UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation
PacifiCorp

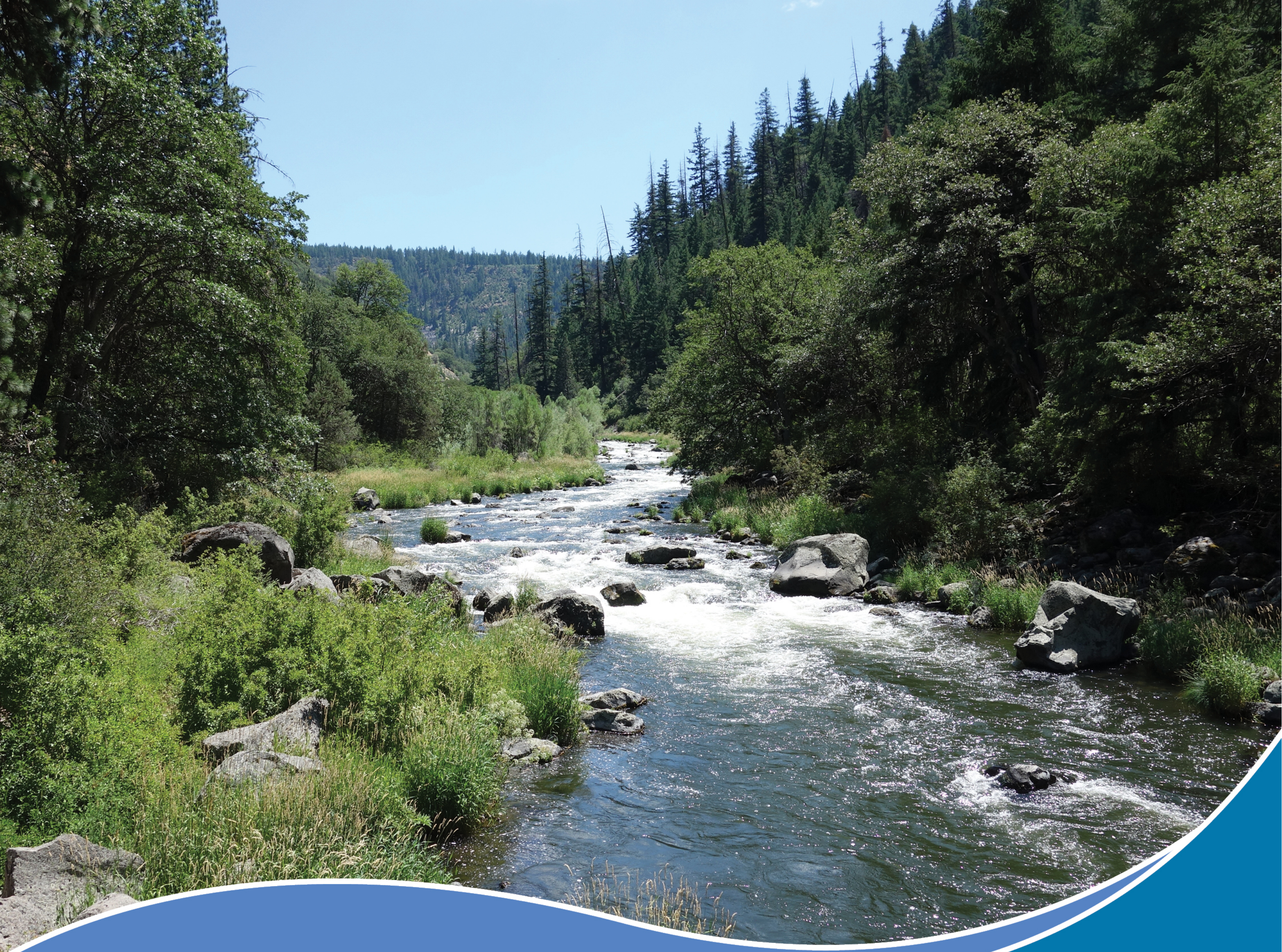
Project Nos. 14803-001;
2082-063

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

Attachment A-12

Lower Klamath Project Biological Assessment

Appendix K
(Essential Fish Habitat Assessment)



Biological Assessment

Appendix K – Essential Fish Habitat Assessment

KLAMATH RIVER RENEWAL CORPORATION

March 2021

Prepared for:

Klamath River Renewal Corporation

Prepared by:

Renewal Corporation Technical Representatives:

AECOM Technical Services, Inc.
300 Lakeside Drive, Suite 400
Oakland, California 94612

CDM Smith
1755 Creekside Oaks Drive, Suite 200
Sacramento, California 95833

River Design Group
311 SW Jefferson Avenue
Corvallis, Oregon 97333

K. ESSENTIAL FISH HABITAT ASSESSMENT

References cited in this appendix are listed in Chapter 8 of the BA.

K.1 Essential Fish Habitat Background

EFH is designated for commercially fished species under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Act). The Magnuson-Stevens Act requires federal fishery management plans, developed by National Oceanic and Atmospheric Administration's NMFS and the Pacific Southwest Fisheries Management Council, to describe the habitat essential to the fish being managed, and to describe threats to that habitat from both fishing and non-fishing activities. Pursuant to Section 305(b) of the Magnuson-Stevens Act (16 U.S.C. Section 1855(b)), federal agencies are required to consult with NMFS on actions that may adversely affect EFH for species managed under the Pacific Coast Salmon Fishery Management Plan.

The objective of this EFH assessment is to determine whether or not the Proposed Action may adversely affect designated EFH for relevant commercially or federally managed fisheries in the proposed Action Area. EFH has been designated for 3 salmon species, 83 groundfish species, and 5 coastal pelagic species. Descriptions of EFH in the area of analysis are provided below.

K.1.1 Chinook salmon and coho salmon

Chinook salmon and coho salmon are managed under the Magnuson-Stevens Act, under the authority of which EFH for coho salmon is described in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan (50 CFR Section 660.412). EFH for Chinook salmon and coho salmon in the Klamath Basin has been designated for the mainstem Klamath River and its tributaries from its mouth to Keno Dam, and upstream to Lewiston Dam on the Trinity River, a tributary to the Klamath River. EFH includes the water quality and quantity necessary for successful adult migration, and holding, spawning, fry, and parr habitat, smolt migration, and estuarine rearing for coho salmon and Chinook salmon.

K.1.2 Groundfish

NMFS defined EFH to include those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. Section 1802 (10)). EFH for Pacific Coast groundfish includes all waters and substrate in areas with a depth less than or equal to 11,483 feet shoreward to the mean higher high water level, or the upriver extent of saltwater intrusion (defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow). The Klamath River estuary, which extends from the Klamath River mouth upstream about 2 miles (Klamath Facilities Removal EIS/EIR), is included in the Pacific groundfish EFH (50 CFR Section 660.395).

K.1.3 Coastal pelagic species

EFH for coastal pelagic species, including finfish (northern anchovy, Pacific sardine, Pacific (chub) mackerel, and jack mackerel) and market squid occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone (3 to 200 miles offshore), and above the thermocline where sea surface temperatures range from 10 to 26°C. During colder winters, the northern extent of EFH for coastal pelagic species may be as far south as Cape Mendocino, and during warm summers it may extend into Alaska's Aleutian Islands. In each of these seasonal examples, the Klamath Estuary and coastline will be included as EFH for these species.

K.2 Proposed Action

A description of the Proposed Action is included in Section 2 of the BA.

K.3 Essential Habitat Requirements for Chinook Salmon and Coho Salmon

K.3.1 Fall-run Chinook salmon

Fall-run Chinook salmon (*Oncorhynchus tshawystcha*) are distributed throughout the Klamath River downstream of Iron Gate Dam. Historical records reviewed by Hamilton et al. (2016), genetic information obtained from archeological sites analyzed by Butler et al. (2010), and first-hand accounts reviewed by Lane and Lane (1981), indicate that prior to the construction of Copco No. 1 Dam, Chinook salmon spawned in the tributaries upstream of Upper Klamath Lake, including the Sprague, Williamson, and Wood rivers.

Adult upstream migration through the estuary and lower Klamath River peaks in early September, and continues through late October (Moyle 2002, FERC 2007, Strange 2009). The ability for Chinook salmon to find their way back to their home stream to spawn is mainly related to the long-term olfaction memory of the salmon but is also aided by their vision (Healey 1991) and may be stimulated by higher streamflow and changes in water turbidity, temperature, and oxygen content (Allen and Hassler 1986). Optimal migratory routes are free of barriers that can impede or prevent movement upstream and downstream.

Spawning peaks in late October and early November. In general, spawning Chinook salmon require gravel and cobble areas, primarily at the head of riffles, with adequate hyporheic flow to increase the probability of embryo survival. Chinook salmon select gravel for spawning with a median diameter between 1.3 to 10.2 centimeters (Bjornn and Reiser 1991).

During incubation, sufficient water must circulate through the redd as deep as the egg pocket to supply the embryos with oxygen and carry away waste products (Bjornn and Reiser 1991). Infiltration of fine sediment into redds may reduce water circulation in the redd and reduce survival of incubating eggs. Fall-run Chinook salmon fry in the Klamath River emerge from redds between December and late February (Klamath Facilities Removal EIS/EIR), although timing may vary somewhat depending on temperatures in different years and tributaries. Fine sediment deposition or capping of redds can impede emergence of fry. Bjornn and Reiser (1991) reported that in laboratory studies, swim-up fry had difficulty emerging from substrate when the percentage of fine sediment exceeded 30 to 40 percent by volume.

Fall-run Chinook salmon in the Klamath Basin exhibit three juvenile life-history types: Type I (ocean entry at age-0[1] in early spring within a few months of emergence); Type II (ocean entry at age-0 in fall or early winter); and Type III (ocean entry at age-1 in spring) (Sullivan 1989). Based on outmigrant trapping data collected at Big Bar on the Klamath River from 1997 to 2000, Scheiff et al. (2001) concluded that 63 percent of natural Chinook salmon outmigrants are Type I, 37 percent are Type II, and less than 1 percent are Type III. Although juvenile Chinook salmon can tolerate relatively high turbidity conditions for short periods of time, excessive SSCs can degrade rearing and smolting habitat quality to the point where reduced growth rates, extreme stress, or mortality can occur (Newcombe and Jensen 1996). Excessive SSCs can also degrade adult migration habitat through pool filling and water quality impairment. Adult Chinook salmon may respond to these conditions by entering non-natal tributary streams to spawn.

K.3.2 Spring-run Chinook salmon

Spring-run Chinook salmon in the Klamath Basin are distributed mostly in the Salmon and Trinity rivers and on the mainstem below these tributaries during migratory periods, although a few fish are occasionally observed in other areas (Stillwater Sciences 2009a). Based on data from 1992 to 2001 (CDFG 2004, unpublished data), the Salmon River contributions to the overall escapement ranged from 1 to 20 percent of the total escapement, and from 2 to 35 percent of the natural escapement. No spawning has been observed in the mainstem Klamath River (Shaw et al. 1997). Spring-run Chinook salmon are believed to have used habitat upstream of Upper Klamath Lake historically (Hamilton et al. 2005, Butler et al. 2010, Hamilton et al. 2016).

There appear to be three juvenile life-history types for spring-run Chinook salmon in the Klamath Basin: Type I (ocean entry at age-0 in early spring within a few months of emergence); Type II (ocean entry at age-0 in fall or early winter [Olson 1996]); and Type III (ocean entry at age-1 in spring) (Sullivan 1989). Based on outmigrant trapping in the Salmon River from 2001 to 2006 (Karuk Tribe, unpublished data), around 80 percent of outmigrants are Type I, 20 percent are Type II, and less than 1 percent are Type III. Rearing of age-0 juveniles likely occurs to some extent in the mainstem Klamath River, although it appears that the majority remain to rear in their natal streams (i.e., Salmon and Trinity rivers). It is unclear to what extent juvenile spring-run Chinook salmon rear in the mainstem Trinity and Klamath rivers, because trapping studies do not differentiate between the spring and fall runs.

Spring-run Chinook salmon upstream migration occurs during two time periods: spring (April through June); and summer (July through August) (Strange 2008). Snyder (1931) also described a run of Chinook salmon

[1] A fish emerging in spring is designated as age 0 until January 1 of the following year, when it is designated as age 1 until January 1 of the next year, when it is designated age 2.

occurring in Klamath River during July and August under historical water quality and temperature conditions. Adults spawn from mid-September to late October in the Salmon River, and from September through early November in the South Fork Trinity River (Stillwater Sciences 2009a). Fry emergence begins in March and continues until early June (West et al. 1990). Spawning, incubation, rearing, and smolting habitat characteristics for spring-run Chinook salmon are similar to those of fall-run Chinook salmon.

Age-0+ juveniles rearing in the Salmon River emigrate at various times of the year, with one of the peaks of outmigration occurring in April through May (Olson 1996), which will be consistent with a Type I life history type. Based on outmigrant trapping from April to November in 1991 at three locations in the South Fork Salmon River, Olson (1996) reported that greatest peak in outmigration of age-0+ juveniles (69 percent) was in mid-October, which will be considered Type II life history. Scale circuli patterns of adults with an identified Type II life history were consistent with those from juveniles outmigrating in mid-October. Sullivan (1989) reported that outmigration of Type II age-0+ juveniles can occur as late in the year as early winter. On the South Fork Trinity River, outmigration occurs in late April and May, with a peak in May (Dean 1994, 1995). Age-1 juveniles (Type III) have been found to outmigrate from South Fork Trinity River during the following spring (Dean 1994, 1995).

It is unclear how much time the outmigrating age-0+ spring-run Chinook salmon spend in the mainstem Klamath River and estuary before entering the ocean. Sartori (2006) identified a period of increased growth (estimated mean of 24 days) just prior to reaching an estuarine environment based on otolith analyses of returning adults to the Salmon River, but this period was never clearly linked to mainstem residence.

K.3.3 Coho salmon

See Appendix G of the BA for a description of coho salmon life history and habitat requirements.

K.4 Effects of the Action

The EFH implementing regulations, 50 CFR Section 600.810(a), define the term "adverse effect" as any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring in EFH or outside of EFH, and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

K.4.1 Chinook salmon and coho salmon

EFH for Chinook salmon and coho salmon in the Action Area includes the water quality and quantity necessary for successful adult migration, and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile Chinook salmon and coho salmon. The Proposed Action includes reservoir drawdown and sediment release from July of the year before drawdown through September of the drawdown year (Year 1). Dam removal begins soon thereafter. Some retained sediment that is trapped in the post-dam removal reservoir areas may be mobilized during the fall and winter of Year 1/2. This release of sediment, as well as low dissolved oxygen concentrations associated with the sediment release, will affect Chinook salmon and coho salmon EFH.

K.4.1.1 Adult Migration Habitat

Fall-run Chinook salmon

Adult fall-run Chinook salmon in the Klamath River migrate upstream from mid-July through October, when suspended sediment levels are generally low, and adults typically take 2 to 4 weeks to reach their spawning grounds. Under the Proposed Action, SSCs in the mainstem Klamath River during the pre-drawdown year migratory period are predicted to be similar to background conditions, since only minor activities will have begun. Therefore, no adverse effect to adult fall-run Chinook salmon migration habitat is expected during the fall prior to Year 1.

Two impact year conditions were determined for fall-run Chinook salmon based on calculated suspended sediment concentration (SSC) effects on fall-run Chinook salmon life stages during the Proposed Action. The median impact year is represented by the 1991 water year (WY). Fall-run Chinook salmon life stages experienced moderate levels of mortality primarily associated with high SSCs during the drawdown year. The severe impact year is represented by the 1973 WY. Under the severe impact year, fall-run Chinook salmon life stages experienced more extreme levels of mortality associated with high SSCs during the drawdown year.

Under median impact year conditions during the drawdown year, adult fall-run Chinook salmon experienced 14-day exposures to median SSCs ranging from 50 mg/L to 389 mg/L over the July 15 to December 1 migration period. High SSCs and the 14-day exposure periods correlated to severity (SEV) of ill effects values (Newcombe and Jensen 1996) ranging from 7 to 9. The SEV values correspond with sublethal effects and behavioral responses including impaired homing. Under severe impact year conditions during the drawdown year, adult fall-run Chinook salmon will be exposed to median SSCs ranging from 25 mg/L to 503 mg/L, corresponding with SEV values of 7 to 9. Adult fall-run Chinook will exhibit similar behavioral responses relative to the median impact year conditions.

During Year 2, median SSC levels will range from 5 mg/L to 14 mg/L under median impact year conditions, and from 2 mg/L to 3 mg/L under severe impact year conditions. Adult fall-run Chinook salmon will experience sublethal effects with the most extreme behavioral response limited to minor physiological stress.

Therefore, in the short term, the Proposed Action may have an adverse effect on fall-run Chinook salmon migration habitat quality downstream of Iron Gate Dam during the summer and fall of Year 1. Over the long term, the Proposed Action will not have an adverse effect on migration habitat as fine sediments are transported by high flow events and habitat conditions return to background levels.

Spring-run Chinook salmon

Spring-run Chinook upstream migration is separated into spring and summer time periods. Under the Proposed Action, spring-run migrants are expected to be exposed to background SSC levels during the pre-drawdown year migration period. Since spring-run Chinook salmon primarily spawn in the Trinity River and the Salmon River, the Orleans water quality station was used to assess SSC effects. During the pre-drawdown migration period, adult spring-run Chinook salmon will experience near 0 mg/L SSCs under both median and severe impact years. No behavioral effects are anticipated.

During the drawdown year, adult spring-run Chinook salmon will experience median SSCs ranging from 18 mg/L to 187 mg/L under median impact year conditions, and SSCs ranging from 20 mg/L to 248 mg/L under severe impact year conditions. SEV values range from 7 to 8 for both impact year conditions, resulting in sublethal behavioral responses including impaired homing and major physiological stress.

During Year 2, median SSC levels at the Orleans water quality station return to background conditions and SSCs approach 0 mg/L. **Therefore, in the short term, the Proposed Action may have an adverse effect on spring-run Chinook salmon migration habitat quality downstream of Iron Gate Dam during the summer and fall of the drawdown year. Over the long term, the Proposed Action will not have an adverse effect on migration habitat as fine sediments are transported by high flow events and habitat conditions return to background levels.**

The Renewal Corporation anticipates the release of trapped bedload sediment from the reservoirs to result in at least partial pool filling downstream of Iron Gate Dam. The effects of the bedload release are not expected to extend beyond Elk Creek, which is approximately 86 miles downstream of Iron Gate Dam. The nearest spawning population of spring-run Chinook salmon occurs in the Salmon River, which is about 120 miles downstream of Iron Gate Dam and will not be affected by the Proposed Action's sediment release. **Therefore, the Proposed Action will result in no adverse effect to holding habitat for migrating adult spring-run Chinook salmon in the short term or in the long term.**

Coho salmon

Adult coho salmon in the Klamath River migrate upstream from early September through early January, when suspended sediment levels are generally low, and adults typically take 2 to 4 weeks to reach their spawning grounds. Two impact year conditions were determined for coho salmon based on calculated SSC effects on coho salmon life stages during the Proposed Action. The median impact year is represented by the 1991 WY. Coho salmon life stages experienced moderate levels of mortality primarily associated with high SSCs during the drawdown year. The severe impact year is represented by the 1970 WY. Under the severe impact year, coho salmon life stages experienced more extreme levels of mortality associated with high SSCs during the drawdown year.

Under median impact year conditions during the drawdown year, migrating adult coho salmon experienced 14-day exposures to median SSCs ranging from 52 mg/L to 194 mg/L, correlating to SEV values of 7 to 8. The SEV values correspond with sublethal effects and behavioral responses including major physiological stress and impaired homing. Under severe impact year conditions during the drawdown year, adult coho salmon will be exposed to median SSCs ranging from 38 mg/L to 123 mg/L, corresponding with SEV values of 7 to 8. Adult coho salmon will exhibit similar behavioral responses relative to the median impact year conditions.

The sediment model predicts SSCs through September 30 in Year 2, only capturing the beginning of the adult coho salmon migration. SSCs at the beginning of the migration period under both the median and severe impact years are less than 15 mg/L, which corresponds to sublethal effects including minor to moderate stress.

Therefore, in the short term, the Proposed Action may have an adverse effect on coho salmon migration habitat quality downstream of Iron Gate Dam during the drawdown year. Over the long term, the Proposed Action will not have an adverse effect on migration habitat as fine sediments are transported by high flow events and habitat conditions return to background levels.

K.4.1.2 Spawning Habitat

Fall-run Chinook salmon

The Klamath River from Iron Gate Dam (RM 193.1) to Cottonwood Creek (RM 185.1) is characterized by coarse, cobble-boulder bars immediately downstream of the dam, transitioning to a cobble bed with pool-riffle morphology farther downstream near Cottonwood Creek (Montgomery and Buffington 1997, PacifiCorp 2004b, Stillwater Sciences 2010). The D_{16} (the substrate particle diameter where 16 percent of the material is finer than) immediately downstream of Iron Gate Dam is not less than 0.7 inch (18 millimeter) (PacifiCorp 2004b, USBR 2011b), which indicates that the sand component is less than 16 percent of the bed material.

There will be an increase in sand content during the drawdown year in the Iron Gate Dam to Bogus Creek (RM 192.6) reach. The percent of sand in the bed is expected to increase to over 20 percent in a dry-year scenario and to 8 percent for median- and wet-year scenarios at two years after drawdown begins. Sand content downstream of Bogus Creek does not increase above 5 percent at any location downstream of Bogus Creek in the first two years after drawdown begins. Sand content could continue to increase in the reach from Iron Gate Dam to Cottonwood Creek for an additional year or two as sand retained in Iron Gate Reservoir is released. Therefore, several additional years of flushing flows, depending on hydrology, could be required to return the sand content to equilibrium levels in the reach from Iron Gate Dam to Cottonwood Creek. A flushing flow is expected to require at least 6,000 cfs for several days to weeks to return the bed composition to mostly cobble and gravel, with a sand content less than 20 percent (USBR 2011b). Based on the historical record, a sufficient flushing flow will likely occur within 5 years following dam removal.

The reach between Iron Gate Dam and Ash Creek (RM 177.8) provides habitat for between 26 and 71 percent of the mainstem Chinook salmon that spawn in the river between Iron Gate Dam and Indian Creek (RM 108.3) (Magneson and Wright 2010). The sand component in the released reservoir bedload could degrade spawning habitat quality in the reach for several years. Braided conditions associated with sediment pulses near Bogus Creek and upstream of Iron Gate Dam could hinder passage for several years. However, once the sediment pulses are reduced in thickness, restored passage through the Hydroelectric

Reach will increase the amount of fall-run Chinook salmon spawning habitat availability. Additionally, over time, as fine sediments are transported from spawning gravels, fall-run Chinook salmon spawning habitat downstream of Iron Gate Dam will improve. **Therefore, the Proposed Action will have an adverse effect on fall-run Chinook salmon spawning habitat in the short term, but a beneficial effect in the long term.**

Spring-run Chinook salmon

Spring-run Chinook salmon spawn primarily in the Salmon and Trinity rivers, with the vast majority (approximately 95 percent) spawning in the Trinity River. Spring-run Chinook salmon are not known to spawn in the mainstem Klamath River. **Therefore, the Proposed Action will have no adverse effect on EFH for spring-run Chinook salmon spawning habitat in the short term. Over time, as spring-run Chinook salmon recolonize historical habitat in and upstream of the Hydroelectric Reach, the Proposed Action will have a long-term beneficial effect on spring-run Chinook salmon spawning habitat.**

Coho salmon

Coho salmon are typically tributary spawners (NMFS 2010a), Based on mainstem spawning from 2001 to 2016 (USFWS 2016), six coho salmon redds, on average, were observed in the mainstem Klamath River. Even though coho salmon spawning habitat is limited in the mainstem Klamath River, it will be adversely affected by the reservoir drawdown and sediment release from the Proposed Action. Similar to the previous analysis of fall-run Chinook salmon spawning habitat, suitable substrate conditions will return once flushing flows have redistributed sediment pulse sediments and restored natural supply and transport processes. **Therefore, due to the low number of redds affected by the Proposed Action, the Proposed Action may have an adverse effect on coho salmon spawning habitat in the short term. The Proposed Action will have a beneficial effect on coho salmon spawning habitat over the long term as coho salmon have access to historical spawning habitat in the Hydroelectric Reach tributaries.**

K.4.1.3 Egg-to-Fry Survival Habitat

Fall-run Chinook salmon

Fall-run Chinook salmon spawning in the Klamath Basin typically peaks in late October and substantially declines by the end of November (Shaw et al. 1997). Up to 4,600 redds (about 8 percent of the Klamath Basin's production) in the mainstem, and the fry associated with the redds, will suffer 100 percent mortality during the reservoir drawdown period. This effect will be caused by reservoir drawdown-released sediment infiltrating spawning gravel interstices and redds and locally by bedload burial below Iron Gate Dam. Under the median impact year conditions, anoxic conditions associated with the high SSC levels are expected to occur over two days in mid-January and extend 30 miles from Iron Gate Dam (RM 193.1) downstream to between the Shasta River and Scott River confluences.

There will be an increase in sand content during the drawdown year in the Iron Gate Dam to Bogus Creek (RM 192.6) reach. The percent of sand in the bed is expected to increase to over 20 percent in a dry-year scenario and to 8 percent for median- and wet-year scenarios at two years after drawdown begins. Sand content downstream of Bogus Creek does not increase above 5 percent at any location downstream of

Bogus Creek in the first two years after drawdown begins. Sand content could continue to increase in the reach from Iron Gate Dam to Cottonwood Creek for an additional year or two as sand retained in Iron Gate Reservoir is released. Therefore, several additional years of flushing flows, depending on hydrology, could be required to return the sand content to equilibrium levels in the reach from Iron Gate Dam to Cottonwood Creek. **Therefore, the Proposed Action will have an adverse effect on incubation habitat for fall-run Chinook salmon in the short term. However, as fines are flushed from incubation habitats, dissolved oxygen levels recover, deposited sediment is redistributed, and fall- run Chinook salmon have access to historical incubation habitat upstream of Iron Gate Dam, the Proposed Action will have a beneficial effect on fall-run Chinook salmon incubation habitat over the long term.**

Spring-run Chinook salmon

Because no spring-run Chinook salmon spawning occurs in the mainstem Klamath River under existing conditions, the Renewal Corporation does not anticipate incubation habitat for this species being affected by suspended sediment resulting from the Proposed Action. **However, over the long term, as fine sediment is transported from incubation habitat downstream of Iron Gate Dam and spring-run Chinook salmon return to historical spawning and incubation habitats, the Proposed Action will have a beneficial effect on spring-run Chinook salmon incubation habitat.**

Coho salmon

Similar to the previous analysis of fall-run Chinook salmon egg-to-fry survival, suspended sediment resulting from the Proposed Action is predicted to infiltrate spawning gravel interstices and redds, which will result in up to 100 percent mortality of eggs and fry in the approximately six coho redds that the Renewal Corporation anticipates will be in the mainstem Klamath River downstream of Iron Gate Dam. The effects of the sediment infiltration will persist until flushing flows occur. Therefore, the Proposed Action will have an adverse effect on mainstem Klamath River incubation habitat for coho salmon in the short term. **However, over the long term, as fine sediment is transported from incubation habitat downstream of Iron Gate Dam and as coho salmon return to historical spawning and incubation habitats, the Proposed Action will have a beneficial effect on coho salmon incubation habitat.**

K.4.1.4 Fry Rearing Habitat

Fall-run Chinook salmon

The Renewal Corporation anticipates SSCs experienced in the mainstem Klamath River during the reservoir drawdown and dam removal (100 to 17,000 mg/L under the severe impact year scenario at the Iron Gate Dam water quality station) to result in degraded fry rearing conditions in Year 1, and the winter and spring of Year 2. These SSCs will result in major stress, reduced growth rates, and/or mortality for individuals rearing in the mainstem Klamath River. The Renewal Corporation anticipates SSCs to return to background levels by the fall of Year 2 at Iron Gate and by the fall of Year 1 at Seiad Valley and Orleans. SSCs that are higher than background levels will persist in the Iron Gate Dam reach through Year 2 but will gradually decrease as the sediment deposits in the reservoir footprints become stabilized and revegetated. **Therefore, the Proposed**

Action will have an adverse effect on fry rearing habitat on the mainstem Klamath River in the short term. However, as fines are flushed from rearing habitats and fall-run Chinook salmon have access to historical rearing habitat upstream of Iron Gate Dam, the Proposed Action will have a beneficial effect on fall-run Chinook salmon rearing habitat over the long term.

Spring-run Chinook salmon

Spring-run Chinook salmon fry rearing takes place primarily in tributary streams. It is possible that an unknown percentage of spring-run Chinook salmon fry move into the mainstem Klamath River and rear. Those fish will be subject to high SSCs as described above, which will result in lethal to para-lethal effects. However, fry will most likely rear in the Lower Klamath River, where SSCs are anticipated to return to background levels by the winter of Year 1. **Therefore, the Proposed Action will have an adverse effect on fry rearing habitat for spring-run Chinook salmon in the short term. However, over the long term, as fine sediment is transported from rearing habitat downstream of Iron Gate Dam and spring-run Chinook salmon return to historical spawning and rearing habitats, the Proposed Action will have a beneficial effect on spring-run Chinook salmon rearing habitat.**

Coho salmon

Although most (assumed greater than 50 percent) age-0+ juvenile coho salmon rearing is believed to occur in tributaries, age-0 juveniles are observed outmigrating from tributaries in spring and early summer. Age-0+ coho salmon will be exposed to SSCs that will result in major physiological stress, reduced growth (possibly no growth at all), and/or mortality for individuals rearing in the mainstem. Modeling shows the SSCs will return to background levels by the spring of Year 2 downstream of the Seiad Valley. SSCs that are higher than background levels will persist downstream of Iron Gate Dam through Year 2, but will gradually decrease as the sediment deposits in the reservoir footprints become stabilized and revegetated. **Therefore, the Proposed Action will have a short-term adverse effect on coho salmon rearing habitat in the mainstem Klamath River. Over the long term, as fine sediment is transported from rearing habitat downstream of Iron Gate Dam and as coho salmon return to historical rearing habitats in the Hydroelectric Reach tributaries, the Proposed Action will have a beneficial effect on coho salmon rearing habitat.**

K.4.1.5 Smolt Migration Habitat

Fall-run Chinook salmon

Approximately 60 percent of the fry produced by fall-run Chinook salmon in the Klamath River exhibit the Type I life history, in which they enter the ocean within a few months of emergence in early spring. Under the Proposed Action, SSCs in the mainstem during Year 1 will degrade smolt migration habitat. Median SSCs will range from 72 mg/L to 1,545 mg/L under the median impact year scenario, to 84 mg/L to 1,433 mg/L under the severe impact scenario. SSC levels correspond with SEV values of 8 to 10, signifying sublethal and lethal effects on outmigrating juvenile fall-run Chinook salmon downstream of Iron Gate Dam. Under the Proposed Action, SSCs could severely degrade smolt migration habitat, and cause up to 20 percent mortality during a quarter of the outmigration period under the median impact year scenario, and up to three quarters of the outmigration period under the severe impact year scenario. SSCs will return to background levels by the fall of Year 1 downstream of Seiad Valley. SSCs that are higher than background level will persist in the Iron Gate Dam reach through the fall of Year 2, but SSCs will gradually decrease as the sediment deposits in the reservoir footprints become stabilized and revegetated.

The Type II life history is also common (approximately 40 percent of cohort) (Sullivan 1989). These juveniles remain to rear in their natal tributaries and will only be exposed to suspended sediment in the mainstem during their outmigration to the ocean in the fall. Under the Proposed Action, SSCs would be sublethal during the fall with the highest SEV values (8 to 9) at the Iron Gate and Seiad Valley water quality stations. SSCs would be high enough to cause moderate to major physiological stress.

Type III life-history fish are relatively rare (fewer than 1 percent of production) in the Klamath River fall-run Chinook salmon population (USFWS 2001). These fish typically remain to rear in their natal tributaries and outmigrate in late winter and early spring as yearlings. Under the Proposed Action, SSCs could severely degrade smolt migration habitat, and cause up to 20 percent mortality during a quarter of the outmigration period under the median impact year scenario, and up to three quarters of the outmigration period under the severe impact year scenario.

SSCs that are higher than background level will persist for a few years but gradually decrease as the sediment deposits in the reservoir footprints become stabilized and revegetated. **Therefore, the Proposed Action will have an adverse effect on fall-run Chinook salmon smolt migration habitat on the mainstem Klamath River in the short term.**

In the long term, the Renewal Corporation anticipates the return of the Klamath River to a more natural hydrologic regime to result in river flows that are either the same or higher than the current condition for March through September. The higher flows will assist smolt migration. **Therefore, the Proposed Action will be beneficial to smolt migration habitat in the long term.**

Spring-run Chinook salmon

Type I juveniles move from tributaries into the mainstem and continue downstream to the ocean in April and May. As described above for fall-run Chinook salmon, the Proposed Action SSCs will degrade smolt migration habitat, and will cause moderate-to-major stress during the Type I and Type II outmigration. Type III outmigrants that overwinter in the mainstem Klamath River, when SSCs are highest, or those migrating from the Salmon River (fewer than 1 percent of outmigrants in Klamath River watershed), will have the greatest exposure to suspended sediment. Suspended sediment conditions will cause major physiological stress during the Type III outmigration. However, given the short distance from the Salmon and Trinity rivers to the Klamath River estuary, and the reduced SSCs downstream of the Trinity River confluence with the Klamath River, spring-run Chinook salmon juveniles will have limited exposure to high SSCs. **Therefore, the Proposed Action will not have an adverse effect on spring-run Chinook salmon smolt migration habitat on the mainstem Klamath River in the short term.**

In the long term, the Renewal Corporation anticipates the return of the Klamath River to a more natural hydrologic regime to result in river flows that are either the same or higher than the current condition from March through September. The higher flows will assist smolt migration. **Therefore, the Proposed Action will be beneficial to spring-run Chinook salmon smolt migration habitat in the long term.**

Coho salmon

Age-1+ coho salmon smolts are expected to outmigrate to the ocean beginning in late February of Year 1, although most natural origin smolts outmigrate to the mainstem Klamath River during April and May (Wallace 2004). As described above for fall-run Chinook salmon, under the Proposed Action, SSCs will be higher during spring than under existing conditions, thereby reducing the quality of coho salmon smolt migration habitat. As a result, coho salmon smolts outmigrating in spring of Year 1 are likely to experience mortality rates of 0 to 6 percent, depending on the SSC exceedance scenario and the coho salmon population unit. Smolts outmigrating in late spring will be exposed to lower SSCs and may experience only slightly worse physiological stress and reduced growth rates compared with background conditions.

Modeling results suggest SSCs will return to background levels by late winter to early spring of Year 2 downstream of Seiad Valley. The greatest SSC effects to coho salmon smolts will occur in the Iron Gate Dam to Shasta River reach, and then decrease in a downstream direction as accretion flows from tributaries dilute the suspended sediment. **Therefore, the Proposed Action will result in an adverse effect to coho salmon smolt migration habitat on the mainstem Klamath River in the short term.**

In the long term, the Renewal Corporation anticipates the return of the Klamath River to a more natural hydrologic regime to result in river flows that are similar to historical conditions and may assist with smolt migration. **Therefore, the Proposed Action will benefit coho salmon smolt migration habitat in the long term.**

K.4.1.6 Estuarine Rearing Habitat

Fall-run Chinook salmon

The Proposed Action will result in elevated SSCs in the estuary, mainly during Year 1. The period of elevated SSCs in the estuary also overlaps with the period when fall- run Chinook salmon rear in the estuary. The elevated SSCs during the summer of Year 1 may affect the ability of these fish to acquire prey, and therefore reduce feeding opportunities. However, SSCs associated with the Proposed Action are within an order of magnitude of background condition SSCs, and therefore, Proposed Action effects are likely to be minimal. Additionally, modeling results suggest the SSCs in the estuary will return to background levels by the fall of Year 1. **Therefore, the Proposed Action will not have an adverse effect to estuarine rearing habitat for fall-run Chinook salmon in the short term or over the long term.**

Spring-run Chinook salmon

The Proposed Action will result in elevated SSCs in the estuary, including the period that spring-run Chinook salmon rear in the estuary. The elevated SSCs during the summer of Year 1 may affect the ability of these fish to acquire prey, and therefore, reduce feeding opportunities. However, SSCs associated with the proposed action are within an order of magnitude of background condition SSCs; therefore, Proposed Action effects are likely to be minimal. Additionally, modeling results suggest the SSCs in the estuary will return to background levels by the fall of Year 1. **Therefore, the Proposed Action will not have an adverse effect to estuarine rearing habitat for spring-run Chinook salmon in the short term or over the long term.**

Coho salmon

The Proposed Action will result in elevated SSCs in the estuary, including the period that coho salmon rear in the estuary. The elevated SSCs during the summer of Year 1 may affect the ability of these fish to acquire prey, and therefore, reduce feeding opportunities. However, SSCs associated with the proposed action are within an order of magnitude of background-condition SSCs; therefore, Proposed Action effects are likely to be minimal. Additionally, modeling results suggest the SSCs in the estuary will return to background levels by the fall of Year 1. **Therefore, the Proposed Action will not have an adverse effect to estuarine rearing habitat for coho salmon in the short term or over the long term.**

K.4.1.7 Conclusion

Based on the descriptions of effects above, the Renewal Corporation concludes that the **Proposed Action will result in adverse effects to EFH conditions for adult migration, spawning, egg-to-fry survival, juvenile rearing, and smolt migration habitat downstream of Iron Gate Dam in the short term. The Proposed Action will result in no adverse effect to estuarine rearing for Chinook salmon and coho salmon.** Over time, as deposited sediments and sediments that remain in the reservoir footprints are transported or stabilized, respectively, the Proposed Action will have no adverse effect, or may benefit Chinook salmon and coho salmon habitat.

K.4.2 Groundfish

The Proposed Action will result in the release of less than 3 million tons of fine sediment to the Klamath River downstream of Iron Gate Dam. Although estimates of long-term average annual sediment discharge to the Klamath Estuary vary considerably, estimates generally exceed the projected 3 million tons. For example, annual sediment supply from the Trinity River alone is calculated to be 8.5 million tons, based on data provided in EPA (2001). Additionally, Stillwater Sciences (2010) estimated that Klamath River annual sediment discharge to the estuary is approximately 5.8 million tons. The predicted sediment release due to the Proposed Action ranges from less than 2 million to as much as 3 million tons, depending on water-year type (USBR 2011b; Appendix I Figure I-1), and is only one-eighth of the cumulative sediment transport in the Klamath River at Hoopa in a 4-day period during the December 1964 flood event. Lastly, the predicted sediment release associated with the Proposed Action is approximately the same as the cumulative sediment transport over a single day at the Salmon River confluence during a very large flood event (i.e., the January 1974 flood) (Stillwater Sciences 2010).

A 1995 Eel River flood with a 30-year return period delivered an estimated 25 ± 3 million metric tons of fine-grained (less than 62 μm) sediment to the ocean (Wheatcroft et al. 1997). Transported sediments formed a distinct layer on the seafloor that was centered on the 70-meter isobath, extended for 30 kilometers along shelf and 8 kilometers across shelf, and was as thick as 8.5 centimeters. Wheatcroft et al. (1997) estimated that 75 percent of the flood-derived sediment did not form a recognizable seafloor deposit but was instead rapidly and widely dispersed over the continental margin.

A considerable amount of fine sediment in the plume is anticipated to initially deposit on the seafloor shoreward of the 60-meter isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River. After this initial deposition, as described by Farnsworth and Warrick (2007), resuspension during the typical winter storms will likely occur before final deposition and burial. Much of this sediment will eventually be transported further offshore to the mid-shelf and into deeper water depths off-shelf through progressive resuspension and fluid-mud gravity flows.

Because of the complexities of the transport processes, the area and depth of the deposition of fine sediment from the Proposed Action cannot be precisely predicted. However, the short-term plume effects and long-term sediment deposit effects will be in line with what currently occurs in the nearshore environment. This is due to the relatively small amount of total sediment input, in comparison to the total annual sediment inputs to the nearshore environment, and the fact that river plume sediment inputs are a naturally occurring process. As a result, net deposition of reservoir sediments to the marine nearshore bottom substrates should be relatively less concentrated (i.e., thinner deposits in any one spot) and more widespread.

K.4.2.1 Conclusion

In summary, the Proposed Action will result in increased SSCs delivered to the nearshore environment. However, the anticipated rapid dilution of the sediment plume as it expands in the ocean, the relatively low rate of deposition of sediments to the shallow (approximately 196 to 230 feet) marine nearshore bottom substrates, and the limited extent of the settlement zone (196 to 230 feet in a 11,483-foot-deep EFH) will likely limit the effect. **The Proposed Action will have a small and temporary adverse effect on Pacific Coast groundfish EFH from the elevated suspended sediment.**

In the long term, SSCs will be similar to background conditions. Natural bedload transport processes will resume, because the dams will no longer trap sediments upstream of Iron Gate Dam. Bedload in the estuary and ocean will not be appreciably affected, because of the small contribution of the area above Iron Gate Dam to the total bedload in the system. With the exception of algal toxins, water quality benefits resulting from dam removal will largely have dissipated upstream of the estuary, and therefore, water quality in the estuary will remain similar to existing conditions. **Long-term effects are likely not adverse for Pacific Coast groundfish EFH.**

K.4.3 Coastal Pelagic Species

The effects of the Proposed Action on pelagic fish EFH will be short-term increases in SSCs. These increases will occur during Year 1 and Year 2. After this time, SSCs will be similar to those under background conditions.

Coastal pelagic fish EFH extends from the California, Oregon, and Washington shoreline to 200 miles offshore. As stated above, the sediment plume generated by the Proposed Action is expected to dilute rapidly once it enters the ocean. This dilution area is a small fraction of the pelagic fish EFH.

K.4.3.1 Conclusion

The Proposed Action will have a small and temporary adverse effect on EFH for coastal pelagic species. Long-term effects are likely not adverse for coastal pelagic species.