Conditions necessary and appropriate to minimize the impacts of incidental take of the Lost River sucker and shortnose sucker from the proposed action.

In order to be exempt from the prohibitions of section 9 of the ESA, the action agency and Renewal Corporation must comply with all of the RPMs and corresponding Terms and Conditions listed below.

RPM-1. FERC shall include in any license surrender order or other authorization for the amended surrender application for the Lower Klamath Project a condition that makes that license order or other authorization subject to the Reasonable and Prudent Measures, Terms and Conditions, and the Monitoring Requirements of this Incidental Take Statement.

RPM-2. FERC shall include in any license surrender order or other authorization for the amended surrender application for the Lower Klamath Project a reopener clause providing for the possible amendment of the order or other authorization to incorporate any reasonable and prudent alternatives, reasonable and prudent measures, terms and conditions, and monitoring requirements resulting from any reinitiated consultation on the authorized action.

RPM-3. FERC and the Renewal Corporation, and its contractors and agents, shall ensure compliance with the criteria and guidelines specified in the Biological Assessment and Biological Opinion and this Incidental Take Statement for the capture, translocation, and monitoring of Lost River and shortnose sucker to minimize incidental take from the capture and translocation.

Terms and Conditions

To be exempt from the prohibitions of Section 9 of the ESA, the action agency must fully comply with the following Terms and Conditions that implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary with respect to species listed under the ESA. To assure this compliance, the action agency (FERC) will include in any issued authorization, or license transfer document, the following Terms and Conditions.

1. To meet RPM-1, FERC shall include in any license surrender order or other authorization for the amended surrender application a condition that makes the order or other authorization subject to the Reasonable and Prudent Measures, Terms and Conditions, and Monitoring Requirements of this Incidental Take Statement.

2. To meet RPM-2, FERC shall include in any license surrender order or other authorization

for the amended surrender application a specific condition that authorizes reopening the order or other authorization to incorporate any reasonable and prudent alternatives, reasonable and prudent measures, terms and conditions, and monitoring requirements resulting from any reinitiated consultation on the authorized action based on circumstances listed in 50 CFR 402.16.

3. To meet RPM-3, FERC and the Renewal Corporation must fully comply with the conservation measure for the Lost River sucker and shortnose sucker, described as part of the proposed action. This includes all methods, timing, coordination, monitoring and reporting described for Action 2 of this conservation measure in the Biological Assessment, and the California and Oregon Adaptive Management Plans for Suckers. This will ensure the capture and translocation effort occurs prior to the drawdown year, in accordance with the described methods, thereby minimizing the effect of the taking.

4. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents or contractors, coordinates and communicates with the Service, the Klamath Tribes, the Oregon Department of Fish and Wildlife, and the California Department of Fish and Wildlife regarding the estimated date for capture and translocation. This is to ensure the translocation areas and staff at the Klamath Tribes' sucker rearing facility, the Klamath Falls National Fish Hatchery, the Tule Lake National Wildlife Refuge, or any other translocation site, are prepared to receive adult Lost River suckers and shortnose suckers, and thereby minimize any harm or mortality when the suckers are received at these translocation sites. Most critically, the FERC and the Renewal Corporation will notify the Klamath Tribes and the Klamath Falls National Fish Hatchery through e-mail correspondence no later than three months before the capture and translocation is planned to occur. This is to ensure that any additional holding ponds, or other holding facilities, are constructed and prepared well in advance to thereby minimize any harm or mortality when the suckers are received at these translocation sites.

5. To meet RPM-3, FERC and the Renewal Corporation will ensure the capture and translocation efforts for Lost River sucker and shortnose suckers are conducted by experienced staff. These staff shall have prior experience conducting capture and sampling of suckers using trammel nets, tangle nets or electrofishing equipment. At least one month prior to conducting this activity, FERC and the Renewal Corporation shall submit a list of staff, with a summary of their qualifications, who will conduct the capture and translocation effort to the Service. The list and summaries shall be provided to both Field Supervisors of the Klamath Falls and Yreka Fish and Wildlife Field Offices. If volunteers participate in this effort, the action agency and Renewal Corporation will ensure the volunteers receive training from experienced staff on capture and handling techniques and that they are monitored by experienced staff. This will help minimize handling stress during the capture and processing of adult suckers.

6. To meet RPM-3, FERC and the Renewal Corporation will ensure that staff from the Klamath Tribes' sucker rearing facility and the Klamath Falls National Fish Hatchery are onsite at both the reservoirs, and the translocation locations, when capture and translocation of Lost River and shortnose suckers occurs, in order to help guide and assist with this process. The action agency and the Renewal Corporation will notify the Field

Supervisor of the Klamath Falls Fish and Wildlife Field Office and the Klamath Tribes through e-mail correspondence at least three weeks in advance of the capture and translocation effort. This will assure that these experienced staff are present during the capture and translocation activities to thereby minimize any harm or mortality.

7. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, will minimize stress as much as possible during capture and relocation of listed suckers.

8. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, comply with NMFS' Backpack Electrofishing Guidelines (June 2000) when using backpack electrofishing equipment. Following these guidelines will help minimize the effect of the taking.

9. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, uses a new or pre-sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish. Following this procedure will help minimize the effect of the taking.

10. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, scans and weighs each sucker prior to loading into the live wells to 1) record the PIT-tag identification and 2) ensure the suckers are stocked into the live wells at densities appropriate to their size and species and the stocking density should be 1 lb. of fish per gallon of water. Following these guidelines will help minimize the effect of the taking.

11. To meet RPM-3, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, comply and are consistent with the "USFWS Klamath Basin Sucker Rearing Program Fish Handling Guidelines" when capturing, handling, and transporting listed fish. Following these guidelines will help minimize the effect of the taking.

12. To meet RPM-3, FERC and the Renewal Corporation will comply with all other Federal, State, and local laws and regulations. This includes any permits associated with transporting fish across state lines. Following these regulations will help minimize the effect of the taking.

Monitoring and Reporting Requirements

When incidental take is anticipated, the Terms and Conditions must include provisions for monitoring to report the progress of the proposed action and its impact on the listed species as specified in the Incidental Take Statement (50 CFR §402.14(i)(3)).

The amount of incidental take of listed suckers is based on the best available information the Service has from prior and recent sampling of adults, and prior entrainment estimates of larvae and juveniles. We will be able to ensure monitoring and reporting on the progress of the capture and translocation effort (Action 2 of the conservation measure), and its impact on the two species. See below.

However, monitoring the amount or extent of take of Lost River suckers and shortnose suckers during the in-water construction activities, and from habitat loss as a result of the proposed action, is impractical. Monitoring and reporting on any other forms of take of Lost River sucker and shortnose sucker from the proposed action will be impractical to detect and measure for the following reasons: (1) precise quantification of the number of listed adults, juveniles and larvae in the hydroelectric reach would require nearly continuous sampling, handling, and identification of these individuals; (2) their cryptic coloration makes detection difficult; (3) the likelihood of finding injured or dead suckers in a relatively large and extensive area, such as a reservoir, is very low; and (4) a high rate of removal of injured or killed suckers by predators or scavengers is likely to occur, which also makes detection and reporting difficult. Furthermore, listed suckers will die from causes unrelated to the project operations and determining the cause of death is unlikely.

Because of these difficulties, we have developed the following monitoring requirements. Monitoring of incidental take shall be conducted by the action agency or any applicant as follows. These reporting requirements are established in accordance with 50 CFR §§402.14(i)(1)(iv), 402.14(i)(3), 13.45. To assure this compliance, the action agency (FERC) will include in any issued authorization, the following Monitoring Requirements.

1. The Renewal Corporation will track and process the Lost River sucker and shortnose sucker capture, handling, transport and translocation data, including information on when capture occurred, the number of captured and transported suckers, and the water quality constituents at the capture locations and translocation areas. The number of individuals lost during handling and transport will also be included (see item 5a below).

2. The Renewal Corporation will provide the data described above to the FERC, the Service, CDFW, ODFW, USGS, and the Klamath Tribes. The data shall be provided in an electronic format (e.g., Microsoft Excel spreadsheet, Word) and shall include any photographs of listed suckers from the capture and translocation effort.

3. The Renewal Corporation will assure the data for the collected fin clips is linked to the individual unique PIT tag identification numbers for each captured sucker. The Renewal Corporation will provide this data in an electronic format, along with the fin clips, to the Service for genetic analysis.

4. Summary Reports will be submitted to the FERC and Service within three months of completing the capture and translocation effort.

5. The Summary Reports shall contain, at a minimum, the following information:

    a. Data for any suckers that die during the capture and translocation effort. This includes information on when an individual died (e.g., during capture, holding, or transport), and the species, sex, measurements, and photographs.

    b. Information on transport densities in the live wells and the dates of transport.

c. The stocking densities of the live wells (e.g. number of fish per lb. of water) when the fish are transported.

d. The date, time, and location data for each translocation including water temperature data at the translocation site, time of translocation (e.g., dusk).

e. The results of disease and pathogen screening by ODFW and USFWS FHC, information on sex ratio.

f. All fin clip data with the associated passive integrated transponder (PIT) tag codes.

DISPOSITION OF SICK, INJURED, OR DEAD SPECIMENS

Upon locating a dead, injured, or sick endangered or threatened species specimen, this must be reported to the U.S. Fish and Wildlife Service's Law Enforcement Division (916-414-6660) and prompt notification must be made to the nearest Service Law Enforcement Office (Wilsonville, Oregon; telephone: 503-682-6131), the Klamath Falls Fish and Wildlife Office (Klamath Falls, Oregon; telephone: 541-885-8481), and the Yreka Fish and Wildlife Office (530) 842-5763). Care should be taken in handling sick or injured specimens to ensure effective treatment and care or the handling of 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 endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed. The Service is to be notified in writing within three working days of the accidental death of, or injury to, a threatened or endangered species, or of the finding of any dead or injured specimen during implementation of the proposed action. Notification must include the date, time, and location (including GPS location information in UTM, NAD 83) of the incident or discovery, as well as any pertinent information on circumstances surrounding the incident or discovery. Care should be taken in handling sick or injured specimens to ensure effective treatment and care, or the handling of 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 endangered or threatened species or preservation of biological materials, the finder has the responsibility to carry out instructions provided by Service Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

The endangered Lost River suckers and shortnose suckers captured and / or killed through Action 2 of the conservation measure are considered exempt from the aforementioned reporting requirements. This is because specific information on injured or dead individuals will be recorded during the capture and translocation effort and reported after this effort, as stipulated in the above Monitoring and Reporting Requirements.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the ESA direct Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. Regulations in 50 CFR § 402.02 define conservation recommendations as discretionary measures suggested by the Service to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat, to help implement recovery plans, or to develop information.

We propose the following conservation recommendations:

1. If a spring capture and translocation effort before drawdown does occur and is unsuccessful, then a fall capture and translocation effort before drawdown shall be completed to help achieve the goals of the conservation measure.

2. Per Term and Condition 7 above, FERC and the Renewal Corporation will ensure the Renewal Corporation, and its agents, contractors, or volunteers, minimize stress as much as possible during capture and relocation of listed suckers. This includes possible anesthetization (following label requirements and the USFWS Klamath Basin Sucker Rearing Program Fish Handling Guidelines) of listed fish to avoid injuring or killing them during handling (measuring, PIT-tagging, and fin clipping); the fish must be allowed to recover before being released. Anesthetization will be implemented if staff from the Klamath Falls National Fish Hatchery, the Service, or CDFW recommend this action based on fish responses.

3. The Renewal Corporation will coordinate with ODFW and the Service on their monitoring efforts for bull trout in Long Creek, Boulder/Dixon Creek, Deming Creek, Leonard Creek and Brownsworth Creek.

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

REINITIATION – CLOSING STATEMENT

This concludes formal consultation on the Lower Klamath Project. As provided in 50 CFR § 402.16, reinitiation of consultation is required and shall be requested by the Federal Agency, or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) If the amount or extent of taking specified in the incidental statement is exceeded.

(2) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this Biological Opinion or

written concurrence; or

(4) If a new species is listed or critical habitat is designated that may be affected by the identified action.

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APPENDIX A – CONSULTATION HISTORY

This Appendix provides a detailed account of the consultation history for the Lower Klamath Project.

- April 28, 2017, Lower Basin Agency Meeting – Overview of proposed 2017 project activities, including schedule, review and discussion of mitigation measures previously included in the 2012 BO, EIS/EIR, and a Detailed Plan specific to threatened and endangered species identified in the 2012 project Action Area. Attendees included the Klamath River Renewal Corporation (Renewal Corporation), NMFS, USFWS, and CDFW (California Department of Fish and Wildlife).
- May 23, 2017, Aquatic and Terrestrial Resource Meeting – Discussion of concerns specific to aquatic resource relocation and potential mortality rates of spawning and juvenile species, analysis of coho salmon effects in the BA, and proposed mitigation measures. This meeting also included a discussion on proposed survey plans and potential minimization measures for terrestrial species, including northern spotted owl (NSO) and listed plants. USFWS and NMFS provided input on the listed species and potential effects to be included in the evaluation presented in this BA. Attendees included the Renewal Corporation, NMFS, USFWS, CDFW, Oregon Department of Environmental Quality (ODEQ), North Coast Regional Water Quality Control Board (NCRWQCB), State Water Resources Control Board (SWRCB); and the Hoopa Valley, Yurok, Karuk, and Klamath tribes.
- May 24, 2017, Aquatic Resources Measures Planning Meeting (Suckers) – Meeting to discuss sucker genetics, trapping and relocation, and potential mitigation measures. Attendees included the Renewal Corporation, USFWS, and USGS.
- June 13, 2017, Aquatic Resources Measures Planning Meeting – Discussion of the 2012 Aquatic Resource Mitigation Measures, development and implementation of an effectiveness monitoring plan, and revised Aquatic Resource Measures Specific to Mainstem Spawning, Outgoing Juveniles, and Pacific Lamprey. Attendees included the Renewal Corporation, NMFS, USFWS, CDFW, and the Hoopa Valley, Yurok, and Karuk tribes.
- June 19, 2017, Aquatic Resources Measures Planning Meeting (Suckers) – Meeting to discuss the sampling and salvage of listed suckers and appropriate methodology, relocation, and permitting options. Attendees included the Renewal Corporation, USFWS, USGS, CDFW, ODFW (Oregon Department of Fish and Wildlife), and Klamath tribes.
- July 27, 2017, Agency Visit to Project Site – Site visit with a focus on terrestrial resources measures and overview of project components. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and Oregon Department of State Lands.
- August 15, 2017, Aquatic Resources Measures Planning Meeting – Ongoing discussions pertaining to refinements to the 2012 Aquatic Resource Mitigation Measures, development and implementation of an effective monitoring plan, and revised Aquatic Resource Measures Specific to Mainstem Spawning, Outgoing Juveniles, and Pacific Lamprey. Attendees included the Renewal Corporation, NMFS, USFWS, CDFW,

ODFW, ODEQ, SWRCB, and the Hoopa Valley, Yurok, and Karuk tribes.

- October 26, 2017, Aquatic Resources Measures Planning Meeting – Proposed monitoring periods, laboratory experiments for turbidity and suspended sediments, evaluation of spawning habitat, and salmonid behavioral response to high sediment loads. Attendees included the Renewal Corporation, NMFS, USFWS, CDFW, ODFW, and the Hoopa Valley, and Yurok tribes.
- October 27, 2017, Terrestrial Resources Coordination Call – Updates on terrestrial resources measures development, proposed field survey schedule, and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, SWRCB, and ODFW.
- November 20, 2017, Terrestrial Resources Coordination Call – Updates on terrestrial resources measures, proposed field survey schedule and results of 2017 reconnaissance work, and species specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, SWRCB, and ODFW.
- December 6, 2017, Section 7 Informal Consultation Meeting – Discussion of needed updates to the BA, including project and baseline changes, schedule, Action Area, and new species. Attendees included the Renewal Corporation, USFWS, and NMFS.
- January 10, 2018, Terrestrial Resources Coordination Call – Updates on terrestrial resources measures, proposed field studies, and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- February 8, 2018, Section 7 Informal Consultation Call – Provided updates on progress on the BA, reviewed the action area, species lists, and schedule. Attendees included the Renewal Corporation, NMFS, and USFWS.
- February 13, 2018, Terrestrial Resources Coordination Call – Updates on terrestrial resources measures, field studies schedule and approach, and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- March 6, 2018, Section 7 Informal Consultation Call – Provided an update on the progress on the BA, follow up on items from the previous meeting, and a request for clarification from the Services on the Action Area definition. Attendees included the Renewal Corporation, NMFS, and USFWS.
- March 28, 2018, Terrestrial Resources Coordination Call – Reporting on field survey results from February, schedule update, and discussion of projects and activities for cumulative effects analysis. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- March 30, 2018, Section 7 Informal Consultation Call – Provided an update on progress on the BA, discussed hatchery considerations, current status of orca, cumulative effects analysis, and ongoing coordination with USBR. Attendees included the Renewal Corporation, NMFS, and USFWS.
- April 24, 2018, Terrestrial Resources Coordination Call – Report on field survey results from March and April, schedule update for field surveys, and species-specific

discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.

- May 3, 2018, Section 7 Informal Consultation Call – Discussion of dam removal hydrology. Attendees included the Renewal Corporation, NMFS, and USFWS.
- May 18, 2018, Section 7 Informal Consultation Meeting – Review and discussion of the first three sections of the BA, schedule updates, and field survey updates. Attendees included the Renewal Corporation, NMFS, and USFWS.
- June 14, 2018, Terrestrial Resources Coordination Call – Reports on field survey results from May, schedule update for upcoming field work, and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- June 14, 2018, Section 7 Informal Consultation Call – Discussion of flood-proofing projects and United States Army Corps of Engineers (USACE) jurisdiction. Attendees included the Renewal Corporation, USACE, and NMFS.
- July 23, 2018, Terrestrial Resources Coordination Call – Reports on field surveys conducted in June and July, schedule for upcoming field work, and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- September 26, 2018, Terrestrial Resources Coordination Call – Reports on field surveys conducted in August and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- November 1, 2018, Section 7 Informal Consultation Call – Webinar providing an overview of the Draft BA. Attendees included the Renewal Corporation, USFWS, and NMFS.
- March 13, 2019, Terrestrial Resources Coordination Call – Reports on field surveys conducted in February and species-specific discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- May 8, 2019, Section 7 Informal Consultation Meeting – Review schedule for project and consultation. Attendees included the Renewal Corporation, USFWS, NMFS, and PacifiCorp.
- June 3, 2019, Terrestrial Resources Coordination Call – Reports on field surveys conducted in April and May, schedule for upcoming fieldwork, project updates, and discussions. Attendees included the Renewal Corporation, USFWS, CDFW, ODFW, and SWRCB.
- September 24, 2019, Section 7 Informal Consultation Meeting – Review and discussion of the 30% design, introduction to the project design-build team, schedule updates, and field survey updates. Attendees included the Renewal Corporation, Kiewit Team, NMFS, USFWS, and USACE.
- October 4, 2019, Meeting of the Aquatic Technical Working Group (ATWG) which is a specific group dedicated to the development of the different fish-related management plans – Presented 2019 data collection results, reviewed aquatic resource measures, and

presented preliminary aquatic organism salvage plans. Attendees included the Renewal Corporation, Kiewit Team, NMFS, USFWS, ODFW, CDFW, and Yurok and Karuk tribes.

- November 15, 2019, Section 7 Informal Consultation Call – Discussion of approaches to evaluate effects on Southern Resident killer whale. Attendees included the Renewal Corporation, NMFS, USFWS, and USGS.
- November 15, 2019, Section 7 Informal Consultation Call – Discussion on changes in the design of the J.C. Boyle powerhouse access road relocation in designated NSO critical habitat. Attendees included the Renewal Corporation and USFWS.
- February 14, 2020, Section 7 Informal Consultation Call – Discussion regarding tree clearing in designated NSO critical habitat. Attendees included the Renewal Corporation and USFWS.
- March 20, 2020, Section 7 Informal Consultation Call - Discussion regarding drafting of the BA, change in project regulatory lead, and drawdown engineering design advancement. Attendees included the Renewal Corporation, USFWS, and NMFS.
    - NMFS recommended that a separate Technical Work Group (TWG) be established for review, coordination, and input on the reservoir drawdown effects analysis.
- Between April 4 through July 2, 2020, TWG meetings:
    - Nine meetings were held with a TWG to review engineering design advancements associated with reservoir drawdown.
    - The TWG included members of NMFS, USFWS, ODFW, CDFW, USBR, Yurok Tribe, Karuk Tribe, and the Renewal Corporation.
    - Meetings reviewed hydraulic modeling results, updated suspended sediment modeling results, reviewed the approach to the effects analysis for the BA, results, and the planned Aquatic Resource Measures to minimize and reduce impacts.
- April 24, 2020, TWG meeting – TWG meeting with the SWRCB and Stillwater Sciences to review the California Clean Water Act Section 401 Certification and Final Environmental Impact Report drawdown and suspended sediment analysis approach and assumptions. The TWG included members of NMFS, USFWS, ODFW, CDFW, USBR, Yurok Tribe, Karuk Tribe, and the Renewal Corporation.
- Between April 24 through June 23, 2020, Section 7 Informal Consultation Coordination Calls:
    - Five Section 7 Informal Consultation coordination calls were held to coordinate on the working group’s agendas (TWG and ATWG) and development of the BA.
    - This included discussion and guidance on the approach to the effects analysis, results, document format, and project description. Meetings were instrumental in defining the approach and scope of the dam removal effort, as well as the mitigation measures.
    - Attendees included USFWS, NMFS and the Renewal Corporation.
- July 9, 2020, Section 7 Informal Consultation Call – Discussion of the results of sucker

sampling, population estimate, and coordination points on the development of the sucker rescue and relocation plan (i.e., salvage plan). Attendees included USFWS and the Renewal Corporation.

- July 23, 2020, Section 7 Informal Consultation Call – Discussion of sucker genetics analysis status, Abernathy lab funding and schedule, PacifiCorp access, and timeline for federal permitting. Attendees included USFWS and the Renewal Corporation.
- August 21, 2020, Draft BA Coordination Call – Update agencies on status of the BA, discussion of areas of overlap between the agencies. Attendees included NMFS, USFWS, and the Renewal Corporation.
- August 26, 2020, Pacific Lamprey Passage and Salvage Discussion – Meeting with USFWS to discuss Pacific lamprey passage. Attendees included USFWS and the Renewal Corporation.
- August 27, 2020, ATWG Meeting – Discussed juvenile salmonid and Pacific lamprey rescue and relocation plan. Attendees included NMFS, USFWS, CDFW, Yurok Tribe, Karuk Tribe, SWRCB, ODFW, SWRCB, and the Renewal Corporation.
- October 7, 2020, Section 7 Informal Consultation – Update for agencies on the project description section of the BA. Attendees included NMFS, USFWS, and the Renewal Corporation.
- October 8, 2020, ATWG Meeting – Discussed fish passage monitoring approach taken in the BA. Attendees included NMFS, USFWS, ODFW, CDFW, Karuk Tribe, Yurok Tribe, and the Renewal Corporation.
- October 20, 2020, Section 7 Informal Consultation – Updated for agencies on the bull trout effects analysis section of the BA. Attendees included USFWS, NMFS, and the Renewal Corporation.
- January 7, 2021, Coordination Meeting – Meeting to establish a timeline for finalizing the BA, as well as the process for document reviews and finalization. Attendees included NMFS, USFWS, CDFW, ODFW, Yurok Tribe, Karuk Tribe, and the Renewal Corporation.
- Between January 15 and March 19, 2021:
    - Eleven weekly meetings were held to work toward finalization of the BA.
    - Attendees included NMFS, USFWS, CDFW, ODFW, Yurok Tribe, Karuk Tribe, the Klamath Tribes, and the Renewal Corporation.
    - Between each weekly meeting, technical calls were held with USFWS and NMFS to review and address comments for the species and effects analysis covered in the Biological Assessment.
- April 1, 2021, Renewal Corporation Presentation – Presentation on 100% Design for dam removal and 60% Design for restoration. Invitees included the Klamath Tribes, the Yurok Tribe, the Karuk Tribe, NMFS, USFWS, ACOE, Bureau of Land Management (BLM), the State Water Resources Quality Control Board (SRWQCB), NCRWQCB, CDFW, ODFW, and ODEQ.
- August 24, 2021, Reservoir Area Management Plan Meeting – Comment resolution call

for the Reservoir Area Management Plan. Attendees included NMFS, USFWS, CDFW, ODFW, BLM, SWQCRB and the Renewal Corporation.

- August 31 and September 9, 2021, Aquatic Resource Management Plan Meeting – Discussed agency comments and resolution for the agency-provided comments on the subplans contained within the Aquatic Resource Management Plan. Attendees included: NMFS, USFWS, CDFW, ODFW, BLM, SWRQCB and the Renewal Corporation.
- Between April 8 and December 15, 2021, Coordination Meetings – The Service provided coordination, review and technical assistance to the Renewal Coordination on the project-level management plans and specific species identified in the plans. This timeframe included multiple coordination meetings with various Service staff and biologists.
- August 2, 2021, Section 7 Formal Consultation – The Service received a request for formal consultation from FERC for the Lost River sucker, shortnose sucker, and bull trout.
- August 11, 2021, Section 7 Formal Consultation – The Service requested additional information regarding the critical habitat determination for the Lost River and shortnose sucker. Included in our request was a clarification regarding conferencing on Franklin's bumble bee (*Bombus franklini*).
- August 16, 2021, Section 7 Formal Consultation – The Service received an erratum to the BA from the Renewal Corporation regarding Lost River sucker and shortnose sucker critical habitat.
- August 31, 2021, Section 7 Formal Consultation – The Service received a response from FERC that clarified the determination that the project *may affect, but is not likely to adversely affect* Lost River sucker or shortnose sucker critical habitat.
- September 3, 2021, Section 7 Formal Consultation – The Service responded to FERC to inform them all of the information required to initiate formal consultation had been received as of August 31, 2021.
- Between December 9 and December 15, 2021 – The Service again reviewed updated versions of the Aquatic Resources Management Plan (ARMP), the Reservoir Area Management Plan (RAMP) and the Terrestrial and Wildlife Management Plan.
- December 13, 16, 21, 2021, Section 7 Formal Consultation – The Service met with Renewal Corporation staff via Microsoft TEAMS virtual meetings, to review the Reasonable and Prudent Measures and the Terms and Conditions for the Lost River and shortnose sucker. We also reviewed and discussed the Conservation Recommendations for Pacific lamprey and freshwater mussels.
- December 22, 2021, Section 7 Formal Consultation – The Service signed and transmitted to the FERC our Biological Opinion for the Lower Klamath Project through electronic filing (consultation code 08EYRE00-2021-F-012). The transmittal and filing includes our concurrence for project actions that *may affect, but are not likely to adversely affect*, listed species or their critical habitat, and the Conservation Recommendations for Pacific lamprey and freshwater mussels.

APPENDIX B – STATUS OF THE SPECIES – LOST RIVER SUCKER AND SHORTNOSE SUCKER

This Appendix describes the range-wide status of the species for the Lost River sucker and shortnose sucker. We describe factors, such as life history, distribution, population size and trends, which help determine the likelihood of both survival and recovery of the species. We also describe species needs and conservation efforts.

The information in this Appendix provides additional background for analyses in Chapters 4, 5, 6 and 7 of the Biological Opinion.

The Service recently completed a Species Status Assessment (SSA) for both species meant to serve as the basis for defining the status and environmental baseline for consultation under section 7 of the ESA (USFWS 2019a). As such, this Appendix provides an overview of the ecology of the species, its status, and the threats; both similar and complementary information related the status of the species can be found in the SSA (USFWS 2019a).

1. LEGAL STATUS

The Lost River sucker and the shortnose sucker were federally listed as endangered throughout their entire ranges on July 18, 1988 (USFWS 1988). They are also listed as endangered by the States of California and Oregon (California Department of Fish and Game 2004). In 2019, the status of each of these species was reviewed by the Service (USFWS 2019a, 2019b, 2019c). A final revised recovery plan for these species was published in 2013 (USFWS 2013a).

2. LIFE HISTORY

The Lost River sucker and shortnose sucker are large-bodied, long-lived fish. The oldest individual for which age has been estimated was 57 years for Lost River sucker and 33 years for shortnose sucker (Buettner and Scoppettone 1991 p. 21, Terwilliger *et al.* 2010 p. 244). Juveniles grow rapidly until reaching sexual maturity sometime between four and nine years of age for Lost River sucker and between four and six years of age for shortnose sucker (Perkins *et al.* 2000b pp. 21–22). On average, approximately 90 percent of adults of both species survive from year to year, though survival may vary among populations, which enables populations to persist through periods with unfavorable spawning or recruitment conditions (Hewitt *et al.* 2018 pp. 17, 21). Upon achieving sexual maturity, Lost River suckers are expected to live on average 12.5 years based on annual survival rates (Hoenig 1983, USFWS 2013a p. 12). Similarly, adult shortnose suckers are estimated to live on average 7.4 years after having joined the adult population. Females produce a large number of eggs per year: 44,000 to 236,000 for Lost River sucker and 18,000 to 72,000 for shortnose sucker, of which only a small percentage survive to become juveniles as is typical for freshwater fish (Houde 1989 p. 479, Houde and Bartsch 2009 p. 31).

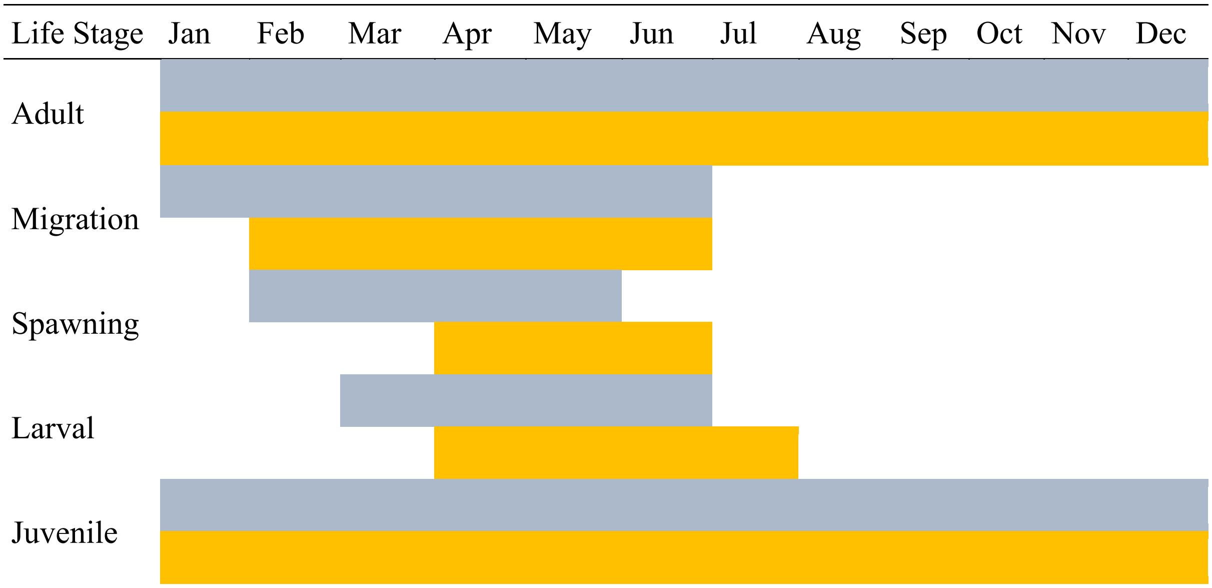

Figure 1. Life Stage Diagram (adapted from Reiser *et al.* 2001 pp. 4–3). Lost River suckers are represented by grey and shortnose sucker are represented by orange.

Lost River and shortnose suckers can generally be classified into five life stages and behaviors that occur at various times throughout the year: migration, spawning, larval, juvenile, and adult (Figure 1). The timing of occurrence of each life stage is similar between the two species, with the main difference occurring during spawning and incubation.

2.1. Migration

To complete their life cycle Lost River and shortnose suckers require distinct growth and spawning habitats. Growth occurs in the lakes of the Upper Klamath Basin, and spawning habitat is typically found in the tributary rivers to these lakes. However, a subset of Lost River suckers use lakeshore groundwater upwelling areas (springs) as their spawning habitat in Upper Klamath Lake. Small numbers of shortnose sucker are also detected at these lakeshore sites (Hewitt *et al.* 2017 p. 24), but the low numbers suggest that they are likely just vagrant individuals not attempting to spawn. Because most individuals utilize distinct growth and spawning habitats, they must complete a spawning migration to reproduce.

Adult Lost River and shortnose suckers in Upper Klamath Lake appear to strongly cue on water temperature to initiate spawning migrations up the Williamson River, which is the only tributary to Upper Klamath Lake with large spawning populations of Lost River and shortnose sucker. Migrations begin only after appropriate water temperatures have been achieved: 10 °C (50 °F) for the Lost River sucker and 12 °C (54 °F) for the shortnose sucker (Hewitt *et al*. 2017 pp. 11 & 24), and decreasing temperatures can reduce numbers of individuals migrating upstream (Hewitt *et al*. 2014 pp. 36–37). Migration into Willow Creek, which is believed to contain the only spawning habitat available from Clear Lake, appears to be triggered by a general rise in stream temperatures rather than exceedance of a specific temperature threshold (Hewitt and Hayes

2013).

Successful migration to spawning habitats can be limited by hydrologic conditions. In Upper Klamath Lake, access to the Williamson River does not appear to be affected by river flows or lake elevations, but access to and/or suitability of the lakeshore springs habitat can be reduced by shallow depths or dewatering at springs due to low lake elevations (Burdick *et al*. 2015b, entire). Access to spawning habitat into Willow Creek, which is the only spawning habitat available from Clear Lake, can be limited by shallow water near the mouth or low flows within the stream (Hewitt and Hayes 2013 p. 7).

2.2. Spawning

Spawning occurs from February through May (Figure 1). In the Lost River drainage, the bulk of upstream migration occurs in March and April (Hewitt and Hayes 2013 pp. 13, 15). In Upper Klamath Lake, some spawning occurs in March, but the bulk occurs in April and early May (Hewitt *et al.* 2014 p. 9). As suckers spawn, fertilized eggs quickly settle within the top few inches of the gravel substrate until hatching, around one week later.

Generally, individuals of both species spawn every year in Upper Klamath Lake, although data from the 2018 spawning season suggested that some individuals may have skipped spawning. In Clear Lake and Gerber Reservoir, suckers skip spawning in some years due to limited access. Spawning activity is typically observed over mixed gravel or cobble substrates in depths typically less than 0.46 m (1.5 ft) ranging from 0.12 to 0.70 m (0.4 to 2.3 ft) in rivers and shoreline springs. Gravel is rock ranging in size from 2 to 64 mm (0.8 to 2.5 in) in diameter, and cobble ranges in size from 65 to 256 mm (2.5 to 10 in) in diameter.

Eggs require flowing water and relatively open substrate that permits sufficient aeration (both from ambient dissolved oxygen [DO] levels and from removal of silt and clays that can smother the egg). These conditions are also important for the elimination of waste materials from the egg during incubation. Lost River suckers were observed to spawn at water velocities of 15 to 82 cm/sec (0.49 - 2.69 ft/sec; (Coleman *et al.* 1988 p. iv). Eggs also require appropriate temperatures to support timely development. Coleman *et al.* (1988 p. iv) observed that Lost River sucker eggs hatched eight days after fertilization at 13.5 °C (56.3 °F). Colder temperatures (7 °C [45 °F]) were observed to delay egg development by at least two weeks (J.E. Rasmussen, USFWS, unpublished data). Eggs also need some protection against potential predators and disease, such as small spaces in gravel, although there are no data to clarify what conditions are optimal. The small spaces between gravel pieces in the substrate help to restrict access from potential predators, and also limit the number of eggs that can randomly clump together, which could reduce the spread of diseases such as certain fungi that can grow on developing eggs.

2.2.1. Larvae

Larvae emerge from the gravel approximately 10 days after hatching at about 7 to 10 mm (0.2 to 0.6 in) total length and are still mostly transparent with a small yolk sac (Coleman *et al.* 1988 p. 27). Generally, Lost River and shortnose sucker larvae spend little time in rivers after swim-up, drifting downstream to the lakes at about 14 mm (0.55 in) in length around 20 days after hatching (Cooperman and Markle 2003 pp. 1146-1147). In the Williamson and Sprague Rivers

(Upper Klamath Lake population) and Willow Creek (Clear Lake Reservoir population), larval drift downstream from the spawning grounds begins in April and is typically completed by July with the peak in mid-May (Scoppettone *et al*. 1995 p. 19). Most downstream movement occurs at night near the water surface (Ellsworth *et al.* 2010 pp. 51-53). Little is known about the drift dynamics of the larvae hatched at the eastern shoreline springs in Upper Klamath Lake.

Once in the lake, larvae tend to inhabit near-shore areas (Cooperman and Markle 2004, entire, Erdman *et al.* 2011 pp. 476-477). Larval density is generally higher within and adjacent to emergent vegetation than in areas devoid of vegetation (Cooperman and Markle 2004 p. 370). Emergent vegetation provides cover from non-native predators (such as non-indigenous fathead minnows; *Pimephales promelas*) and habitat for prey items (Cooperman and Markle 2004 p. 375, Crandall 2004 p. 3). Such areas may also provide refuge from wind-blown currents and turbulence, as well as areas of warmer water temperature which may promote accelerated growth (Crandall 2004 p. 5, Cooperman *et al*. 2010 p. 36). These areas of emergent vegetation tend to occur along the fringes of the lakes in shallower areas. However, the two species appear to have slightly different habitat usage as larvae; shortnose sucker larvae predominantly use nearshore areas adjacent to and within emergent vegetation, but Lost River sucker larvae tend to occur more often in open water habitat than near vegetated areas (Burdick and Brown 2010 p. 19).

2.2.2. Juveniles

Larvae transform into juveniles in mid-July at 20 and 30 mm (0.8-1.2 in) total length and transition from predominantly feeding at the surface to feeding near the lake bottom (Markle and Clauson 2006 p. 496). In Upper Klamath Lake, some juvenile suckers continue to use relatively shallow (less than approximately 1.2 m [3.9 ft]) vegetated areas, but overall juveniles are found in a wide variety of habitats including deeper, un-vegetated off-shore habitat (Buettner and Scoppettone 1990 pp. 32, 33, 51, Hendrixson *et al.* 2007 pp. 15-16, Burdick *et al.* 2008 pp. 427-428, Bottcher and Burdick 2010 pp. 12-14, Burdick and Brown 2010 pp. 42, 45, 50). One-year-old juveniles occupy shallow habitats during April and May, but have been found in higher concentrations in deeper areas along the western shore of Upper Klamath Lake as the summer progresses until DO levels become reduced (Bottcher and Burdick 2010 p. 17, Burdick and Vanderkooi 2010 pp. 10, 11, 13). Once DO levels in this deeper area become suboptimal, juveniles appear to move into shallower areas throughout the rest of the lake.

2.2.3. Adults

Adult Lost River and shortnose suckers use the lakes of the Upper Klamath Basin as their primary habitat for feeding and growing; they migrate to spawning habitats during spring. In their growth habitat, adult suckers require adequate food, water quality, and refuge from predation. Both spawning subpopulations of Lost River sucker in Upper Klamath Lake have experienced an average annual survival rate of around 91 percent between 2002 and 2015 (range: 80-96 percent across locations and sexes; Hewitt *et al*. 2018 pp. 12 & 17). Shortnose suckers experienced average annual survival rates of 84 percent between 2001 to 2015 (range: 74-95 percent; Hewitt *et al.* 2018 p. 21). Although adult suckers are hardier than juveniles and larvae, they are still susceptible to poor water quality, which can be associated with die-offs. Thus, adult suckers require adequate water quality, or at least refugia from poor water quality conditions, within their growth habitat.

Adult Lost River and shortnose suckers are distributed throughout the northern portion of Upper Klamath Lake during summer (Banish *et al*. 2009 p. 160), but in the spring, congregations form in the north-east quadrant of the lake prior to moving into tributaries or shoreline areas for spawning. There is no information on their distribution in the lake during fall and winter. Less is known about populations in Gerber and Clear Lake Reservoirs because they have been studied much less (Leeseberg *et al*. 2007, entire). However, in Clear Lake adults appear to inhabit the western lobe of the reservoir more so than the eastern lobe (Barry *et al*. 2009 p. 3), which is probably due to its greater depth.

Based on radio-telemetry studies of suckers in Upper Klamath Lake, adults of both species tend to avoid depths of less than 2 m (6.6 ft) and most individuals are found at depths of 2-4 m (6.6-13.1 ft; Banish *et al*. 2007 p. 10, 2009 pp. 159-161). An exception to these patterns occurs during poor water quality conditions when suckers tend to seek refuge from stressful conditions in the shallow habitats in and around spring-fed areas such as Pelican Bay (Banish *et al*. 2009 pp. 159-160). These spring-dominated sites likely provide better water quality conditions because the water is typically cooler (cooler water can hold more oxygen than warmer water) and clearer because of the flowing nature of area. Selection of deeper than average habitats may reflect the distribution of their prey or it may confer protection from avian predators, which can consume suckers as large as 730 mm (28.7 in; Evans *et al.* 2016 p. 1262).

The limited available data on adult Lost River and shortnose sucker diets, which come from Clear Lake, suggest that Lost River suckers tend to feed directly from the lake bottom whereas shortnose suckers primarily consume zooplankton from the water column (Scoppettone *et al.* 1995 p. 15). This diet difference aligns with the mouth morphology of the species; shortnose suckers have terminal or subterminal (forward-facing) mouths whereas Lost River suckers have more ventral (bottom-facing) mouths (Miller and Smith 1981 pp. 1 & 7).

3. RANGE AND DISTRIBUTION

3.1. Historical Distribution

The Lost River and shortnose sucker are endemic to the upper Klamath Basin, including the Lost River sub-basin (Figure 2). Documented historical occurrences of one or both species include

Upper Klamath Lake (Cope 1879 pp. 784-785) and Tule Lake (Bendire 1889 p. 444, Eigenmann 1891 p. 667), but the species likely occupied all of the major lakes within the upper Klamath Basin, including Lower Klamath Lake, Lake Ewauna, and Clear Lake. In addition to inhabiting the lakes throughout the upper basin, the species historically utilized all major tributaries to the lakes for spawning and rearing. For example, the species ascended the Williamson River in the thousands and were "taken and dried in great numbers by the Klamath and Modoc Indians" (Cope 1879 p. 785). Historically, large sucker spawning migrations also occurred from Tule Lake up the Lost River to near Olene and Big Springs near Bonanza (Bendire 1889, entire). Suckers were also known to spawn in great numbers at several springs and seeps along the eastern shoreline of Upper Klamath Lake, including Barkley (Bendire 1889 p. 444) and likely spawned at other spring-dominated areas in the northwestern corner of the lake, including Harriman, Crystal, and Malone Springs.

At the time of listing (1988), Lost River and shortnose suckers were known to occupy Upper Klamath Lake and its tributaries and outlet (Klamath Co., Oregon), including a "substantial population" of shortnose sucker in Copco Reservoir (Siskiyou Co., California), as well as collections of both species from Iron Gate Reservoir (Siskiyou Co., California) and J.C. Boyle Reservoir (Klamath Co., Oregon) (Figure 2). Remnants and/or highly hybridized populations were also documented to occur in the Lost River system (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) including both species in Clear Lake Reservoir (Modoc Co., California), but it was apparently presumed that Lost River sucker populations in Sheepy Lake, Lower Klamath Lake, and Tule Lake (Siskiyou Co. California) had been "lost" (USFWS 1988 p. 27130). Although not stated explicitly, the shortnose suckers within Gerber Reservoir (Klamath Co., Oregon) were likely part of the "highly hybridized populations" in the Lost River Basin referenced in the listing.

3.2. Current Distribution

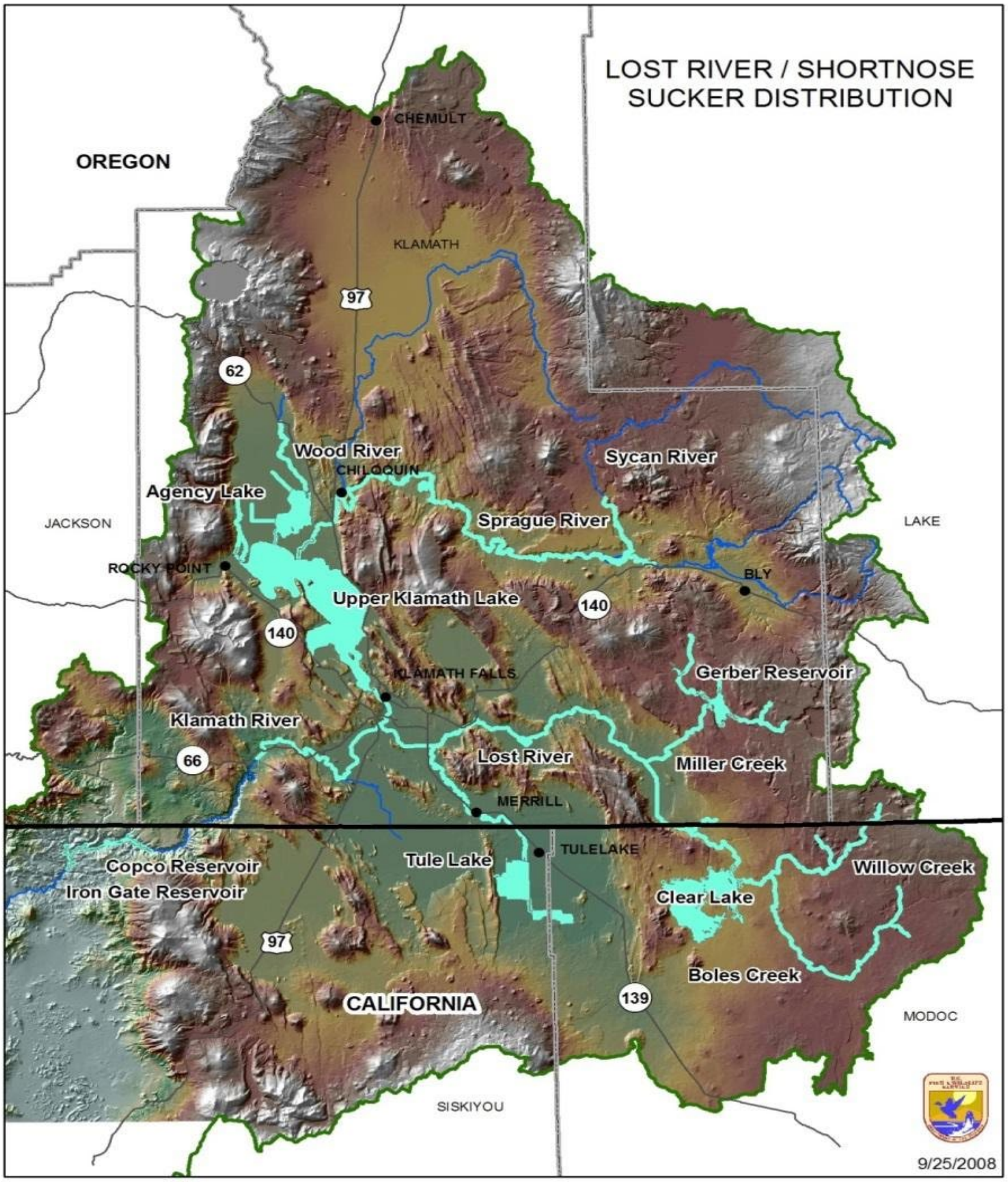

Figure 2. The Lost River and shortnose suckers are endemic to the lakes and rivers of the Upper Klamath Basin in south, central Oregon and north, central California. Lower Klamath Lake and Sheepy Lake are not depicted on the map because populations no longer occur there.

3.2.1. Upper Klamath Lake

At approximately 64,000 acres (26,000 hectares), Upper Klamath Lake is the largest remaining contiguous habitat for endangered suckers in the Upper Klamath Basin. Upper Klamath Lake is a natural lake that was dammed in 1921 to allow for management of lake elevations both higher and lower to support irrigation deliveries. Approximately 70 percent of the original 50,400 acres (20,400 hectares) of wetlands surrounding the lake, including the Wood River Valley, was diked, drained, or significantly altered between 1889 and 1971 (Gearhart *et al.* 1995 p. 7). Spawning aggregations at numerous locations within the Upper Klamath Lake system have disappeared, but Lost River suckers continue to use two spawning locations in relatively large numbers: the Williamson River and the eastern shoreline springs, and Upper Klamath Lake contains the largest remaining population of Lost River sucker by far. Shortnose suckers are only known to spawn in significant numbers in the Williamson River.

Spawning in the Williamson River and the Sprague River, its major tributary, occurs primarily in a 7.8 km (4.8 mile) stretch continuing from the Williamson River downstream of the confluence with the Sprague to the historical Chiloquin dam site on the Sprague River. Although the Chiloquin dam was removed in 2008, only small numbers of suckers migrate beyond the historical dam site to spawn (Martin *et al*. 2013 p. 10).

3.2.2. Clear Lake

The present-day Clear Lake Reservoir ranges from 8,400 to 26,000 acres (3,400 to 10,400 hectares), depending on lake elevation. Clear Lake is a natural lake that was greatly increased in size after damming in 1910. It is a shallow, turbid lake with little wetland vegetation. The primary inflow to Clear Lake comes from Willow Creek, which is characterized by relatively flashy hydrology. Willow Creek and its major tributary, Boles Creek, contain the only known spawning habitat available to shortnose and Lost River suckers in Clear Lake. There is approximately 43 km (27 miles) of stream spawning and migratory habitat utilized by the Lost River sucker and 105 km (65 miles) utilized by the shortnose sucker in this watershed. Due to the flashy hydrology, access to the spawning habitat can be reduced in years without significant snowpack to support sustained spring run-off.

3.2.3. Gerber Reservoir

Gerber Reservoir is only inhabited by shortnose suckers and the non-listed Klamath largescale sucker. The dam built on Miller Creek in 1925 created Gerber Reservoir with a maximum surface area of 3,830 acres (USBR 2000a p. 12). There are two spawning tributaries, Barnes Valley Creek and Ben Hall Creek, which combined have roughly 32 km (20 miles) of potential habitat (spawning or migratory). This population of shortnose sucker has similar population dynamics to Clear Lake Reservoir populations, but data are much sparser.

3.2.4. Other Lakes and Reservoirs

Other endangered sucker populations also contain small numbers in a handful of other waterbodies. These populations are comprised predominantly of shortnose sucker, but a smaller number of Lost River suckers are also present. Both shortnose and Lost River suckers are found in Lake Ewauna (Kyger and Wilkens 2011a p. 3), Tule Lake (Hodge and Buettner 2009 p. 4), hydropower reservoirs along the Klamath River (Desjardins and Markle 2000 pp. 14-15), and the Lost River proper (Shively *et al.* 2000 pp. 82-86).

4. POPULATION ABUNDANCE AND DYNAMICS

Starting in the late 1800s, large areas of sucker habitat were converted to agriculture and barriers were created that isolated populations from spawning grounds. Although there are no survey records until the 1900s, it is likely that these once superabundant species began to decline in numbers around the turn of the 20th century concurrent with significant destruction and degradation of sucker habitat. Later, from the 1960s to the early 1980s, recreational harvests of suckers in Upper Klamath Lake progressively decreased (Markle and Cooperman 2001 p. 98), which reflected further declines in the Lost River and shortnose sucker populations and led to their listing under the ESA in 1988. From 1995 to 1997, water quality-related die-offs killed thousands of adult suckers in Upper Klamath Lake (Perkins *et al.* 2000a, entire). Over that 3-year period, more than 7,000 dead suckers were collected, and many other suckers likely died but were not detected.

The wide-ranging behavior, expansive habitat, and rarity of these species make obtaining accurate population estimates challenging. However, long-term monitoring using capture-recapture methods provide accurate information on relative changes in abundance *(Hewitt et al*. 2018, entire), and abundance can be roughly estimated for some populations based on the size of catches and the proportion of individuals that are tagged in annual sampling.

4.1. Upper Klamath Lake

Upper Klamath Lake likely contains the largest remaining populations of both the Lost River and shortnose sucker, though the shortnose sucker population in Clear Lake may be similar in size. Although robust abundance estimates are difficult for this population due to low recapture rates of tagged fish, these recapture rates can be used to obtain rough estimates of abundance. Over the last decade, abundance estimates were roughly 100,000 adult Lost River sucker river-spawners, 8,000 adult Lost River sucker shoreline-spring-spawners, and 19,000 adult shortnose suckers (Hewitt *et al*. 2014 p. 16). However, in 2018, the estimates of fish participating in spawning aggregations were estimated to be much lower: 32,000, 8,000, and 7,000, respectively (D. Hewitt, USGS, personal communication August 16, 2018). These estimates may not reflect the true population size due to the statistical challenges of estimating abundance from the available data, particularly if some individuals skipped spawning in 2018. Overall, the populations in Upper Klamath Lake are characterized by high annual survival of adults (Hewitt *et al.* 2018 pp. 12, 17, 21). These adults spawn successfully and produce larvae, but few juveniles survive their first year, and captures of individuals 2 to 6 years old is exceedingly rare (Burdick and Martin 2017 p. 30). Similarly, there has not been evidence of significant numbers of new individuals joining the adult spawning populations since the late 1990s (Hewitt *et al.* 2018 p. 24), and the lack of significant recruitment has led to sharp declines in population sizes (Hewitt *et al.* 2018 pp. 14, 20, 24).

Survival of adult shortnose and Lost River suckers in Upper Klamath Lake varied little over the past decade. Annual adult survival rates of the shortnose sucker in Upper Klamath Lake appear to vary more than the Lost River sucker, but adult survival for both species in Upper Klamath

Lake appears to have been relatively stable since high quality estimates became available in the early 2000s (Hewitt *et al*. 2018 pp. 12, 17, 21). Adult Lost River suckers in Upper Klamath Lake average approximately 93 percent survival annually (Hewitt *et al.* 2017 pp. 15, 21). The approximate average annual survival for adult shortnose sucker in Upper Klamath Lake is slightly less at 87 percent (Hewitt *et al*. 2017 p. 28). However, preliminary data indicate that survival from spring 2016 to spring 2017 (i.e., 2016 survival) was low for both species, in some cases lower than has been observed during the period with robust estimates. For the shortnose sucker, estimates for 2016 survival are 77 percent for females and 74 percent for males. The preliminary estimates of survival for both sexes are 78 percent for Lost River suckers that spawn in the Williamson River and 85 percent for Lost River suckers spawning at the lakeshore springs (D.A. Hewitt, USGS, personal communication, August 16, 2018). Additionally, hundreds of dead adult suckers were observed during a die-off in the summer of 2017, and data to resolve whether the die-off event influenced annual survival rates will not be available until later in 2019 because survival estimates are confounded with detection probabilities in the final interval for the survival model.

Juvenile mortality and the resulting lack of recruitment of new individuals into the adult populations have led to steep declines in Lost River and shortnose sucker populations in Upper Klamath Lake. Although there is uncertainty about the rates of decline, the best available estimates indicate that the Lost River sucker lakeshore springs spawning population declined by approximately 56 percent for females and 64 percent for males between 2002 and 2015 (Hewitt *et al*. 2018 p. 10, Figure 3). The decline in the Williamson River Lost River sucker population is more difficult to assess due to sampling issues specific to that population (Hewitt *et al*. 2018 pp. 25-26), but it is likely that the population dynamics are similar to those of the shoreline springs population. The shortnose sucker population in Upper Klamath Lake has also declined substantially since 2001, losing approximately 77 percent of females and 78 percent of males between 2001 and 2016 (Hewitt e*t al*. 2018 p. 19, Figure 3).

Recent Lost River and shortnose sucker size distribution trends reveal the adult spawning populations in Upper Klamath Lake are composed of similar-sized, similar-age relatively old individuals. Median lengths of individuals of both species in Upper Klamath Lake generally increased since the between the 1990s and 2010, but since about 2010 size distributions have been more or less stable among years (Hewitt *et al*. 2018 pp. 19, 22-23, 27, 29). This indicates that few new individuals are joining the adult populations. The fish recruited in the 1990s are now approximately 29 years old and are well beyond the average survival past maturity of 12 years for the shortnose sucker and equal to that of 20 years for the Lost River sucker.

The effects of senescence on the survival and reproduction of these two species are unknown at present, but the populations in Upper Klamath Lake are clearly aging (Hewitt *et al*. 2018 pp. 15, 18, 21). The low recent survival rates could be an early signal that senescence is leading to increased mortality rates and accelerated population declines. Additional years of survival data will help to resolve whether the low survival reveals increased mortality of aging individuals or unique environmental conditions to that year.

Both species spawn successfully in the Sprague River, producing larvae that drift downstream to Upper Klamath Lake. Captures of 1,000s to 10,000s of larvae from the Sprague and Williamson Rivers (Cooperman and Markle 2003 pp. 1146–1147, Ellsworth and Martin 2012 p. 32) conservatively suggest that combined larval production of both species is on the order of 1,000,000s; note that these numbers are rough estimates and not a characterization of inter-annual variation, which is also substantial. Successful spawning in the Sprague River suggests that the needs of both species for spawning access and suitable egg incubation habitat are at least minimally met; however, available information does not permit comparisons with historical conditions.

Lost River suckers also spawn successfully at groundwater seeps along the Upper Klamath Lake margin. No robust estimates of larval production at these sites exist but given the number of Lost River sucker females and average fecundity, it is likely that millions of larvae hatch annually, even with the expected high mortality of eggs. There is typically access to these areas between February and May; however, lake elevations lower than approximately 4,141.4-4,142.0 ft (1,262.3-1,262.5 m) reduce the number of spawning individuals and the amount of time spent on the spawning grounds. Upper Klamath Lake elevations less than 4,142.0 ft (1,262.5 m) occurred by May 31 in 6 years between 1975 and 2019, which is equivalent to 14 percent of spawning seasons. Thus, lake elevations have the potential to negatively impact spawning for the Lost River sucker, but this has rarely occurred over the last 45 years.

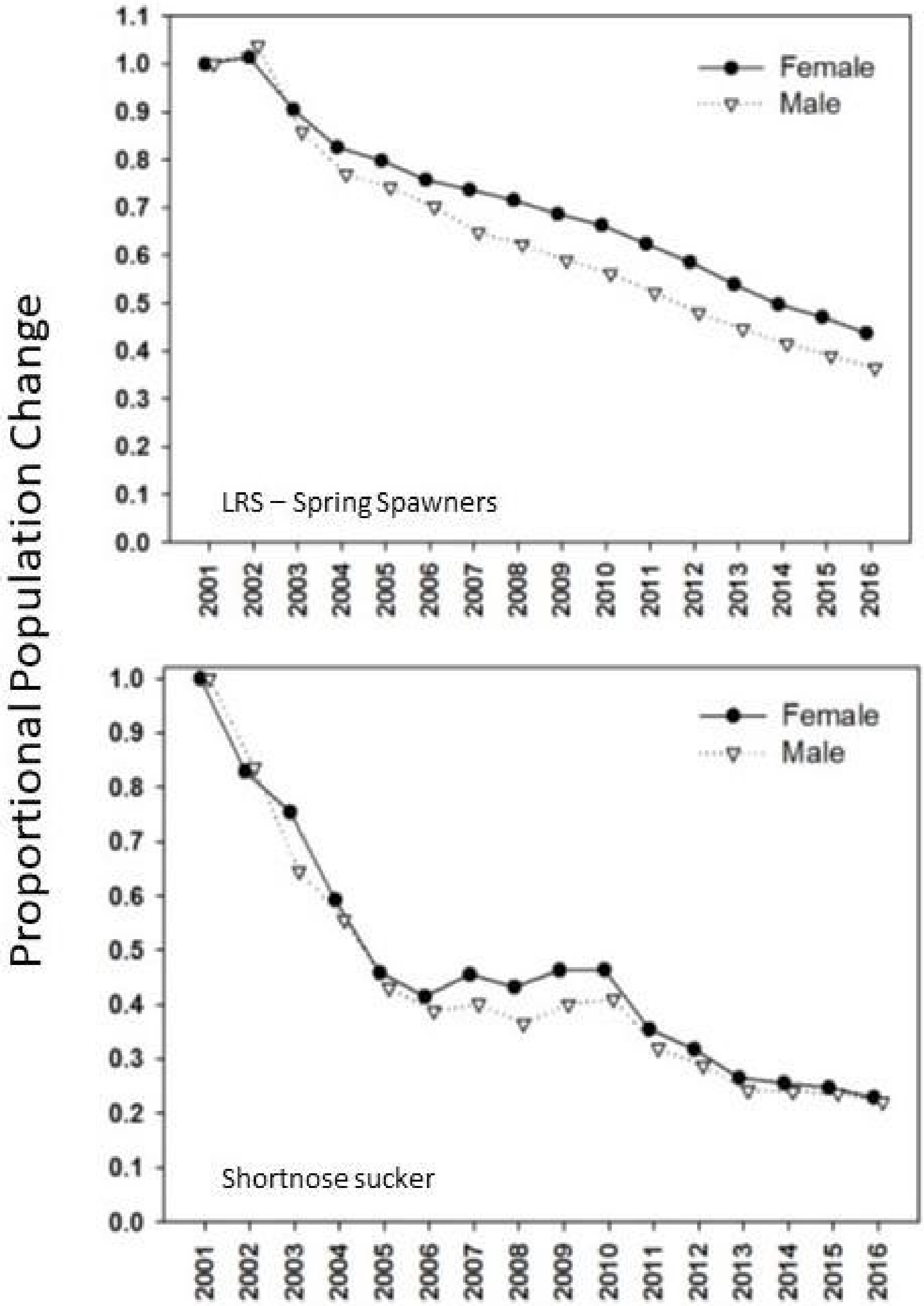

Figure 3. Adult spawning populations of suckers in Upper Klamath Lake have consistently declined since at least 2001, as estimated by two approaches using mark-recapture models in Program MARK (from Hewitt *et al*. 2018 pp. 14 & 20). The number of spawning female Lost River suckers in Upper Klamath Lake has declined by nearly 60 percent and shortnose sucker by 80 percent between 2002 and 2016.

Although numerous larvae are produced annually, the number of juveniles captured during sampling efforts is low and typically decreases to nearly zero in late summer. Very few individuals are captured as age-1 or older (Burdick and Martin 2017 p. 30), suggesting complete cohort failure each year. The declines in captures commonly occur during the periods with the most degraded water quality conditions in Upper Klamath Lake, but a clear empirical link between water quality parameters and mortality rates has not been established. One prominent hypothesis is that water quality is directly responsible for the unnaturally high levels of juvenile mortality. Another is that water quality interacts with other sources of mortality by causing chronic stress that renders the individuals more susceptible to forms of predation or infection (USFWS 2019a pp. 21-41). The specific causes of repeated cohort failure at the juvenile stage are a critical uncertainty challenging recovery because juvenile mortality is the primary factor that contributes to the low resilience of both Lost River and shortnose sucker populations in Upper Klamath Lake.

Even though viable eggs and larvae are produced each year, there is a lack of recruitment of new adults into Upper Klamath Lake sucker populations, which continue to exist only because of their long life. Although we do not know specifically how this current uniform age distribution compares to historical conditions, healthy adult populations of long-lived species should generally possess multiple reproducing year-classes. Both species are expected to become extirpated from Upper Klamath Lake without significant recruitment, but the current dynamics are particularly untenable for the shortnose sucker, and without substantial recruitment in the next decade, the population will be so small that it is unlikely to persist without intervention (Rasmussen and Childress 2018 p. 586).

4.2. Clear Lake

Data for the Clear Lake populations are very limited compared to those in Upper Klamath Lake, but we can make some generalizations. Clear Lake currently supports the largest populations of both suckers in the Lost River drainage. Shortnose and Lost River sucker survival rates appear to be slightly less than conspecifics in Upper Klamath Lake and more variable with some annual estimates as low as 47 percent (D.A. Hewitt, Personal Communication, September 14, 2017), but the estimates are somewhat uncertain given the low detection probabilities. Size distributions of Lost River sucker in Clear Lake have few year classes represented, whereas the shortnose sucker population exhibits relatively broad representation across adult sizes (Hewitt and Hayes 2013 pp. 14, 16). However, the shortnose sucker population in Clear Lake Reservoir is highly introgressed with Klamath largescale sucker (Tranah and May 2006 p. 313, Dowling *et al*. 2016 pp. 10-11).

Despite our inability to accurately estimate absolute abundance of the populations due to the lack of robust data, the low numbers of captures and recaptures suggests that these populations are smaller than those in Upper Klamath Lake. This is particularly true for the Lost River sucker.

In Clear Lake, shortnose suckers are more abundant than Lost River sucker. Approximately 5,100 tagged shortnose suckers were detected during the spawning run during 2016; slightly more than 800 tagged Lost River suckers were detected during the same period (D.A. Hewitt, Personal Communication, September 14, 2017). Although reliable estimates of total population numbers are unavailable, the data suggest it is unlikely that more than 25,000 adult shortnose suckers and 10,000 adult Lost River suckers occur in Clear Lake.

Between 2004 and 2010, only 1,360 individual Lost River suckers were captured in Clear Lake Reservoir for all years combined (Hewitt and Hayes 2013 p. 5). In comparison, captures in Upper Klamath Lake of Lost River suckers averaged over 2,000 individuals annually with more than 12,000 individuals captured during this same time period (Hewitt *et al*. 2017 p. 12). Clear Lake is sampled in the fall whereas Upper Klamath Lake is sampled in spring while the fish are congregated in preparation for spawning migrations, but the magnitude of the difference suggests that the Lost River sucker population in Clear Lake Reservoir is much smaller than the Lost River sucker population in Upper Klamath Lake. The Clear Lake Lost River sucker population also appears to be much smaller than the Clear Lake shortnose sucker population. Over the 2004 to 2010 period, 4.5 times as many individual shortnose suckers (6,240 individuals) were captured in Clear Lake Reservoir compared to Lost River sucker (Hewitt and Hayes 2013 p. 6). The average annual captures of individual shortnose suckers in Clear Lake Reservoir (1,040 per year) is comparable to Upper Klamath Lake rates (1,350 individuals), which may suggest that the population sizes are similar.

One important source of larval mortality in Clear Lake Reservoir is predation by several native or non-native aquatic species, including blue chub, fathead minnow, Sacramento perch, or bullfrog. Also, entrainment by flows through the Clear Lake dam into the Lost River appears to be a significant impact to suckers and juveniles. Although a fish screen was installed when Clear Lake dam was replaced in 2003, it is estimated around 270,000 larval and 3,600 juvenile suckers were entrained through the dam in 2013 (Sutphin and Tyler 2016 p. 10). Nevertheless, when spawning conditions are suitable for producing strong annual cohorts – estimated to be slightly less than half of the years (Hewitt and Hayes 2013) – juveniles, particularly shortnose sucker, can survive to recruit to the adult population. Evidence for this is seen in the multiple age classes of juveniles captured during sampling (Burdick and Rasmussen 2013 p. 14), as well as the diverse size class distributions of adults (Hewitt and Hayes 2013 p. 16). Lost River sucker adults in Clear Lake Reservoir exhibit more restricted size class distributions and less consistent recruitment (Hewitt and Hayes 2013 p. 14). For example, a cohort that appeared in the trammel net sampling in 2007 was not evident in sampling in subsequent years, but the drivers of this mortality and the more tenuous status of Clear Lake Lost River suckers are unknown.

4.3. Gerber Reservoir

Spawning surveys of the shortnose sucker population in Gerber Reservoir in 2006 detected approximately 1,700 of the nearly 2,400 shortnose suckers that had been tagged the previous year (Barry *et al*. 2007a p. 7). Based on mark-recapture data from 2004 (Leeseberg *et al*. 2007, entire), 2005, and 2006 (Barry *et al*. 2007a, entire), the population of shortnose sucker may have been as high as 42,000 individuals. In 2015, drought conditions reduced water levels within the reservoir to approximately one percent of the maximum storage. This undoubtedly reduced shortnose sucker numbers because of the limited available habitat, but we do not have specific data to accurately estimate the extent of this reduction, although Reclamation initiated population monitoring work in 2018. Similarly, due to a lack of robust data, we are not able to estimate survival rates.

The outlet of Gerber Reservoir does not have a fish screen, so suckers are vulnerable to entrainment downstream into Miller Creek, which historically connected to the Lost River, but is now completely blocked and diverted for irrigation purposes. Small numbers of juvenile suckers (10s to 100s per year) have been caught in Miller Creek (Shively *et al*. 2000 p. 89, Hamilton *et al.* 2003 pp. 3-4), but the proportion of juveniles entrained and the population impacts of entrainment are largely unknown.

4.4. Other Lakes and Reservoirs

Insufficient monitoring data are available to determine trends for other Lost River and shortnose sucker populations, but since the declining populations in Upper Klamath Lake are the source of most of the Lost River and shortnose sucker populations elsewhere, we expect the trends in those populations to be similar to those in Upper Klamath Lake.

Data on the Lost River and shortnose sucker populations in Keno Reservoir, Klamath River reservoirs, Tule Lake, Gerber Reservoir, and the Lost River are limited. Limited monitoring of these populations indicate low numbers of each species, with perhaps fewer than 5,000 individuals total for the Lost River sucker and shortnose sucker in Tule Lake (Hodge and Buettner 2009, entire), Keno Reservoir (Kyger and Wilkens 2011a, entire), and the Klamath River reservoirs below Keno (Desjardins and Markle 2000, entire). Shortnose suckers dominate in the Keno Reservoir and downstream in the hydropower reservoirs (Desjardins and Markle 2000 p. 39, Kyger and Wilkens 2011a p. 7).

Lake Ewauna probably functions as a subpopulation to Upper Klamath Lake to some degree. Hundreds of listed suckers (both species) have been captured, tagged, and translocated to Upper Klamath Lake from Lake Ewauna since 2010 (Kyger and Wilkens 2011a p. 3, USBR 2018b). There is a fish ladder at Link River Dam that provides some connectivity between Lake Ewauna and Upper Klamath Lake, though only small numbers of individuals have been documented using it. Although water quality conditions are consistently quite poor during late summer and early fall, small numbers of endangered suckers apparent persist in Lake Ewauna, perhaps by using the Link River as a refuge from poor water quality conditions (Piaskowski 2003 p. 9). Successful spawning in the Link River, which is the only potential spawning habitat below Link River Dam, has not been documented.

Tule Lake was extensively diked, and its volume has been greatly reduced through evaporation related to retention of water above dams and irrigation as well as diversion of water to the Klamath River as well as to Lower Klamath National Wildlife Refuge through the D Pump. The remaining lake habitat, referred to as Sump 1A and Sump 1B, is approximately 9,081 acres and 3,259 acres, respectively. Hundreds of individuals of both species were captured in Tule Lake Sump 1A during a 3-year effort (Hodge and Buettner 2009 pp. 4-6). Spawning aggregations have been observed in the Lost River below Anderson Rose dam, but the habitat is not high quality. Locations in the Lost River where historical spawning was documented, such as Olene, are inaccessible from Tule Lake due to multiple dams and inundation behind dams. Thus, the Tule Lake populations are considered sinks, entirely composed of the offspring of other populations that found their way through the Lost River or the irrigation system into Tule Lake and without sufficient means to be self-sustaining.

In the main stem hydropower reservoirs on the Klamath River, a two year effort produced slightly more than 200 captures, 99 percent of which were shortnose suckers (Desjardins and Markle 2000 pp. 14-15). The sizes of catches given the effort suggests that these populations contain very few individuals. This population is also very likely a sink, with new individuals generally being spawned elsewhere in the system, such as Upper Klamath Lake. None of these sink populations are thought to contribute significantly to maintaining and recovering Lost River and shortnose suckers because they have extremely low resiliency due to a combination of degraded habitat, low numbers, and restricted access to suitable spawning habitat (Desjardins and Markle 2000 pp. 14-15, Hodge and Buettner 2009 pp. 4-6, Kyger and Wilkens 2011a p. 3).

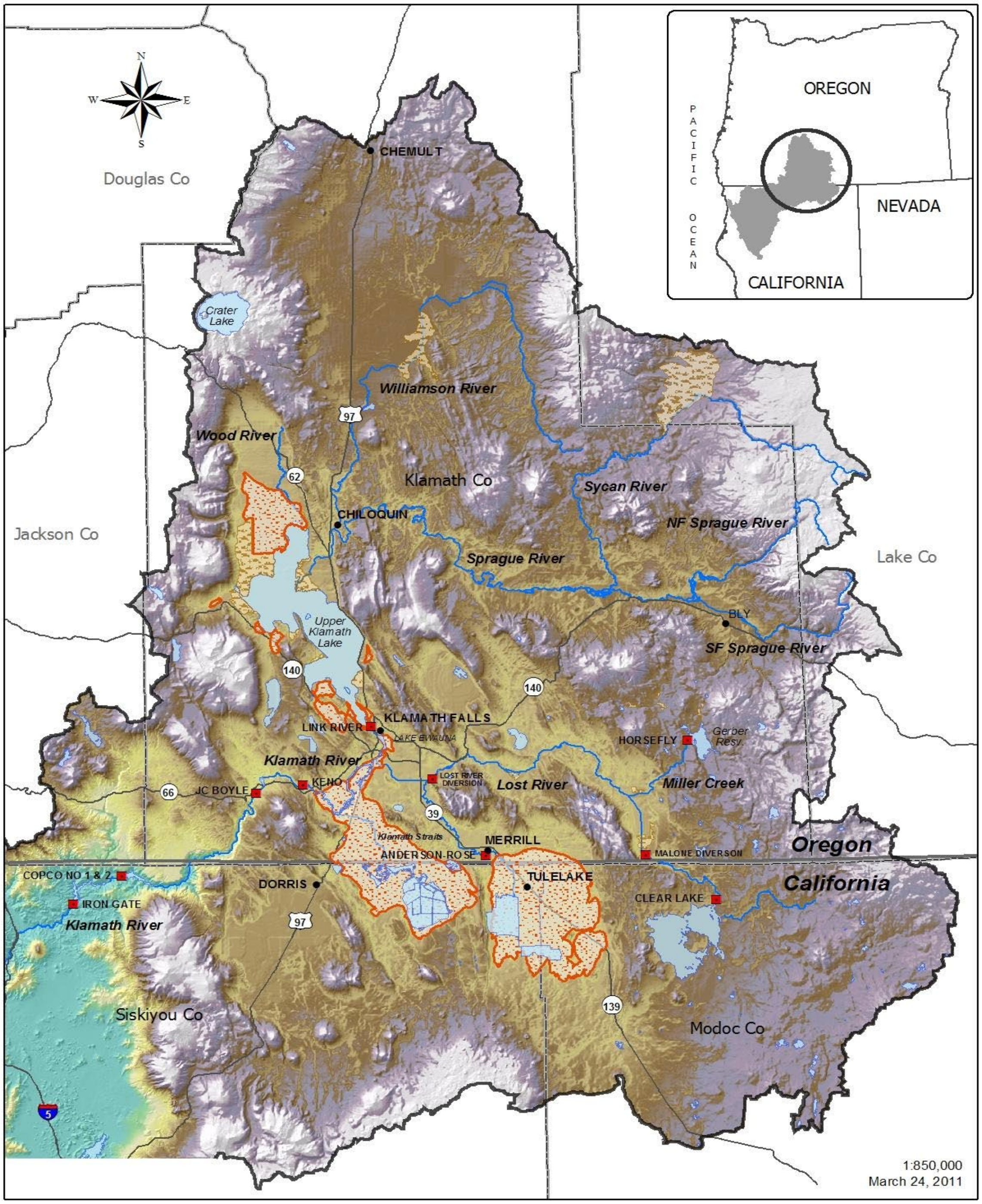

Figure 4. The upper Klamath Basin indicating areas of lost aquatic and wetland habitat that have been lost since 1900 with current conditions overlain. The lost areas are outlined in orange.

5. PREDATION, DISEASE AND PARASITES

5.1. Predation

The Lost River and shortnose suckers evolved with substantial predation pressure on larvae and juveniles from native fish species, including redband trout (*Oncorhynchus mykiss newberrii*), blue chub (*Gila coerulea*), and Tui chub (*Gila bicolor*), as well as predation pressure on all life stages from numerous bird species. Non-native fishes introduced to the system also potentially impact suckers through predation. Approximately 20 fish species were introduced accidentally or deliberately into the upper Klamath Basin. These comprised about 85 percent of fish biomass in Upper Klamath Lake when the suckers were listed (Scoppettone and Vinyard 1991 p. 375, National Research Council 2004 pp. 188–189). The introduced fish species most likely to affect Lost River and shortnose suckers are the fathead minnow (*Pimephales promelas*) and yellow perch (*Perca flavescens*). Additional exotic, predatory fishes found in sucker habitats, although typically in relatively low numbers, include bullheads (*Ameiurus* species), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* species), green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*), and Sacramento perch (*Archoplites interruptus*) (Koch *et al*. 1975 p. 17, Logan and Markle 1993 pp. 27-29). These fish may prey on young suckers as well as compete with them for food or space (Markle and Dunsmoor 2007 pp. 573–577).

Fathead minnows were first documented in the Klamath Basin in the 1970s and are now the most numerous fish species in Upper Klamath Lake (Simon and Markle 1997 p. 146). Laboratory experiments have demonstrated that adult fathead minnows prey on sucker larvae (Markle and Dunsmoor 2007 pp. 573, 576). In Upper Klamath Lake, higher fathead minnow abundances were associated with lower sucker survival rates (Markle and Dunsmoor 2007 p. 576). Likewise, as indirect evidence, higher larval sucker survival rates were also associated with greater water depth and shoreline vegetative cover, habitat that helps larvae avoid predation (Markle and Dunsmoor 2007 p. 575). Nonetheless, suckers outgrow fathead minnow's gape limitation quickly, and spatial and temporal overlap with other non-native predators (such as yellow perch) may be limited.

Several species of birds can prey on Lost River and shortnose suckers. Bald eagles frequent sucker spawning sites, such as Ouxy Springs and the Sprague River near the Chiloquin Dam site, during the spawning season. Pelicans (*Pelecanus erythrorhynchus*) and double-crested cormorants (*Phalacrocorax auritus*) can also target juveniles and adults. There are also numerous other species of piscivorous birds, including terns, grebes, and mergansers, that may prey on juvenile and larval suckers throughout their range. Avian predation can be responsible for mortality of at least 8.4 percent of juveniles and 4.2 percent of adults annually in Clear Lake (Evans *et al*. 2016a pp. 1261-1262). Predation on spawning adults may increase mortality rates of this life stage and alter behavior during this critical period. For example, predation on adults, or the threat of predation, at spawning sites may limit the amount of time spent on the spawning ground, affecting overall reproductive outputs. It is difficult to determine whether avian predation has increased or decreased relative to historic levels, but bird populations in general in the Klamath Basin have certainly declined from historic numbers. Overall, it is more likely that the absolute amount of predation has also diminished.

5.2. Disease and Parasites

Numerous types of diseases and parasites infect Lost River and shortnose suckers, some of which are associated with morbidity and mortality. Infections can cause physiological stress, blood loss, decreased growth rates, reduced swimming performance, lower overwinter fitness, and mortality, especially in small fish (Marcogliese 2004, entire, Kirse 2010, entire). Additionally, parasites may provide a route for other infectious pathogens by creating a wound in the skin, or they can make fish more susceptible to predation by modifying their behavior (Robinson *et al*. 1998 pp. 605-606, Marcogliese 2004, entire).

The Lost River sucker and shortnose sucker are hosts to various species of bacteria, protozoa, myxozoa, trematodes, nematodes, leeches and copepods (Foott 2004 pp. 3-4, Janik 2017 pp. 6-7). These can infect the eye, gills, kidney, blood, heart, muscle, skin and gut. Many of these are pathogenic and can be associated at times with morbidity in suckers (Foott 2004 pp. 3-5, Foott and Stone 2005 pp. 7-9, Foott *et al*. 2010 pp. 5-13, Burdick *et al*. 2015a pp. 36-39, Hereford *et al*. 2016 pp. 35-39).

It is likely that most of the parasites currently able to infect Klamath suckers share an evolutionary history with suckers, suggesting that it is unlikely that native parasites cause the annual loss of juvenile cohorts. It is possible that the advent of a hyper-abundant introduced species has also increased the number of parasite hosts in the system. This could then theoretically increase the total number of parasites in the system, which could increase the infection rates of suckers. Furthermore, *Lernaea cyrpinacae* (anchor worms) are likely introduced and consistently parasitize sucker juveniles (Janik *et al*. 2018 pp. 1678 & 1683). While it is clear that parasites and disease affect individual survival, we currently do not have enough information to assess accurately the degree to which these negatively affect sucker population survival and viability.

6. SPECIES NEEDS

This information on species needs, primarily water quality conditions, is provided to help inform and compare and contrast the environmental baseline in the action area for larval, juvenile and adult Lost River and shortnose suckers (BO-Chapter 5), notably within the hydroelectric reach reservoirs. Additional details on species needs and life stages are included the Species Status Assessment (USFWS 2019c).

Refer to Table 1 to review the upper median lethal concentrations for pH, un-ionized ammonia, and water temperature. Table 1 also displays the lower median lethal concentrations for dissolved oxygen to larval (35 days) and juvenile (3-7 months) Lost River and shortnose suckers.

6.1. Larvae

Once in the lake environment, larvae require suitable habitat including appropriate water quality (Table 1), sufficient food, and refuge from predators and turbulence. Larvae need a pH below approximately 10.35, un-ionized ammonia (NH_3) below 0.48 mg/L (Lost River sucker) and 1.06 mg/L (shortnose sucker), temperatures below 31 °C (88 °F), and dissolved oxygen above 2.1 mg/L (Saiki *et al*. 1999).

As larvae are in the process of transitioning to juveniles, they finish the remains of their yolk sac and begin eating external food. This includes midge larvae and adults, as well as small crustaceans (Markle and Clauson 2006). Emergent vegetation provides cover from non-native predators (such as non-indigenous fathead minnows; *Pimephales promelas*) and habitat for prey (Cooperman and Markle 2004). These areas also provide refuge from wind-blown currents and turbulence, as well as areas of warmer water temperature which can promote growth (Cooperman *et al*. 2010). This emergent vegetation tends to occur along the fringes of the lakes in shallow areas (littoral areas), including coves.

6.2. Juveniles

Juvenile needs are similar to late-stage larvae, with some distinctions. Larvae transform into juveniles by mid-July reaching 25 mm (1 in) in length. In addition to midge and crustacean prey, juveniles eat other macroinvertebrates (such as caddis flies) and an indistinguishable material comprised of sand, filamentous algae, and other digested materials (Buettner and Scoppettone 1990, Markle and Clauson 2006). No data for the diet of juvenile fish beyond early summer of their first year has been gathered.

Juveniles primarily use relatively shallow (less than approximately 1.2 m) vegetated areas, but have also been observed moving to deeper, un-vegetated offshore habitats (Buettner and Scoppettone 1990, Hendrixson *et al*. 2007, Bottcher and Burdick 2010, Burdick and Brown 2010). One-year old juveniles occupy shallow habitats during April and May but move into deeper areas along the western shore of Upper Klamath Lake until dissolved oxygen levels become reduced (Bottcher and Burdick 2010, Burdick and Vanderkooi 2010). Once dissolved oxygen levels in deeper areas become suboptimal, juveniles move back to shallower areas.

Minimum water quality needs for juveniles are similar to larvae but juveniles appear slightly more tolerant of poor water quality (Table 1). Several predators prey on juveniles, including fish and birds. Klamath suckers are subject to impacts from numerous diseases and parasites, which may have increased in density from the high abundance of non-native species. Juveniles need habitat structure or deeper water to avoid predation, and also require water quality conditions within appropriate ranges to reduce stress; thereby minimizing their vulnerability to predators and pathogens.

6.3. Adults

Adult Lost River and shortnose sucker require distinct habitats where they can grow and spawn. Suckers grow in lakes where they feed, and spawn in the tributaries to these lakes. To grow, adults require adequate food, water quality, and refuge from predation. Although adults are hardier than juveniles and larvae, they are still susceptible to poor water quality, which can be associated with die-offs.

Lost River suckers tend to feed directly from the lake bottom, whereas shortnose sucker primarily consume zooplankton from the water column (Scoppettone *et al*. 1995). This diet difference aligns with their different mouth form or morphology; shortnose suckers have terminal or subterminal (forward-facing) mouths whereas Lost River suckers have more ventral (bottom-facing) mouths (Miller and Smith 1981). Shortnose suckers primarily strain zooplankton from the water column (Miller and Smith 1981, Scoppettone and Vinyard 1991). Ninety-two percent of the gut contents of adult shortnose suckers in Clear Lake Reservoir consisted of small crustaceans known as cladocerans or water fleas (Parker *et al*. 2000). These water fleas are typically distributed throughout the water column.

Lost River suckers have triangular gill rakers and mouths oriented more ventrally, suggesting a dependency on benthic (bottom dwelling) organisms, such as macroinvertebrates. Midge larvae comprised 96 percent of the gut contents of adult Lost River suckers in Clear Lake Reservoir (Parker *et al*. 2000). Midge larvae inhabit lake bottoms until they swim up to emerge from the water as flying adults. Adult Lost River suckers also tended to consume more detritus than shortnose suckers (Parker *et al.* 2000).

Adults of both species occupy areas with water depths greater than 2 m (6.5 ft). Selection of these deeper habitats may reflect the distribution of their prey, or afford protection from avian predators, which can consume suckers as large as 730 mm (28.7 in; Evans *et al*. 2016). Adults will use shallower habitats when searching for more favorable water quality conditions in spring-fed areas, such as Pelican Bay (Banish *et al*. 2009). These spring-dominated sites provide better water quality because of the colder water and more continuous flow that holds more oxygen than warmer water.

6.4. Water Temperature

Water temperatures are controlled primarily by solar radiation (Wetzel 2001). Solar radiation adsorption in lakes is associated with surface area or depth. So alterations to water surface area or depth (such as those caused by impoundments) will affect water temperatures.

Increasing water temperature has many potential indirect effects that include reducing dissolved oxygen concentrations, increasing total ammonia-nitrogen concentrations, increasing growth rates of pathogens, and requiring greater energy demands from fish.

Temperatures exceeding 25 °C (77 °F) are considered a “low stress threshold” for adults of both species, and they start to move closer to the surface to breathe (Loftus 2001). Temperatures exceeding 28 °C (82.4 °F) are a high stress threshold (Loftus 2001) and adult mortality is more likely once this water temperature is reached.

The temperature range lethal to at least 50 percent of larval and juvenile Lost River suckers and shortnose suckers over 96 hours is between 30.0-31.9 °C (86.0-89.4 °F) (Saiki *et al*. 1999). Therefore, the two species have temperature limits for surviving in lakes or reservoirs of the Upper Klamath Basin. Increased temperatures reduce Lost River sucker survival, and each 2.5 °C (4.5 °F) increase in temperature decreased fry survival by 47 percent over seven days of exposure (Stone *et al.* 2017). This emphasizes the importance of thermal relief provided by the cold-water springs in Upper Klamath Lake and the colder water inflows from the Williamson and Wood Rivers, particularly during summer.

6.5. Dissolved Oxygen

The amount of dissolved oxygen in water depends on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration (Graham 1990). Important inputs of oxygen to lakes include diffusion from the atmosphere, inflow from streams and rivers, and photosynthesis from plants and cyanobacteria.

Respiration due to decomposition of decaying organic matter is the major source of oxygen uptake in lakes, but during dark periods photosynthetic plants will also respire and take up oxygen (Diaz and Breitburg 2009). Given that oxygen diffuses through water relatively slowly, the dynamics of inputs and uptake create zones of extremely low oxygen concentrations (Graham 1990).

The available dissolved oxygen for respiration by suckers is influenced by the bloom and crash dynamics of algal communities, which in turn depend on nitrogen and phosphorus availability. Concentrations in spawning streams during migration are generally not harmful to suckers because the cold temperatures and churning of water in riffle areas increases oxygen concentrations.

Lethal dissolved oxygen levels in lake habitats were determined in laboratory settings for larval and juvenile suckers over a 4-day period (96 hours) (Saiki *et al*. 1999). Sublethal levels of dissolved oxygen were also determined for juvenile Lost River suckers (Meyer and Hansen 2002) over a 14-day period. In both, the range of dissolved oxygen concentrations that was lethal to at least 50 percent of the individuals exposed was from 1.34 to 2.10 mg/L. Low dissolved oxygen leads to gasping behavior at the water's surface in juvenile suckers (Martin and Saiki 1999), which can also increase exposure to avian predators.

6.6. Nutrients

Nutrient cycling dynamics in Upper Klamath Lake have been affected by the loss and modification of wetlands that have been converted to other land uses. Wetlands influence nutrient dynamics through 1) trapping and immobilizing nutrients and sediments, and 2) producing dissolved organic matter. When wetlands are drained or modified, the exposure of peat soils to air and oxygenated water releases nutrients and organic matter through accelerated decomposition (Snyder and Morace 1997).

The Upper Klamath Basin has naturally high levels of nutrients in the soils, particularly phosphorus (Bradbury *et al.* 2004) because of the surrounding volcanoes that have been active in the recent geologic past. Runoff and erosion deliver phosphorus downstream to lakes, elevating them from a naturally eutrophic or nutrient-rich state, to a hypereutrophic state. The hypereutrophic state is caused by algal blooms that kill fish because of oxygen depletion waters on the lake bottom.

In Upper Klamath Lake, phosphorus concentrations vary seasonally and spatially (e.g., annual median values of total phosphorus > 250 µg/L; Kann 2017). Irrigated pastures are a substantial nutrient source (Ciotti *et al*. 2010). Other external sources further add to the eutrophication (the process of becoming enriched with nutrients) of the lake (Bortelson and Fretwell, Marvin 1993). The elevated levels of phosphorus contribute to shifts in the algal composition (Eilers *et al*. 2004).

There are two forms of ammonia in solution: ionized and un-ionized. The latter is more toxic to fish, and the proportion of each depends on water temperature and water pH level. Periods of low dissolved oxygen are also often associated with high levels of un-ionized ammonia, which can be toxic to fish. Ammonia toxicity is complex because it is a function of total ammonia nitrogen concentration, pH, and temperature. The toxic form, ammonia, is most prevalent at higher pH levels.

Larval shortnose suckers require un-ionized ammonia to be below 0.48 mg/L and 1.06 mg/L (Saiki *et al.* 1999). The lowest significant partial-mortality concentration of un-ionized ammonia for larval Lost River sucker is 0.69 mg/L at a pH of 9.5 (Lease *et al*. 2003). Un-ionized ammonia concentrations occasionally exceed these levels in deeper areas of Upper Klamath Lake during late July, coincident with blue-green algae bloom decline and low dissolved oxygen levels.

6.7. pH Levels

In the Upper Klamath Basin, summertime pH levels are elevated above neutral. Extended periods of higher pH are associated with large summer algal blooms. Generally, pH in the reach from Link River Dam through the Keno Reservoir increases from spring to early summer and decreases in the fall; however, there are site-dependent variations in the observed trend.

Table 5. Upper median lethal concentrations (LC50s) for pH, un-ionized ammonia (NH3), and water temperature (TEMP), and lower LC50s for dissolved oxygen (DO) to larval (35 days) and juvenile (3-7 months) Lost River (LR) and shortnose (SN) suckers at 24-h exposure intervals during 96-h-long tests. From Saiki *et al*. (1999 p. 40).

Variable	Species	Life Stage	Weight (g)	24 h		48 h		72 h		96 h	
pH	LR	Larva	NW[a]	10.42	(10.38±10.47)	10.39	(10.32±10.46)	10.36	(10.27±10.46)	10.35	(10.26±10.45)
	LR	Juvenile	0.28±0.49	10.66	(10.59±10.74)	10.62	(10.54±10.71)	10.39	(10.12±10.67)	10.3	(9.94±10.67)
	SN	Larva	NW[a]	10.38	(10.31±10.46)	10.38	(10.31±10.46)	10.38	(10.31±10.46)	10.38	(10.31±10.46)
	SN	Juvenile	1.01±1.11	10.69	(10.61±10.77)	10.66	(10.61±10.72)	10.58	(10.56±10.61)	10.39	(10.22±10.56)
NH3	LR	Larva	NW[a]	0.56	(0.52±0.61)[c]	0.51	(0.47±0.55)[c]	0.49	(0.45±0.54)[c]	0.48	(0.44±0.52)c
(mg/L)	LR	Juvenile	0.49±0.80	1.02	(1.01±1.04)	0.92	(0.82±1.04)	0.89	(0.77±1.04)	0.78	(0.70±0.86)
	SN	Larva	NW[a]	1.29	(0.83±2.00)	1.24	(0.82±1.88)	1.19	(0.79±1.78)	1.06	(0.73±1.53)
	SN	Juvenile	0.53±2.00	0.51	(0.30±0.87)	0.48	(0.28±0.82)	0.54	(0.35±0.82)	0.53	(0.34±0.82)
TEMP	LR	Larva	NW[a]	31.93	(31.82±32.04)[c]	31.85	(31.69±32.01)[c]	31.77	(31.58±31.96)[c]	31.69	(31.47±31.91)[c]
(°C)	LR	Juvenile	0.48±0.86	30.76	(30.04±31.50)	30.76	(30.04±31.50)	30.65	(30.04±31.27)	30.51	(29.99±31.04)
	SN	Larva	NW[a]	31.85	(31.75±31.96)	31.85	(31.75±31.96)	31.85	(31.75±31.96)	31.82	(31.75±31.90)
	SN	Juvenile	0.54±0.64	31.07	(29.44±32.80)	30.35	(29.44±31.28)	30.35	(29.44±31.28)	30.35	(29.44±31.28)
DO	LR	Larva	NW[a]	2.01	(1.90±2.13)	2.1	(2.07±2.13)	2.1	(2.07±2.13)	2.1	(2.07±2.13)
(mg/L)	LR	Juvenile	0.39±0.86	1.58	(1.35±1.86)	1.58	(1.35±1.86)	1.62	(1.41±1.86)	1.62	(1.41±1.86)
	SN	Larva	NW[a]	1.92	(1.89±1.96)	2.04	(1.90±2.18)	2.09	(1.90±2.29)	2.09	(1.90±2.29)
	SN	Juvenile	0.39±1.15	1.14	(0.84±1.55)	1.34	(1.15±1.55)	1.34	(1.15±1.55)	1.34	(1.15±1.55)

[a] NW, test animals were not weighed. This test was not repeated; the 95 percent confidence interval was calculated from statistical procedures used to estimate the LC_{50} valu

7. CONSERVATION AND RECOVERY EFFORTS

7.1. Klamath Basin Sucker Rearing Program

The Service started an assisted rearing program for Lost River and shortnose sucker in 2015 to supplement populations in Upper Klamath Lake through augmentation. The primary target of the effort is shortnose sucker, but the lack of an effective way to identify live larvae and juveniles means that both species are collected and reared. In 2013, the Bureau of Reclamation agreed to fund such a program as a way to improve the environmental baseline of the species to minimize impacts to suckers that may result from Klamath Project operations with a 10-year target of releasing a total of 8,000 to 10,000 suckers with lengths of at least 200 mm. The Service funded expansion of the program and aims to collect around 20,000 larval suckers for assisted rearing in spring of 2019.

The program was designed to maximize retention of genetic diversity and maintain natural behaviors post-release as much as possible (Day et al. 2017 pp. 306–307). Larvae are collected as they drift downstream in the Williamson River, so no brood stock are maintained, and the effects of artificial breeding are avoided. Collection efforts are currently spread across the drift season to maximize the genetic variability. Juveniles are stocked into semi-natural ponds and growth depends on a combination of natural and artificial feed.

The first release of reared suckers into Upper Klamath Lake occurred in spring 2018, and the proportion of released individuals that will join the spawning population is unknown. Thus, the assisted rearing program is likely to be a source of recruitment for both shortnose sucker and Lost River sucker in Upper Klamath Lake, but the specific impact on population trajectories will be uncertain until information on survival and recruitment probabilities of released individuals is available.

7.2. Habitat Restoration

Numerous agencies and organizations have restored important components of habitat to reduce threats to these species over the last 20 years. In most instances, considerable time is necessary to determine the efficacy of such recovery actions because of the time needed for the habitat to achieve full functioning and the subsequent time needed for a long-lived species to respond with improved demographics. For example, actions to increase reproduction and recruitment into adult populations require at least 5 years for shortnose sucker and 9 years for Lost River sucker to achieve minimal functioning.

Hundreds of on-the-ground restoration projects, wetland, riparian, in-stream, upland, and fish passage projects have been implemented in the Upper Klamath Basin that directly or indirectly benefit suckers. Many of the projects included elements of more than one category of restoration project type taking a holistic or ecosystem approach based on the assumption that restoration of natural ecosystem functioning will ultimately benefit multiple species, including listed suckers.

Major sucker recovery-oriented projects completed include screening of irrigation diversions, eliminating barriers to fish passage, and restoration of rearing and spawning habitat (Table X).

For example, restoration of the Williamson River Delta by the Nature Conservancy, with substantial support from PacifiCorp and other organizations, has provided approximately 2,500 hectares (~6,000 acres) that can serve as rearing habitat for the largest spawning populations of both species despite much of the area being deeper than it was historically due to subsidence. The removal of Chiloquin dam in 2008 opened approximately 120 kilometers (75 miles) of potential spawning and migration corridor. Additionally, screening the A-canal in 2002 reduced entrainment of fish greater than 30 millimeters (1.2 inches) into the irrigation systems of the Klamath Project canal system. Prior to placement of the screen, up to hundreds of thousands of juveniles were estimated to be entrained into the irrigation canals at this point each year (Gutermuth *et al*. 2000 p. 14). In addition to these major accomplishments, private landowners, the Oregon Department of Fish and Wildlife, Bureau of Reclamation, Natural Resources Conservation Service and the Service have realized countless other smaller projects that can benefit Lost River sucker and shortnose sucker populations.

Table 6. Summary of some recent major restoration projects benefitting Lost River sucker and shortnose sucker populations. Many of these projects were cooperative efforts of state and federal agencies, non-profit organizations, and private landowners.

Project	Year Completed	Potential Benefits
Reducing Entrainment		
A-Canal Screen	2002	Retain more larvae and juveniles in Upper Klamath Lake by limiting entrainment into the canal
Clear Lake Dam Screen	2003	Retain more larvae, juveniles, and adults in Clear Lake Reservoir by limiting entrainment into the canal
Modoc Irrigation District Williamson River Diversion Screen	2007	Reduce larval mortality due to entrainment
Geary Canal Screen	2009	Retain more larvae and juveniles in Upper Klamath Lake by limiting entrainment into the canal
Eliminating Barriers		
Link River Dam fish Ladder	2008	Restore connectivity of sucker populations in Upper Klamath Lake and Lake Ewauna by allowing for adult passage upstream, which may than contribute to spawning populations.
Chiloquin Dam Removal	2008	Opening 120 km (75mi) of historic migration, rearing, and spawning habitats in the Sprague River
Providing Habitat		
Williamson River Delta Restoration	2008	Provide ~2,500 hectares (6,000 acres) of potential rearing habitat for Larvae and juvenile suckers

APPENDIX C – STATUS OF THE SPECIES – BULL TROUT

This Appendix describes the range-wide status of the species for bull trout. We describe factors such as life history, habitat preferences, geographic distribution, population trends, and threats that help determine the likelihood of both survival and recovery of the species. We also summarize conservation needs. This includes a description of the effects of past human activities and natural events that have led to the current status of the bull trout.

The information in this Appendix provides the background for analyses in Chapters 4, 5, 6 and 7 of the Biological Opinion. The proposed and final listing rules contain a physical species description (63 FR 31647, June 10, 1998; 64 FR 58910, November 1, 1999).

The Service is in the process of completing a Species Status Assessment for the bull trout.

LISTING STATUS AND CURRENT RANGE

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout 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 (Bond 1992, pg. 2; Brewin and Brewin 1997, pg. 215; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 716-719; 63 FR 31647; 64 FR 58910; 75 FR 2269, January 14, 2010; USFWS 2015a, pg. 1).

The final listing rule for the United States coterminous population of the bull trout discusses the consolidation of five distinct population segments (DPSs) into one listed taxon and the application of the jeopardy standard in accordance with the requirements of section 7 of the ESA of 1973, as amended (Act; 16 U.S.C. 1531 et seq.) relative to this species, and the five interim recovery units for each of these DPSs for the purposes of Consultation and Recovery (64 FR 58910).

After the listing rule, six draft recovery units were identified based on new information (75 FR 63898, October 18, 2010). This new information confirmed these six recovery units were needed to ensure a resilient, redundant and representative distribution of bull trout populations throughout the range of the listed entity. The final Recovery Plan for the Coterminous Bull Trout Population (bull trout recovery plan) formalized these six recovery units (USFWS 2015a, pg. 36-43) (see Figure BT-1). The final recovery units replace the previous five interim recovery units and will be used in the application of the jeopardy standard for Section 7 consultation proceedures.

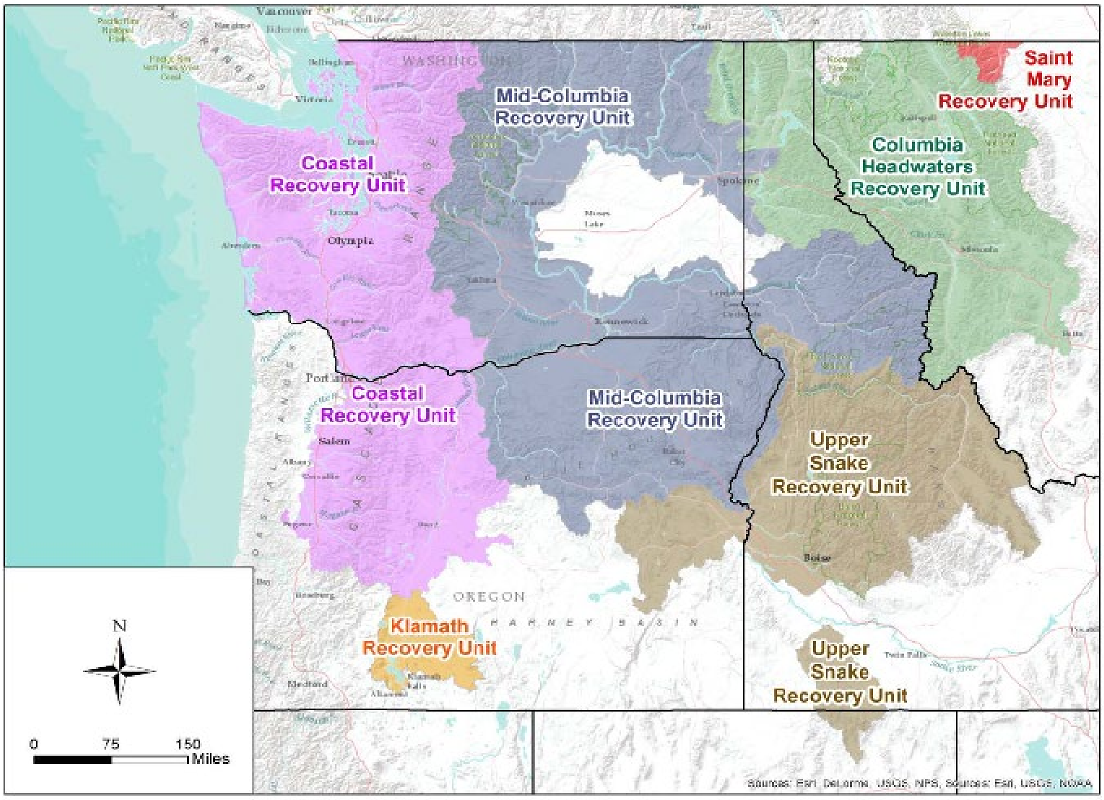

Figure 4. Locations of the six bull trout recovery units in the coterminous United States.

Reasons for Listing, Rangewide Trends and Threats

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced non-native species (63 FR 31647; 64 FR 58910).Poaching and incidental mortality of bull trout during other targeted fisheries are identified described in the bull trout recovery plan (see Threat Factors B and D) as additional threats (USFWS 2015a, pg. 150). Since the time of coterminous listing the species (64 FR 58910) and designation of its critical habitat (69 FR 59996, October 6, 2004; 70 FR 56212, September 26, 2005; 75 FR 63898) a great deal of new information has been collected on the status of bull trout. The Service's Science Team Report (Whitesel *et al*. 2004, entire), the bull trout core areas templates (USFWS 2005b, entire; USFWS 2009, entire), Conservation Status Assessment (USFWS 2005a), and 5-year Reviews (USFWS 2008, entire; USFWS 2015h, entire) have provided additional information about threats and status. The final recovery plan lists other documents and meetings that compiled information about the status of bull trout (USFWS 2015a, pg. 3). As well, 2015 5-year review maintained the listing status as threatened based on the information compiled in the final bull trout recovery plan (USFWS 2015h, pg.3) and the recovery unit implementation plans (RUIPs) (USFWS 2015b-g, entire).

When first listed, the status of bull trout and its threats were reported by the Service at subpopulation scales. In 2002 and 2004, the draft recovery plans (USFWS 2002, entire; USFWS 2004a, entire; USFWS 2004b, entire) included detailed information on threats at the recovery unit scale (i.e. similar to subbasin or regional watersheds), thus incorporating the metapopulation concept with core areas and local populations. In our 2008, 5-year Review, the Service established threats categories (i.e. dams, forest management, grazing, agricultural practices, transportation networks, mining, development and urbanization, fisheries management, small populations, limited habitat, and wildfire.) (USFWS 2008, entire). In the final recovery plan, threats and recovery actions are described for 109 core areas, forage/migration and overwintering areas, historical core areas, and research needs areas in each of the six recovery units (USFWS 2015a, p 10-11). Primary threats are described in three broad categories: Habitat, Demographic, and Nonnative Fish for all recovery areas described in the listed range of the species. The 2015 5-year status review (USFWS 2015h, entire) references the final recovery plan and the recovery unit implementation plans and incorporates by reference the threats described therein. Although significant recovery actions have been implemented since the time of listing, the 5-year review concluded that bull trout still meets the definition of a “threatened” species (USFWS 2015h, entire).

New or Emerging Threats

The final Recovery Plan for the Coterminous Bull Trout Population (USFWS 2015a, pg. 17) describes new or emerging threats, climate change, and other threats. Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs (USFWS 2015b-g, entire) summarize the threat of climate change and acknowledge that some bull trout local populations and core areas may not persist into the future due to small populations, isolation, and effects of climate change (USFWS 2015a, pg. 48). The recovery plan further states that use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015a, pg. vii, and pp. 17-20). Mote *et al*. (2014, entire) summarized climate change effects to include rising air temperature, changes in the timing of streamflow related to changing snowmelt, increases in extreme precipitation events, lower summer stream flows, and other changes. 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 water temperatures (Poff *et al.* 2002, entire; Koopman *et al.* 2009, entire; PRBO Conservation Science 2011, entire). Lower flows as a result of smaller snowpack could reduce habitat, which might adversely affect bull trout reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit nonnative fishes that prey on or compete with bull trout. Increases in the number and size of forest fires could also result from climate change (Westerling *et al*. 2006, entire) and could adversely affect watershed function by resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. Lower flows also may result in increased groundwater withdrawal for agricultural purposes and resultant reduced water availability in certain stream reaches occupied by bull trout (USFWS 2015c, pg. B-10). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin *et al*. 2007, pp. 6672-6673; Rieman *et al.* 2007, pg. 1552). Climate change is expected to reduce the extent of cold water habitat (Isaak *et al*. 2015, entire), and increase competition with other fish species (lake trout (*Salvelinus namaycush*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and northern pike (*Esox Lucius*))) for resources in remaining suitable habitat. Brook trout, a fish species that competes for resources with and predates on the bull trout, will continue increasing their range in several areas (an elevation shift in distribution) due to the effects from climate change (Ficke *et al*. 2009, pg. 1; Peterson *et al*. 2013, pg. 117; Howell 2017, pg. 2).

LIFE HISTORY AND POPULATION DYNAMICS

Distribution

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, pg. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, pg. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin and Brewin 1997, entire).

Reproductive Biology

The iteroparous reproductive strategy (fishes that spawn multiple times, and therefore require safe two-way passage upstream and downstream) of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a safe downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, pg. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, pg. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, pg. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, pg. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 220 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, pg. 1; Ratliff and Howell 1992, pg. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, pg. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart *et al.* 2007, pg. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch. 2 pp. 23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, pg. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, pg. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, pg. 138; Goetz 1989, pg. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, pg. i; WDFW *et al.* 1997, pg. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, pg. 135; Leathe and Graham 1982, pg. 95; Pratt 1992, pg. 8; Rieman and McIntyre 1996, pg. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream, and resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Swanberg, 1997, entire; Brenkman and Corbett 2005, pp. 1075-1076; Goetz *et al*. 2004, pg. 105, Starcevich *et al* 2012, entire; USFWS 2016, pg. 170). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Some river systems have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Rivers. In these areas with connectivity bull trout can migrate between large rivers lakes, and spawning tributaries. Other migrations in Central Washington have shown that fluvial and adfluvial life forms travel long distances, migrate between core areas, and mix together in many locations where there is connectivity (Ringel *et al*. 2014, entire; Nelson and Nelle 2008, entire). Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits of connected habitat for migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, pg. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, pg. 2).

Whitesel *et al*. (2004, pg. 2) noted that although there are multiple resources that contribute to the subject, Spruell *et al.* (2003, entire) best summarized genetic information on bull trout population structure. Spruell *et al*. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell *et al*. 2003, pg. 17). They were characterized as:

- "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.
- "Snake River", which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.
- "Upper Columbia River" which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell *et al.* (2003, pg. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.
- Spruell *et al*. (2003, pg. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor *et al*. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello *et al*. (2003, pg. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Taylor and Costello (2006, pg. 1165-1170), Spruell *et al*. (2003, pg. 26) and

the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor *et al.* (1999, pg. 1166) and Spruell *et al.* (2003, pg. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the Service identified additional genetic units within the coastal and interior lineages (Ardren *et al*. 2011, pg. 18). Based on a recommendation in the Service's 5-year review of the species' status (USFWS 2008, pg. 45), the Service reanalyzed the 27 recovery units identified in the 2002 draft bull trout recovery plan (USFWS 2002, pg. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren *et al*. 2011, entire). In this examination, the Service applied relevant factors from the joint USFWS and NMFS Distinct Population Segment (DPS) policy (61 FR 4722, February 7, 1996) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (75 FR 63898). These six recovery units, adopted in the final bull trout recovery plan (USFWS 2015a, entire) and described further in the RUIPs (USFWS 2015b-g, entire) include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. A number of additional genetic analyses within core areas have been completed to understand uniqueness of local populations (Hawkins and Von Bargen 2006, entire; 2007, entire; Small *et al*. 2009, entire; DeHaan and Neibauer 2012, entire).

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pg. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders *et al.* 1991, entire). Burkey (1989, entire) 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, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, pg. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, pg. 645; Spruell *et al.* 1999, pp. 118-120; Rieman and Dunham 2000, pg. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Research does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho (Whiteley *et al.* 2003, entire), while Whitesel *et al.* identifies that bull trout fit the metapopulation theory in several ways (Whitesel *et al*., 2004, pg. 18-21).

HABITAT CHARACTERISTICS

The habitat requirements of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout throughout all hierarchical levels.

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, pg. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, pg. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, pg. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, pg. 2; Spruell *et al.* 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, pg. 137; Pratt 1992, pg. 5; Rieman and McIntyre 1993, pg. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, pg. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, pg. 4; Goetz 1989, pg. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham *et al.* (2003, pg. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, pg. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, pg. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, pg. 137; Goetz 1989, pg. 19; Hoelscher and Bjornn 1989, pg. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, pg. 238). Maintaining bull trout habitat requires stable and complex stream channels and stable stream flows (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pg. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, pg. 141; Pratt 1992, pg. 6; Pratt and Huston 1993, pg. 70). Pratt (1992, pg. 6) indicated that increases in fine sediment reduce egg survival and emergence.

DIET

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, pg. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout generally feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, pg. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz *et al.* 2004, pg. 105; WDFW *et al.* 1997, pg. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies and their environment. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources both within and between core areas. Connectivity between the spawning, rearing, overwintering, and forage areas maintains this diversity. There have been recent studies documenting movement patterns in the Columbia River basin that document long distance migrations (Borrows *et al*. 2016, entire; Schaller *et al*. 2014, entire; USFWS 2016, entire). For example, a data report documented a juvenile bull trout from the Entiat made over a 200-mile migration between spawning grounds in the Entiat River to foraging and overwintering areas in Columbia and Yakima River near Prosser Dam (PTAGIS 2015, Tag Code 3D9.1C2CCD42DD). As well, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW *et al.* 1997, pg. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz *et al.* 2004, entire).

CONSERVATION NEEDS

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: (1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable in six recovery units; (2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; (3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; (4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and (5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015a, pg. 24.).

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002, entire; 2004a, entire; 2004b, entire) provided information that identified the original list of threats and recovery actions across the range of the species and provided a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation. Many recovery actions were completed prior to finalizing the recovery plan in 2015.

The 2015 recovery plan (USFWS 2015a, entire) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the coterminous bull trout listing.

The Service has developed a recovery approach that: (1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; (2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and (3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the ESA are no longer necessary (USFWS 2015a, pg. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes the recovery of bull trout will entail effectively managing threats to ensure the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life history forms within each of six recovery units (USFWS 2015a, pg. 50-51)." The recovery plan defines four categories of recovery actions that, when implemented and effective, should:

1. Protect, restore, and maintain suitable habitat conditions for bull trout;
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity;
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout; and
4. Result in actively working with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change (USFWS 2015a, pg. 50-51).

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biological-based recovery units: (1) Coastal Recovery Unit; (2) Klamath Recovery Unit; (3) Mid-Columbia Recovery Unit; (4) Upper Snake Recovery Unit; (5) Columbia Headwaters Recovery Unit; and (6) Saint Mary Recovery Unit (USFWS 2015a, pg. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015a, pg. 33).

Each of the six recovery units contain multiple bull trout recovery areas which are non-overlapping watershed-based polygons, and each core area includes one or more local population. Currently there are 109 occupied core areas, which comprise 611 local populations

(USFWS 2015a, pg. 3, Appendix F). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015a, pg. 3, Appendix F). Core areas can be further described as complex or simple (USFWS 2015a, pg. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and foraging, migration, and overwintering habitats (FMO). Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A core area is a combination of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat) and constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area's likelihood to persist. A core area represents the closest approximation of a biologically functioning unit for bull trout. Core areas are presumed to reflect the metapopulation structure of bull trout.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015a, pg. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (*e.g.*, those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

POPULATION UNITS

The final recovery plan (USFWS 2015a, entire) designates six bull trout recovery units as described above. These units replace the five interim recovery units previously identified (USFWS 1999, entire). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015a, entire), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015b-g, entire), which identify recovery actions and conservation recommendations needed for each core area, forage/ migration/ overwinter (FMO) areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout's numbers and distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. For more details on Federal, State, and tribal conservation actions in this unit see the actions since listing, contemporaneous actions, and environmental baseline discussions below.

Coastal Recovery Unit

The Coastal RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b, entire). The Coastal Recovery Unit is divided into three Geographic Regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River regions. This recovery unit contains 20 core areas comprising 84 local populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011. This recovery unit also has four historically occupied core areas that could be re-established (USFWS 2015a, pg. 47; USFWS 2015b, pg. A-2).

Although population strongholds do exist across the three regions, populations in the Puget Sound region generally have better demographic status while the Lower Columbia River region exhibits the least robust demography (USFWS 2015b, pg. A-6). Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which allow for the continued natural population dynamics in which the core areas have evolved (USFWS 2015b, pg. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015a, pg.79; USFWS 2015b, pg. A-3). These are the most stable and abundant bull trout populations in the recovery unit. The Puget Sound region supports at least two core areas containing a natural adfluvial life history.

The demographic status of the Puget Sound populations is better in northern areas. Barriers to migration in the Puget Sound region are few, and significant amounts of headwater habitat occur in protected areas (USFWS 2015b, pg. A-7). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species (USFWS 2015b, pg. A-1 – A-25). Conservation measures or recovery actions implemented or ongoing include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats (USFWS 2015b, pg. A-33 – A-34).

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c, entire). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015a, pg. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015a, pg. 47; USFWS 2015c, pg. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015c, pg. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015c, pg. B-3). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices (UFWS 2015c, pg. B-13 – B-14).Conservation measures or recovery actions implemented or ongoing include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culver replacement, and habitat restoration (USFWS 2015c, pg. B-10 – B-11).

Mid-Columbia Recovery Unit

The Mid-Columbia RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d, entire). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and 7 FMO habitats (USFWS 2015a, pg. 47; USFWS 2015d, pg. C-1 – C-4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining (USFWS 2015d, pg. C-9 – C-34). Conservation measures or recovery actions implemented or ongoing include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements (USFWS 2015d, C-37 – C-40).

Columbia Headwaters Recovery Unit

The Columbia headwaters RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene geographic regions (USFWS 2015e, pg. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015e, pg. D-1). Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015e, pg. D-42), while others remain fragmented. Unlike other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap (USFWS 2015e, pg. D-

42). Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015e, pg. D-42). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development (USFWS 2015e, pg. D-10 – D-25). Conservation measures or recovery actions implemented or ongoing include habitat improvement, fish passage, and removal of nonnative species (USFWS 2015e, pg. D-42 – D-43).

Upper Snake Recovery Unit

The Upper Snake RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations, with over 70 percent being present in the Salmon River Region (USFWS 2015a, pg. 47; USFWS 2015f, pg. E-1 – E-2). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing) (USFWS 2015f, pg. E-15 – E-18). Conservation measures or recovery actions implemented or ongoing include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration (USFWS 2015f, pg. E-19 – E-20).

St. Mary Recovery Unit

The St. Mary RUIP describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015g, entire). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015g, pg. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species (USFWS 2015g, pg. F-7 – F-8). The primary issue precluding bull trout recovery in this recovery unit relates to impacts of water diversions, specifically at the Bureau of Reclamations Milk River Project (USFWS 2015g, pg. F-5). Conservation measures or recovery actions implemented or ongoing are not identified in the St. Mary RUIP; however, the Service is conducting interagency and tribal coordination to accomplish conservation goals for the bull trout (USFWS 2015g, pg. F-9).

FEDERAL, STATE AND TRIBAL ACTIONS SINCE LISTING

Since our listing of bull trout in 1999, numerous conservation measures that contribute to the conservation and recovery of bull trout have been and continue to be implemented across its range in the coterminous United States. These measures are being undertaken by a wide variety of local and regional partnerships, including State fish and game agencies, State and Federal land management and water resource agencies, Tribal governments, power companies, watershed working groups, water users, ranchers, and landowners.

In many cases, these bull trout conservation measures incorporate or are closely interrelated with work being done for recovery of salmon and steelhead, which are limited by many of the same threats. These include removal of migration barriers (culvert removal or redesign at stream crossings, fish ladder construction, dam removal, etc.) to allow access to spawning or FMO habitat; screening of water diversions to prevent entrainment into unsuitable habitat in irrigation systems; habitat improvement (riparian revegetation or fencing, placement of coarse woody debris in streams) to improve spawning suitability, habitat complexity, and water temperature; instream flow enhancement to allow effective passage at appropriate seasonal times and prevent channel dewatering; and water quality improvement (decommissioning roads, implementing best management practices for grazing or logging, setting pesticide use guidelines) to minimize impacts from sedimentation, agricultural chemicals, or warm temperatures.

At sites that are vulnerable to development, protection of land through fee title acquisition or conservation easements is important to prevent adverse impacts or allow conservation actions to be implemented. In several bull trout core areas, it is necessary to continue ongoing fisheries management efforts to suppress the effects of non-native fish competition, predation, or hybridization; particularly brown trout, brook trout, lake trout, and northern pike (DeHaan *et al.* 2010, entire; DeHaan and Godfrey 2009, entire; Rosenthal and Fredenberg 2017, pg. 2).

Projects that have undergone ESA section 7 consultation have occurred throughout the range of bull trout. Singly or in aggregate, these projects could affect the species' status.

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Enclosure 2

Conservation Recommendations for Lamprey and Mussels
Surrender and Decommissioning of the Lower Klamath Hydroelectric Project, Nos. 14803-001, 2082-063

CONSERVATION RECOMMENDATIONS FOR LAMPREY AND MUSSELS

December 21, 2021
Yreka Fish and Wildlife Office
(Adopted from the Oregon Fish and Wildlife Office)

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by implementing conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities designed to minimize or avoid adverse effects of a proposed action on listed species or designated critical habitat, to assist in the implementation of recovery plans or to obtain information. Although lamprey and mussels are not endangered or threatened species, they are both facing population declines. These conservation recommendations are meant to provide guidance on actions Federal agencies (an others) can take to conserve these species and help avoid the need to list these species in the future.

Pacific and Other Native Lamprey Species

The following recommendations are for Pacific lamprey (*Entosphenus tridentatus*), but may also benefit other species of lamprey (e.g. Klamath River lamprey (*Entosphenus similis*), Western brook lamprey (*Lampetra richardsonii*)). Considering Pacific lamprey during permitted in-water work for salmonids is important because their abundance and distribution has significantly declined throughout its range over the past three decades, and efforts to reverse this decline are needed (USFWS 2019[1]). Pacific lampreys are culturally important as a Tribal Trust species and have cultural significance to Native American tribes from California to Alaska (Close et al. 2002). Lamprey are also ecologically important as predators and as a food source for native fish and wildlife (Close et al. 2002).

While Pacific lamprey are anadromous (migrating up from the ocean to spawn in rivers) like salmon, there are differences. These differences are not typically considered during implementation of instream activities, when using design considerations and best management practices for salmonids. Adjustments to minimize adverse effects to Pacific lamprey can be made at the project design phase to accommodate lamprey passage, lamprey spawning periods, protect nests, provide upstream and downstream movement, and avoid direct mortality to larval lamprey burrowed in the substrate.

As adults, Pacific lamprey return from the ocean to fresh water mostly during spring and summer months, typically moving at night. They spend about 1 year in freshwater habitat before spawning, living under large substrates (e.g., large boulders, bedrock crevices) associated with slower water velocities. The following spring, they move to spawning areas. Adult lampreys spawn between March and July in gravel bottomed streams, usually at the upstream end of a riffle. These areas are near suitable habitat for larval lamprey (sometimes called ammocoetes). Adults die after spawning (Beamish 1980).

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[1] U.S. Fish and Wildlife Service. 2019. Pacific lamprey (*Entosphenus tridentatus*) Assessment. 283 pp. https://www.fws.gov/pacificlamprey/Documents/PacificLamprey_2018Assessment_final_02282019.pdf

After hatching, larval lamprey drift downstream to areas with slow water velocities and burrow into areas with sand or silt substrate, where they filter feed on algae, diatoms, and detritus for 3 to 7 years. Larvae can be difficult to detect since they range in size from about 0.2-15cm long. Larvae will move downstream during higher flow events, mostly at night. Many age classes of larvae will congregate together, often occurring in large clusters in depositional sites with fine sediments where habitat is optimal. This makes lamprey larvae particularly susceptible to activities that involve dredging, excavating, stranding, and use of toxic chemicals.

Metamorphosis of larval lamprey into the juvenile outmigrant form (sometimes called macrophthalmia) generally occurs from July through November but is variable depending on the distance to salt water. Out-migration to the ocean occurs during or shortly after transformation (Beamish 1980). Out-migration generally peaks with rising stream and river flows in late winter or early spring (Kostow 2002).

Lampreys provide substantial benefits to ecosystem health and water quality. Lampreys are prey for many different animal species, including 20 species of fish (both native and non-native), 11 species of birds, and 9 marine mammals (ODFW, 2020, p.119; Table A3.4). Because the caloric content of Pacific Lamprey is significantly higher than salmon (Close et al. 2002; Clemens et al. 2019 as cited in ODFW 2020), lampreys may serve as important "predation buffers" for salmonids. They are buffers because predators can be more likely to prey on lamprey than salmon.

Lampreys provide three types of ecological benefits. They are:

1) ecosystem engineers
2) nutrient suppliers to freshwater ecosystems and recyclers of nutrients within these systems
3) prey sources for other animals and predation buffers for salmonid species (ODFW 2020).

> "As 'ecosystem engineers' lampreys benefit the surrounding habitat in freshwater streams in ways that differ by life stage. For example, as adults, lampreys construct redds in which they spawn. Construction of these redds alters the streambed in ways that favor aggregations of aquatic insects that process stream nutrients and feed juvenile fishes (Hogg et al. 2014). In addition, the burrowing behavior of larval lamprey has been associated with increased water exchange between the stream and substrate in the streambed, increased oxygen in the substrate, and an increase in fine particulate matter on the surface of the substrate (Shirakawa et al. 2013; Boeker and Geist 2016).
>
> "Anadromous lampreys provide marine-derived nutrients to freshwater ecosystems (Close et al. 2002; Nislow and Kynard 2009). Their spawned-out carcasses decay and release nutrients into the surrounding water (Weaver et al. 2015). These nutrients are assimilated by aquatic insects (Weaver et al. 2016), which may be consumed by juvenile salmonids. As nutrient recyclers, larval lamprey feed on detritus and algae and convert these food sources into energy stored as animal (larval lamprey) tissue (Close et al. 2002) that is then available to larger predators that eat them. Lampreys are a prey source for humans (see below) and many different animals (Table A3.4).
>
> "Larval and juvenile lampreys migrating downstream may focus the attention of predatory fishes and birds, thereby potentially offering a predation reprieve for juvenile salmon and steelhead.

> Similarly, the high caloric content, ease of capture (relative to salmonids), and the tendency to migrate in schools may make Pacific Lamprey desirable prey sources for pinnipeds, thereby buffering adult salmon and steelhead from predation (Close et al. 2002)."

Threats to Pacific Lampreys

Threats to lampreys include:

- Lack of awareness and corresponding conservation
- Poor passage conditions and entrainment
- De-watering and streamflow management from water diversions, instream projects, and hydropower peaking
- Dredging from construction, channel maintenance, and mining activities
- Chemical poisoning from accidental spills or chemical treatments
- Poor water quality
- Stream and floodplain degradation (channelization, loss of side channels, scouring).

Many of the same threats to anadromous salmon also impact Pacific lamprey and so best management practices for salmon also benefit lamprey. However, lamprey have some unique life-history aspects that are not often considered during implementation of instream activities

Lamprey Recommendations: Species-specific adjustments to minimize adverse effects to Pacific lamprey can be made during project design and implementation to accommodate lamprey passage, lamprey spawning periods, protect nests, provide upstream and downstream movement, and avoid direct mortality to larval lamprey burrowed in the substrate.

Biological considerations of lamprey should be incorporated into project design, objectives, salvage and best management practices for the protection and conservation of this species. Such efforts collectively may reduce the need for future ESA listings. Currently there are several guidance documents available to assist in such actions:

1. *Best Management Guidelines for Native Lampreys during In-Water Work* (Lamprey Technical Workgroup 2020) https://www.fws.gov/pacificlamprey/Documents/2020%20Lamprey%20BMG%20Final.pdf covers a broad spectrum of actions including biology, salvage during dewatering actions, habitat restoration, screening, and passage and includes case studies.

2. *Practical Guidelines for Incorporating Adult Pacific Lamprey Passage at Fishways* (Lamprey Technical Workgroup 2017) (https://www.fws.gov/pacificlamprey/Documents/2017.06.20%20LampreyPsgFINAL.pdf) includes specific guidance on providing upstream passage within existing fishways and in new fishway designs, and includes case studies.

3. *Barriers to Adult Pacific Lamprey at Road Crossings: Guidelines for Evaluating and Providing Passage* https://www.fws.gov/pacificlamprey/Documents/LTW_2020_LampreyPassage@RdXings_Final_062920.pdf (Lamprey Technical Workgroup 2020) includes culvert passage

assessments and recommendations for lamprey passage, and includes case studies. Available: https://www.fws.gov/pacificlamprey/LTWGMainpage.cfm

4. Additional documents, information, materials and updates may be found on the website for the Pacific Lamprey Conservation Initiative's Lamprey Technical Workgroup: https://www.fws.gov/pacificlamprey/LTWGMainpage.cfm

Lamprey Reporting
So, we can be kept informed of actions that minimize or avoid adverse effects or that benefit Pacific lamprey, other lamprey species, and their habitats, we request notification if the above conservation recommendations are implemented. Please send documents to:

U.S. Fish and Wildlife Service
Yreka Fish and Wildlife Office
Attn: Jenny Ericson
1829 South Oregon Street
Yreka, CA 96097

Freshwater Mussels

Freshwater mussels are culturally, ecologically, and environmentally important. The western ridged mussel (*Gonidea angulata)* was petitioned to be listed by the Xerces Society on August 18, 2020. The Service has added it to their list to determine if it warrants protection under the ESA. The finding is scheduled for 2024.

We recommend that Action Agencies (and others) consider the biological needs of native freshwater mussel species for instream or near-stream projects. All three genera of western freshwater mussels are present in the Klamath Basin: *Gonidea, Margaritifera* and *Anodonta.* The Xerces Society for Invertebrate Conservation (Xerces Society) maintains a great resource for western freshwater mussels at https://xerces.org/endangered-species/freshwater-mussels. To paraphrase from the Xerces Society's website:

> "Freshwater mussels are experiencing a dramatic decline; 72% percent of North American freshwater mussels are considered extinct or imperiled, representing one of the most at-risk groups of animals in the United States. The decline of freshwater mussels has been well studied in eastern North America but has received very little attention in states west of the Rocky Mountains….
>
> "Native freshwater mussels have immense ecological and cultural significance. As filter-feeders, they can substantially improve water quality by filtering out harmful pollutants, which benefits both humans and aquatic ecosystems…. These animals can be highly sensitive to environmental changes and thus have great potential to be used as indicators of water quality. Freshwater mussels have been historically important sources of food, tools, and other implements for many Native American tribes. Native Americans in the interior Columbia Basin have harvested these animals for at least 10,000 years, and they remain an important cultural heritage for tribes today."

Mussel Recommendations: Freshwater mussel conservation should be incorporated into project designs, considered in project objectives, evaluated for salvage and relocation, and included in best management practices.

- The Xerces Society has developed a publication "*Conservation the Gems of Our Waters: Best Management Practices for Protecting Native Western Freshwater Mussels during Aquatic and Riparian Restoration, Construction, and Land Management Projects and Activities* (Blevins et al. 2017), and a companion handbook, *Mussel Friendly Restoration* (Blevins et al. 2019)- both available online at https://xerces.org/publications/guidelines/mussel-friendly-restoration. These documents include information on determining if mussels are present at your site, considering mussels in project development and review, methods for salvage and relocation of mussels, monitoring of mussels, and practices for minimizing project impacts to mussels for several different activities (i.e. construction, vegetation management, flow management, restoration).

- The Xerces Society website also has a field identification guide developed by the Xerces Society and Confederation Tribes of the Umatilla Indian Reservation at https://pnwmussels.org/wp-content/uploads/2016/07/QuickMusselGuide_CTUIR.pdf

Freshwater Mussels Reporting

So, we can be kept informed of actions that minimize or avoid adverse effects or that benefit Pacific lamprey, other lamprey species, and their habitats, we request notification if the above conservation recommendations are implemented. Please send documents to:

U.S. Fish and Wildlife Service
Yreka Fish and Wildlife Office
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Yreka, CA 96097

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