34. Upper Klamath River Population

Interior Klamath Stratum

Core, Functionally Independent Population

High Extinction Risk

Population likely below depensation threshold

8,500 Spawners Required for ESU Viability

1,400 mi^2 watershed (47% Federal ownership)

425 IP-km (264 IP-mi) (49% High)

Dominant Land Uses are Timber Harvest, Grazing, and Rural Development

Key Limiting Stresses are 'Barriers' and 'Altered Hydrologic Function'

Key Limiting Threats are 'Dams/Diversions' and 'Roads'

Highest Priority Recovery Actions

• Remove or provide passage at Iron Gate, Copco 1, Copco 2, and JC Boyle Dams • Reduce road-stream hydrologic connection • Reduce warm water inputs by reducing tailwater from irrigation	• Increase beaver abundance • Re-connect the channel to off-channel ponds, wetlands, and side channels • Improve flow timing and volume by increasing flows and restoring peak flows

34.1 History of Habitat and Land Use

Hydrologic and geomorphic alteration of the Upper Klamath River basin has been occurring for over 100 years. Current facilities and operations for irrigation and hydropower include 5 dams and hundreds of miles of canals and pumps which support significant water withdrawals, transfers, and diversions throughout the sub-basin. In 1905, the U.S. Bureau of Reclamation began developing the Klamath Project near Klamath Falls, Oregon. Starting around 1912, construction and operation of the numerous facilities associated with the Klamath Project significantly altered the natural hydrographs of the Upper and Lower Klamath River and continues today. Marshes were drained, dikes and levees were constructed (National Research Council 2008), water withdrawal and transfer infrastructure was developed and in 1922 the level of Upper Klamath Lake was raised. The Link River and Keno dams also support the current irrigation project. The Klamath Project now consists of an extensive system of canals, pumps, diversion structures, and dams capable of routing water to approximately 171,300 acres of irrigated farmlands in the Upper Klamath River sub-basin (Hicks 2013).

PacifiCorp operates the Klamath Hydroelectric Project, consisting of five mainstem dams between river mile (RM) 190 and 233. The construction of Copco 1 Dam (RM 199) in 1918 created the first hydroelectric structure blocking salmon migration into the Upper Klamath River sub-basin. The construction of the impassable Copco 2 Dam (1925) and Iron Gate Dam (1962) followed. The dams block approximately 76 miles of coho salmon habitat, interrupt the natural passage of flow and sediment, alter the natural hydrograph, and degrade Klamath River water quality (USDOI and CDFG 2012). PacifiCorp's license expired on March 1, 2006, and the hydroelectric project is currently operating on annual extensions granted by the Federal Energy Regulatory Committee (FERC).

Processes are underway to provide long-term fisheries and ecological restoration through fish passage prescriptions or dam removal and to provide interim conservation for coho salmon prior to these large-scale restoration actions.

Hecht and Kamman (1996) analyzed the hydrologic records for similar water years (pre- and post-Klamath Project construction) at several locations throughout the Klamath River basin and concluded that the timing of peak and base flows changed significantly after construction of the Klamath Project, and that water release operations below Klamath Hydroelectric Project dams unnaturally increases flows in October and November and decreases flows in the late spring and summer as measured at Keno, Seiad, and Klamath. The modeled dataset also clearly shows a decrease in the magnitude of peak flows, a two-month shift in timing of flow minimums from September to July, and a reduction in the amount of discharge in the summer months. Hecht and Kamman (1996) also noted that water diversions in areas outside the Klamath Project boundaries occur as well and likely further influence the hydrology in these areas. NMFS and USFWS (2013) recently analyzed the effects of the Klamath Project on the Upper Klamath coho salmon population and found impacts to water quality, hydrologic function, habitat quality, habitat availability, and disease. In addition to the Klamath Project, agricultural diversions in both the Shasta and Scott rivers, especially during dry water years, can dewater sections of these rivers, impacting coho salmon in these streams as well as those in the Klamath River (Moyle 2002).

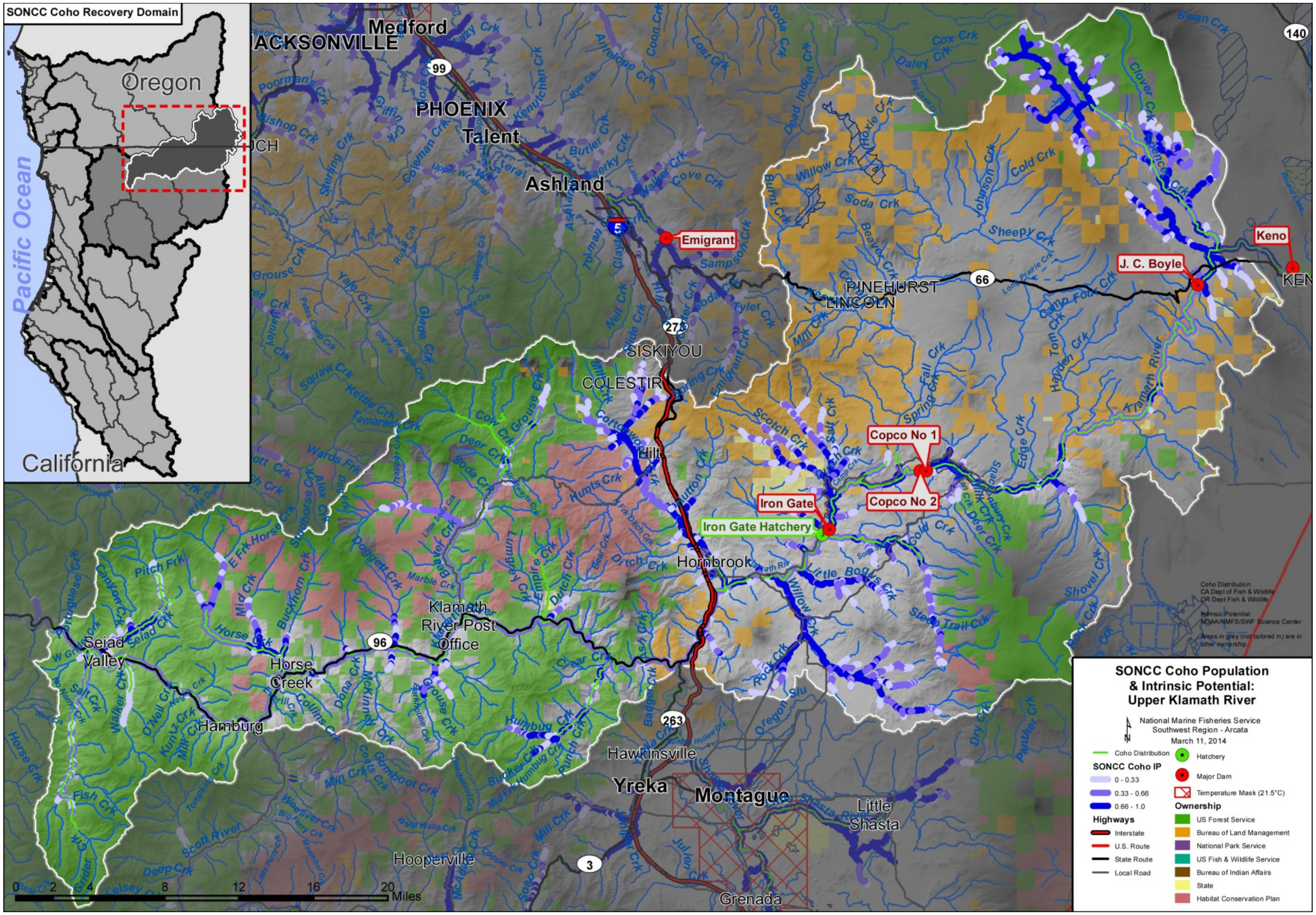

Figure 34-1. The geographic boundaries of the Upper Klamath River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2012a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath River diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Furthermore, the U.S. Bureau of Reclamation's operation of the Rogue River basin project annually diverts an average of about 24,000 acre-feet of water from the Klamath River basin (Jenny Creek) to the Rogue River basin (U.S. Bureau of Reclamation 2009b), further impacting the hydrology in the Klamath River basin.

Timber production has historically been the dominant land use below Iron Gate Dam. Almost all of the Seiad Valley hydrologic subarea is managed by the Klamath National Forest and approximately half of the Beaver Creek hydrologic subarea is part of the Klamath National Forest, with the other half composed largely of private timber company holdings. The Klamath National Forest was among the largest timber-producing national forests in California from the 1950s until the advent of the Northwest Forest Plan and Aquatic Conservation Strategy in 1994.

Since that time, Klamath National Forest lands have continued to recover from high road densities and concomitant environmental impacts, namely high watershed erosion rates and compromised fish passage at road/stream crossings. In recent years, the Klamath National Forest has aggressively addressed fish passage issues on many of their roads, and aquatic conservation policies mandated under the 1994 Northwest Forest Plan have reduced timber harvest in sensitive areas and generally improved aquatic function in many Klamath River tributaries. Also, recently in watersheds under private ownership, habitat conservation plans (HCPs) are in place to minimize and mitigate timber harvest effects on listed SONCC coho salmon and its habitat (i.e., Fruit Growers HCP). The Hornbrook, Iron Gate and Copco hydrologic subareas lie outside the national forest boundaries, but share a legacy of human-caused disturbance centered on effects from the Klamath Hydroelectric Project dams and degraded riparian forests.

34.2 Historic Fish Distribution and Abundance

Historically, coho salmon are thought to have inhabited all accessible stream reaches within the Upper Klamath population unit up to, and including, Spencer Creek (Hamilton et al. 2005, Williams et al. 2006). The current upstream limit for Klamath River salmon is Iron Gate Dam at river mile 190. Based on the IP model, coho salmon likely occupied much of the area upstream of the Iron Gate Dam and occupied numerous large tributaries. Areas with the highest IP and therefore the likeliest places for historic coho salmon production are listed in Table 34-1.

Table 34-1. Tributaries with high IP reaches (IP > 0.66). Williams et al. (2006)

Subarea[1]	**Stream Name**	**Subarea**[1]	**Stream Name**
Seiad Valley	Seiad Creek	**Iron Gate**	Bogus Creek
	Horse Creek	**Copco**	Scotch Creek
Beaver Creek	Barkhouse Creek		Jenny Creek
	Humbug Creek		Spencer Creek
Hornbrook	Cottonwood Creek	**Hornbrook**	Little Bogus Creek
	Willow Creek		

[1]Subarea refers to hydrologic subarea (HSA) in the CALWATER classification system.

Little information exists to provide insight on the historical abundance of coho salmon within the Upper Klamath River sub-basin. Population estimates mostly arose from fishing and canning records within the Lower Klamath River and estuary, and reach-specific estimates for upstream sections of the river do not exist. Snyder (1931) reported the first commercial gill net catch of 11,162 coho salmon in the lower reaches of the Klamath River in 1919 and was the first author to report a concern for declining salmon populations in California, due to commercial fishing, forestry and agricultural practices. Long-term monitoring data suggests a marked decrease in abundance of adult coho salmon by the 1950s, which likely resulted from over-harvest and habitat loss (Klamath River Basin Fisheries Task Force 1991, Weitkamp et al. 1995, California Department of Fish and Game [CDFG] 2004b). By 1983, the annual escapement abundance of Klamath River basin adult coho salmon was estimated to range from 15,000 to 20,000 fish (Leidy and Leidy 1984). These estimates, which include hatchery stocks, could be less than six percent of the abundance in the 1940s (Weitkamp et al. 1995, CDFG 2004b). Ackerman et al. (2006) developed a run size approximation for tributaries in the Upper Klamath using reports from the USFWS and making the assumption that approximately 100 fish spawn in the mainstem. The total estimated returns for the population from 2001 to 2004 were between 600 to 4,000 fish, and returns to and strays from Iron Gate Hatchery make up a substantial portion of the overall population abundance (Ackerman et al. 2006).

34.3 Status of Upper Klamath River Coho Salmon

Spatial Structure and Diversity

The Upper Klamath River population is currently comprised of approximately 64 miles of mainstem habitat and numerous tributaries to the mainstem Klamath River upstream of Portuguese Creek to Iron Gate Dam. Historically, the population extended upstream of Iron Gate Dam to Spencer Creek. The PacifiCorp Hydroelectric Project, of which Iron Gate Dam is the lowest of four mainstem dams, blocks access to approximately 76 miles of spawning, rearing and migratory habitat for SONCC coho salmon (USDOI and CDFG 2012). As a result, coho salmon within the Upper Klamath River population spawn and rear primarily within several of the larger tributaries between Portuguese Creek and Iron Gate Dam, namely Bogus, Horse, Beaver, and Seiad creeks. Since 1965, local ranchers have constructed fish ladders enabling coho salmon to successfully spawn and rear in an additional six miles of habitat in upper Bogus Creek and adjacent Cold Creek. This work has been complemented by voluntary cattle exclusion riparian fence construction, riparian planting, irrigation pipe installation, cold water instream flow enhancement, and tailwater recovery along upper Bogus Creek (Hampton 2009). A small proportion of the population spawns within the mainstem channel, primarily within the section of the river several miles below Iron Gate Dam. Coho salmon parr and smolts rear within the mainstem Klamath River by using thermal refugia near tributary confluences to survive the high water temperatures and poor water quality common to the Klamath River during summer months.

Many of the streams comprising the Upper Klamath population unit are small and may go dry near their confluence with the mainstem Klamath River. Yet these intermittent tributaries sometimes remain important rearing habitat for coho salmon, when and where sufficient instream flows, water temperature, and habitat conditions are suitable to sustain them. Coho salmon have adapted life history strategies (spatial and temporal) to use intermittent streams. For example, adult coho salmon will often stage within the mainstem Klamath River at the mouth of natal streams until hydrologic conditions allow them to migrate into tributaries, where they are able to find more suitable spawning conditions, and juveniles can find adequate rearing conditions and cover. In summer when the lower sections of these tributaries may go dry, the shaded, forested sections upstream provide cold water over-summering rearing habitat for juvenile coho salmon. By early spring, when outmigration of yearling coho salmon primarily occurs, base flows of these small streams are relatively high and full connectivity to the mainstem Klamath River exists.

Surveys by California Department of Fish and Wildlife (formerly CDFG) between 1979 to 1999 and 2000 to 2004 showed coho salmon moderately well distributed downstream of Iron Gate Dam. Juveniles were found in 25of the 48 surveyed tributary streams, with sustained presence in Portuguese, Seiad, Grider, Beaver, Little Bogus, and Bogus creeks (Garwood 2012). Streams with coho salmon presence in both 1979 to 1999 and 2000 to 2004 included Grider, Seiad, Horse, Walker, Beaver, W. Fork Beaver, Cottonwood, Bogus, Little Bogus, and Dry creeks. The Karuk Tribe (2009) conducted juvenile surveys between 2002 and 2005, and found coho salmon using Tom Martin, Walker, Seiad, Grider, Beaver, Humbug, O'Neil, and Horse creeks. No juvenile coho salmon were found in Lumgrey, Willow, Bittenbender, Barkhouse, Empire, Cottonwood, Bogus, and Kuntz Creeks during these surveys. In Bogus Creek, adult coho salmon returns occurred every year between 1979 and 2004 (Garwood 2012); and every year between 2004 and 2013, and averaged 184 per year since 2004 (Knechtle and Chesney 2014). The Karuk Tribe found adult coho salmon spawning in Fort Goff, Grider, Horse, and Seiad creeks, during surveys in 2013-2014 (Corum 2014). No evidence of spawning was found in Little Horse Creek (Corum 2014).

The Upper Klamath River population is highly influenced by the Iron Gate Hatchery, and has likely experienced a loss of life history diversity due to environmental conditions and loss of habitat. Currently, genetic work is being conducted to determine the genetic makeup of wild and hatchery fish from the Upper Klamath and it is likely to show that the combination of high stray rates and inbreeding at the hatchery has reduced the genetic diversity of the population. Given that most of the fish in the population come from the hatchery and the fact that hatchery fish are also known to have reduced life history diversity (e.g., all released as yearling smolts from one location), the overall life history diversity of the population is likely limited. The loss of habitat upstream of Iron Gate Dam and poor conditions in the mainstem between April and September also contribute to the loss of life history diversity. Smolt and adult migration is now confined to a short period of time when conditions in the mainstem are favorable and mainstem rearing and spawning is likely reduced from historic levels given the degradation of mainstem habitat.

In summary, the more restricted and fragmented the distribution of individuals within a population, and the more diversity, spatial distribution, and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 20 coho salmon per IP-km of habitat are needed (8,500 spawners total) to approximate the historical distribution of Upper Klamath River coho salmon and habitat. The current population is well below this and has a reduced genetic and life history diversity.

Population Size and Productivity

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 425 coho salmon must spawn in the Upper Klamath River each year to avoid such effects of extremely low population sizes (depensation). The low risk spawner threshold for the population is 8,500 spawners.

Based on juvenile surveys in the Upper Klamath between 2002 and 2005 there is low production in the Upper Klamath tributaries with fewer than 200 juveniles found in most tributaries and most years (Karuk Tribe 2012). The greatest number of juveniles was just over 1000, in Horse Creek in 2005. Spawning surveys also give an indication of the population size and productivity. In 2012-2013 and 2013-2014, the total observed coho salmon adults for surveyed streams (excluding Bogus Creek) was at least 20 and 80, respectively, with the majority of coho salmon found spawning in Seiad Creeks (Corum 2014).

A weir on Bogus Creek, monitored returns to the hatchery, and various tributary spawner surveys provide some indication of what the population size might be presently (Figure 34-2). Annual returns to Bogus Creek are significantly affected by hatchery strays (i.e., 51 percent from 2004 to 2013) but have averaged 154 adult coho salmon during the 2004 to 2012 period (Knechtle and Chesney 2014). Tributary spawner surveys indicate low numbers of coho salmon (<100) in the remaining habitat. Using a variety of methods, including these data and an Intrinsic Potential (IP) database, Ackerman et al. (2006) developed run size approximations for tributaries in the Upper Klamath River reach. Ackerman et al. (2006) estimated the abundance of the Upper Klamath River population to be between 100 and 4,000 adults, far lower than the 8,500 spawners needed for this population to achieve a low extinction risk (Williams et al. 2008). Therefore, the Upper Klamath River population is at a high risk of extinction given its low population size and negative population growth rate.

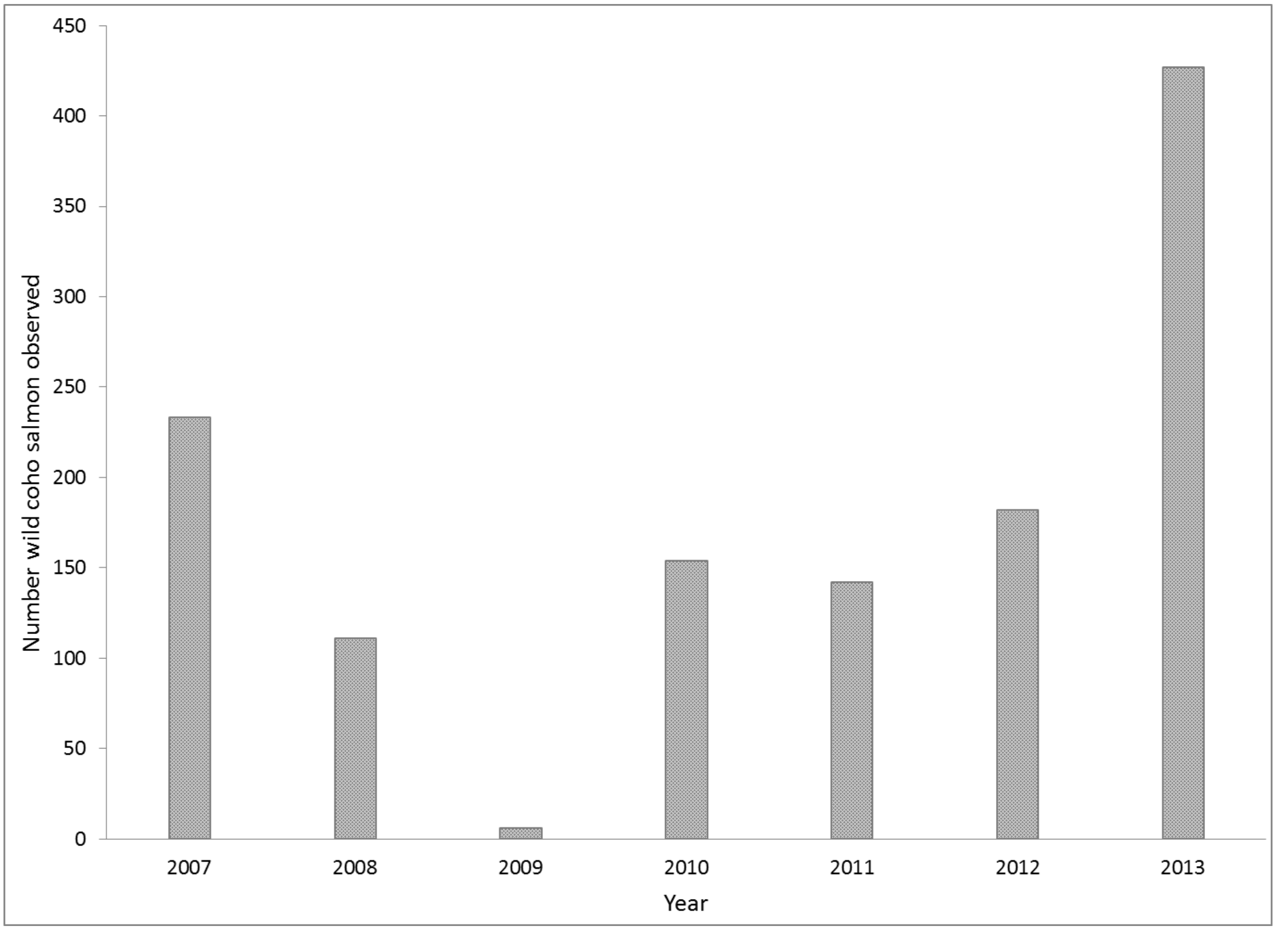

Figure 34-2. Returns of coho salmon to Bogus Creek, a tributary in the Upper Klamath population (Knechtle 2013)

The population growth rate of the Upper Klamath population has not been estimated but given the current trends in spawner abundance and the high incidence of hatchery fish and inbreeding depression, population growth is likely negative. The combination of low population abundance and a negative population growth rate mean that the population is at an elevated risk of extinction.

Extinction Risk

The Upper Klamath River population is at high risk of extinction because the ratio of the three consecutive years of lowest abundance within the last twelve years to the amount of IP-km in a watershed is likely less than one, the criterion described by Williams et al. (2008). NMFS' determination of population extinction risk is based on the viability criteria provided by Williams et al. 2008 (Table 3, page 17). These viability criteria reflect population size and rate of decline. As Williams et al. (2008) provided no viability criteria for assessing moderate and high risk based on spatial structure and diversity, spatial structure and diversity were not considered in NMFS' determination of population extinction risk.

Role in SONCC Coho Salmon ESU Viability

The Upper Klamath River population is a core, Functionally Independent population within the Interior Klamath River diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, and with population dynamics or extinction risk over a 100-year time period that are not substantially altered by exchanges of individuals with other populations (Williams et al. 2006). To contribute to stratum and ESU viability, the Upper Klamath River core population needs to have at least 8,500 spawners. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. Besides its role in achieving demographic goals and objectives for recovery, as a core population the Upper Klamath population may serve as a source of spawner strays for nearby populations. At present, the capacity of the Upper Klamath coho salmon population to provide recruits to adjacent independent populations is limited due to its low spawner abundance. Conversely, recruits straying from the nearby populations in the Klamath basin may enhance recovery of the Upper Klamath River population. However, Upper Klamath River tributaries, refugia, and mainstem habitat function as migratory and rearing habitat for Scott and Shasta juveniles, smolts, and adults. Therefore restoration of the Upper Klamath River is important for recovery of these populations as well.

34.4 Plans and Assessments

Mid Klamath Watershed Council

Since 2001, the Mid Klamath Watershed Council (MKWC) has been engaged in habitat restoration work along the Klamath River corridor, including the Upper Klamath River area. Reports related to fisheries and aquatic resources, available via MKWC's homepage (http://www.mkwc.org), including the following:

> *Middle Klamath Restoration Implementation Plan, Instream Working Group* (Grunbaum et al. 2013)

The Instream Working Group's Instream Candidate Actions Table (Grunbaum et al. 2013) includes recovery actions that specifically address constraints to recovery in 35 tributary watersheds within the Mid Klamath Basin, and in 31 tributary watersheds within the Upper Klamath Basin. Though these tributaries are not all mentioned by name in the SONCC coho salmon ESU recovery plan, the recommended candidate actions in the table for each tributary watershed are incorporated into the SONCC recovery plan's recovery actions.

> *Middle Klamath Sub-basin Fisheries Resource Recovery Plan, December 1, 2008*

> *Off-Channel Coho Salmon Rearing Pond Projects: Seiad Creek and Grider Creek (2012 update)*

> *2008 DFG Klamath Tributary Fish Passage Improvement Results*

> *Restoring Coho Salmon in the Klamath River, One Beaver At A Time*

The Effect of the Klamath Hydroelectric Project on Traditional Resource Uses and Cultural Patterns of the Karuk People within the Klamath River Corridor (Salter 2003)

U.S. Forest Service

The Klamath National Forest (KNF) has conducted numerous watershed assessments and developed a Forest Land and Resource Management Plan for National Forest lands within the Upper Klamath River sub-basin. Relevant management plans and analysis reports that affect coho salmon in the Upper Klamath include:

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Seiad Creek and Antelope Creek were identified as high priority 6th field sub-watersheds in the Klamath National Forest (USFS and BLM 2011)

The Klamath National Forest Land and Resource Management Plan

Klamath National Forest Road Analysis

Forest-Wide Late Successional Reserve Analysis

Watershed Condition Assessment

Thompson/Seiad/Grinder Ecosystem Analysis

Horse Creek Watershed Analysis

Callahan Watershed Analysis

Karuk Tribal Fisheries Department and Restoration Division

Middle Klamath Restoration Partnership

Klamath River Basin Conservation Area Restoration Program

Mid Klamath Sub-basin Fisheries Resource Recovery Plan

In 2003, the Karuk Tribe developed the Mid Klamath fisheries resource plan (Soto et al. 2008) to identify core variables pertaining to ecological function in the sub-basin, and to provide management priorities and objectives to guide efforts to improve conditions in the sub-basin. The Tribe will administer the long-range plan, in cooperation with federal and state management agencies, private landowners, and local communities. The resource plan focuses on active restoration of those processes most degraded by historic and current land uses and passive restoration for protection of currently functioning sub-basin processes.

PacifiCorp Habitat Conservation Plan

In February 2012, NMFS issued an Incidental Take Permit for PacifiCorp's Habitat Conservation Plan (HCP; PacifiCorp 2012) to minimize and mitigate for the interim operations of PacifiCorp's Klamath Hydroelectric Project on the mainstem Klamath River (http://www.westcoast.fisheries.noaa.gov/publications/habitat/hcp_swr/pacificorps_hcp/pacificorp_klamath_coho_hcp_final.pdf).

Seven goals of the HCP's Coho Salmon Conservation Strategy were designed based on the conservation needs of SONCC coho salmon, and include the following: Goal I: offset biological effects of blocked habitat upstream of Iron Gate dam by enhancing the viability of the Upper Klamath coho salmon population; Goal II: enhance coho salmon spawning habitat downstream of Iron Gate Dam; Goal III: improve instream flow conditions for coho salmon downstream of Iron Gate dam; Goal IV: improve water quality for coho salmon downstream of Iron Gate dam; Goal V: reduce disease incidence and mortality in juvenile coho salmon downstream of Iron Gate dam; Goal VI: enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor; Goal VII: enhance and expand rearing habitat for coho salmon in key tributaries. More information about water use HCPs in the Upper Klamath can be found in Section 3.2.9.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. The recommendations developed by CDFG for the mid-Klamath population have been considered and incorporated into the recovery strategy and list of recovery actions for this population.

34.5 Stresses

Table 34-2. Severity of stresses affecting each life stage of coho salmon in the Upper Klamath River. Stress rank categories, assessment methods, and data used to assess stresses are described in Appendix B.

	Stresses	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Barriers[1]	-	Very High	Very High[1]	Very High	Very High	Very High
2	Adverse Hatchery-Related Effects	Very High	Very High	Very High	Very High	Very High	Very High
3	Altered Hydrologic Function[1]	Low	Medium	Very High[1]	High	High	High
4	Impaired Water Quality	Low	Medium	Very High	High	High	High
5	Altered Sediment Supply	High	High	High[1]	High	High	High
6	Lack of Floodplain and Channel Structure	Low	Very High	Very High	Very High	Medium	Very High
7	Increased Disease/Predation/Competition	Low	High	Very High	Very High	Medium	Very High
8	Degraded Riparian Forest Conditions	-	Medium	High[1]	High	High	High
9	Impaired Estuary/Mainstem Function	-	Medium	High[1]	High	Low	High
10	Adverse Fishery- and Collection-Related Effects		-	Low	Low	Medium	Low

[1] Key limiting stresses and limited life stage.

Key Limiting Stresses, Life Stages, and Habitat

Several factors limit the viability of the Upper Klamath population. The most dominant of these factors stem from the effects of the mainstem hydroelectric dams and water diversions within and upstream of this population boundary on water quality, hydrologic function, floodplain and channel structure, disease, and habitat access upstream of Iron Gate Dam. The hatchery also plays an important role in limiting the Upper Klamath population through negative genetic and ecological interactions. Looking at the overall productivity of the population, the juvenile life stage is the most limited due to the degradation of summer and winter rearing habitat and the issues associated with disease and water quality that affect survival and growth in the mainstem Klamath.

Key limiting stresses are barriers, altered hydrologic function and, as a consequence, impaired water quality. The loss of approximately 76 miles of habitat upstream of Iron Gate Dam (USDOI and CDFG 2012), much of which is high quality spawning and rearing habitat, severely limits the spatial structure and natural productivity of the population. The operation of the Klamath Project and hydroelectric project has led to additional limiting stresses related to the loss of flow variability and impaired water quality. These impairments have led to the loss of rearing and migratory habitat and an increase in the incidence of disease among other, less significant impacts (NMFS 2012, NMFS and USFWS 2013).

Summer and winter rearing habitat for juveniles is limited in the Upper Klamath. The period of time when fry and juvenile rearing, as well as smolt migration, is possible along the mainstem, has been shortened and is therefore a temporal limitation. In the summer, the diversion and impoundment of water continues to lead to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality in tributaries and the mainstem. Most tributaries with summer rearing potential are highly impacted by agriculture and past timber harvest. Very few remaining areas exist downstream of Iron Gate Dam with the potential and opportunity for summer rearing. Based on the low abundance of streams with age-1 coho salmon, overwintering survival appears to be low, thus overwintering habitat may be limited in the Upper Klamath. Frequently, streams with juvenile coho salmon presence had no observed age-1 juveniles (Karuk Tribe 2012). Winter rearing habitat has been primarily impacted by the past mining and diking activities in the mainstem and many tributaries, which has led to the loss and degradation of floodplain and channel structure. The majority of winter habitat that does exist is small, degraded, and poorly connected. Because of the increased incidence of disease and water quality issues in the mainstem in late spring and summer, the time period of optimal rearing and migratory conditions is limited to early spring (March-May). After early spring, growth and survival are appreciably reduced (National Research Council 2004).

In order to improve the viability of this population, addressing these limiting stresses and improving habitat and conditions for the juvenile life stage are imperative. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population.

Tributary thermal refugia are one of the most vital habitat types in the Upper Klamath population unit due to its importance for rearing and migration in the Klamath River. The Mid Klamath Watershed Council and Yurok Tribe have collected temperature data in tributaries and the mainstem Middle Klamath River (MKWC 2006) and surveyed potential refugia to assess where refugia areas are available and used by juvenile coho salmon. The tributaries in Table 34-3 below, though not an exhaustive list, provide cooler water temperatures important as refuges from the elevated water temperatures in the mainstem Klamath River. The presence of juveniles in these tributaries, especially when water temperatures in the mainstem Klamath River are high, supports the conclusion that they are used as refugia areas. Based on the estimated 250 cfs of constant cold groundwater accretion to the mainstem Klamath River in the JC Boyle reach, the highest quality refugia habitat likely lies upstream of Iron Gate Dam.

Table 34-3. Potential refugia areas in the Upper Klamath River.

Sub-basin	Stream Name	Sub-basin	Stream Name
Hornbrook	Bogus Creek	Hornbrook	Cottonwood Creek
Hornbrook	Willow Creek	Beaver Creek	Barkhouse Creek
Beaver Creek	Humbug Creek	Seiad Valley	O'Neil Creek
Beaver Creek	Beaver Creek	Seiad Valley	Seiad Creek
Seiad Valley	Horse Creek	Seiad Valley	Grider Creek
Seiad Valley	Walker Creek	Seiad Valley	West Grider
Seiad Valley	Tom Martin Creek	Seiad Valley	O'Neil Creek

Other important vital habitat exists in Seiad Creek where habitat conditions are sufficient to support consistent coho salmon use throughout the year. The distance from Iron Gate Hatchery also means that Seiad Creek has less hatchery influence than other, more proximate, tributaries. Restoration to improve winter rearing habitat in this watershed will add to its importance in supporting natural fish production in this population.

Barriers

Instream barriers are a very high stress to the population due to restricting spatial structure (i.e., prohibiting access to upstream habitat). The most significant barriers within the watershed are Iron Gate Dam, Copco 1 and 2 dams, and J.C. Boyle Dam, which have blocked upstream access to approximately 76 miles of coho salmon habitat for several decades (USDOI and CDFG 2012). Diversion dams, alluvial barriers, low flow conditions, and poorly functioning road/stream crossings also block passage by juvenile and/or adult fish in several mainstem tributaries within the watershed (e.g., Seiad and Cottonwood Creeks). Records indicate that there are approximately 43 total or partial road crossing barriers that could exist in the Upper Klamath population area (CalFish 2013). The most notable road-stream crossing barriers exist on Highway 96 at Tom Martin Creek and on Seiad Creek Road at Canyon Creek. Many push up dams and diversions seasonally block access to high IP and vital cold-water rearing habitat. A push-up dam on Horse Creek acts as a barrier when combined with low flow conditions in the stream, preventing both upstream and downstream access to high quality rearing habitat and refugia. Low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug creeks create flow barriers as well (Mid Klamath Restoration Partnership 2010). Also, the reduction of flushing flows in the mainstem Klamath has caused alluvial barriers to seasonally form at the mouths of mainstem tributaries (e.g., Walker, O'Neil, and Grider Creeks) where they act as barriers to fish migration, further decreasing spatial structure and habitat availability (Mid Klamath Restoration Partnership 2010).

Adverse Hatchery-Related Effects

Iron Gate Hatchery (IGH), which is located in the Upper Klamath River population area, releases approximately 6 million Chinook salmon, 75,000 coho salmon, and 200,000 steelhead annually. The hatchery volitionally releases Chinook salmon from the middle of May to the end of June, a time when flows from Iron Gate Dam are usually in decline and water temperatures are increasing, further increasing stressful conditions for wild juvenile coho salmon. The proportion of hatchery fish among returning adult coho salmon increases in proximity to Iron Gate Hatchery, due to the homing of hatchery fish to the place they were born. Hatchery adult coho salmon are also observed in Bogus Creek, a tributary of the Klamath next to Iron Gate Hatchery. From 2004 to 2012, on average 51 percent of observed adults at Bogus Creek were of hatchery origin (Knechtle and Chesney 2014). Adverse hatchery-related effects pose a very high stress to all life stages because hatchery origin adults make up greater than 30 percent of the total number of adults (Appendix B). In January 2013, NMFS received an application from the California Department of Fish and Wildlife and PacifiCorp for a permit for scientific purposes, and to enhance the propagation and survival of SONCC coho salmon. This application included a Hatchery and Genetic Management Plan (HGMP) that specifies methods for the operation of the Iron Gate Hatchery coho salmon program. NMFS anticipates making a final decision on whether to issue the permit and approve the HGMP in 2014. If permitted, the HGMP incorporates artificial propagation, monitoring, and evaluation activities for the next ten years.

Altered Hydrologic Function

Coho salmon in the Upper Klamath are negatively impacted by the altered hydrologic function within the Upper Klamath River and its tributaries. Individual coho salmon, as well as their spawning and rearing habitat in the mainstem, are primarily impacted by irrigation water diversions upstream of Iron Gate Dam, within the Scott and Shasta watersheds, and by the Klamath hydroelectric project. Both the timing and volume of flows is manipulated by diversion and dam activities leading to altered life-history adaptations and degraded rearing and migratory conditions critical to juvenile coho salmon survival. The altered hydrologic regime and poor water quality conditions likely increase disease susceptibility within the mainstem Klamath River, elevating disease infection rates and ultimately the loss of juvenile coho salmon. Changes to the flow regime have also been linked to increased incidences of disease (Bartholomew 2008).

The altered hydrologic function is the result of a combination of anthropogenic and climatological factors, including surface diversions and groundwater pumping (NMFS 2012, NMFS and USFWS 2013). These activities have severely altered the natural timing and volume of flows in the mainstem Klamath River. This change in hydrologic function has shifted the timing and duration of the spring peak-flow event, causing spring flows to peak approximately a month earlier and subside to summer baseflow approximately two months earlier during most years (USDOI and CDFG 2012). As a result, important life history strategies/traits (e.g., smolt outmigration timing, spring juvenile/fry redistribution) have now been either modified or lost entirely due to the hydrologic shift. The earlier onset of summer baseflow conditions also prolongs poor water conditions and causes them to overlap with the timing of peak smolt outmigration through the mainstem reach.

In addition to altered hydrologic regimes in the mainstem Klamath River, several tributaries also experience significant alterations to their hydrology, and summer base flow are often too low to support rearing and migration. Low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug creeks have been shown to create flow barriers and impaired summer rearing conditions (Mid Klamath Restoration Partnership 2010). Generally the flow regime has been rated as fair (partially functional) in Cottonwood Creek, Seiad Creek, and Walker Creek and poor (non-functional) in Beaver Creek, Humbug Creek, and Horse Creek

(Mid Klamath Restoration Partnership 2010). Bogus Creek and adjacent Cold Creek provide good habitat and cool water temperatures for rearing coho salmon (Hampton 2009). Grider Creek and Shovel Creek are thought to have functional flow regimes (Mid Klamath Restoration Partnership 2010).

Impaired Water Quality

Impaired water quality within the Upper Klamath River sub-basin creates a high stress for the population and is especially harmful for juvenile coho salmon. Water quality within the Upper Klamath sub-basin varies spatially and temporally. Water temperature and quality within both mainstem and tributary reaches are often stressful to juvenile and adult coho salmon during late spring, summer, and early fall months. Generally, water quality conditions are suitable for coho salmon from late fall through early spring. However, by late spring (April-May) water quality can become impaired, especially in the mainstem Klamath River, where the combination of elevated water temperatures and high nutrient loads can create stressful conditions for coho salmon and increase risks to survival of juveniles. Water quality is generally poor within the Upper Klamath watershed during much of the summer and early fall when mainstem water temperatures can exceed lethal thresholds above 25 °C. MKWC documented mainstem and tributary temperatures in the summer of 2006 and showed that while mainstem temperatures are often higher than the range of coho salmon suitability (>19 ºC), tributary temperatures are suitable (<19 ºC) in these areas for coho salmon in the summer (MKWC 2006).

Upstream impoundments, particularly PacifiCorp's Klamath Hydroelectric Project reservoirs, contribute to seasonal and daily changes in temperature regimes in the mainstem Upper Klamath. Seasonally, these impoundments create a thermal lag resulting in a delay in spring warming and fall cooling of mainstem temperatures (Karuk Tribe 2011, Beaman and Juhnke 2012). Daily, there is little diurnal variation in temperature and little if any of the natural nighttime cooling that would also help fish to recover from elevated daytime temperatures. Thermal impacts from the PacifiCorp Klamath Hydroelectric Project reservoirs diminish downstream from Iron Gate Dam until they become insignificant around the mouth of the Scott River (RM 144; PacifiCorp 2012). Summer water quality can vary within Upper Klamath River tributaries as well, and is heavily influenced by riparian corridor condition, instream sediment levels, and the extent to which diversions dewater the stream channel. Tributaries tend to have cooler stream temperatures in their upper reaches and warmer temperatures in their degraded lower reaches. Most reaches with IP have fair to poor daily mean and daily maximum water temperatures (>22 °C) during July and August each summer (Asarian and Kann 2013). Elevated seasonal stream temperatures impact juvenile coho salmon growth and survival during the summer, and, to a lesser degree, fry and smolt growth and survival in tributaries during late spring.

During the summer dissolved oxygen (DO) concentrations and pH can also become degraded downstream of Iron Gate Dam due to temperature trends and the decreased quality and quantity of water emanating from reservoirs upstream. DO and pH impacts from the PacifiCorp Klamath Hydroelectric Project reservoirs are, in turn, affected by water quality problems from upstream nutrient and organic matter loads from Upper Klamath Lake.

The mainstem Klamath River downstream of Iron Gate Dam generally has fair to poor DO conditions (<6.75 mg/l; Karuk Tribe 2011, Asarian and Kann 2013). Levels of pH in the mainstem are also rated as fair to poor (< 6.5 daily average minimum and >8.5 daily average maximum; Karuk 2011). Dissolved oxygen can reach as low as 5.5 mg/L in the mainstem downstream of the dam (North Coast Regional Water Quality Control Board 2010, Karuk Tribe 2011). PacifiCorp is currently implementing methods to ameliorate these water quality problems downstream from Iron Gate Dam. Data on PacifiCorp's turbine venting shows that DO concentrations immediately downstream of Iron Gate Dam are generally at least 85 percent saturation (i.e., >7 mg/L) with occasional days of 65 to 80 percent saturation (i.e., approximately 6 to 7 mg/L; PacifiCorp 2014).

Related to DO and temperature trends, pH tends to rise throughout the summer, peaking in late August (Karuk Tribe 2011) and fluctuating widely between day and night (NMFS 2007b). Elevated levels of nutrients and algae also contribute to poor water quality conditions since nutrient cycles and algae levels are altered by reservoir dynamics and can influence water quality in downstream reaches below Iron Gate Dam (Asarian and Kann 2013). Impaired water quality in the mainstem during the summer likely limits use of these habitats by juveniles and restricts rearing to tributary and confluence habitat where water quality is better. Poor water quality also contributes to increased stress, reduced growth, and increased susceptibility to disease.

Altered Sediment Supply

Altered sediment supply is considered a high stress to the population due to high fine sediment delivery and the lack of adequate spawning gravel. Past and present land use practices continue to deliver fine sediment into the mainstem and many important tributary streams between Iron Gate Dam and Seiad Creek (KNF 1993, KNF 1996, KNF 2002). High sediment levels degrade tributary rearing habitat by filling in pools and simplifying instream habitat complexity. Many Upper Klamath tributaries contain highly erodible sediment which, besides degrading habitat quality, can also lower egg survival and spawning success. Furthermore, the supply of spawning gravel has decreased due to blockage by the mainstem dams and tributary road crossings. The volume and quality of spawning gravel available to adult coho salmon is especially compromised below Iron Gate Dam where the majority of mainstem spawning occurs (PacifiCorp 2012). However, PacifiCorp has begun augmenting gravel in the mainstem Klamath River to minimize the geomorphic effects of the Klamath Hydroelectric Project.

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure presents a very high stress for the population and primarily affects fry, juveniles, and smolts. Tributary and mainstem habitat complexity is limited by a lack of coarse sediment and wood, modified flows, remnant dredge piles, and impaired riparian function. Additionally, many tributary streams suffer from high sediment levels, poor riparian habitat, and overall poor instream habitat complexity and volume. In many tributaries, fine sediment has also filled pools, off-channel ponds, and wetlands. Past mining activities and levy construction have also led to limited floodplain complexity and connectivity (e.g., Seiad, Horse, and Humbug Creeks). The primary issue in the mainstem is the removal of naturally deposited sediments by past mining activities combined with lack of transport flows which would lead to the creation and maintenance of side and off-channel habitat (Soto et al. 2003). Although large wood and complex floodplain habitat were not dominant features of the historic mainstem Klamath River channel, this area continues to lack rearing and spawning habitat. Floodplain connectivity (based on USFS judgment) is generally fair (partially functional) in the Beaver Creek, Seiad Creek, Walker Creek, Bogus Creek, and Shovel Creek sub-basins and generally poor (non-functional) in the Humbug Creek, Cottonwood Creek, and Horse Creek sub-basins (CAP data, Soto et al. 2003, KNF 2002, KNF 1996, KNF 1993). The one exception was Grider Creek which was rated as having very good (fully functional) floodplain connectivity (CAP data). Wood frequencies have not been quantified in many tributaries but in Camp Creek and at Jenny Creek they were found to be poor (<1 key piece/100m; ODFW CAP data). Juveniles and smolts are most limited by poor habitat complexity within tributary reaches and refugia due to the need for off-channel winter refugia and complex rearing and refugia habitat. Fry are affected by the lack of refugia from high flows and predation and a lack of complex rearing habitat in tributaries.

Increased Disease/Predation/Competition

The combined effect of increased disease, predation, and competition is an overall very high stress to coho salmon in this population. Of these three stresses, disease is the most significant; however competition and predation by hatchery fish are also issues occurring in all Klamath River populations. Pathogens that cause diseases in juveniles include *Ceratonova shasta, Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (FERC 2007). Of the aforementioned biological vectors, infection by the myxozoan *C. shasta* (and co-infection with *P. minibicornis*) has the most significant effect on survival of coho salmon in the sub-basin (Nichols et al. 2003, Bartholomew 2008). Disease effects vary annually based on water temperature, water year, and other factors (Bartholomew 2008). Spatially and temporally, mortality rates from exposure to disease vary by location and month, but are consistently higher in the mainstem between Shasta River and the Scott River and are highest in May and June (Bartholomew 2012). Given that most juveniles rear in tributaries (Lestelle 2007, Sutton and Soto 2010), the greatest impacts are to rearing and dispersing fry, juveniles, and smolts during emigration. Average mortality is estimated to be approximately 50 percent at 17 °C and approximately 12 percent at 15 °C in the Upper Klamath and studies show mortality could be much higher at some sites (Figure 34-3). The long migration and exposure of this population to disease means that this population is one of the most susceptible to disease and most likely to experience abnormally high disease-induced mortality.

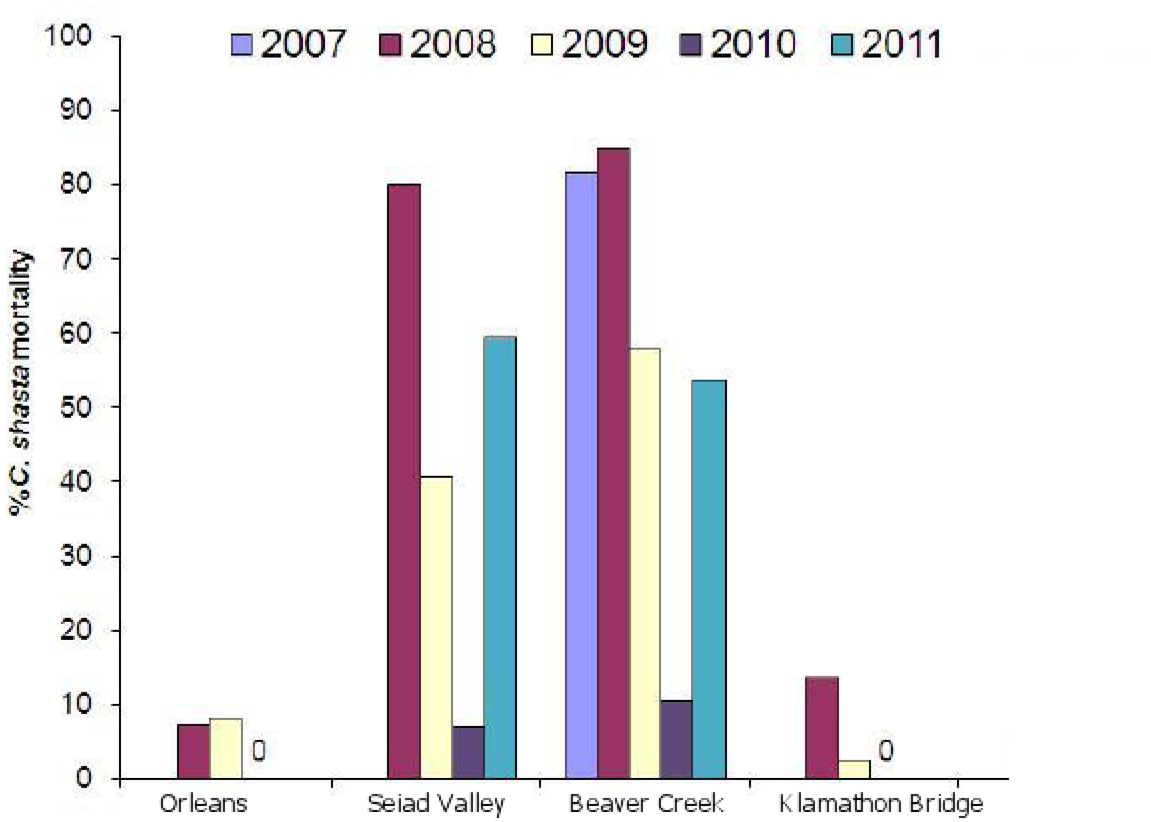

Figure 34-3. Comparison of percent mortality of juvenile coho salmon exposed in the Klamath River for 72 hours in June 2007- 2011. In 2011, coho were held only near Beaver Creek and Seiad Valley (Bartholomew 2012).

Researchers believe modifications to the river's hydrologic regime have likely created instream conditions that favor disease proliferation and fish infection (Stocking and Bartholomew 2007). Less frequent and lower magnitude flows are likely affecting disease transmission from adult salmon carcasses to the intermediate polychaete host, increasing the potential for juveniles and smolts to become infected. In an unaltered hydrologic regime, fall and winter freshets help distribute salmon carcasses downstream into lower sections of the watershed, effectively dispersing nutrients, as well as diluting infective spore densities that enter the aquatic environment as the carcasses decompose. Low stable flow regimes do not effectively redistribute carcasses within the reach between Iron Gate Dam and the Shasta River, resulting in high densities of decomposing fish downstream of popular spawning areas.

In addition to disease impacts, there are competition and predation pressures that act to limit coho salmon productivity and survival. Competition with hatchery fish for habitat and refugia may affect the growth and survival of juvenile coho salmon. Chinook, steelhead, and coho salmon fingerling released from Iron Gate Hatchery may not only compete with yearling and sub-yearling wild coho salmon but may also predate on sub-yearling coho salmon. Some steelhead may also remain in the Upper Klamath and exert additional predation pressure on juvenile coho salmon. These types of impacts have been identified in other Klamath tributaries such as the Trinity River (Naman 2008) but their prevalence and impacts are unknown for this population. Another important but unknown impact may be predation by non-native brown trout on juvenile coho salmon. Brown trout are rarely found in the Scott, Shasta, and Bogus Creek but they have been documented to co-occur with juvenile coho salmon and may have seasonal or local effects on juvenile populations (Hampton 2010).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions are considered a high stress for this population because of the reduced quality and quantity of riparian forest along the mainstem and in tributaries of the Upper Klamath. The extent of degraded riparian habitat within the Upper Klamath River population is primarily due to grazing, altered hydrology, past mining, fire, and timber harvest. These disturbances create localized, short term reductions in riparian vegetation and/or long-term widespread loss of riparian forest. The extent of impacts to coho salmon depends on the degree and extent of coho salmon use of the area. Most stream reaches within the Upper Klamath are either lacking riparian forest altogether or lack complex, late seral forest. This lack of functional riparian forest has resulted in the degradation of water quality, unstable banks, and simplified channel and floodplain structure. Grazing and flow impairments along the mainstem and in tributaries such as Horse, Humbug, Willow, and Cottonwood creeks have severely degraded riparian function. Stream corridor vegetation was rated at fair (partially functional) to poor (non-functional) in all surveyed reaches of the Upper Klamath (CAP data, Soto et al. 2003, KNF 1993, KNF 1996, KNF 2002). Past mining activities and flood control in areas such as Seiad Valley and along the mainstem Klamath have also altered floodplain sediment, elevation, and connectivity and led to depleted riparian forests. The seasonal diversion of water in many Upper Klamath tributaries limits the availability of areas where riparian vegetation can persist.

Impaired Estuary/Mainstem Function

All salmon that originate from the Upper Klamath River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. The Klamath River mainstem and estuary play an important role by providing holding habitat and foraging and refuge opportunities for juvenile coho salmon and smolts from the Upper Klamath River sub-basin (Soto et al. 2008a, Hillemeier et al. 2009, Soto et al. 2013). Although short and small compared to the large size of the watershed, the estuary provides numerous habitat types and rearing habitat for juvenile coho salmon. The degraded condition that exists throughout the Klamath River basin may mean that the estuary plays an even larger role for all Klamath River populations by providing the opportunity for juvenile and smolt growth and available refugia prior to entering the ocean.

The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain (Hiner 2006). Levees along the lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary. Despite the degraded state of habitat in the estuary, research in two tributaries near the mouth of the Klamath River have shown that juveniles from natal streams in the Upper Klamath sub-basin disperse to and fully utilize small, coastal tributaries and estuarine habitats before moving out to the ocean, and that these fish are significantly larger and more robust than individuals who quickly outmigrate to the ocean (Soto et al. 2008a, Hillemeier et al. 2009). Mainstem conditions downstream in the Middle and Lower

Klamath contribute additional stress to the population because of the propagation of issues related to disease and degraded water quality and habitat.

Adverse Fishery- and Collection-Related Effects

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium stress to adults and a low stress to juveniles and smolts.

34.6 Threats

Table 34-4. Severity of threats affecting each life stage of coho salmon in the Upper Klamath River. Threat rank categories, assessment methods, and data used to assess threats are described in Appendix B.

	Threats	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Threat Rank
1	Dams/Diversions[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Roads[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
3	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
4	Climate Change	Medium	Medium	Very High	Very High	Medium	Very High
5	Channelization/Diking	High	Very High	Very High	Very High	Very High	Very High
6	Agricultural Practices	High	High	High	High	High	High
7	High Severity Fire	Medium	Medium	Medium	Medium	Medium	Medium
8	Road-Stream Crossing Barriers	-	Medium	Medium	Medium	Medium	Medium
9	Timber Harvest	Medium	Medium	Medium	Medium	Low	Medium
10	Fishing and Collecting	-	-	Low	Low	Medium	Low
11	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
12	Urban/Residential/Industrial Dev.	Low	Low	Low	Low	Low	Low
13	Invasive Non-Native/Alien Species	Low	Low	Low	Low	Low	Low

[1] Key threats and limited life stage

Key Limiting Threats

The two key limiting threats, those which most affect recovery of the population by influencing stresses, are dams/diversions and roads.

Dams/ Diversions

Irrigation and hydroelectric dams are a major threat to coho salmon within the Upper Klamath River watershed and cause a very high threat to all life stages. PacifiCorp's series of four mainstem hydroelectric dams, beginning with Iron Gate Dam at RM 190, preclude upstream passage of coho salmon into approximately 76 miles of historic habitat (USDOI and CDFG 2012). The threat from these mainstem dams will continue until fish passage or dam removal occurs, which is expected to occur in the 2020s either through dam removal if there is an affirmative Secretarial Determination under the terms of the Klamath Hydroelectric Settlement Agreement (KHSA), or through mandatory fishway prescriptions in the Federal Energy Regulatory Commission relicensing process.

Smaller private diversion dams also block passage on several important streams within the Upper Klamath, including Cottonwood Creek and Horse Creek. In addition to seasonal and permanent dams in the Upper Klamath, diversions in tributaries reduce flow and act as fish barriers when unscreened. There have been some efforts to screen diversions in Horse Creek and some other tributaries; however, the California Fish Passage Assessment Database (CalFish 2013) indicates that there could be over 60 additional diversions in the Upper Klamath sub-basin.

The Klamath River suffers from numerous threats to coho salmon. Foremost is the over-allocation (as defined by the 1992 Oregon Water Resources Commission) of water resources throughout the mainstem Klamath River and major tributaries. This over-allocation is generally acknowledged as the primary mechanism responsible for the poor water quality, elevated disease incidence, and impaired passage conditions common to much of the Klamath River basin. Water diversions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug creeks are known to impair and/or eliminate coho salmon habitat and water quality during critical low flow periods. Water diversions in the Scott and Shasta rivers also impair hydrologic function and water quality in the mainstem Klamath River, further exacerbating low flow conditions, high disease transmission rates, and poor water quality conditions. Flow barriers are common in the Upper Klamath and many of these low flow conditions are a direct result of legal and illegal summer diversions (Soto et al. 2003).

Roads

High road densities within the Upper Klamath sub-basin pose a very high threat to the coho salmon and its habitat. The construction and maintenance of roads across the landscape have detrimental effects on the essential features of coho salmon habitat primarily through hydrological effects (e.g., disconnecting watercourses) and through erosion and sedimentation. Road-related erosion is a problem in many of the larger tributaries downstream of the Shasta River where timber harvest was historically most pronounced. Watersheds with the highest road densities (>3 mi./sq. mi.) include Beaver, Horse, McKinney, Doggett, O'Neil, Empire-Lumgrey, Cottonwood, lower reaches of Grider Creek, and upper reaches of Humbug Creek and Seiad Creek (CAP data, KNF 1993, KNF 1996, KNF 2002). Road densities are substantially lower in tributaries upstream of Iron Gate Dam, due largely to the lack of timberland within the hydropower reach. Roads will continue to act as sediment sources to tributaries although the threat from roads is likely to decrease as roads on public land are decommissioned and upgraded.

Hatcheries

Hatcheries pose a very high threat to all life stages in the Upper Klamath River sub-basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Climate Change

Climate change poses a very high threat to this population. As the result of current fuel loads and the impacts of climate change, fire could have a major impact on habitat quality in the future. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 3 °C in the summer and by 1.3 °C in the winter. Recent studies have already shown that water temperatures in the mainstem Klamath River have already been increasing at a rate of 0.4 to 0.6 °C/decade since the early 1960s (Bartholow 2005). The season of high temperatures that are potentially stressful to salmon has lengthened by about 1 month and the average length of mainstem river with cool summer temperatures (<15 °C) has declined by about 5 mi/decade (Bartholow 2005). Annual precipitation in this area is already very low and is predicted to trend downward over the next century (Thieler and Hammer-Klose 2000). Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile and smolt rearing and migratory habitat in the Klamath River and its tributaries is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. Adult coho salmon will also be negatively affected by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Channelization/Diking

Although channelization and diking is not widespread throughout the watershed, stream reaches essential for successful juvenile rearing in the Upper Klamath have been extensively levied for flood control and agriculture. Roads and dredge tailings from past mining activities also act to channelize and dike some stream reaches in the Upper Klamath. Much of the floodplain area along the upper-Klamath River corridor, including the lower reaches of tributaries (e.g., Seiad, Horse, and Grider Creeks) where off-channel habitat could develop, is effectively channelized or diked. Providing additional off-channel habitat will provide increased rearing opportunities for the Upper Klamath River population, as well as improved non-natal rearing benefits for outmigrating juvenile fish from the Scott River and Shasta River coho salmon populations. The most affected streams include Seiad and Horse Creek although localized channelization and diking likely occurs in almost every tributary with extensive streamside private land (e.g., Cottonwood, Bogus, and Willow creeks). Dikes in affected reaches lead to floodplain disconnection and reduced habitat capacity. Overall, channelization and diking is a very high threat to the population since there is no current effort to restore existing channelized and diked reaches along the upper middle Klamath River corridor.

Agricultural Practices

Agricultural practices pose a high threat to Upper Klamath River coho salmon through effects on water quality, flow, bank stability, and riparian function. Runoff from agricultural lands has the potential to negatively impact water quality in the Klamath Basin by increasing nutrient loads, increasing biological oxygen demand, and increasing thermal loading (USGS 1999). Agricultural diversions from Upper Klamath Basin and from the larger tributary sub-basins in the Upper Klamath River watershed (e.g., Shasta and Scott rivers) have severely altered the timing, duration and volume of the historic Upper Klamath River hydrologic regime. Summer low-flow conditions now occur at an earlier date and persist for a longer period than historically occurred, subjecting rearing juvenile coho salmon to poor water quality for up to 4 months of the year. Smaller-scale agricultural diversions in tributaries such as Beaver, Willow, Grider, Bogus, Horse, Seiad, Walker, Elliot, Little Girder, Little Horse, and Tom Martin Creeks can lead to diminished and eventually the loss of summer rearing habitat and refugia, and to stranding in some instances. Another important impact of agricultural practices in the Upper Klamath is the negative effects of grazing on riparian vegetation and instream habitat. Grazing is common along many tributaries but the highest grazing intensity occurs on private land in Cottonwood, Bogus, Willow, Horse, and Beaver Creeks, and along the mainstem Klamath River corridor. Agriculture in general is highest within the lower reaches of the Willow Creek, Cottonwood Creek, and Bogus Creek watersheds where 5 to 10 percent of the sub-basin area is used for agriculture (CAP data, National Research Council 2004). With notable exceptions, such as riparian restoration-oriented ranch operations along Bogus and Cold creeks, failure to exclude cattle from riparian areas and to lower grazing intensity will continue to lead to poor water quality, bank instability, loss of riparian vegetation, and the simplification of stream habitat. Agricultural operations, if unaltered, will therefore continue to degrade instream habitat in many tributary reaches through impacts to water quality, flow, riparian function, and bank stability (62 FR 24588, May 6, 1997).

High Severity Fire

High severity fire is a medium threat to coho salmon in the Upper Klamath population unit and hazardous fuel loads have been identified in Seiad, Barkhouse, and Williams Creek sub-basins (Soto et al. 2008a). Historically, fire played a natural function within the Klamath River watershed, and small, low-intensity forest fires were common. However, more recently the fire regime within the basin has been altered as drought conditions and active fire suppression has increased the amount of understory brush available to burn. The result has been that large-scale, high severity forest fires are more common in the Upper Klamath. High severity fires can lead to increased erosion rates, loss of riparian forest, and decreased stability of streambanks and upslope areas in many areas of the basin. Erosion rates can be especially severe on steep hillslopes exposed to high-intensity burn conditions.

Road-Stream Crossing Barriers

Road-stream crossings continue to block fish passage within the Upper Klamath River watershed, although recent restoration efforts have addressed many of the problem culverts on National Forest land. A number of culverts located on private, county, and state roads continue to preclude upstream fish passage and constitute a medium threat to coho salmon. Road crossings on Highway 96 (Tom Martin) and Seiad Creek Road (Canyon Creek) have the greatest known impacts due to the high quality of habitat that exists in these areas.

Table 34-5. List of potential barriers in the Upper Klamath River.

IP Priority	Stream Name	Sub-basin	County
High	Canyon Creek	Seiad Valley	Siskiyou
High	Tom Martin	Beaver Creek	Siskiyou
Medium	Empire Creek	Beaver Creek	Siskiyou
Medium	Soda Creek	Beaver Creek	Siskiyou
Medium	Clear Creek	Beaver Creek	Siskiyou
Medium	Collins Creek	Beaver Creek	Siskiyou
Medium	Dona Creek	Beaver Creek	Siskiyou
High	McKinney Creek (LB+RB)	Beaver Creek	Siskiyou
Medium	Vesa Creek(LB+RB)	Beaver Creek	Siskiyou
High	Middle Fork Humbug Creek	Beaver Creek	Siskiyou
High	South Fork Humbug Creek	Beaver Creek	Siskiyou
Medium	Little Bogus Creek	Iron Gate	Siskiyou

Timber Harvest

Although timber harvest has the potential to adversely affect coho salmon or salmon habitat, most former timber lands in the Upper Klamath River sub-basin are now under sustainable timber harvest management. Potential timber resources are also limited in the Upper Klamath and future timber sales are likely to be small. Timber harvest has generally been greatest (>25 percent total area) in the upper reaches of Beaver Creek, Cottonwood Creek, and in Doggett Creek (CAP data, KNF 1996). The USFS, BLM, and private timber companies manage most timber land in the watershed and detrimental impacts on fish habitat from timber harvest are expected to remain medium to high until forest soils stabilize and priority stream crossings are upgraded. Federal agencies operate under the Aquatic Conservation Strategy of the Northwest Forest Plan and a portion of private timber lands are managed under the Fruitgrowers Habitat Conservation Plan (HCP). Overall, timber harvest is considered to be a high threat to the population.

Fishing and Collecting

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium threat to adults and a low stress to juveniles and smolts.

Mining/Gravel Extraction

Though significant in the past, present and future mining activities pose a low threat to the population. Hydraulic mining (placer and suction dredging) can degrade habitat through the disturbance and alteration of streambed substrate. Oftentimes, material is excavated into tailing piles, leaving unnatural channel formations. The persistence of such features is variable, and associated impacts can be prolonged and widespread. The number of mining claims that could be used in the future suggests this is a threat that still needs to be monitored. Adverse effects could include increasing turbidity, modifying spawning channels, decreasing emergent macroinvertebrate prey, and disturbing and displacing juveniles and smolts from refugia. The level of this threat is primarily dependent on the types of methods used and the way in which these methods are applied.

Currently, mining is regulated by CDFW to ensure safe environmental practices and minimal impacts on salmon and salmon habitat. Regulations include special closed areas, closed seasons, and restrictions on methods and operations (Hillman et al. v. CDFG et al. 2009). Mining activities in the region have decreased significantly from historic levels, however recent mining operations had been increasing until the cessation of suction dredging permits by the state of California in 2009. In 2009, Governor Schwarzenegger signed into law SB 670 (Wiggins), instituting a moratorium on suction dredging (to include existing permit holders), with the exception of dredging for the purpose of maintaining energy or water supply management infrastructure, flood control or navigation. The California Department of Fish and Wildlife is currently prohibited by statute from issuing suction dredge permits. (Fish & G. Code, § 5653.1, subd. (b), making it unlawful to use any vacuum or suction dredge equipment in any river, stream, or lake in California (see http://www.dfg.ca.gov/suctiondredge). This prohibition will remain in effect until CDFW completes a court-ordered environmental review of its permitting program, and institutes any changes that are necessary to its former regulations. On June 28, 2013, the Office of Administrative Law (OAL) approved an emergency regulation proposed by the CDFW that changes the regulatory definition of suction dredging for purposes of Fish and Game Code section 5653. With OAL approval and related filing with the California Secretary of State, the new regulation is now in effect. Under this new regulation, the use of any vacuum or suction dredge equipment (i.e., suction dredging) is defined as the use of a suction system to vacuum material from a river, stream or lake for the extraction of minerals (Cal. Code Regs., tit. 14, § 228, subd. (a), effective June 28, 2013.)

Careful monitoring of mining activity will be necessary in the future to ensure that regulations properly condition mining activities, so that mining threats remain low.

Urban/Residential/Industrial Development

The number of people currently living in the Upper Klamath River watershed is small (likely less than a few thousand residents), and is unlikely to change significantly in the near future. Large residential and industrial development is not widespread in the Upper Klamath River watershed and therefore poses only a low threat to coho salmon. The largest cities and towns have populations well under 1,000 residents, and populations have remained unchanged or decreased over the past several decades (US DOC 2011). Impervious surface area is low throughout the Upper Klamath (0 to 5 percent based on CAP data, US DOC 2011). Small residential communities on important tributaries, such as Horse, Seiad and Beaver creeks will likely continue to impact water quality, instream habitat conditions, streamflow, and riparian vegetation. However these impacts are not believed to be increasing.

Invasive Non-Native/Alien Species

Several populations of non-native species exist below Iron Gate Dam and could pose a threat to the Upper Klamath population. The extent of this threat is currently unknown but presumed to be low. Brown trout are rarely found in Bogus Creek but they have been documented to co-occur with juvenile coho salmon and may have seasonal or local effects on juvenile populations (Hampton 2010). Populations of warm-water species are also established in the mainstem below Iron Gate Reservoir and may exert some competitive and predatory pressure on the population.

34.7 Recovery Strategy

The potential for coho salmon recovery in the Upper Klamath is high; however, the population is currently not viable and habitat is degraded and/or unavailable in many areas. Summer and winter rearing habitat is in poor condition in many areas and is limited in its extent and connection to adjacent stream reaches occupied by coho salmon. Mainstem conditions during the summer are unsuitable for migration and rearing. Hatchery influences on the population are very high. Recovery activities in the watershed should focus on the key limiting stresses/threats and life stage and restoration should include both short-term improvement of habitat, as well as long-term restoration of the function of the mainstem river.

The Klamath Basin Restoration Agreement and Klamath Hydropower Settlement Agreement have been signed and are awaiting Federal legislation that would authorize funding for habitat restoration programs and a determination by the Secretary of the Interior whether removal of four dams on the Klamath River (Iron Gate, Copco 1 and 2, and J.C. Boyle dams) would advance restoration of the salmonid fisheries of the Klamath Basin and is in the public interest. Over the long-term (>10 years), removing the PacifiCorp dams would allow coho salmon passage into 76 miles of habitat above the dams, and help to restore hydrological function through increased flow variability (NMFS 2007c, USDOI and CDFG 2012). As a result of restored hydrologic function, NMFS anticipates that disease rates in the Upper Klamath River will be reduced. Water quality benefits are also expected, which would reduce stresses to juvenile coho salmon that may reside in the mainstem Klamath River during late spring and summer (NMFS 2007b). Overall, the removal of the mainstem Klamath River dams and improved volitional fish passage throughout the PacifiCorp reach are the most significant actions that can be taken to restore the viability of the Upper Klamath population unit. As such, dam removal or, in the alternative, volitional fish passage past the four dams, are the highest priority for recovery of this population. If dam removal is complete, new recovery actions for the hydropower reach may need to be developed. PacifiCorp has received an incidental take permit under ESA Section 10(a)(1)(b), and is implementing several conservation measures, including: funding for fish disease research to benefit coho salmon; turbine venting to increase dissolved oxygen concentrations downstream of Iron Gate Dam; funding habitat enhancement projects, including gravel augmentation, downstream of Iron Gate Dam; providing large woody debris below Iron Gate Dam; and coordinating efforts with the U.S. Bureau of Reclamation and NMFS to allow for flow variability to the Klamath River.

Prior to dam removal, the restoration and maintenance of tributary water quality, hydrologic function, and floodplain and channel structure for spawning and rearing will help increase productivity, abundance, and distribution of the population. Recovery actions should focus on protecting and restoring those tributaries that have been identified as being important to coho salmon. In addition, hatchery reform at the Trinity and Iron Gate hatcheries is important to reducing negative interactions and allowing for a more natural population. The effects of fishing on this population's ability to meet its viability criteria should be evaluated.

Table 34-6. Recovery action implementation schedule for the Upper Klamath River population. Recovery actions for monitoring and research are listed in tables at the end of Chapter 5.

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.5.1.19	Passage	Yes	Improve access	Remove barriers	Iron Gate, Copco 1 and 2, and JC Boyle dams	1
SONCC-UKR.5.1.19.1	*Remove four Klamath Hydroelectric Project dams as provided in the KHSA or, in the alternative, construct and operate fishways prescribed by NMFS for Project relicensing*					
SONCC-UKR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Restore peak flows	Mainstem Klamath River	1
SONCC-UKR.3.1.5.1	*Assess current hydrograph and develop a flow variability/environmental water account plan to re-establish a natural hydrograph that reduces alluvial*					
SONCC-UKR.3.1.5.2	*Maintain minimum flow requirements below IGD and implement plan to restore a more natural hydrograph*					
SONCC-UKR.1.2.49	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	1
SONCC-UKR.1.2.49.1	*Implement recovery actions for Lower Klamath River population that address the target "Estuary", including the creation/restoration of off-channel rearing habitat throughout the lower Klamath River*					
SONCC-UKR.30.1.25	Disease, Predation, Competition	No	Reduce disease	Disrupt the disease cycle between salmon, myxospore, polychaetes, and actinospore stages.	Population wide	1
SONCC-UKR.30.1.25.1	*Assess all means possible to disrupt disease cycle and develop a plan to do so*					
SONCC-UKR.30.1.25.2	*Disrupt the disease cycle, guided by assessment results*					
SONCC-UKR.5.1.20	Passage	Yes	Improve access	Reduce sediment barriers	Walker, O'Neil, Humbug, and Grider creeks, and all streams where coho salmon would benefit immediately	2a
SONCC-UKR.5.1.20.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-UKR.5.1.20.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					
SONCC-UKR.5.1.79	Passage	Yes	Improve access	Reduce sediment barriers	Population wide	2b
SONCC-UKR.5.1.79.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-UKR.5.1.79.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Seiad Valley, Beaver, Hornbrook, Cottonwood, Bogus, Grider, Little Grider, Willow, Horse, Little Horse, Walker, Elliott, and Tom Martin creeks, and all streams where coho salmon would benefit immediately	2a
SONCC-UKR.3.1.6.1	*Develop program to decrease diversion during critical periods of seasonal low flows*					
SONCC-UKR.3.1.6.2	*Encourage users to reduce stream diversions during the summer by providing educational materials describing how to increase water use efficiency*					
SONCC-UKR.3.1.6.3	*Establish and provide consistent water master service to ensure water is allocated according to established water rights*					
SONCC-UKR.3.1.75	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2b
SONCC-UKR.3.1.75.1	*Develop program to decrease diversion during critical periods of seasonal low flows*					
SONCC-UKR.3.1.75.2	*Encourage users to reduce stream diversions during the summer by providing educational materials describing how to increase water use efficiency*					
SONCC-UKR.3.1.75.3	*Establish and provide consistent water master service to ensure water is allocated according to established water rights*					
SONCC-UKR.3.1.66	Hydrology	No	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately	2a
SONCC-UKR.3.1.66.1	*Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer*					
SONCC-UKR.3.1.66.2	*Reduce diversions using a combination of incentives and enforcement measures*					
SONCC-UKR.3.1.77	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2d
SONCC-UKR.3.1.77.1	*Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer*					
SONCC-UKR.3.1.77.2	*Reduce diversions using a combination of incentives and enforcement measures*					
SONCC-UKR.5.2.24	Passage	Yes	Decrease mortality	Screen all diversions	Horse, Cottonwood, and Bogus creeks, and all streams where coho salmon would benefit immediately	2b
SONCC-UKR.5.2.24.1	*Assess diversions and develop a screening program*					
SONCC-UKR.5.2.24.2	*Screen all diversions*					
SONCC-UKR.5.2.81	Passage	Yes	Decrease mortality	Screen all diversions	Population wide	2d
SONCC-UKR.5.2.81.1	*Assess diversions and develop a screening program*					
SONCC-UKR.5.2.81.2	*Screen all diversions*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.2.1.4	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem Klamath corridor, Seiad, Bogus, Cottonwood, Willow, Barkhouse, Humbug, O'Neil, Beaver, Horse, Tom Martin, and Grider creeks, and all streams where coho salmon would benefit immediately	2b
SONCC-UKR.2.1.4.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-UKR.2.1.4.2	*Place instream structures, guided by assessment results*					
SONCC-UKR.2.1.71	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2d
SONCC-UKR.2.1.71.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-UKR.2.1.71.2	*Place instream structures, guided by assessment results*					
SONCC-UKR.26.1.65	Low Population Dynamics	No	Increase population abundance	Rescue and relocate stranded juveniles	Population wide	2b
SONCC-UKR.26.1.65.1	*Survey coho-bearing tributaries and relocate juveniles stranded in drying pools*					
SONCC-UKR.2.2.3	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	High IP sub-watersheds (especially, Seiad, Horse, Little Horse, Cottonwood, and Tom Martin creeks), and all streams where coho salmon would benefit immediately	2b
SONCC-UKR.2.2.3.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-UKR.2.2.3.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-UKR.2.2.73	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Population wide	2d
SONCC-UKR.2.2.73.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-UKR.2.2.73.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-UKR.2.2.2	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Seiad, Horse, Little Horse, and Cottonwood creeks, and all streams where coho salmon would benefit immediately	2b
SONCC-UKR.2.2.2.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-UKR.2.2.2.2	*Mechanically alter side channels, off channel ponds and wetlands to achieve connectivity*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.2.2.72	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Population wide	2d
SONCC-UKR.2.2.72.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-UKR.2.2.72.2	*Mechanically alter side channels, off channel ponds and wetlands to achieve connectivity*					
SONCC-UKR.2.2.1	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Seiad and Horse creeks, and all areas where coho salmon would benefit immediately	2b
SONCC-UKR.2.2.1.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees and dikes have been removed or set back*					
SONCC-UKR.2.2.1.2	*Remove levees and dikes and restore channel form and floodplain connectivity, guided by the plan*					
SONCC-UKR.17.2.18	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Iron Gate Hatchery	2b
SONCC-UKR.17.2.18.2	*Implement Hatchery and Genetic Management Plan and revise when necessary*					
SONCC-UKR.8.1.28	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Beaver, Horse, Walker, McKinney, Cottonwood, Doggett, Kohl, Empire, Lumgrey, and Dutch creeks, and all areas where coho salmon would benefit immediately	2b
SONCC-UKR.8.1.28.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-UKR.8.1.28.2	*Decommission roads, guided by assessment*					
SONCC-UKR.8.1.28.3	*Upgrade roads, guided by assessment*					
SONCC-UKR.8.1.28.4	*Maintain roads, guided by assessment*					
SONCC-UKR.8.1.83	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	2d
SONCC-UKR.8.1.83.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-UKR.8.1.83.2	*Decommission roads, guided by assessment*					
SONCC-UKR.8.1.83.3	*Upgrade roads, guided by assessment*					
SONCC-UKR.8.1.83.4	*Maintain roads, guided by assessment*					
SONCC-UKR.30.1.26	Disease, Predation, Competition	No	Reduce disease	Conduct monitoring and research actions as described in the Klamath River Fish Disease Research Plan	Mainstem Klamath River	2b
SONCC-UKR.30.1.26.1	*Develop monitoring plan and research actions as described in the Klamath River Fish Disease Research Plan*					
SONCC-UKR.30.1.26.2	*Implement Klamath River Fish Disease Research Plan*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.10.1.16	Water Quality	No	Reduce water temperature, increase dissolved oxygen	Reduce warm water inputs	Bogus, Willow, Horse, Seiad, Beaver, Barkhouse, Tom Martin, Elliott, and Cotttonwood creeks, and all streams where coho salmon would benefit immediately	2b
SONCC-UKR.10.1.16.1	*Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater input*					
SONCC-UKR.10.1.16.2	*Implement tailwater reduction program*					
SONCC-UKR.10.1.68	Water Quality	No	Reduce water temperature, increase dissolved oxygen	Reduce warm water inputs	Population wide	2d
SONCC-UKR.10.1.68.1	*Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater input*					
SONCC-UKR.10.1.68.2	*Implement tailwater reduction program*					
SONCC-UKR.5.1.21	Passage	Yes	Improve access	Remove structural barriers	Highway 96 crossing on Tom Martin Creek and Seiad Creek Road culvert on Canyon Creek (tributary to Seiad), and all streams where coho salmon would benefit immediately	3a
SONCC-UKR.5.1.21.1	*Assess road-stream crossing barriers and prioritize for removal*					
SONCC-UKR.5.1.21.2	*Remove road-stream crossing barriers and upgrade culvert*					
SONCC-UKR.5.1.80	Passage	Yes	Improve access	Remove structural barriers	Population wide	3b
SONCC-UKR.5.1.80.1	*Assess road-stream crossing barriers and prioritize for removal*					
SONCC-UKR.5.1.80.2	*Remove road-stream crossing barriers and upgrade culvert*					
SONCC-UKR.3.1.48	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Seiad, Horse, Little Horse, and Cottonwood creeks, and all streams where coho salmon would benefit immediately	3a
SONCC-UKR.3.1.48.1	*Install flow gage to ensure appropriate flows for coho salmon*					
SONCC-UKR.3.1.48.2	*Maintain flow gage annually*					
SONCC-UKR.3.1.74	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	3b
SONCC-UKR.3.1.74.1	*Install flow gage to ensure appropriate flows for coho salmon*					
SONCC-UKR.3.1.74.2	*Maintain flow gage annually*					
SONCC-UKR.3.2.12	Hydrology	Yes	Increase water storage	Improve regulatory mechanisms	Population wide	3a
SONCC-UKR.3.2.12.1	*Improve protective regulations for beaver and develop guidelines for relocation that are practical for restoration groups*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.3.2.11	Hydrology	Yes	Increase water storage	Increase beaver abundance	Seiad, Horse, Cottonwood, Little Horse, Horse, and Beaver creeks, and all streams where coho salmon would benefit immediately	3a
SONCC-UKR.3.2.11.1	*Develop a beaver conservation plan that includes education and outreach, technical assistance for land owners, and methods for reintroduction and/or relocation of beaver as a last resort*					
SONCC-UKR.3.2.11.2	*Implement education and technical assistance programs for landowners, guided by the plan*					
SONCC-UKR.3.2.11.3	*Reintroduce or relocate beaver if appropriate, guided by the plan*					
SONCC-UKR.3.2.78	Hydrology	Yes	Increase water storage	Increase beaver abundance	Population wide	3b
SONCC-UKR.3.2.78.1	*Develop a beaver conservation plan that includes education and outreach, technical assistance for land owners, and methods for reintroduction and/or relocation of beaver as a last resort*					
SONCC-UKR.3.2.78.2	*Implement education and technical assistance programs for landowners, guided by the plan*					
SONCC-UKR.3.2.78.3	*Reintroduce or relocate beaver if appropriate, guided by the plan*					
SONCC-UKR.5.1.22	Passage	Yes	Improve access	Remove push-up dam type barriers	Horse Creek	3b
SONCC-UKR.5.1.22.1	*Develop a plan to remove the push up dam and increase flows*					
SONCC-UKR.5.1.22.2	*Remove push up dam, guided by the plan*					
SONCC-UKR.5.1.22.3	*Install flow measuring devices to ensure that water rights and flows are maintained*					
SONCC-UKR.5.1.22.4	*Maintain flow measuring devices*					
SONCC-UKR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3b
SONCC-UKR.3.1.8.1	*Work with partners to streamline the process needed for the dedication of water to fish and wildlife resources under CA Water Code section 1707*					
SONCC-UKR.3.1.8.2	*Implement water dedications to increase instream flows using the streamlined process*					
SONCC-UKR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3b
SONCC-UKR.3.1.9.1	*Establish a categorical exemption under CEQA for water leasing to increase instream flows*					
SONCC-UKR.3.2.10	Hydrology	Yes	Increase water storage	Improve regulatory mechanisms	Population wide	3b
SONCC-UKR.3.2.10.1	*Establish a comprehensive groundwater permit process*					
SONCC-UKR.3.1.64	Hydrology	No	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately	3b
SONCC-UKR.3.1.64.1	*Identify and cease unauthorized water diversions*					
SONCC-UKR.3.1.76	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3d
SONCC-UKR.3.1.76.1	*Identify and cease unauthorized water diversions*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.3.1.67	Hydrology	No	Improve flow timing or volume	Provide adequate instream flow for coho salmon	Population wide	3b
SONCC-UKR.3.1.67.1	*Conduct study to determine instream flow needs of coho salmon at all life stages.*					
SONCC-UKR.3.1.67.2	*If coho salmon instream flow needs are not being met, develop plan to provide adequate flows. Plan may include water conservation incentives for landowners and re-assessment of water allocation.*					
SONCC-UKR.3.1.67.3	*Implement coho salmon instream flow needs plan.*					
SONCC-UKR.7.1.13	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Private lands along the mainstem Klamath Corridor, Horse, Cottonwood, Willow, Bogus, and Beaver creeks, and all areas where coho salmon would benefit immediately	3b
SONCC-UKR.7.1.13.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-UKR.7.1.13.2	*Develop grazing management plans to improve water quality and coho salmon habitat*					
SONCC-UKR.7.1.13.3	*Plant vegetation to stabilize stream bank*					
SONCC-UKR.7.1.13.4	*Fence livestock out of riparian zones*					
SONCC-UKR.7.1.13.5	*Remove instream livestock watering sources*					
SONCC-UKR.7.1.82	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	3d
SONCC-UKR.7.1.82.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-UKR.7.1.82.2	*Develop grazing management plans to improve water quality and coho salmon habitat*					
SONCC-UKR.7.1.82.3	*Plant vegetation to stabilize stream bank*					
SONCC-UKR.7.1.82.4	*Fence livestock out of riparian zones*					
SONCC-UKR.7.1.82.5	*Remove instream livestock watering sources*					
SONCC-UKR.8.2.27	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Mainstem, downstream of Iron Gate dam	3b
SONCC-UKR.8.2.27.1	*Develop a spawning substrate management plan that identifies quantity, quality, location, and timing of gravel supplements*					
SONCC-UKR.8.2.27.2	*Supplement gravel, guided by the plan*					
SONCC-UKR.8.1.29	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Watersheds that provide natal habitat and/or thermal refugia for coho salmon, and all areas where coho salmon would benefit immediately	3c
SONCC-UKR.8.1.29.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-UKR.8.1.29.2	*Implement plan to stabilize slopes and revegetate areas*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.8.1.84	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3d
SONCC-UKR.8.1.84.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-UKR.8.1.84.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-UKR.10.2.51	Water Quality	No	Reduce pollutants	Reduce pesticides	All areas where coho salmon would benefit immediately	3c
SONCC-UKR.10.2.51.1	*Develop a pesticide management plan*					
SONCC-UKR.10.2.51.2	*Implement pesticide management plan and technical assistance program*					
SONCC-UKR.10.2.69	Water Quality	No	Reduce pollutants	Reduce pesticides	Population wide	3d
SONCC-UKR.10.2.69.1	*Develop a pesticide management plan*					
SONCC-UKR.10.2.69.2	*Implement pesticide management plan and technical assistance program*					
SONCC-UKR.10.7.63	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	All streams where coho salmon would benefit immediately	3c
SONCC-UKR.10.7.63.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-UKR.10.7.63.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-UKR.10.7.70	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	Population wide	3d
SONCC-UKR.10.7.70.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-UKR.10.7.70.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-UKR.16.1.30	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-UKR.16.1.30.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-UKR.16.1.30.2	*Identify level of fishing impacts that does not limit attainment of population-specific viability criteria*					
SONCC-UKR.16.1.61	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	Tribal lands	3d
SONCC-UKR.16.1.61.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-UKR.16.1.61.2	*Identify level of fishing impacts that does not limit attainment of population-specific viability criteria*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.16.1.31	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-UKR.16.1.31.1	*Determine actual fishing impacts*					
SONCC-UKR.16.1.31.2	*If actual fishing impacts limit attainment of population-specific viability criteria, modify management so that fishing does not limit attainment of population-specific viability criteria*					
SONCC-UKR.16.1.62	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	Tribal lands	3d
SONCC-UKR.16.1.62.1	*Determine actual fishing impacts*					
SONCC-UKR.16.1.62.2	*If actual fishing impacts limit attainment of population-specific viability criteria, modify management so that fishing does not limit attainment of population-specific viability criteria*					
SONCC-UKR.16.2.32	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-UKR.16.2.32.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-UKR.16.2.32.2	*Identify level of scientific collection impact that does not limit attainment of population-specific viability criteria*					
SONCC-UKR.16.2.33	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Reduce impacts of scientific collection to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-UKR.16.2.33.1	*Determine actual impacts of scientific collection*					
SONCC-UKR.16.2.33.2	*If actual scientific collection impacts limit attainment of population-specific viability criteria, modify collection so that impacts do not limit attainment of population-specific viability criteria*					
SONCC-UKR.5.1.23	Passage	Yes	Improve access	Reduce flow barriers	Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug creeks	BR
SONCC-UKR.5.1.23.1	*Assess low flow tributaries and their sediment sources that contribute to seasonal flow barriers. Develop a plan to alleviate sediment delivery and remove current barriers*					
SONCC-UKR.5.1.23.2	*Alleviate sediment delivery in areas with low flow conditions and seasonal flow barriers as described in the plan*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-UKR.3.1.7.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-UKR.7.1.14	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Private land in the Upper Klamath Basin	BR
SONCC-UKR.7.1.14.1	*Develop fire hazard reduction educational materials for landowners*					
SONCC-UKR.7.1.14.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-UKR.7.1.14.3	*Implement fire-safe community action plans in identified areas*					
SONCC-UKR.7.1.15	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Seiad, Barkhouse, and Williams creeks	BR
SONCC-UKR.7.1.15.1	*Identify areas prone to high severity fire and develop a plan to reestablish a natural fire regime that benefits coho habitat*					
SONCC-UKR.7.1.15.2	*Carry out fuel reduction projects such as thinning and prescribed burning, guided by the strategic plan*					