Klamath River Anadromous Fishery Reintroduction and Restoration Monitoring Plan

for California Natural Resources Agency and California Department of Fish and Wildlife

MESSAGE FROM THE DIRECTOR

The largest river restoration project in American history is underway with the removal of the four dams on the Klamath River. This project will improve water quality and provide access to hundreds of miles of upstream habitat for salmon, steelhead and Pacific lamprey. At the present pace of dam deconstruction, fish will soon navigate independently through the newly restored river channel where the former dam footprints blocked their passage. For the first time in a century, volitional fish passage is expected in the next couple of months—take a moment to reflect on this monumental milestone.

In preparation for volitional fish passage through the former dam sites, the California Department of Fish and Wildlife (CDFW), in collaboration with Native American Tribes and our basin fisheries partners at state and federal agencies, prepared this Anadromous Fisheries Reintroduction and Restoration Monitoring Plan. This plan is an important step in our ongoing commitment to expand and strengthen our partnerships with Klamath Basin tribes, build on existing co-management efforts with tribes, and chart long-term collaboration with Oregon and federal government agencies.

The plan is focused on the reintroduction and monitoring of Chinook salmon, coho salmon, steelhead and Pacific lamprey. Goals of reintroduction include reestablishing viable, wild, self-sustaining populations upstream of former dam sites for species conservation, ecological benefits, and to enhance Tribal, commercial and recreational fisheries. The approach outlined in the plan minimizes interruption of natural biological processes to allow natural demographics, ecology and evolution to unfold thus promoting wild fitness, life history diversity and resiliency of these species. Reintroduction relies on an adaptive management approach which is informed by monitoring and includes close coordination with basin fisheries partners on data collection, interpretation and decision making. Also, an important consideration in the reintroduction of fall-run Chinook salmon and coho salmon is that these populations will be supplemented by the newly constructed Fall Creek Hatchery. The hatchery's annual production goals include 3.25 million Chinook salmon of various age classes at release and 75,000 coho salmon yearlings at release with hatchery production slated to continue for the next eight years.

Monitoring performed under this plan will inform fisheries managers on the status of reintroduction and repopulation of newly available habitat and contribute valuable information to support fisheries conservation and management. This includes information considerations for Tribal, commercial and recreational fishing regulations, establishing future escapement thresholds, and prioritizing research and restoration efforts.

As outlined in the monitoring plan, CDFW will work closely with our basin fisheries partners to monitor and manage the long-awaited return of salmon, steelhead and Pacific lamprey as they repopulate historical habitats upstream of the former dam footprints.

As California Governor Newsom's recent California Salmon Strategy for a Hotter, Dryer Future makes abundantly clear – "California needs thriving salmon runs. …Just as California needs salmon, salmon need us." By restoring the Klamath River Basin as salmon stronghold and improving population resiliency through removing barriers for salmon migration, restoring and expanding habitat, and strengthening partnerships, we chart the path to a brighter future and help bring restorative justice to our Tribal partners.

Charlton H. Bonham, Director
California Department of Fish and Wildlife

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

Four hydroelectric dams (i.e., J.C. Boyle, Copco No.1, Copco No.2, and Iron Gate) on the mainstem Klamath River that physically block anadromous species from accessing hundreds of miles of historical upstream habitats, impair water quality, and provide favorable conditions downstream for fish pathogens are scheduled for removal with volitional fish passage through the former dam footprints by as early as fall 2024. In preparation for the reintroduction of anadromous species into habitats upstream of Iron Gate Dam, the California Department of Fish and Wildlife prepared this anadromous fishery reintroduction and restoration monitoring plan. The plan focuses on the reintroduction and monitoring of Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead (O. *mykiss*), and Pacific lamprey (*Entosphenus tridentatus*) within the mainstem Klamath River and tributaries from Iron Gate Dam upstream to the California/Oregon border. In total it encompasses approximately 31.2 kilometers (19.4 miles) of the mainstem Klamath River and approximately 26.3 kilometers (16.4 miles) of tributary habitats.

The approach to reintroduction of anadromous species is through volitional migration with the goal of reestablishing viable, wild, self-sustaining anadromous fish populations in the upper Klamath River for species conservation and ecological benefits as well as to enhance Tribal, commercial, and recreational fisheries. Hatchery produced fall-run Chinook salmon and coho salmon will supplement reintroduction with PacifiCorp funding Fall Creek Hatchery operations for a period of up to eight years, post dam removal. Consideration for active reintroduction will be deferred for three to four generations (12-15 years), depending on species, to provide time for volitional reintroduction. However, reintroduction will rely on an adaptive management strategy, will be informed by monitoring, and will include close coordination with Klamath Basin partners.

Monitoring performed under this plan will inform fisheries management including the regulatory framework for Tribal, commercial, and recreational fishing regulations as well as species conservation and ecological restoration. A variety of monitoring methods are being considered to monitor the reintroduction of anadromous fishes into historical habitats, followed by long-term monitoring of these populations. Based on coordination with Klamath Basin partners, the monitoring methods to be implemented once the dams are removed and volitional passage is achieved are identified in Attachment A. Many of these monitoring methods are currently used downstream of Iron Gate Dam, and elsewhere, and flexibility is built into this plan to allow for other methods to be used to answer specific questions as fish populations volitionally move into and reestablish in habitats upstream of Iron Gate and as habitat processes evolve based on environmental conditions. The plan also describes Klamath River habitat restoration efforts and plans, restoration programs, and potential funding sources for future restoration in the Klamath Basin.

1.0 INTRODUCTION

The Klamath River is one of several major river systems on the U.S. West Coast. It originates in southern Oregon and flows approximately 423 kilometers (263 miles) (National Oceanic and Atmospheric Association National Marine Fisheries Service [NOAA Fisheries] 2009) through southern Oregon and northern California before emptying into the Pacific Ocean. The Klamath River Basin encompasses approximately 40,507 square kilometers (15,640 square miles) (Lane and Lane 1981) (Figure 1). Historically, the Klamath River was the third largest salmon producing river on the U.S. contiguous West Coast (NOAA Fisheries 2019a). The decline in natural salmon and steelhead abundance in the Klamath River Basin has been attributed in part to the construction of four hydroelectric dams on the mainstem Klamath River that block access to historical habitats, impair water quality, and provide favorable conditions downstream for fish pathogens. Three of the four dams are located in Siskiyou County, California, and include Iron Gate Dam, Copco 1 Dam, and Copco 2 Dam. The fourth, J.C. Boyle Dam, is in Klamath County, Oregon. The locations of the four dams are shown in Figure 1.

Prior to the construction of these dams, the upper Klamath River Basin, defined as the portion of the basin upstream of Iron Gate Dam, was occupied by several anadromous fish species, including fall- and spring-run Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), and Pacific lamprey (*Entosphenus tridentatus*). Historical information on the geographic extent of anadromy in the upper Klamath River Basin is well documented by Lane and Lane (1981), Hamilton et al. (2005), Hamilton et al. (2016), and others, and is discussed in more detail in Section 1.3.

Volitional fish passage to the upper Klamath Basin is expected to be restored by as early as 2024 through removal of the four mainstem hydroelectric dams. It is important to note that two other channel-spanning dams, Link River Dam and Keno Dam, occur further upstream in Klamath County, Oregon, and will remain (Figure 1). Both Link River and Keno dams have fish ladders designed to allow volitional passage and both are expected to serve as new control points for regulating downstream flows once the four hydroelectric dams are removed.

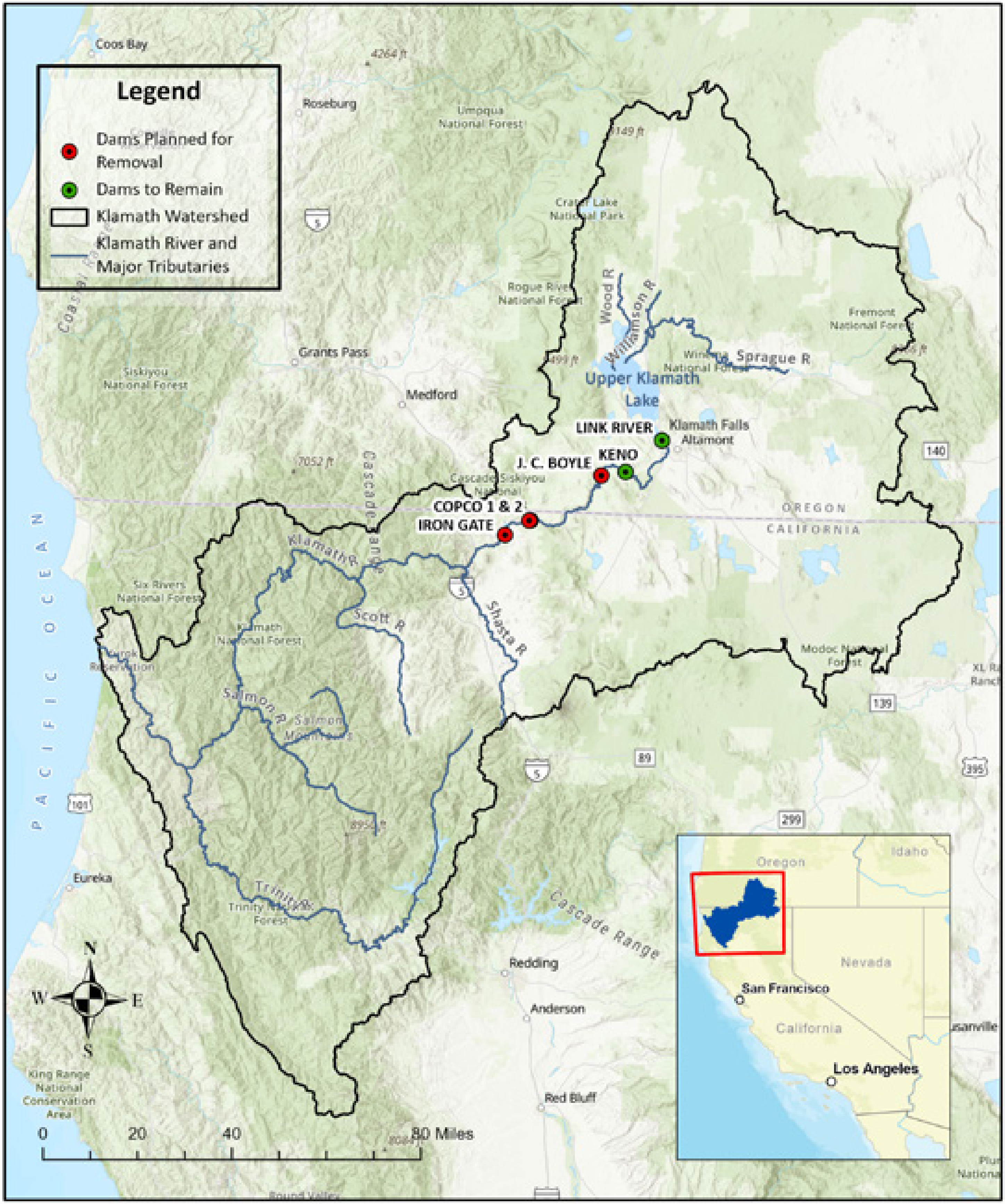

FIGURE 1. Map showing the Klamath River Basin; mainstem Klamath River and major tributaries; Upper Klamath Lake and major tributaries; the four hydroelectric dams planned for removal; and the two dams to remain.

The current migratory extent of anadromous species in the Klamath River is Iron Gate Dam at river kilometer (RKM) 310.8 (river mile [RM] 193.1) in Siskiyou County, California. Over 676 kilometers (420 miles) of potential habitat in the upper Klamath River Basin is physically inaccessible to anadromous species due to these dams (Huntington et al. 2006; U.S. Department of Interior [DOI] and NOAA Fisheries 2013). Once fish passage is restored, anadromous species that currently migrate to the base of Iron Gate Dam are, with a high degree of confidence, expected to volitionally move upstream and spawn in historical upstream habitats in California and Oregon. By reconnecting access to historical habitats, Klamath River anadromous salmonid and Pacific lamprey populations are expected to improve and become more resilient in the face of climate change. Monitoring the reintroduction of anadromous fishes into historical habitats, followed by long-term monitoring of these populations, will be critical for the conservation of these species as well as for informing fisheries managers of Klamath River salmon and steelhead populations for Tribal, commercial, and recreational harvests, as well as non-consumptive uses.

This *Klamath River Anadromous Fishery Reintroduction and Restoration Monitoring Plan for the California Natural Resources Agency and the California Department of Fish and Wildlife* (Monitoring Plan) was prepared by the California Department of Fish and Wildlife (CDFW) with support from the Oregon Department of Fish and Wildlife (ODFW), and other basin partners including the Yurok Tribe, Karuk Tribe, NOAA Fisheries, U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Reclamation who helped inform the material in this plan. As a state trustee agency of California's fish, wildlife, and plant resources, the CDFW prepared this Monitoring Plan to provide a framework for the reintroduction and monitoring of anadromous fishes in the upper Klamath Basin of California once the four dams are removed and fish passage is restored. Monitoring performed under this Monitoring Plan will be used to support federal, Tribal, and state fisheries management, species conservation, and ecological restoration post dam removal. The geographic scope focuses primarily on the mainstem Klamath River and associated tributaries from the California/Oregon border (Stateline) downstream to Iron Gate Dam. However, for the Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) of coho salmon (SONCC coho salmon) it also includes the California portion of the Upper Klamath River Population as defined in the *Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (Oncorhynchus kisutch)* (SONCC Coho Recovery Plan) (NOAA Fisheries 2014). The geographic scope is further discussed in Section 1.4. The CDFW will implement this Monitoring Plan in close coordination with basin partners which is anticipated to occur through co-management and/or development of a science advisory committee or technical working group.

This Monitoring Plan relies on an adaptive management strategy with volitional migration as the preferred method for reintroduction but also includes general guidance for active reintroduction. In California, consideration for active reintroduction will initially be deferred for a number of years to allow time for volitional reintroduction. This strategy is further discussed in Section 5.1.2. Implementation of this Monitoring Plan will help inform whether active reintroduction may be necessary in the future and if necessary, the CDFW will work closely with federal and state agencies, Tribes, and other basin fisheries partners to develop an active reintroduction plan for implementation.

The preparation of this Monitoring Plan was coordinated with development of the Klamath Basin Integrated Fisheries Restoration and Monitoring Plan (IFRMP) (Environmental and Social Systems Analysts [ESSA] 2023). Additionally, this Monitoring Plan was designed to be compatible and complementary with current monitoring programs for anadromous fishes downstream of Iron Gate Dam and with the ODFW and The Klamath Tribes *Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin* (2021). The CDFW recognizes that close collaboration with basin partners will be important to effectively monitor the reintroduction of anadromous fishes to the upper Klamath River Basin.

This Monitoring Plan is organized as follows. It first describes the environmental setting, provides a brief history of mainstem Klamath River dams with fish passage constraints, and discusses the fish species of the Klamath River Basin with a focus on anadromous species. It identifies the spatial and temporal extent of monitoring, provides the purpose and need for reintroduction and monitoring, describes the regulatory setting, and identifies key issues and uncertainties that will affect successful reintroduction and monitoring. Lastly, it describes the monitoring framework that will be implemented in California following removal of the four hydroelectric dams and describes Klamath River restoration monitoring activities and potential funding sources in a post dam removal world.

1.1 KLAMATH RIVER

The Klamath River is unique in that it originates east of the Cascade Mountain Range in southern Oregon and flows in a westerly direction through the Cascade and Klamath mountains to the temperate rainforest of the California coast where it enters the Pacific Ocean. The Klamath River flows approximately 423 kilometers (263 miles) (NOAA Fisheries 2009) and has a watershed that encompasses approximately 40,507 square kilometers (15,640 square miles) (Land and Lane 1981) (Figure 1).

The hydrology of the Klamath River mainstem and its major tributaries are dominated by seasonal melt of snowpack (National Research Council [NRC] 2004). Several tributaries in the upper Klamath River Basin are also well supported by springs and exhibit relatively stable hydrographs and water temperatures. Numerous lakes occur in the upper Klamath River Basin including Upper Klamath Lake, Lower Klamath Lake, Tule Lake, and Clear Lake. The area once supported vast wetlands; however, beginning in the late 1800's significant portions of these wetlands were converted to agricultural lands. For example, over 30,000 acres of wetlands adjacent to Upper Klamath Lake were isolated or eliminated by dike construction and wetland draining (Independent Multidisciplinary Science Team 2003). Despite historical changes, some remnant wetlands remain, many of which are now within National Wildlife Refuges. Primary land uses in the upper Klamath River Basin include agriculture, ranching, and forestry.

Flow releases from J.C. Boyle Dam in southern Oregon downstream to Iron Gate Dam in California (referred to as the hydroelectric reach) are primarily managed for hydropower purposes. Further downstream snow melt and precipitation become more predominant sources of instream flow as there appears to be little accrual of groundwater to the Klamath mainstem below Iron Gate Dam (NRC 2004). The lower Klamath River, defined as the portion of river downstream of Iron Gate Dam, flows through the rugged Klamath Mountains and temperate rainforest of coastal northern California before reaching the Pacific Ocean. Historically, stretches of the lower river were substantially altered by mining activities including large-scale hydraulic mining of gold-bearing placer deposits. Mining brought extensive timber harvest and other resource extractions to the region. Some lands continue to be managed for timber and other natural resources. Most lands along the lower section of river are under Tribal or federal ownership (NOAA Fisheries 2014).

In California, the largest tributaries to the Klamath River occur downstream of Iron Gate Dam, though there are several important fish bearing tributaries upstream of Iron Gate Dam to the Stateline. These include Scotch and Camp creeks (RKM 308.9 [RM192.0][1]), Jenny Creek (RKM 318.0 [RM 197.5][1]), Fall Creek (RKM 321.5 [RM 199.8][1]), and Shovel Creek (RKM 337.5 [RM 209.7]), as shown in Figure 2. Many of these tributaries historically supported anadromous fishes and are expected to once again support them once volitional fish passage is restored through the hydroelectric reach. Moreover, many of these tributaries, regardless of watershed size, provide daily and seasonal cool-water habitat which once accessible are expected to support several life stages of anadromous fishes including over-summering juvenile coho salmon and perhaps adult spring-run Chinook salmon.

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1 Source: Klamath River Renewal Corporation 2021. Approximate river kilometer (river mile) based on probable location of tributary confluence with Klamath River as derived from bathymetry and historical channel alignments.

1.2 HISTORY OF MAN-MADE BARRIERS TO FISH PASSAGE ON THE KLAMATH RIVER

One of the first reported dams on the upper Klamath River in California was the Klamathon Dam, a log crib, rock-filled dam constructed by the Klamath River Improvement and Lumber Company in 1889. The dam created a mill pond on the Klamath River at the historic lumber town of Klamathon near present-day Hornbrook (Figure 2). Initially built without fish passage (Hamilton et al. 2016), the dam was reported to be 10 to 12 feet in height (Fortune et al. 1966) and is thought to have intermittently impaired fish migration. During the winter of 1889-1890 the dam was washed out by high flows and was subsequently rebuilt (Hamilton et al. 2016). It remained in place until 1902 when a fire destroyed the town of Klamathon including the log crib dam.

In 1910, the U.S. Bureau of Fisheries placed racks (Klamathon Racks) near the town of Klamathon to collect broodstock with the intent of maintaining, enhancing, or creating new fish runs (Lane and Lane 1981). The racks were described as two barriers spanning the Klamath River that were used to trap migrating fish. According to Snyder (1931), the racks were usually in place by late July in anticipation of the early arrivals and they sometimes remained until late November.

Beginning in 1912, three hydroelectric dams were constructed on the mainstem Klamath River in California including Copco 1, Copco 2, and Iron Gate (Figure 2). The first to be constructed was Copco 1 at RKM 324.9 (RM 201.9) which began construction in 1912 and was built without fish passage resulting in a complete barrier to anadromous fishes. Fall Creek Hatchery, which is further described in Section 3.2 below, was built in 1919 as compensation for the loss of spawning grounds that occurred with construction of Copco 1 Dam. Subsequent construction of Copco 2 at RKM 324.4 (RM 201.6) further blocked passage and also converted approximately 2.4 RKMs (1.5 RMs) of the Klamath River into a low flow bypass reach, referred to as the Copco 2 Bypass Reach. Iron Gate Dam, completed in 1962 at RKM 310.8 (RM 193.1), is the furthest downstream of the three dams and resulted in another barrier to fish migration and loss of

Figure 2. Map showing Klamath River and main tributaries through the hydroelectric reach; Fall Creek and Iron Gate hatcheries; the four hydroelectric dams planned for removal; and the historic Klamathon Dam.

roughly 13.6 RKMs (8.5 RMs) of mainstem habitat plus additional tributary habitats. As mitigation for habitat blocked by Iron Gate Dam, Iron Gate Hatchery was constructed, replacing Fall Creek Hatchery, and began operating in 1966 and is further described in Section 3.1.

In addition to the three dams in California, J.C. Boyle Dam built in 1958 at RKM 366.9 (RM 228.0) in Oregon is yet another hydroelectric dam on the Klamath River (Figure 2). A fish ladder was constructed at J.C. Boyle to provide upstream passage; however, the ladder does not meet current federal or state fish passage criteria and is considered a substantial partial barrier to fish passage in the mainstem Klamath River. Table 1 provides a summary of the general specifications for each of the four hydroelectric dams that are planned for removal and their associated reservoirs.

The four mainstem hydroelectric dams: Iron Gate, Copco 1, Copco 2, and J.C. Boyle, are currently owned and operated by PacifiCorp through a Federal Energy Regulatory Commission (FERC) license. FERC is the federal authority that oversees both construction and operation, through licensing, of hydropower projects in the United States. On February 28, 2006, PacifiCorp's 50-year FERC license (FERC Project No. 2082-062) to operate the dams expired. PacifiCorp initially pursued relicensing the four hydroelectric facilities for another 50 years and under the Federal Power Act, NOAA Fisheries and USFWS required prescriptions for fishways and recommended certain fishery protection, mitigation, and enhancement measures for relicensing. In addition, relicensing required compliance with Section 401 of the Clean Water Act (CWA) to improve degraded water quality created by the reservoirs (DOI and NOAA Fisheries 2013). For PacifiCorp these conditions put into question the economic viability of the dams and identified potential risks to their ratepayers, thus PacifiCorp opted to become a signatory of the 2010 Klamath Hydroelectric Settlement Agreement (KHSA) and subsequent 2016 amended KHSA. PacifiCorp currently operates the facilities under an annual license administered by FERC. Additionally, an abeyance for a CWA Section 401 Water Quality Certification is currently in place for operation of the hydroelectric facilities per the amended KHSA.

The amended KHSA provides a process for the decommissioning and removal of the four dams with the intent of restoring Klamath Basin natural resources, including anadromous fish passage, fisheries, and water quality. It is a multi-party agreement to resolve disputes regarding the FERC relicensing proceedings by establishing a process for potential dam removal and operation of the dams until that time (KHSA 2016).

Iron Gate Dam and associated hydroelectric facilities, CDFW Photo.

Table 1. General specifications for the four mainstem Klamath River hydroelectric dams planned for removal and associated reservoirs.

General Specifications	J.C. Boyle Dam	Copco 1 Dam	Copco 2 Dam	Iron Gate Dam
Year Completed[1]	1958	1922	1925	1962
Dam Type[1]	Concrete and Earth Fill	Concrete	Concrete	Earth Fill
Dam Location by River Kilometer (River Mile)[2]	366.9 (228.0)	324.9 (201.9)	324.4 (201.6)	310.8 (193.1)
Reservoir Surface Area by Hectares (Acres)[3]	170 (420)	405 (1,000)	16 (40)	382 (944)
Reservoir Storage Volume by Hectare-Meter (Acre-Feet)[3]	431 (3,495)	4,160 (33,724)	9 (73)	7,252 (58,794)

Data Sources: [1]DOI and NOAA Fisheries 2013; [2]ODFW and The Klamath Tribes 2021; and [3]KRRC 2020.

On September 23, 2016, PacifiCorp and the Klamath River Renewal Corporation (KRRC), a non-profit organization that was formed by the amended KHSA to serve as the party responsible for dam removal, applied to the FERC for the transfer and surrender of the FERC license to remove the four dams and associated facilities that together form the Lower Klamath Project (FERC Project No. 14803-000). On July 16, 2020, FERC denied the request for license transfer but instead approved a partial transfer of license to KRRC (172 FERC 61,062). Under this arrangement KRRC and PacifiCorp would be co-licensees of the Lower Klamath Project and share the burden of dam removal. In this ruling, FERC would not initiate the review process of the license surrender application until license transfer was resolved. FERC's decision was unexpected as the intent of the amended KHSA was for PacifiCorp to transfer the FERC license and ownership of the hydroelectric facilities to KRRC for the purposes of removal. Despite this unexpected decision, PacifiCorp, KRRC, California, Oregon, Karuk Tribe, and Yurok Tribe negotiated an alternative path to license transfer and surrender and entered into a Memorandum of Agreement (MOA) on November 16, 2020. Per the MOA, PacifiCorp and KRRC filed with FERC the *Joint Application for Approval of License Transfer and Request for Expedited Review and Other Relief* (KRRC 2021). This joint application was submitted on January 13, 2021, and requested, among other things, FERC approval of transfer of the Lower Klamath Project license from PacifiCorp to the KRRC and states of California and Oregon as the co-licensees, thereby removing PacifiCorp from the license. FERC approved the requested joint application for license transfer on June 17, 2021, and shortly after initiated the National Environmental Policy Act (NEPA) review process for license surrender. The Draft Environmental Impact Statement (EIS) was released in February 2022 followed by the Final EIS in August 2022. The FERC Commission issued a License Surrender Order on November 17, 2022, of which KRRC and the states of California and Oregon have accepted as co-licensees for the purposes of license surrender.

1.3 FISHES OF THE KLAMATH RIVER BASIN AND ANADROMOUS SPECIES COVERED UNDER THIS MONITORING PLAN

Eighty-three fish species are known to occur in the Klamath River Basin, including 45 native and 38 non-native species (Carter and Kirk 2008). Twenty-one of these native fish species are either listed under the Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) or are identified by the CDFW as species of special concern or fully protected species (Table 2). Several of these species, as well as others that reside only in the Oregon portion of the watershed, are also identified by ODFW as special status species including sensitive or sensitive-critical species. Native anadromous species known to occur in the Klamath River Basin include spring-run Chinook salmon, fall-run Chinook salmon, coho salmon, fall-, winter-, and summer-run steelhead, coastal cutthroat trout (*Oncorhynchus clarkii clarkii*), Pacific lamprey, eulachon (*Thaleichthys pacificus*), and green sturgeon (*Acipenser medirostris*).

While the Klamath River Basin supports a diverse array of native fish species, this Monitoring Plan focuses solely on those native anadromous species that were historically known to occur in the Klamath River upstream of Iron Gate Dam. These include spring-run Chinook salmon, fall-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey.

The historical distribution of each is discussed in more detail beginning in Section 1.3.1. For reference, rivers and streams with potential to support anadromous fishes following dam removal are illustrated in Figure 3.

Coastal cutthroat trout, eulachon, and green sturgeon are only known to inhabit the lower reaches of the Klamath River and likely never occurred as far upstream as Iron Gate Dam; therefore, these species are not included in this Monitoring Plan. For information on the geographic extent of coastal cutthroat trout, eulachon, and green sturgeon in the Klamath River Basin please refer to Kroeber and Barret (1960), Moyle (2002), and Hamilton et al. (2005).

Table 2. Federal and California special status fishes of the Klamath River Basin.

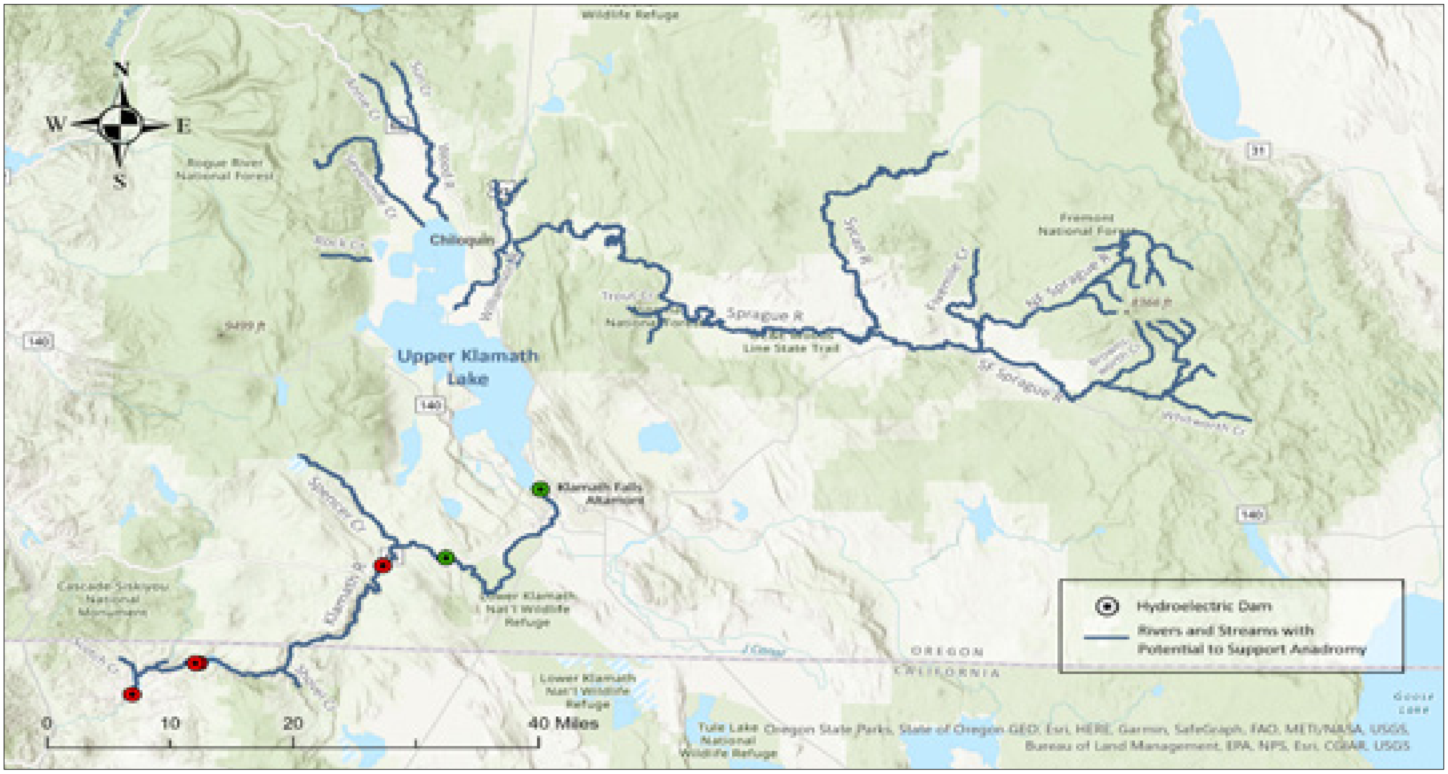
Species Common Name (Scientific Name)	**Status** (Federal[1]/California[2])
Green Sturgeon – Northern DPS (*Acipenser medirostris)*	SC/SSC
Green Sturgeon – Southern DPS (*Acipenser medirostris*)	FT/--
White Sturgeon (*Acipenser transmontanus*)	--/SSC
Klamath Largescale Sucker (*Catostomus snyderi*)	--/SSC
Shortnose Sucker (*Chasmistes brevirostris*)	FE/CE, FP
Klamath Marbled Sculpin (Cottus klamathensis)	--/SSC
Lost River Sucker (*Deltistes luxatus*)	FE/CE, FP
Northern California Brook Lamprey (*Entosphenus folletti*)	--/SSC
Pit-Klamath Brook Lamprey (*Entosphenus lethophagus*)	--/SSC
Klamath River Lamprey (*Entosphenus similis*)	--/SSC
Pacific Lamprey (*Entosphenus tridentatus*)	--/SSC
Tidewater Goby (*Eucyclogobius newberryi*)	FE/--
Blue Chub (*Gila coerulea*)	--/SSC
Chinook Salmon – Upper Klamath and Trinity Rivers ESU (*Oncorhynchus tshawytscha*)[3]	FC/CT, SSC
Chinook Salmon – Southern Oregon/Northern California Coastal ESU (*Oncorhynchus tshawytscha*)	FC/SSC
Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*)	--/SSC
Coho Salmon – Southern Oregon/Northern California ESU (*Oncorhynchus kisutch*)	FT/CT
Steelhead – Klamath Mountains Province DPS (*Oncorhynchus mykiss irideus*)	--/SSC
Bull Trout (*Salvelinus confluentus*)	FT/CE
Longfin Smelt (*Spirinchus thaleichthys*)	FC/CT
Eulachon (*Thaleichthys pacificus*)	FT/--

[1] **Federal Status:** FT = Federal Threatened; FE = Federal Endangered; FC = Federal Candidate/Under Petition for Listing; and SC = National Marine Fisheries Service Species of Concern.

[2] **California Status:** CT = California Threatened; CE = California Endangered; FP = Fully Protected; and SSC = California Species of Special Concern.

[3] Chinook Salmon – Upper Klamath and Trinity Rivers Evolutionarily Significant Unit (ESU) was petitioned for Endangered Species Act (ESA) listing on November 2, 2017 and is currently undergoing an ESA status review. The petition requests that either the ESU be listed as threatened or endangered under the ESA or alternatively a new ESU is defined for the spring-run component of the Upper Klamath and Trinity Rivers ESU and that ESU be listed as threatened or endangered. Under a separate California Endangered Species Act (CESA) status review, the California Fish and Game Commission listed the spring-run Chinook Salmon component of the Upper Klamath and Trinity Rivers ESU as threatened under CESA on January 24, 2022.

Figure 3. Rivers and streams of the upper Klamath River Basin with potential to support anadromous species following removal of the four mainstem hydroelectric dams.



Data Source: ODFW and The Klamath Tribes 2021.

1.3.1 Chinook Salmon

The Klamath River and its headwaters were once one of the major anadromous fish sources between the Columbia and Sacramento rivers and supported considerable populations of spring- and fall-run Chinook salmon (Lane and Lane 1981). Fall-run Chinook salmon may have numbered between 400,000 and 600,000 fish in the early 1900's (Moyle 2002) and spring-run Chinook salmon are believed to have substantially outnumbered fall-run Chinook salmon in the Klamath Basin (DOI and NOAA Fisheries 2013). Interviews with Klamath Tribal members identified salmon fishing locations on lakes and streams in Oregon including the Sprague River, Williamson River, Spencer Creek, and at Barclay Springs and Pelican Bay, Upper Klamath Lake (Lane and Lane 1981). Two historical photographs from around 1860 and 1891 show fishermen with their catch of Chinook salmon on the Link River, near the town of Klamath Falls, Oregon (Hamilton et al. 2005) as shown in Figure 4. Through DNA analysis of fish bones from six ethnographically known archeological sites in the upper Klamath Basin, Stevenson and Butler (2015) found the presence of Chinook salmon at many of these sites and at differing time periods.

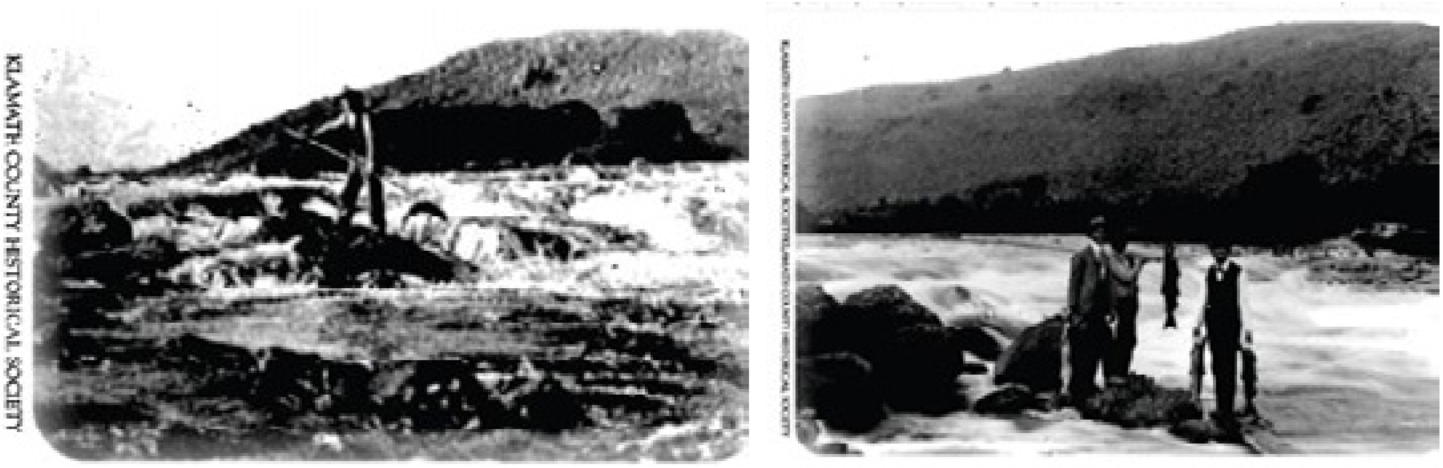


Figure 4. Picture on left taken around 1860 shows salmon fishing on Link River and picture on right from 1891 shows fisherman with their catch of salmon on Link River.

Source: Hamilton et al. 2005. Photographs Klamath County Historical Society as cited in Hamilton et al. 2005.

Prior to the construction of the hydroelectric dams, small-scale commercial salmon harvest occurred at Shovel Creek (RKM 337.5 [RM 209.7]) near Beswick, California (Hamilton et al. 2016) (Figure 2). In the 1880's, the Klamath Hot Springs Resort was established at the mouth of Shovel Creek and among the resort's major attractions was fishing for migratory trout and salmon in Shovel Creek and the Klamath River (Hamilton et al. 2016). Before Iron Gate Dam was constructed the California Department of Fish and Game (CDFG), now CDFW, conducted annual adult Chinook salmon counts on Fall and Jenny creeks (Figure 2). Chinook salmon counts were conducted between 1950 and 1959 on Fall Creek and 1953 through 1960 on Jenny Creek (Riley 1964). The number of salmon in each creek varied annually but in 1955 over 2,000 Chinook salmon were counted independently in both Fall Creek and Jenny Creek as reported by Riley (1964).

The CDFG also measured spawning efficiency of Chinook salmon in Fall Creek from 1950 through 1954 (Wales and Coots 1954). This effort took place shortly after the initial closure of Fall Creek Hatchery in 1948. The 1948 and 1949 runs of salmon entering Fall Creek were estimated between 2,500 and 3,000 fish and overcrowding of available spawning habitat was noted (Coots 1953). Between 1950 and 1954 the CDFG regulated the number of Chinook salmon pairs entering Fall Creek which ranged from 750 in 1950 to 300 in 1953 and 1954 (Wales and Coots 1954).

Klamath River fall-run Chinook salmon currently migrate to the base of Iron Gate Dam and are collected at Iron Gate Hatchery for broodstock. Iron Gate Hatchery, which is owned by PacifiCorp and operated by CDFW, was established to mitigate for the loss of roughly 13.6 RKM (8.5 RM) of anadromous fish habitat between Iron Gate Dam and the Copco dams, and currently raises and releases fall-run Chinook salmon and SONCC coho salmon. Iron Gate Hatchery is discussed in more detail in Section 3.1.

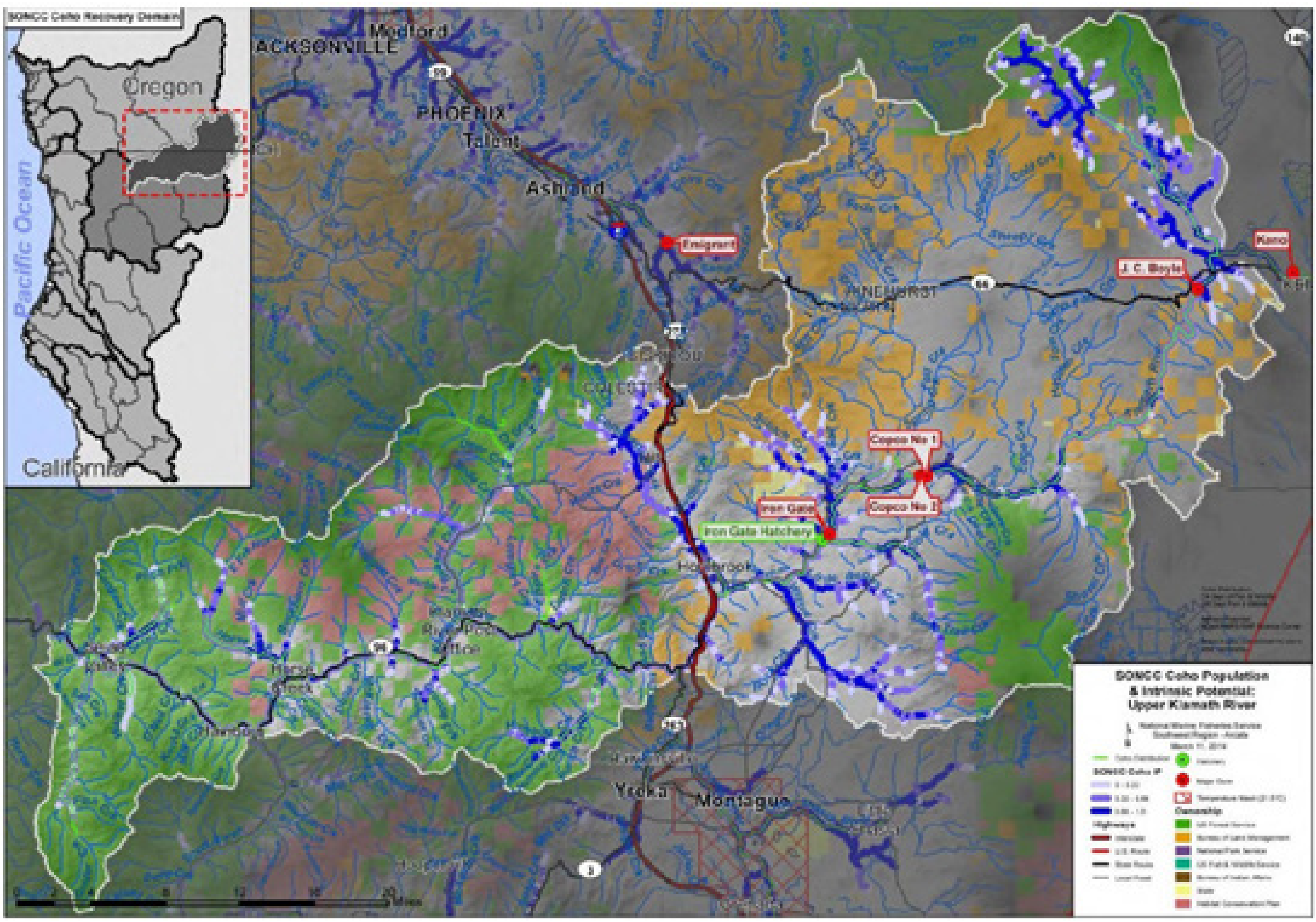
As previously mentioned, spring-run Chinook salmon are believed to have substantially outnumbered fall-run Chinook salmon in the Klamath Basin (DOI and NOAA Fisheries 2013). Prior to the construction of the four dams, spring-run Chinook salmon were documented in tributaries of Upper Klamath Lake as reported by Lane and Lane (1981), Hamilton et al. (2016), and others. At present, the only known extant populations of spring-run Chinook salmon in the Klamath River Basin are in the Trinity River and Salmon River over 160 kilometers (100 miles) downstream of Iron Gate Dam.

1.3.2 Coho Salmon

Klamath River coho salmon are part of the SONCC ESU (SONCC coho salmon). This ESU includes all naturally spawned coho salmon populations from Cape Blanco, Oregon south to Punta Gorda, California as well as three hatchery propagation programs including the Cole Rivers hatchery in Oregon and the Trinity River and Iron Gate hatcheries in California (NOAA Fisheries 2014). SONCC coho salmon are listed under both the ESA and CESA as threatened. Within the geographic area of the four hydroelectric dams is the Upper Klamath River Population of SONCC coho salmon. Although not currently present upstream of Iron Gate Dam, the geographic range of this population extends along the mainstem Klamath River from Portuguese Creek, California upstream to and including Spencer Creek, Oregon, and with the exceptions of the Scott and Shasta rivers, includes numerous other tributaries within that reach. The geographic boundary and intrinsic potential habitat for the Upper Klamath River Population of SONCC coho salmon are shown in Figure 5. One of the highest priority recovery actions for this population is either the removal of the four hydroelectric dams or creation of fish passageways at each dam (NOAA Fisheries 2014). Overall, long-term declines in Klamath Basin coho salmon have been estimated to be between 52 to 95 percent and attributed to the cumulative effects of dams, hydrologic modifications, changing ocean conditions, agricultural development, timber harvest, overfishing, and mining (DOI and NOAA Fisheries 2013).

Based on review of historical information, Hamilton et al. (2005) concluded that the furthest upstream distribution of coho salmon likely extended to at least Spencer Creek, Oregon. Other sources report coho salmon once migrated to the vicinity of Upper Klamath Lake (Kroeber and Barrett 1960; Moyle 2002). Prior to the construction of Iron Gate Dam, the CDFG documented coho salmon spawning in Fall Creek (Coots 1957), and the confluence of Jenny Creek and the Klamath River was once a well-known location by fishing guides to fish for coho salmon (Kent Bulfinch, Klamath River Basin Task Force representative as cited in Hamilton et al. 2005).

Figure 5. Geographic boundary and intrinsic potential habitat of Upper Klamath River Population of Southern Oregon/Northern California Coast (SONCC) coho salmon. This Monitoring Plan includes the California portion of this population**.**



Source: NOAA Fisheries 2014.

Similar to fall-run Chinook salmon, coho salmon currently migrate to the base of Iron Gate Dam and are collected at Iron Gate Hatchery for broodstock. Coho salmon as well as Chinook salmon also spawn in Bogus Creek (RKM 309.9 [RM 192.6]) which flows into the Klamath River immediately downstream of the hatchery and is currently the furthest upstream tributary supporting anadromous salmonids.

1.3.3 Steelhead

The Klamath River was historically noted for steelhead as well as salmon, and steelhead entered the river in great numbers (Lane and Lane 1981). Kroeber and Barret (1960) reported that historically both salmon and steelhead ran up the Klamath River into the Klamath lakes and associated tributaries. As previously mentioned, the Klamath Hot Springs Resort was established at the mouth of Shovel Creek in the 1800's and among the resort's major attractions was fishing for migratory trout and salmon (Hamilton et al. 2016). Anadromous rainbow trout were noted in Fall Creek by Coots (1957) during spawning investigations in 1954 and 1955. Additionally, CDFG records indicate steelhead spawned in Camp Creek and in at least one tributary to Camp Creek as well as in Scotch Creek (Dennis Maria, CDFG. Pers. comm as cited in Hamilton et al. 2005).

A recent study on the Elwha River in Washington examined the impacts of removal of the Glines Canyon and Elwha dams on O. *mykiss* genetics and found that steelhead descendants from populations both upstream and downstream of the dams contributed to steelhead reintroduction on the Elwha River after dam removal (Fraik et al. 2021). The results suggest that despite there being physical barriers to anadromy for 80 to 100 years, the presence of the dams did not significantly reduce genetic diversity underlying the anadromous and non-anadromous life history strategies of O. *mykiss* in the watershed (Fraik et al. 2021). Based on these findings, the reintroduction of steelhead to historical habitats in California and Oregon is also likely to include descendants from both upstream and downstream of the dams.

1.3.4 Pacific Lamprey

Historical accounts of Pacific lamprey in the upper Klamath Basin are difficult to confirm due to the presence of four other morphologically similar looking lamprey species. However, the geographic distribution of Pacific lamprey has been found in other river systems to be similar to that of anadromous salmonids. According to Kroeber and Barret (1960), Pacific lamprey, like the salmonids, ascended the Klamath River to the Klamath lakes in Oregon. A review of historical literature conducted by Hamilton et al. (2005) concluded that anadromous Pacific lamprey likely migrated past the location of Iron Gate Dam to at least Spencer Creek, Oregon. In the description of Fall Creek provided by Coots (1957) he mentions that in addition to salmon, Pacific lamprey also enter the creek.

1.4 Geographic Extent of Monitoring

The geographic extent of this Monitoring Plan is specific to California and primarily focuses on the Klamath River and associated tributaries from the Iron Gate Dam location at RKM 310.8 (RM 193.1) upstream to the Stateline at RKM 342 (RM 212.5) (referred to as the monitoring reach). The monitoring reach encompasses approximately 31.2 kilometers (19.4 miles) of the mainstem Klamath River and approximately 26.3 kilometers (16.4 miles) of tributary habitats (Figure 6). The tributaries to be monitored, the approximate extent of anadromy within each tributary, and the fish passage barrier type that defines the extent of anadromy in each tributary are provided in Table 3. It is important to mention that through an adaptive management process other tributaries within the monitoring reach, such as Beaver Creek at RKM 326.6 (RM 203.0), are likely to be phased into monitoring efforts as information becomes available after dam removal on their habitat characteristics and importance to anadromous species.

In addition, the geographic scope of this Monitoring Plan includes the California portion of the Upper Klamath River Population of SONCC coho salmon. This population overlaps the hydroelectric reach and extends upstream to and includes Spencer Creek, Oregon and extends downstream to but does not include Portuguese Creek, California (Figure 5). Monitoring of this population is currently conducted downstream of Iron Gate Dam to Portuguese Creek by the Mid Klamath Watershed Council, Karuk Tribe, Yurok Tribe, Klamath National Forest, USFWS, and CDFW. These efforts include the mainstem Klamath River and 17 tributaries identified in Table 4 (Krasner et al. 2022). These efforts also include Portuguese Creek. Funding for these efforts is, in large part, provided by PacifiCorp through the *Hatchery and Genetic Management Plan for Iron Gate Hatchery Coho Salmon* (IGH HGMP) (CDFW and PacifiCorp 2014). However, this funding will expire with dam removal and thus without other funding sources most if not all of this important SONCC coho salmon monitoring will be discontinued. In the event that funding becomes available, CDFW has included plans for this specific monitoring to ensure that methods and sampling designs remain consistent and to allow for these data to be easily incorporated into the larger monitoring effort. It is important to mention that CDFW does not have secured funding for these efforts but will work with Basin partners to help secure funding. Some Basin partners are already seeking funding, for example the Mid Klamath Watershed Council is seeking grant funding from USFWS to continue these efforts for another 2 years. In terms of the monitoring, the CDFW does not anticipate changing any roles or responsibilities currently in place but to simply help maintain and potentially expand these efforts following dam removals. More information on SONCC coho salmon monitoring is provided in Section 4.1.2. Future hatchery operations and the IGH HGMP are discussed in more detail in Section 3.0.

Figure 6. Map showing the monitoring reach and hydroelectric dams planned for removal.

Table 3. Proposed tributaries to be monitored, approximate extent of anadromy following removal of the dams and barriers defining approximate extent of anadromy.

Tributary	Approximate Extent of Anadromy in Kilometers (Miles)	Barrier Defining Extent of Anadromy
Shovel Creek	4.5 (2.8)	High gradient stream reach
Fall Creek	1.4 (0.9)	High gradient stream reach[1]
Jenny Creek	1.8 (1.1)	Falls
Camp Creek	10.6 (6.6)	High gradient stream reach
Scotch Creek	8.0 (5.0)	High gradient stream reach
Total	**26.3 (16.4)**	

[1]As part of dam removal, fish velocity barriers are to be constructed in Fall Creek immediately downstream of the water intake structures for the City of Yreka's water supply and the Fall Creek Hatchery water supply to prevent entrainment of anadromous salmonids post dam removal.

Table 4. Tributaries of the Upper Klamath River Population of Southern Oregon/Northern California Coast coho salmon where monitoring under the Hatchery and Genetic Management Plan for Iron Gate Hatchery Coho Salmon is currently conducted.

Tributary Name (River Kilometer [River Mile])

1. Bogus Creek (309.9 [192.6])
2. Cottonwood Creek (297.9 [185.1])
3. Humbug Creek (279.9 [173.9])
4. Beaver Creek (262.8 [163.3])
5. West Fork Beaver Creek (Tributary to Beaver Creek)
6. Barkhouse Creek (254.9 [158.4])
7. McKinney Creek (249.9 [155.3])
8. Horse Creek (240.6 [149.5])
9. Buckhorn Creek (Tributary to Horse Creek)
10. Middle Creek (Tributary to Horse Creek)
11. Salt Gulch (Tributary to Horse Creek)
12. Tom Martin Creek (232.7 [144.6])
13. O'Neil Creek (223.9 [139.1])
14. Walker Creek (217.6 [135.2])
15. Grider Creek (212.6 [132.1])
16. Seiad Creek (212.3 [131.9])
17. West Grider Creek (212.3 [131.9])

It is important to mention that there may be limitations to the proposed monitoring including available funding, access constraints (e.g., unsafe to access, no landowner permission), and staffing or equipment constraints. Any limitations encountered will be handled through an adaptive approach and prioritization of monitoring efforts based on information needs.

This Monitoring Plan combined with the monitoring efforts proposed by ODFW and The Klamath Tribes as well as other basin partners, and in concert with existing monitoring efforts downstream of Iron Gate Dam should provide for a relatively robust anadromous fishes monitoring network following removal of the dams.

1.5 REINTRODUCTION AND MONITORING GOALS

This section describes the goal of reintroducing anadromous fishes to historical habitats upstream of Iron Gate Dam in California as well as the purpose and goal of monitoring reintroduction efforts.

1.5.1 Reintroduction Goal

The goal of the reintroduction is to reestablish viable, wild, self-sustaining anadromous fish populations in the upper Klamath River for species conservation and ecological benefits as well as to enhance Tribal, commercial, and recreational fisheries. The goal is consistent with the intent of the KHSA and the primary method to achieve this goal is by restoring access to historical habitats through removal of the four hydroelectric dams.

1.5.2 Monitoring Purpose

Current salmonid monitoring efforts downstream of Iron Gate Dam contribute critical information to fisheries management and conservation including the regulatory framework for Tribal, commercial, and recreational fishing regulations; escapement thresholds and allocation adjudication; research and restoration; ESA and CESA evaluations; and enforcement. These monitoring efforts will need to be expanded in a post-dam environment to include the evaluation and assessment of anadromous fishes as they move into and repopulate historical upstream habitats. Additionally, this expanded monitoring is intended to inform and guide ongoing and future research, restoration, and reintroduction efforts; interagency coordination and regulatory actions that may be required to help achieve the reintroduction goal; future funding needs on behalf of all monitoring and restoration partners in the watershed; and effectiveness of dam removal on restoring anadromous fish populations in the Klamath River Basin.

1.5.3 Monitoring Goal

The overarching goal of monitoring is to measure and track the reintroduction of anadromous fishes and progress toward viable self-sustaining populations of anadromous fishes in the upper Klamath River of California following removal of the four hydroelectric dams. The overarching goal along with objectives, and the monitoring framework are discussed in detail in Section 6.0.

Adult salmon surveys in river, CDFW Photo.

Water flows in a raceway at the Iron Gate Fish Hatchery on the Klamath River, CDFW Photo.

2.0 REGULATORY FRAMEWORK AND FISHERIES MANAGEMENT

This section identifies the federal and state regulatory requirements pertinent to implementing anadromous fisheries monitoring and includes a summary on the Pacific Fishery Management Council's (PFMC) process for determining annual salmon harvest allocations and fishing regulations.

2.1 FEDERAL REGULATORY REQUIREMENTS

2.1.1 Federal Endangered Species Act

The Endangered Species Act (ESA) was enacted in 1973 with the purpose of protecting and recovering imperiled species and the ecosystems upon which they depend. The ESA is administered by the USFWS and NOAA Fisheries. Section 9 of the ESA and federal regulations prohibit the "take" of a species listed as threatened or endangered under the ESA. The term "take" is defined under Section 3 (Definitions) of the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct."

The ESA was established to regulate a wide range of activities affecting ESA-listed species and the habitats upon which they depend. With some exceptions, the ESA prohibits activities affecting ESA-listed species and their habitats unless authorized by a permit from the USFWS or NOAA Fisheries. Permits issued by these federal agencies are designed to be consistent with the conservation of the species.

Federally listed fish species known to occur in the vicinity of the hydroelectric reach include SONCC coho salmon (Threatened; 62 Federal Register [FR] 24588, 6 May 1997), Lost River sucker (*Deltistes luxatus*) (Endangered; 53 FR 27130, 18 July 1988), and shortnose sucker (*Chasmistes brevirostris*) (Endangered; 53 FR 27130, 18 July 1988). Additionally, NOAA Fisheries consults on Southern Resident Killer Whale (*Orcinus orca*) (Endangered; 70 FR 69903, 16 February 2006) when Klamath River Chinook salmon, an important food sources for killer whales, have the potential to be impacted. Activities identified in this Monitoring Plan will require ESA compliance through existing ESA permitting pathways.

2.1.2 National Environmental Policy Act

The National Environmental Policy Act (NEPA) applies to all federal agencies and most activities they manage, regulate, or provide funding for that affect the environment. The NEPA establishes environmental policies for the nation, provides an interdisciplinary framework for federal agencies to assess environmental impacts, and contains procedures to ensure federal agency decision makers take environmental factors into account. The act requires the analysis and public disclosure of the potential environmental impacts of a proposed federal action. As it relates to this Monitoring Plan, the permitting of research and monitoring activities by NOAA Fisheries or the USFWS is a federal action triggering NEPA compliance.

2.1.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson Act) was first passed in 1976 and is the primary law governing marine fisheries management in U.S. federal waters. The key objectives of the Magnuson Act are to prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, and ensure a safe and sustainable supply of seafood (NOAA Fisheries 2020a).

The 1996 Sustainable Fisheries Act amended the Magnuson Act to add provisions requiring NOAA Fisheries and fisheries management councils to identify and protect essential fish habitat (EFH) for fish species managed under the Magnuson Act. EFH can include oceans, coastal areas, and rivers used by anadromous fish. The monitoring reach includes EFH for Pacific salmon, which includes both Chinook salmon and coho salmon. Whenever a federal agency, funds, authorizes, or carries out an action that may adversely affect EFH, NOAA Fisheries must be consulted, and the regulatory process is similar to an ESA consultation.

2.1.4 Federal Wild and Scenic Rivers Act

Two sections of the Klamath River are designated as Wild and Scenic Rivers under the Wild and Scenic Rivers Act of 1968. The first is an 11-mile stretch from J.C. Boyle Powerhouse downstream to the Stateline and the second begins 3,600 feet downstream of Iron Gate Dam and extends to the Pacific Ocean. Any actions taken within a designated Wild and Scenic River needs to be beneficial and not adverse. It is anticipated that any monitoring within designated Wild and Scenic Rivers would contribute information to better understand the overall characteristics of the river and would not adversely affect the designation.

2.1.5 U. S. Bureau of Land Management Resource Management Plan

U.S. Bureau of Land Management (BLM) lands occur adjacent to the upper Klamath River in California and are managed through BLM's Redding field office. The Redding Resource Area Proposed Resource Management Plan (1993) includes objectives for the Klamath River including maintaining water-oriented recreation opportunities along the river and improving the condition of riparian zones on anadromous fish streams. If monitoring activities or riparian restoration occur on BLM land, permits would likely be required along with NEPA compliance.

2.2 CALIFORNIA REGULATORY REQUIREMENTS

2.2.1 California Endangered Species Act

The California Endangered Species Act (CESA) is a California environmental law enacted in 1970 and amended in 1984 and 1997 that conserves and protects plant and animal species at risk of extinction (CDFW 2020a). Plant and animal species may be designated threatened or endangered under CESA after a formal listing process by the California Fish and Game Commission. Approximately 250 species are currently listed under CESA. A CESA-listed species, or any part or product of the plant or animal, may not be imported into the state, exported out of the state, "taken" (i.e., killed), possessed, purchased, or sold without proper authorization.

CESA listed fish species known to occur in the Klamath River from the vicinity of Iron Gate Dam to the Stateline include SONCC coho salmon (listed as threatened in 2005), shortnose sucker (listed as endangered in 1974), and Lost River sucker (listed as endangered in 1974). It is also important to note that spring-run Chinook salmon of the Upper Klamath and Trinity Rivers ESU was listed as threatened under CESA on January 24, 2022. Although spring-run Chinook salmon are not currently known to occur in the vicinity of the dams, they may be present in the future either through active reintroduction or by volitional means. The CDFW may authorize the incidental take of a CESA listed species if certain conditions are met. Primary pathways for permitting include issuance of an Incidental Take Permit, Consistency Determination, Memorandum of Understanding, or Safe Harbor Agreement.

2.2.2 California Environmental Quality Act

The California Environmental Quality Act (CEQA) is California's broadest environmental law and generally requires state and local government agencies to inform decision makers and the public about the potential environmental impacts of proposed projects, and to reduce those environmental impacts to the extent feasible. The laws governing the CEQA process are included in the CEQA statute, the CEQA Guidelines, published court decisions interpreting CEQA, and locally adopted CEQA procedures. Any issuance of a permit by CDFW requires compliance with the CEQA (CDFW 2020b).

2.2.3 California Fish and Game Code

The Fish and Game Code provides statutes, ordinances, and administrative rules and regulations relating to the management of wildlife resources in California. One of CDFW's primary responsibilities is to regulate compliance with Fish and Game Code. Activities identified in this Monitoring Plan will need to comply with Fish and Game Code rules and regulations.

2.2.4 California Fish and Game Commission

The California legislature has delegated to the California Fish and Game Commission powers over a wide range of responsibilities. These responsibilities include, but are not limited to, the following:

- The listing and delisting of threatened or endangered species under CESA;
- Establishing protected lands and/or waters (e.g., marine protected areas, wildlife areas, ecological reserves) and regulating uses of those protected areas;
- Establishing hunting, sport fishing, and some commercial fishing seasons, bag limits and methods of take (discussed in more detail in Section 2.3);
- Establishing general CDFW policies;
- Prescribing terms and conditions for issuance, suspension, revocation of licenses/permits issued by CDFW and assuming a quasi-judicial role in considering appeal hearings for revocation or suspension of licenses and permits; and,
- Accepting mitigation lands on behalf of the state.

2.2.5 California Wild and Scenic Rivers and Wild Trout Waters

California passed the California Wild and Scenic Rivers Act in 1972, roughly four years after the federal Wild and Scenic Rivers Act was passed. The mainstem Klamath River from 100 yards downstream of Iron Gate Dam to the Pacific Ocean is designated as a California Wild and Scenic River under California Public Resources Code (PRC) (PRC 5093.50 et seq.). The intent of this PRC is to preserve in their free-flowing state, rivers which possess extraordinary scenic, recreational, fishery, or wildlife values, along with their immediate environments, for the benefit and enjoyment of the people of the state. This designation could potentially be expanded post dam removal to include the Klamath River from 100 yards downstream of Iron Gate Dam upstream to the Stateline.

The Klamath River from the Stateline to Copco Reservoir (approximately 6.2 miles of river) is designated by CDFW as Wild Trout Waters. Wild Trout Waters are those that support self-sustaining trout populations, are aesthetically pleasing and environmentally productive, provide adequate catch rates in terms of number or size of fish, and are open to the public for angling (Rogers et al. 2016). Waters under this designation may not be stocked with catchable-sized hatchery trout. The California Fish and Game Commission designated this section of stream in 1974 because of its excellent wild trout angling opportunities (Rogers et al. 2016).

2.3 PACIFIC FISHERY MANAGEMENT COUNCIL SALMON ALLOCATION AND FISHING REGULATIONS

The Pacific Fishery Management Council (PFMC) has regulatory jurisdiction over salmon fishing regulations from 3 to 200 miles off the U.S. West Coast, while the states of California, Oregon, and Washington have jurisdiction between the shore to 3 miles out into the Pacific Ocean, as well as inland areas. South of Cape Falcon, Oregon, PFMC-managed fisheries are subject to ESA consultations for several Chinook salmon and coho salmon ESUs, including SONCC coho salmon. To comply with the ESA, the PFMC strictly adheres to the protection measures required through ESA consultation.

Currently, California salmon management in marine areas "auto conforms" to annual PFMC regulations, meaning the California Fish and Game Commission adopts regulatory measures the PFMC promulgates annually. CDFW confirms the annual ocean commercial fishing regulations in April of each year after receiving recommendations from the PFMC. Additionally, the Fish and Game Commission is the regulatory authority over the Klamath River recreational fishery including recreational inland salmon fishing and makes regulatory decisions based upon PFMC allocations; the regulation adoption meeting is held in April or May of each year (Pierce 1998).

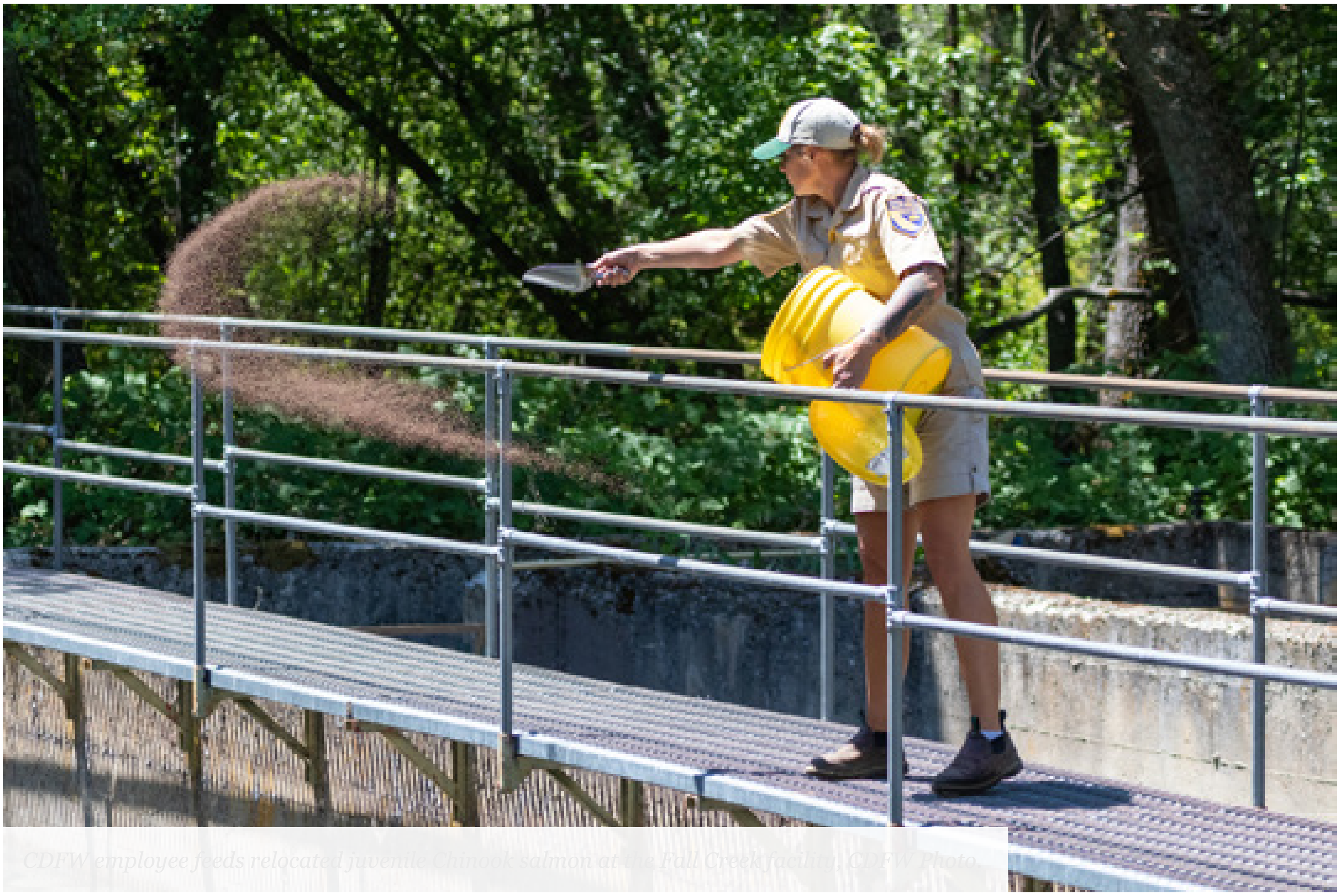
The Yurok and Hoopa Valley Tribes of the Klamath Basin have federally reserved fishing rights. Combined, the Tribes are entitled to 50 percent of the harvestable surplus of each run of fish that, absent interception, would migrate through their reservations (DOI Solicitors Opinion 1993). The Tribes' fisheries are regulated by their respective Tribal Councils for the benefit of their Tribal members and the conservation of the resource. As co-managers of the Klamath Basin fishery resource, the Tribes collaborate through the PFMC process annually to determine the harvestable surplus for Klamath River fall-run Chinook salmon, which is then used by each Tribal government to determine their respective entitlement for the year.

CDFW holds a public meeting on salmon (Salmon Informational Meeting) in February of each year to share the past year's management results and discuss preliminary forecasts of Klamath fall-run Chinook salmon, Sacramento fall-run Chinook salmon, and Sacramento winter-run Chinook salmon abundance for current year management. With stakeholder input, CDFW and the Tribes begin to develop harvest allocation and regulation recommendations for the PFMC to consider. The PFMC goal is to confirm regulations and quotas are in place for Tribal and non-Tribal fisheries that will target 50 percent of the available harvest for each fishery (Tribal and non-Tribal fisheries) while protecting natural-area escapement objectives. CDFW informs the PFMC by early March of what the targeted in-river recreational fishery harvest will be, based on a percentage of the overall (non-Tribal) allocation (Pierce 1998; D. Killam, CDFW, personal communication 2019).

Spawning escapement is a driving factor in Klamath fall-run Chinook salmon management. Numerous basin partners participate in monitoring of adult fall-run Chinook salmon annually including the Hoopa Valley Tribe, Karuk Tribe, Mid-Klamath Watershed Council, Northern California Resource Center, Quartz Valley Indian Reservation, Siskiyou Resource Conservation District, Salmon River Restoration Council, U.S. Forest Service (USFS), USFWS, AmeriCorps Watershed Stewards Program, Yurok Tribe, and CDFW (Klamath River Technical Team [KRTT] 2021a). These efforts culminate into basin estimates that are provided in the KRRT annual reports (e.g., age composition report), PFMC reports (e.g., Preseason Report 1) and are also consistent with estimates entered into the Klamath Basin Megatable (CDFW 2021a) and the forecast of ocean stock abundance (KRTT 2021b). Ocean and river fisheries are managed to meet harvest rate combinations (total proportion of abundance that is landed catch) that under full fishing will allow a maximum exploitation rate of 68 percent which takes into account all sources of fishing mortality. Additionally, Klamath River age-4 marine harvest rate is used as a surrogate to protect listed California Coastal Chinook (CCC) salmon stocks and under current NOAA Fisheries guidance must not exceed 16 percent. Within the constraints imposed by fishery conservation measures, annual harvest opportunities are generally maximized to the extent possible.

Once anadromous fish populations repopulate the areas above Iron Gate Dam, it is anticipated that there will be a point at which salmonid populations in the upper Klamath Basin are of sufficient distribution, diversity, productivity, and abundance to initiate a regulatory phase for inland salmon harvest in the upper basin. In addition to the process overseen by PFMC, coordination amongst CDFW, ODFW, and the Tribes will be critical in terms of establishing Tribal, commercial, and recreational fishing regulations. The Klamath Tribes, whose lands lie upstream of the dams, are expected to once again be able to actively fish for anadromous fish within the Klamath River and its tributaries as they historically did. As such, the Klamath Tribes are expected to become engaged in the fishery allocation process maintained by PFMC. Additionally, for ESA-listed species, continued coordination with NOAA Fisheries will be needed to protect the species and facilitate recovery.

Four Yurok Tribal Members stand alongside Governor Jerry Brown as he speaks before the signing of the Klamath Hydroeletric Settlement Agreement in Requa, CA. CDFW Photo.



CDFW employee feeds relocated juvenile Chinook salmon at the Fall Creek facility, CDFW Photo.

3.0 HATCHERY FACILITIES AND OPERATIONS

Two hatcheries are associated with the mainstem Klamath River: Iron Gate Hatchery and Fall Creek Hatchery (Figure 2). Each is further discussed below along with future hatchery operations and production goals following the removal of the four hydroelectric dams.

3.1 IRON GATE HATCHERY

Iron Gate Hatchery is located on the mainstem Klamath River just downstream of Iron Gate Dam. The hatchery program was initiated in 1966 to mitigate habitat blocked between Iron Gate Dam and the Copco dams. The hatchery's annual production goals were established in the 1960's and include 900,000 yearling fall-run Chinook salmon, 5.1 million fall-run Chinook salmon smolts, 75,000 yearling coho salmon, and 200,000 yearling steelhead (CDFG and Pacific Power and Light Company 1996). However, steelhead production was discontinued in 2012 for several reasons, including a lack of returning adults, and the production goal is currently unachievable without mining native steelhead for broodstock (W. Sinnen, CDFW, personal communication 2020).

The coho salmon program at Iron Gate Hatchery is operated through an ESA Section 10(a)(1)(A) Permit administered by NOAA Fisheries and the *Hatchery and Genetic Management Plan for Iron Gate Hatchery Coho Salmon* (IGH HGMP) (CDFW and PacifiCorp 2014). The IGH HGMP redefined the operation of the hatchery's coho salmon program to incorporate conservation principles to protect and conserve the genetic resources of the Upper Klamath River Population of the SONCC coho salmon ESU. The IGH HGMP is built around the principles and recommendations of the Hatchery Scientific Review Group (HSRG) and California Hatchery Scientific Review Group. The IGH HGMP was developed so that it could be amended in the future to ensure hatchery operations are consistent with the most current plans for species conservation and reintroduction efforts (CDFW and PacifiCorp 2014). While there is no Hatchery Genetic Management Plan for the Chinook salmon program, the program has incorporated some of the best management practices recommended by the HSRG.

3.2 FALL CREEK HATCHERY

Fall Creek Hatchery is located on Fall Creek, a tributary to the Klamath River that currently flows into Iron Gate Reservoir. The hatchery is located approximately 1.6 kilometers (1.0 mile) upstream of the reservoir. The hatchery was built in 1919 as compensation for the loss of spawning grounds that occurred with the construction of Copco 1 Dam. It was built with a 116-trough hatchery building and three ponds and later expanded in 1937 to include a total of nine ponds. The hatchery was mainly operational before the construction of Iron Gate Dam in 1966 but was also used periodically from 1979 to 2003 and as recently as 2021 and 2022 when the existing raceways were repaired and used to rear juvenile Iron Gate Hatchery fall-run Chinook salmon.

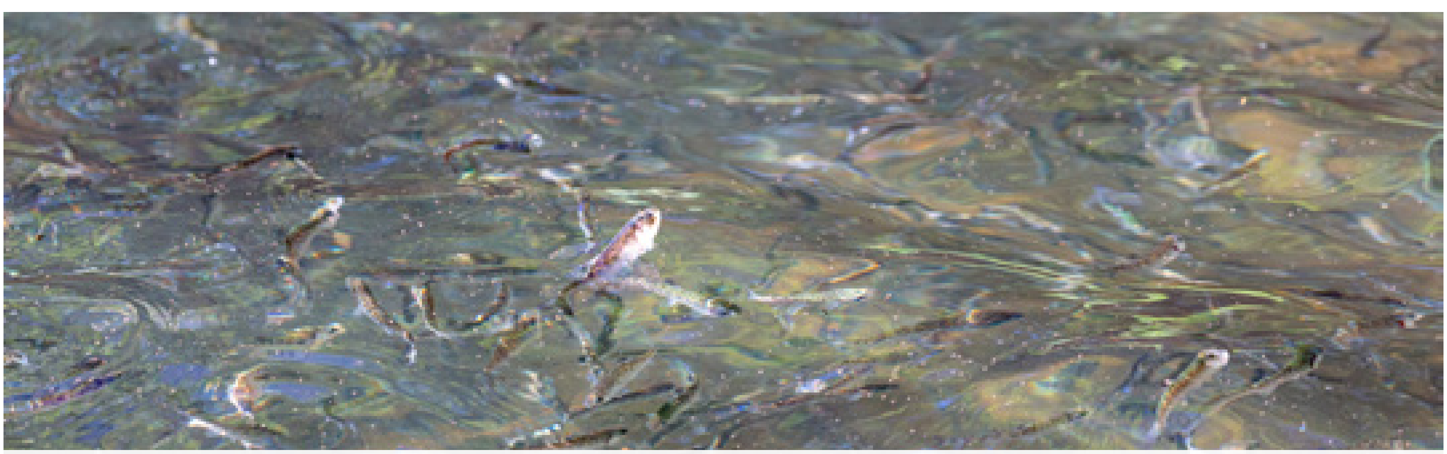
3.3 POST DAM REMOVAL HATCHERY OPERATIONS AND PRODUCTION GOALS

Prior to planned removal of the four hydroelectric dams, hatchery operations are to be moved from Iron Gate Hatchery to an improved Fall Creek Hatchery. The moving of hatchery operations to Fall Creek is due, in part, to the loss of water supply that will occur at Iron Gate Hatchery with removal of Iron Gate Dam and the availability of high-quality water in Fall Creek to support hatchery production. Fall Creek Hatchery would be modified, and new facilities constructed. The CDFW would retain Iron Gate Hatchery and may continue to use the facility or portions thereof, as needed. PacifiCorp is slated to fund construction and hatchery operations for up to eight years following removal of Iron Gate Dam to fulfill annual mitigation objectives identified in the amended KHSA (KHSA 2016). Currently there are no plans or funding to operate the hatchery beyond eight years. However, if there is a future need to operate beyond eight years, it will be decided in coordination with regulatory agencies, Tribes, and other basin partners; informed by Klamath Basin monitoring; and will need to adhere to federal and state regulatory permitting requirements.

The improved Fall Creek Hatchery design includes an adult holding capacity of 100 coho salmon and 200 Chinook salmon and sufficient space to accommodate the hatchery production goals of:

- 75,000 coho salmon yearlings at approximately 10 fish per pound (fpp) at release with brief overlap in age classes reared at the hatchery;
- 250,000 fall-run Chinook salmon yearlings at approximately 10 fpp at release, with only 25 percent (62,500) marked for monitoring and evaluation based on fish size limitations (i.e., large enough to mark); and
- 3 million fall-run Chinook salmon sub-yearlings split into 1.75 million at 90-100 fpp and 1.25 million "swim ups" at 520 fpp. Minimum of 1.5 million coded wire tagged for monitoring and evaluation.

It is important to note that the new production goals for fall-run Chinook salmon are lower than those currently in place at Iron Gate Hatchery as described in Section 3.1 above. The Fall Creek Hatchery production goals were established at conservative values based on density index calculations similar to other anadromous fisheries conservation programs in the Pacific Northwest. The lower production goals for fall-run Chinook salmon are based in part on the smaller facility and water supply, and wastewater discharge limitations at Fall Creek Hatchery compared to Iron Gate Hatchery.



Juvenile Chinook salmon from the Iron Gate Fish Hatchery leap from the water at the Fall Creek facility after being relocated, CDFW Photo.

The production goal for coho salmon will remain unchanged and will be directed by a new Hatchery and Genetic Management Plan (HGMP). A new ESA enhancement permit application and associated HGMP for the Fall Creek Hatchery coho salmon program was submitted by CDFW to NOAA Fisheries on February 1, 2023. Similar to the IGH HGMP, the program will culture the Upper Klamath River Population of SONCC coho salmon with the primary purpose of protecting the genetic resources of this population and reducing extinction risks. The purpose would be achieved by integrating natural origin adults into broodstock and using a genetically based spawning matrix to prevent or otherwise reduce potential inbreeding. Natural origin adults will be obtained from Bogus Creek, the Iron Gate Hatchery auxiliary fish ladder, and Fall Creek. The secondary purpose of the program is to provide adult coho salmon that could disperse into newly available habitats following dam removal. This would occur through straying and in some years when Fall Creek Hatchery receives adult returns beyond the capacity of the adult holding ponds or broodstock requirements, the excess fish will be returned to Fall Creek or the Klamath River near the Fall Creek confluence to volitionally move elsewhere to support repopulation through natural spawning. Overall, the success of hatchery production in terms of survival from egg to juvenile release is expected to be high at Fall Creek Hatchery due to the high-quality water source and conservative rearing densities.

Operation of a hatchery program with reduced production of Chinook salmon may yield lower adult returns, at least initially, until use of natural spawning areas downstream and upstream of former Iron Gate Dam have been reestablished and annual abundance meets or exceeds pre-dam removal observed ranges. Given recent returns have been poor and greatly impacted by a range of contributing factors, the re-building of naturally spawning populations will likely take multiple generations; however, the eventual and appropriate phasing out of hatchery reared fish has the potential to greatly improve the resiliency of salmonid runs in the Klamath River by allowing populations to return to a more natural, dynamic, and wild condition.

A hatchery truck unloads juvenile Chinook salmon from the Iron Gate Fish Hatchery into the Fall Creek facility, CDFW Photo.

4.0 CURRENT DOWNSTREAM MONITORING AND PROPOSED MONITORING FOR RESERVOIR DRAWDOWN AND DAM REMOVAL ACTIVITIES

4.1 CURRENT MONITORING BELOW IRON GATE DAM

Long-term monitoring of salmonids has occurred downstream of Iron Gate Dam since 1978 and is ongoing. Most of this work has been focused on adult fall-run Chinook salmon and data collected are used to analyze annual salmonid age-specific composition and to inform regulatory decisions as well as monitoring and restoration efforts. Outmigration of juvenile salmonids is also monitored annually. For example, the USFWS Arcata Fish and Wildlife Office (AFWO) and the Karuk Tribe monitor the outmigration of juvenile salmonids on the mainstem Klamath between Iron Gate Dam and the Scott River using rotary screw traps. A similar effort was initiated in 2021 by the Yurok Tribe and USFWS AFWO to monitor the outmigration of juvenile salmonids on the mainstem Klamath River just above the confluence with the Trinity River. The Karuk Tribe also operates rotary screw traps on the mainstem Klamath River at Big Bar and on the Salmon River. Additionally, partners of the Trinity River Restoration Program use rotary screw traps at two locations on the Trinity River to primarily assess juvenile Chinook salmon production and CDFW operates juvenile outmigration traps on Klamath River tributaries including the Shasta and Scott rivers, and Bogus Creek.

Long-term monitoring partners in the watershed include the USFWS, USFS, CDFW, Hoopa Valley Tribe, Yurok Tribe, Karuk Tribe, Quartz Valley Indian Reservation, Shasta Valley Resource Conservation District, Siskiyou Resource Conservation District, Salmon River Restoration Council, Mid-Klamath Watershed Council, and Northern California Resources Center. An expansion of monitoring above the Iron Gate Dam site in California will likely include several of these partners and potentially new partners.

4.1.1 Chinook Salmon

The Klamath River Basin downstream of Iron Gate Dam contains an estimated 1,123 RKMs (698 RMs) of fall-run Chinook salmon habitat (Hardy et al. 2006). In an effort to monitor all of that habitat, the river has been separated into smaller, more manageable areas, with responsibilities for monitoring given to different entities. The geographic representation of the monitoring activity is contingent on several aspects of the sampling design including the life stage being monitored. Entities that participate in monitoring include the long-term monitoring partners mentioned above in Section 4.1, as well as local schools and volunteers.

Cooperative salmonid spawner surveys have occurred annually in the Klamath River Basin since 1978 (CDFW 2017). CDFW's Klamath-Trinity Program is dedicated to surveying and studying anadromous fishes within the current anadromous portions of the Klamath River and Trinity River basins. The program contains two projects: Klamath River Project (KRP) and Trinity River Project (TRP). The KRP encompasses the Klamath River from Iron Gate Dam downstream to the Pacific Ocean and includes the Salmon, Scott, and Shasta rivers, as well as Bogus Creek and a dozen other smaller tributaries. The TRP covers the Trinity River from Lewiston Dam (furthest upstream extent of anadromy) downstream to the confluence of the Klamath River. The goals of the KRP and TRP include assessing population abundance, age structure, hatchery composition, run timing, spawning distribution, fork length frequency, and sex ratios for salmonids, primarily of fall-run Chinook salmon.

Spring-run Chinook salmon are also monitored under the TRP. Monitoring efforts focus on producing annual run-size, angler harvest, and spawner escapement estimates for spring-run Chinook salmon within the Trinity River Basin (Kier et al. 2022). These efforts include evaluating both natural-origin and hatchery-origin (Trinity River Hatchery origin) fish. Spring-run chinook are also monitored on the Salmon River by the Salmon River Restoration Council and other partners. These include annual snorkel surveys in late July for spring-run Chinook salmon and summer steelhead (adults and half pounders) as well as spawner, carcass, and redd surveys for spring-run Chinook in early fall.

A substantial portion of the annual survey work is funded by the USFWS, originally as part of the Klamath River Basin Conservation Area Restoration Program, which was administered in 1986 under Public Law 99-552 (the Klamath Act). The intent of the Klamath Act was to restore anadromous fish, primarily salmon and steelhead, of the Klamath River Basin (USFWS 2008). The 1986 middle Klamath Cooperative Spawning Ground Surveys (SGS) were originally funded by the Klamath Act. The Klamath Act expired on October 1, 2006, and was not reauthorized by Congress. Since that time the USFWS has continued to contribute funding to the survey effort using discretionary funding from their annual budget (CDFW 2017).

4.1.2 Coho Salmon

Prior to the California Fish and Game Commission listing SONCC coho salmon as threatened under CESA in 2005, the CDFG as directed by the Commission and in collaboration with various interest groups, developed the *Recovery Strategy for California Coho Salmon (Oncorhynchus kisutch)* (CDFG 2004). The recovery strategy is a guide for the process of recovering coho salmon throughout the species range in California and includes detailed range-wide and watershed restoration recommendations. It recognizes a need for funding, public and private support, and maintaining a balance between regulatory and voluntary efforts with success ultimately hinging on the long-term commitment of those in and involved in the coho salmon watersheds (CDFG 2004). The primary objective is to return coho salmon to a level of sustained viability through improving populations and habitats.

In 2015, CDFW produced the *Recovery Strategy for California Coho Salmon Progress Report 2004 – 2012* (CDFW 2015). The progress report findings indicate that despite considerable restoration efforts and expenditures, the number of adult coho salmon in monitored streams have declined since 2004 and the overall picture of coho salmon in California is one of severely depleted populations (CDFW 2015).

The SONCC Coho Recovery Plan (NOAA Fisheries 2014) consists of a series of prioritized actions designed to recover the SONCC coho salmon ESU to the point where the ESU no longer needs the protections afforded by the ESA and can be removed from the ESA list of threatened and endangered species. The SONCC Coho Recovery Plan also provides a framework to track the performance of coho salmon recovery efforts and evaluate the condition of coho salmon populations, habitats, and the effects of human activities on them. Both physical and biological elements are to be monitored to track the status and trends of coho salmon populations and habitats.

In 2016, NOAA Fisheries published their most recent 5-year status review on SONCC coho salmon (status review) as directed under Section 4(c)(2) of the ESA (NOAA Fisheries 2016). The status review included relevant information submitted by the public as well as federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals (NOAA Fisheries 2016). In general, adult counts in the Klamath River watershed were relatively scarce; however, some longer-term data was available for the Scott and Shasta rivers. Based on the best scientific information available, NOAA Fisheries recommended that the ESA status of SONCC coho salmon ESU remain classified as a threatened species (NOAA Fisheries 2016).

As mentioned in Section 3.1, coho salmon production at Iron Gate Hatchery is operated through an ESA Section 10(a)(1)(A) Permit administered by NOAA Fisheries and the IGH HGMP (CDFW and PacifiCorp 2014). The IGH HGMP identifies a need to better understand hatchery influence on natural spawning SONCC coho salmon in the Upper Klamath River Population and therefore includes monitoring of this independent population. Monitoring under the IGH HGMP is primarily funded by PacifiCorp and has occurred since 2016. The monitoring effort includes spawning and carcass surveys in the mainstem Klamath River and in the 17 tributaries identified in Table 4. Monitoring specific to the IGH HGMP is conducted by the Mid Klamath Watershed Council, Karuk Tribe, Klamath National Forest, USFWS, and CDFW. These efforts culminate into annual reports as part of the monitoring and evaluation of the IGH HGMP and are used to inform the status of this population. These efforts are an important development because tributaries to the mainstem Klamath River downstream of Iron Gate Dam are part of this independent population of coho salmon that includes untapped habitat upstream of Iron Gate Dam to and including Spencer Creek in Oregon. The HGMP for Fall Creek Hatchery does not require continuation of these coho salmon mainstem and tributary surveys and once hatchery operations are moved to Fall Creek Hatchery, these surveys will be discontinued as a result of no funding. In the event funding becomes available, CDFW has included plans for this specific monitoring to ensure the methods and sampling designs stay consistent and to allow for these data to be easily incorporated into the larger monitoring effort. It is important to note that CDFW does not have funding secured for these efforts but will work with Basin partners to help secure funding to continue this important work and potentially expand it following dam removals.

4.1.3 Steelhead

Fall and winter steelhead are more widely distributed than any other anadromous salmonid in the Klamath River system downstream of Iron Gate Dam (State Water Resources Control Board 2018). Research completed by Hodge et al. (2016) found a diverse life-history portfolio that the authors partitioned into 38 life-history types. While fall and winter steelhead are more widely dispersed, most remaining summer steelhead are believed to spawn in tributaries between the Trinity River (RKM 69.7 [RM 43.3]) and Seiad Creek (RKM 213.6 [RM 132.7]).

Current monitoring efforts focused on adult fall and winter steelhead in the Klamath Basin are limited. Under the KRP, video monitoring conducted by CDFW on the Shasta River, Scott River, and Bogus Creek provide recent adult fall and winter steelhead counts. However, in most years, video monitoring was terminated in December or January due to high flow events or other limitations and did not capture the full migration period. In years where video monitoring and SONAR counts covered the full migration period (i.e., 2013 and 2016-2020 for Bogus Creek, 2012, 2015, and 2016 for Shasta River) more complete steelhead counts were generated.

Since 1985, the USFS has conducted summer steelhead holding counts on tributaries located on or adjacent to lands administered by the USFS Orleans and Happy Camp Ranger districts in the lower Klamath River. Counts are performed through snorkel surveys and include adults and half pounders and are a sum of the surveys conducted on Bluff Creek, Red Cap Creek, Camp Creek, Wooley Creek, Dillon Creek, Clear Creek, Elk Creek, Indian Creek, Thompson Creek, Grider Creek, and other tributaries to the Klamath River between Aikens Creek and Beaver Creek. As previously mentioned, the Salmon River Restoration Council conducts annual snorkel surveys for spring-run Chinook salmon and summer steelhead (adults and half pounders) on the Salmon River.

4.1.4 Pacific Lamprey

There are no comprehensive monitoring programs for Pacific lamprey in the Klamath Basin. Anadromous lampreys such as the Pacific lamprey are unusual among anadromous fishes in that they do not appear to locate spawning habitat through philopatry (Spice et al. 2012). The lack of river or stream fidelity makes monitoring Pacific lamprey populations challenging. Pacific lampreys tend to be incidentally observed and recorded during salmonid monitoring efforts. They are also commonly observed during instream restoration projects, as well as during fish screen maintenance on water diversion structures.

In 2006, the Yurok Tribal Fisheries Program initiated a pilot study using sonic (acoustic) telemetry to assess the movements and distribution of migrating Pacific lamprey in the Klamath River and associated tributaries (McCovey and Benson 2006). Fourteen individuals were tagged, and no detections were made over the course of the study. Although the results suggest that acoustic telemetry may not be a feasible method to study Pacific lamprey, recent advances in acoustic telemetry technology (e.g., Jsat tags) have likely made it a feasible tool for use today.

In 2008, the Pacific Lamprey Conservation Initiative (PLCI) was formed by Native American Tribes, federal, state, and local agencies, and non-government organizations for the purposes of achieving long term persistence of Pacific lamprey and their habitats, and to support traditional Tribal uses of Pacific lamprey across their historical range (Pacific Lamprey Conservation Initiative 2022). The PLCI maintains a data repository with general Pacific lamprey distribution data, including the Klamath River Basin. This data is available on the PLCI web page at www.pacificlamprey.org/.

4.2 MONITORING REQUIRED UNDER THE LOWER KLAMATH PROJECT

The KRRC's *Definite Plan for the Lower Klamath Project* (Definite Plan) (KRRC 2018) and subsequent *Definite Decommissioning Plan* (KRRC 2020) describe the process for complete removal of the dams including, among other things, measures to reduce project-related effects on aquatic and terrestrial resources. The *Definite Decommissioning Plan* is guided by 16 resource management plans including an Aquatic Resources Management Plan (ARMP) and Reservoir Area Management Plan (RAMP). The final FERC approved resource management plans are available on FERC's eLibrary at https://elibrary.ferc.gov/eLibrary/search under Docket Number P-14803-001. Both the ARMP and RAMP contain measures specific to anadromous fishes. The ARMP consists of six subplans; four are related to anadromous species and are summarized below.

4.2.1 Fish Presence Plan

The Fish Presence Plan describes monitoring efforts to be undertaken by KRRC to document anadromous fish presence and distribution following dam removal. The effort focuses on the adult life stage of Chinook salmon, coho salmon, steelhead, and Pacific lamprey. Monitoring will be conducted within the hydroelectric reach and the lower reaches of tributaries that are currently inundated by the reservoirs. The monitoring effort will occur for four years following dam removal with the goal of determining anadromous fish presence. Monitoring in a given tributary or mainstem reach will cease if presence of any of the anadromous fish mentioned above are documented in that tributary or mainstem reach during a given year. This effort truly focuses on fish passage and will be closely coordinated with CDFW and other monitoring partners to share information on status of anadromous fish presence and to guide more robust monitoring efforts.

4.2.2 Tributary-Mainstem Connectivity Plan

The Tributary-Mainstem Connectivity Plan describes the monitoring to be undertaken by KRRC to identify fish passage barriers within the 8-mile reach downstream of Iron Gate Dam, within the Copco 2 Bypass Reach, and at the confluences of Bogus Creek, Dry Creek, Little Bogus Creek, Willow Creek, and Shovel Creek. This monitoring effort will begin in the drawdown year and continue for two additional years. Remedial actions will be taken to remove any potential channel spanning barrier to fish migration if certain conditions exist. Implementation of this plan will include close consultation with the Aquatic Resources Group (ARG), which is comprised of fisheries scientists and other subject matter experts representing NOAA Fisheries, USFWS, CDFW, ODFW, Yurok Tribe, Hoopa Valley Tribe, Karuk Tribe, The Klamath Tribes, and KRRC.

4.2.3 Juvenile Salmonid and Pacific Lamprey Rescue Plan

The Juvenile Salmonid and Pacific Lamprey Rescue Plan establishes the thresholds of when mainstem Klamath River suspended sediment concentrations and tributary water temperatures will be high enough that KRRC in consultation with the ARG will consider capturing juvenile fish from tributary confluences and relocating them to in-basin sites with suitable or unimpaired water quality. This plan provides the framework for monitoring temperature, dissolved oxygen, suspended sediments, and fish behavior. It includes the methods to capture and transport juvenile fish, if warranted, and describes the selection process for identifying relocation sites in real time. This plan will be implemented during the drawdown year between March and July when suspended sediment concentrations and elevated water temperatures are modeled to be potentially lethal to fish. The plan focuses on monitoring mainstem turbidity and other water quality parameters using three U.S. Geological Survey (USGS) monitoring gages and installing water temperature loggers in the thirteen tributary confluences identified in Table 5.

Table 5. Thirteen Klamath River tributary confluences where water temperature loggers are proposed.

Tributary Name (River Kilometer [River Mile])	
1. Seiad Creek (212.3 [131.9])	2. Beaver Creek (262.8 [163.3])
3. Grider Creek (212.6 [132.1])	4. Humbug Creek (279.9 [173.9])
5. Walker Creek (217.6 [135.2])	6. Shasta River (288.5 [179.3])
7. O'Neil Creek (223.9 [139.1])	8. Cottonwood Creek (297.9 [185.1])
9. Tom Martin Creek (232.7 [144.6])	10. Dry Creek (307.2 [190.9])
11. Scott River (223.5 [145.1])	12. Bogus Creek (309.9 [192.6])
13. Horse Creek (240.6 [149.5])	

4.2.4 Spawning Habitat Availability Report and Plan

The Spawning Habitat Availability Report and Plan is to offset the short-term effects of dam removal on anadromous spawning habitat. This effort includes post reservoir drawdown field surveys and remote sensing to determine the distribution and extent of spawning habitat available within the hydroelectric reach and several key tributaries including Jenny, Fall, and Shovel creeks in California, and Spencer Creek in Oregon. This effort is planned for the year prior to reservoir drawdown and the year of drawdown. Information gathered during this effort will be used to inform whether target goals for the availability of spawning habitat are met and if implementation of spawning habitat enhancement activities are necessary to meet target goals.

4.2.5 Reservoir Area Management Plan

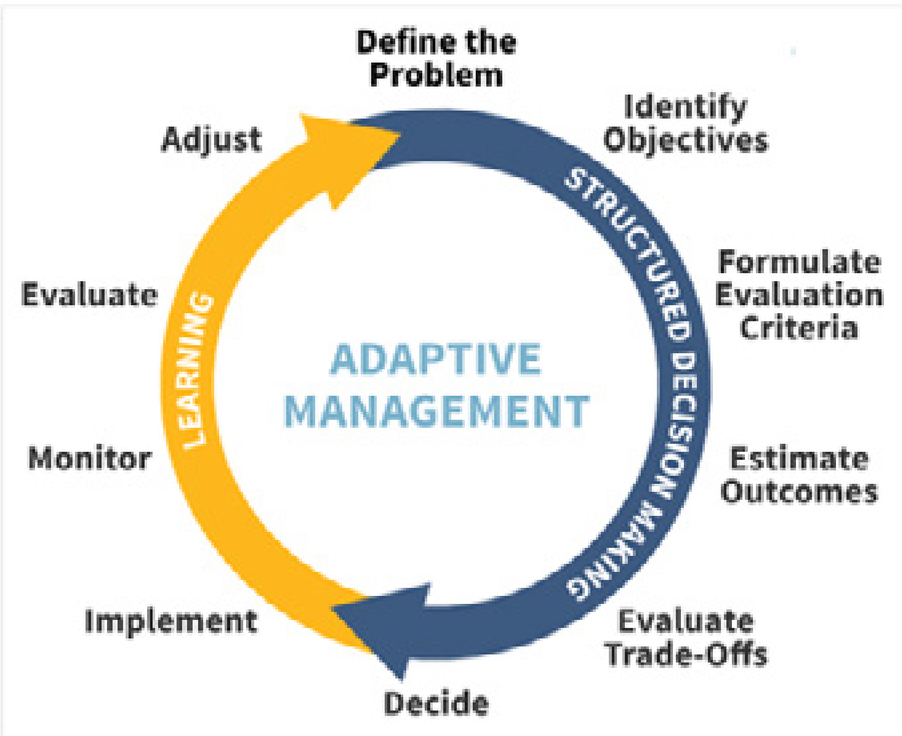
In addition to the Tributary-Mainstem Connectivity Plan, the Reservoir Area Management Plan (RAMP) includes monitoring and remediation of fish passage barriers within the reservoir footprints and the associated tributaries and confluences within those footprints. It also provides habitat restoration activities designed to help restore fish habitat and reestablish upland and riparian habitats in the reservoir footprints. More information on the RAMP is provided in Section 7.0.

5.0 REINTRODUCTION

This section defines reintroduction and describes the proposed approaches to the reintroduction of anadromous fishes following the removal of the four hydroelectric dams with a focus on the California portion of the mainstem Klamath River and tributaries upstream of Iron Gate Dam (i.e., monitoring reach). It also identifies some key issues and uncertainties associated with the reintroduction.

As stated in the introduction, this Monitoring Plan relies on an adaptive management strategy. This approach to resource management allows for plans and restoration activities to be readily adjusted as environmental conditions change or as new information is obtained. The adaptive management process includes identifying performance objectives, developing metrics to evaluate performance, monitoring specific metrics to track performance, evaluating information collected during monitoring, and procedures to use the evaluated information to inform and improve or adjust future management. A general diagram of the adaptive management process is shown in Figure 7.

Figure 7. General diagram of the adaptive management cycle. Blue arrow represents the systematic identification of the problem, objectives, and associated decision-making, while orange arrow represents the learning process associated with implementation.



Source: CDFW (adapted from Birge et al. 2016)

5.1 REINTRODUCTION

This Monitoring Plan adopts the definition of reintroduction provided in the *IUCN Guidelines for Re-Introductions* (International Union for Conservation of Nature [IUCN] 1989) and is consistent with the definition used by Anderson et.al (2014) and ODFW and The Klamath Tribes (2021). The IUCN (1989) defines reintroduction as "an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct."

Under this Monitoring Plan the preferred anadromous fish reintroduction approach is natural reintroduction through removal of fish passage barriers to allow volitional migration. This of course will be influenced by Fall Creek Hatchery operations (e.g., adult broodstock collection from Bogus Creek) and hatchery origin-fish. The alternative approach to natural reintroduction is active reintroduction by transplanting individuals. Both approaches may include hatchery- or natural-origin fish. For the purposes of this reintroduction effort, volitional reintroduction is expected to be the most effective and the lowest risk approach because anadromous fishes currently migrate to the base of Iron Gate Dam and would likely continue to migrate upstream if unobstructed. Additionally, the approach requires little to no human intervention and thereby "*minimizes the interruption of natural biological processes*" (Anderson et al. 2014) and will *"promote the natural demographic, ecological, and evolutionary processes essential to the conservation benefit"* (Anderson et al. 2014) for both fish populations and recovery of threatened or endangered species. This approach gives migrating adults an opportunity through several generations to volitionally repopulate historical habitats. In addition to minimizing biological and ecological risks, reintroduction via volitional migration is also the least expensive option.

Active reintroduction by transplanting adults, juveniles, or fertilized gametes could "jumpstart" the reintroduction process (USFWS 2019) but is often costly and if not carefully planned may have other unintended or undesirable negative consequences. Both approaches, volitional reintroduction, and active reintroduction, are further discussed below.

5.1.1 Natural Reintroduction Through Volitional Reintroduction

A primary purpose of removing the four mainstem hydroelectric dams is to restore anadromous fish passage to the upper Klamath Basin for the purposes of reestablishing anadromous fishes into historical habitats and improving anadromous fish populations in the Klamath Basin. Fall-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey currently migrate to the base of Iron Gate Dam and are, with a high degree of certainty, expected to migrate into the upper Klamath Basin following dam removal. For these species, populations, and runs, repopulation from the site of Iron Gate Dam to the Stateline is expected to occur at a rate that will not require active reintroduction, contingent on environmental conditions such as adequate flows to activate and restore habitat processes through the newly restored Klamath River and tributary reaches. Adult run timing, number of individuals, and extent of volitional migration as well as juvenile movements during outmigration and dispersal into newly available habitats will vary annually with changes in habitat conditions and other factors.

For Chinook salmon and steelhead, CDFW is proposing to follow guidance provided by ODFW and The Klamath Tribes (ODFW and The Klamath Tribes 2021) by deferring consideration of active reintroduction for roughly three generations (i.e., fall-run Chinook salmon = 12 years, steelhead = 15 years). For SONCC coho salmon, NOAA Fisheries recommends using at least a four generational or 12-year time horizon to assess viability criteria (Williams et al. 2008); therefore, CDFW proposes to defer consideration of active reintroduction of SONCC coho salmon for 12 years. These proposed generational time frames should be sufficient for volitional reintroduction to occur. In the context of environmental conditions, monitoring will help inform whether volitional reintroduction is trending toward success or if active reintroduction or other adaptive management strategies should be considered.

Per the recommendation of ODFW and The Klamath Tribes, CDFW proposes a 15-year period to allow Pacific lamprey to naturally repopulate historical habitats. This 15-year period should be sufficient for Pacific lamprey to become reestablished and is supported by recent investigations in other watersheds where dam removal has occurred. For example, following the removal of Condit Dam on the White Salmon River, Jolley et al. (2017) found that Pacific lamprey naturally reinhabited the basin within a few years, and Pacific lamprey rapidly reoccupied tributaries upstream of the Elwha Dam following its removal in 2012 (Moser and Paradis 2017).

Spring-run Chinook salmon historically migrated through the hydroelectric reach to spawn in tributaries of Upper Klamath Lake in Oregon. The hydroelectric reach and associated tributaries likely provide holding and rearing habitats for spring-run Chinook salmon and may also provide spawning habitat. Spring-run Chinook salmon have been extirpated from the upper Klamath Basin for over a century due to the dams and the only remaining extant populations in the Klamath Basin are believed to occur in the Trinity and Salmon rivers over 160 kilometers (100 miles) downstream of Iron Gate Dam. Due to the geographic distance between extant populations and historical habitats, spring-run Chinook salmon may not volitionally repopulate habitats in the upper Klamath Basin. This conclusion has been reached by others including Goodman et al. (2011) and ODFW and The Klamath Tribes (2021). Active reintroduction of Klamath spring-run Chinook salmon is not currently being considered in California, but the possibility is being explored in Oregon due to historical distribution and available habitats including access to year-round cold-water habitats. Active reintroduction is discussed in more detail below.

5.1.2 Active Reintroduction Through Transplanting

Under this strategy, adult fish, juveniles, or fertilized gametes may be placed in reintroduction sites in an effort to initiate reintroduction. Consideration for active reintroduction of Chinook salmon, coho salmon, steelhead, and Pacific lamprey in the California portion of the upper Klamath Basin will be deferred to allow sufficient time for these species to naturally repopulate newly available habitat as described in Section 5.1.1.

While CDFW is not considering active reintroduction, ODFW and The Klamath Tribes are evaluating the potential to actively reintroduce spring-run Chinook salmon to historic spawning and over-summering habitats in Oregon. As identified by Anderson et al. (2014), active reintroduction is often best suited for areas that are distant from extant populations, where long distance dispersal may be unlikely. In this case, transplanting can ensure an adequate number of individuals reach the reintroduction site (Anderson et al. 2014) with the expectation that lineages will continue to breed naturally at the site and thus populations will persist. CDFW will have the opportunity to learn from ODFW and the Klamath Tribes as they evaluate the potential to reintroduce spring-run Chinook, which will provide valuable insight into any future considerations for active reintroduction in California. It is anticipated that any reintroduction effort by ODFW and The Klamath Tribes would be coordinated with NOAA Fisheries, CDFW and others. If active reintroduction of spring-run Chinook salmon does occur, it will be critical to monitor these reintroduced fish in Oregon and California, and to the extent possible offshore oceanic waters, including distinguishing them from Chinook that reestablish through volitional migration.

In-basin stock(s) or populations of Chinook salmon would likely be most appropriate for reintroduction efforts in the upper Klamath Basin to help maintain genetic integrity. Spring-run Chinook salmon from the Trinity River Hatchery may be the most feasible source stock for reintroduction. ODFW and the Klamath Tribes, along with their collaborators, are currently conducting studies in the upper Klamath Basin using juvenile Trinity River Hatchery spring-run Chinook that were hatched and reared at ODFW's Klamath Fish Hatchery. These studies will help inform potential future active reintroduction efforts and to identify specific locations where reintroduction would be expected to be successful.

A hatchery truck filled with juvenile Chinook salmon bound for the Fall Creek facility drives on the road next to Iron Gate Reservoir, CDFW Photo.

Although CDFW is not considering active reintroduction, if a future need to actively reintroduce anadromous fishes is identified, studies would be conducted to inform feasibility and to help ensure the source population used would be genetically appropriate and have the best opportunity to successfully rear, emigrate to the ocean, and return to spawn. A separate active reintroduction plan would be developed at that time.

5.2 KEY ISSUES AND UNCERTAINTIES WITH REINTRODUCTION

Several key issues and uncertainties exist with the reintroduction of anadromous fishes in the California portion of the upper Klamath Basin and are briefly described below. Many of these issues are similar to those identified in the *Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin* (ODFW and The Klamath Tribes 2021).

5.2.1 Flow Management and Water Quality

Water demands for anthropogenic use, and the associated impacts those uses have to water quality, are some of the factors that can degrade anadromous fish habitat. Many aspects of water quality affect anadromous fish. For example, water temperature is a key component to fish habitat and health, affecting migration and spawning, egg incubation, feeding and growth rates, response to predation, and susceptibility to disease (DOI and NOAA Fisheries 2013). High nutrient loads, especially nitrogen and phosphorus, also affect anadromous fish by fostering algal growth which can lower dissolved oxygen and increase pH (DOI and NOAA Fisheries 2013) thereby creating stressful or lethal conditions.

The theme of Klamath Basin water availability and water quality are reflected in Biological Opinions relating to federal water management (NOAA Fisheries and USFWS 2013, NOAA Fisheries 2019b) and the legal challenges those Biological Opinions have faced. Efforts to work with a variety of water users to satisfy user needs while also achieving adequate Upper Klamath Lake surface water elevations for endangered Shortnose and Lost River suckers, as well as sufficient water for national wildlife refuges and suitable flow regimes for anadromous salmonids in the Klamath River are ongoing and critical to the ecological function of the Klamath Basin as well as the health of basin communities. This general theme is not limited to the upper basin, it is also present in tributaries downstream of Iron Gate Dam including the Scott, Shasta, and Trinity watersheds.

Water quality in the Klamath River has been of great concern for many years. Following a lawsuit filed in 1997 by the Pacific Coast Federation of Fishermen's Association against the Environmental Protection Agency, a decree for Total Maximum Daily Loads (TMDL) was issued to be developed in the Klamath Basin. In 2010, TMDL's for temperature, dissolved oxygen, nutrients, and microcystin impairments were established for the mainstem Klamath River (North Coast Regional Water Quality Control Board 2010). Currently, the Klamath River is on the List of Impaired Waters under Section 303(d) of the Clean Water Act. The removal of the dams and creation of a free-flowing river through the hydroelectric reach will improve water quality conditions within the hydroelectric reach immediately by simply eliminating the stagnant habitat conditions favoring annual toxic algae blooms and reconnecting cold-water tributaries to the river. This will improve water quality conditions within and downstream of the hydroelectric reach in the Klamath River and restore access to critically important thermal refugia, both of which will facilitate reintroduction of anadromous species.

5.2.2 Dam Removal and Restoration

Significant planning for the removal of the four hydroelectric dams has occurred over the years. Planning efforts to date encompass a range of potential scenarios and include contingency planning and risk management strategies.

Inherent to dam removal are some uncertainties associated with environmental factors including the water year type (i.e., wet year versus dry year) during drawdown and dam removal which will influence the magnitude and duration of suspended sediment concentrations (SSC) released downstream and the physical condition of reservoir area sediments following completion of drawdown. Each is briefly discussed below.

During and following reservoir drawdown, reservoir sediments will be flushed downstream, and the magnitude and duration of SSC will be primarily influenced by water year type and volume of water flowing through the hydroelectric reach. Sediment evacuation is expected to be the most severe impact of dam removal (Federal Energy Regulatory Commission 2021). KRRC completed an SSC effects analysis in coordination with NOAA Fisheries to analyze potential impacts on coho salmon and Chinook salmon for ESA consultation. The analysis included several steps and built upon modeling of suspended sediments by Greimann et al. (2011). Steps included updating the modeling with revised drawdown rates; modeling predicted daily SSCs for each year of flow data in the 48-year period of record (1961-2008); utilizing the Newcombe and Jenson (1996) severity of ill effects indices in combination with life history information to evaluate impacts including exposure periods and duration; and identifying median and severe impact years to derive potential levels of take associated with SSC. Actual SSC impacts are expected to fall within the range of potential impacts analyzed by KRRC; however, there is some inherent uncertainty as to what the actual impacts will be due to the inability to forecast water year type and account for other factors (e.g., potential shifts in construction schedule) that will influence sediment evacuation during drawdown.

Additionally, some uncertainty exists as to what the physical conditions of the soils will be in the former reservoir areas given the uncertainty around effectiveness of sediment evacuation and other factors that will influence soil conditions post drawdown. The physical condition of soils will influence revegetation efforts and timeline for establishment of native vegetation to meet success criteria. The Reservoir Area Management Plan was developed to account for some of this uncertainty by deferring completion of final restoration design until after drawdown is complete and initiating pioneer seeding of reservoir areas in hast post drawdown to take advantage of residual soil moisture. While significant planning and pre-work (e.g., soil tests, native seed collection and propagation) have gone into the restoration plan there is still some inherent uncertainty around timeliness of restoration and level of effort and resources that will be required to complete the restoration.

The Klamath River flows through the former Copco 2 Dam site, CDFW Photo.

5.2.3 Climate Change

It is difficult to predict how climate change will alter anadromous fish reintroduction and to what degree it will affect fish response and populations. The current projection is that climate change will produce warmer water temperatures and the Klamath River will see earlier spring runoff (DOI and NOAA Fisheries 2013). Changes in precipitation are also expected with reductions in annual snowpack. Modeled water temperatures for the fall-run Chinook salmon migration period on the Klamath River indicate future (2020-2061) water temperatures will be 1-3 degrees Celsius higher than historically (1961-2009) due to climate change (DOI and NOAA Fisheries 2013). Although water temperatures are expected to increase and there is uncertainty on how fish will respond to increased water temperatures and changes in precipitation, there is a high-level of certainty that dam removal will provide access to large cold-water sources in the upper Klamath Basin that would provide refugia for migrating salmonids (DOI and NOAA Fisheries 2013). These cold-water sources will also provide important habitats for other salmonid life stages, including rearing juvenile salmonids.

This Monitoring Plan provides a phased approach to monitoring and includes general performance objectives to assess progress toward re-establishing anadromous fish populations following the removal of the four dams and will collect data to inform fisheries management, conservation, and restoration of these populations. The recent and anticipated climate changes require that the performance objectives and monitoring tools be appropriate to accommodate the dynamic and changing climatic conditions.

5.2.4 Rate and Extent of Natural Reintroduction

Over 60 years have passed since anadromy extended upstream of Iron Gate Dam and over 100 years since anadromous species were able to access habitats upstream of Copco 1 Dam. Uncertainties revolve around the rate and extent of natural repopulation of upstream habitats after the four dams are removed, though dam removals elsewhere have provided some context.

Anadromous salmonid escapement numbers are much lower than were reported prior to and during construction of the dams. Anadromous fish population abundances are dynamic and respond to a range of environmental conditions in both freshwater and marine environments which over the past 15 to 20 years have been less than favorable for anadromous species. Moreover, recent conditions in the Klamath River such as disease have been particularly hard on fish populations. Some loss of anadromous fishes is expected in the short term with the removal of the dams. However, based on salmonid responses to other dam removal projects on the West Coast, including removal of the Elwha and Glines Canyon dams on the Elwha River, anadromous salmonids are expected to begin dispersal into the newly restored river and upstream habitats within the first few years following dam removal.

Pacific lampreys are generally found wherever anadromous salmonids occur. The species currently occurs downstream of Iron Gate Dam and is expected to repopulate newly accessible habitat but in the absence of active reintroduction, dispersal into historical habitat could take decades (DOI and NOAA Fisheries 2013). However, recent studies suggest natural reintroduction could occur more quickly. For example, within a few years after the removal of Condit Dam on the White Salmon River in Washington, Pacific lamprey naturally moved into the basin (Jolley et al. 2017) and Pacific lamprey rapidly dispersed into tributaries upstream of the Elwha Dam on the Elwha River in Washington following its removal in 2012 (Moser and Paradis 2017).

5.2.5 Source Stocks and Potential Active Reintroduction

If individuals from proximate populations do not disperse into newly available habitat after multiple generations, active reintroduction may be needed and is therefore included in this plan as a potential adaptive management tool. The selection of progeny will be re-evaluated based on the existing environmental conditions and the fish species population estimates at that time. Compared to hatchery fish, wild fish have gone through natural selection in the wild, are typically more diverse genotypically and are more successful at surviving in natural environments. Additionally, several studies have demonstrated hatcheries reduce the fitness of wild fish (DOI and NOAA Fisheries 2013) by the straying and subsequent breeding of hatchery origin fish with wild fish.

Reducing hatchery influence on individual fish and populations dispersing into the reconnected habitat will be important to maintain the natural viability of these populations. Possible management actions to reduce the amount of hatchery influence on actively reintroduced fish include planting of artificially spawned eggs from wild salmonid parents, releasing first-generation hatchery juveniles derived from wild parents (ODFW and Klamath Tribes 2021), or release of adult broodstock into newly available habitat to spawn and create wild offspring (U. S. Bureau of Reclamation 2018).

5.2.6 Fish Pathogens

The four mainstem Klamath River dams are also barriers for some fish pathogens and once removed, some pathogens have the potential to spread from reintroduced anadromous fishes to upstream native fishes and vice versa. However, salmonids and their associated pathogens were historically present in the upper Klamath Basin and available information suggests that the risk of potential reintroduction of pathogens to native fish upstream of the dams would be low (DOI and NOAA Fisheries 2013).

The prevalence of the myxozoan parasite *Ceratonova shasta* (formerly *Ceratomyxa shasta*) and other pathogens currently detrimental to salmonid populations downstream of Iron Gate Dam are of concern. *Ceratonova shasta* is known to be a significant cause of juvenile salmonid mortality in the Klamath system (Ray et al. 2012). One of the factors that needs to be resolved to achieve substantial gains in salmonid abundance and distribution is to change the hydrology, sediment movement, and spawning distribution to reduce disease incidences to levels that do not cause high mortality in juveniles or pre-spawning adults (Goodman et al. 2011). While dam removal is expected to decrease the prevalence of certain diseases such as *Ceratonova shasta* through changes in hydrology, sediment movement, and spawning distribution, there is still some level of uncertainty as to what the decrease in prevalence and severity of infection will be post dam removals considering flows will continue to be regulated under the Klamath Project with the new flow control points being Link River and Keno dams. Pathogen monitoring downstream of Iron Gate Dam is currently led by the USFWS and Oregon State University in coordination with others including NOAA Fisheries, U.S. Bureau of Reclamation, CDFW, the Karuk Tribe, and the Yurok Tribe. Efforts are also underway by Oregon State University in coordination with CDFW, ODFW and others to understand pathogens upstream of Iron Gate Dam prior to dam removals. A continuation and expansion of these efforts following dam removal will be important to track the spatial and temporal distribution of pathogens and host species in the Klamath Basin.

5.2.7 Fish Passage and Artificial Structures

Maintaining fish passage through the newly restored stretch of the Klamath River and its tributaries is a top priority for the KRRC, federal and state agencies, Tribes, and other basin partners. KRRC's *Definite Plan* (KRRC 2018) and subsequent *Definite Decommissioning Plan* (KRRC 2020) provide methods for monitoring and rectifying barriers to fish passage that may occur from dam removals as summarized in Section 4.2. However, irrigation diversion structures upstream of Copco Reservoir to the Stateline and beyond may prevent, entrain and or otherwise influence movement (immigration or emigration) of anadromous fishes of all life stages. NOAA Fisheries, Pacific States Marine Fisheries Commission (PSMFC), and Trout Unlimited recently cataloged and assessed diversions from Link River Dam downstream to Iron Gate Dam. The identified diversion structures may need to be brought into compliance with landowners' support to meet federal and state fish screening and passage requirements. A similar effort should be conducted on the tributaries.

5.2.8 Predation on Juvenile Anadromous Fishes

Removal of the dams and reservoirs should significantly reduce or eliminate many non-native predatory fish species that currently reside in Iron Gate and Copco reservoirs such as largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) thereby improving conditions for native fishes (DOI and NOAA Fisheries 2013). The low occurrence of non-native fish in catches downstream of Iron Gate Dam provides evidence of what the potential fish species assemblage would look like in the newly restored stretch of the Klamath River (DOI and NOAA Fisheries 2013). Predation by resident *O. mykiss* is expected to be similar to observed levels of predation downstream of Iron Gate. One expected change would be a reduction in predation on wild fish from hatchery-origin fall-run Chinook salmon, since the future hatchery production goal of fall-run Chinook salmon is much lower than the current production goal.

5.2.9 Potential Effects of Reintroduction on Resident Native Fishes

As mentioned in Section 2.2.5, designated Wild Trout waters occur from Copco Reservoir upstream to the Stateline. The reintroduction of anadromous fishes to this stretch of water is not expected to significantly affect the native resident (non-anadromous) assemblage and would likely benefit resident fish through the reintroduction of marine-derived nutrients. Efforts are ongoing to collect baseline information on resident *O. mykiss* populations upstream of Iron Gate Dam prior to dam removal.

6.0 MONITORING FRAMEWORK

This section provides the conceptual framework for monitoring that will be used to inform management and conservation of anadromous fish populations in the monitoring reach and allows for coordination and compatibility with efforts elsewhere in the Klamath Basin. Some key components of this monitoring framework include data collection to track performance objectives (e.g., distribution, occupancy, abundance, productivity, diversity) necessary to inform fisheries management and conservation. Data collection will also contribute information to evaluate the efficacy of the reintroduction and to inform adaptive management actions that could be implemented to promote the re-establishment of wild, self-sustaining anadromous fish populations.

A variety of tools will be used to monitor anadromous fishes at various life stages. A fundamental aspect of the monitoring framework is for monitoring to guide adaptive methods and tools for data collection based on management information needs, thereby allowing maximum flexibility in techniques and tools. This includes potential use of new innovative methods, tools, and analyses to accommodate uncertainties in future environmental and habitat conditions. The specific monitoring methods and the spatial and temporal use of those methods will be decided in close coordination with basin partners, is expected to change over time based on information needs, and will be contingent on accessibility (e.g., landowner permission, safety), staffing capabilities, available funding, and what specific monitoring activities our basin partners are performing in the basin at any given time.

As previously mentioned, the overarching goal of monitoring is to measure and track the reintroduction of anadromous fishes and progress toward viable self-sustaining populations of anadromous fishes in the monitoring reach following removal of the dams. The proposed approach is to monitor volitional reintroduction of fall-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey for three to four generations (12 to 15 years) depending on species. For spring-run Chinook salmon, CDFW will coordinate with ODFW and The Klamath Tribes on monitoring efforts while feasibility studies are underway, as appropriate, and following any active reintroduction to the upper Klamath Basin. The conceptual monitoring framework follows a four-phased approach: **Phase I** – Reintroduction, **Phase II** – Establishment, **Phase III** – Abundance and Productivity, and **Phase IV** – Spatial Structure and Diversity. The phases are designed to coincide with the temporal and spatial aspects of volitional reintroduction, habitat restoration, and physical and ecological processes; however, monitoring to a particular phase will ultimately be driven by management information needs. For example, productivity, the number of adults returning and juveniles out-migrating, and adult abundance information will be required for fall-run Chinook salmon beginning year one to inform fisheries management; therefore, Phase I and III monitoring would be initiated, to the extent practicable, in year one for fall-run Chinook salmon. The general performance objective(s) for each phase along with monitoring metric(s) are further discussed beginning in Section 6.1.

Performance objectives take into consideration the specific species and management interests associated with the species; the observed or measured spatial and temporal progression in habitat condition and species occupancy and abundance in the monitoring reach; and habitat restoration activities in the monitoring reach.

6.1 PHASE I: REINTRODUCTION

Monitoring for volitional reintroduction is the initial phase in the conceptual monitoring framework and will be implemented once volitional passage is restored. In general, reintroduction monitoring will focus on determining temporal presence and spatial distribution of anadromous fishes moving upstream into or through the monitoring reach. For Chinook salmon and coho salmon, monitoring will likely include both adult (spawning) and juvenile (outmigration or seasonal rearing) life stage surveys. However, if funding or staffing limitations prevent monitoring both, monitoring efforts will be prioritized based on fisheries management information needs (e.g., adult escapement). This prioritization process would occur in coordination with basin fisheries managers.

Natural reintroduction is expected to begin once upstream fish passage is restored. Reintroduction may or may not be immediate and some underlying assumptions as to how quickly reintroduction could occur include, but are not limited to:

- The ability for the non-reservoir reaches of the Klamath River to provide spawning, rearing, and holding habitats following removal of the dams and completion of associated sediment evacuations and instream restoration activities; and,
- The time frame and flow regime necessary for stream processes to adequately restore substrate and channel conditions (e.g., flow events) in the reservoir reaches and riverbed areas impacted by sediment evacuation to provide habitats (e.g., holding, spawning, rearing) for anadromous species.

Monitoring the reintroduction will be species and life-stage specific and focused on founders and returning progeny. The general performance objective is an increase over time in the extent of mainstem and tributary reaches a given species is reasonably expected to volitionally access given habitat and environmental conditions in the monitoring reach. This would be monitored on a generational time frame where the expectation is to observe several generations of fish returns (e.g., F2, F3) as habitats come online.

The monitoring performance metrics will be based on fish presence/absence spatially and are as follows:

- Chinook salmon, coho salmon, steelhead, and Pacific lamprey have volitionally moved through or are otherwise utilizing available habitats in the mainstem Klamath River in the monitoring reach; and,
- Chinook salmon, coho salmon, steelhead, and Pacific lamprey have moved into and are utilizing available tributary habitats in the monitoring reach.

Monitoring for reintroduction will occur in close coordination with federal and state agencies, Tribes, and other basin fisheries partners including KRRC as they implement restoration and monitoring efforts under the Lower Klamath Project management plans (e.g., ARMP, RAMP). With the various restoration and monitoring activities occurring in the monitoring reach following dam removal, tributaries other than those currently included in this Monitoring Plan (i.e., Shovel, Fall, Jenny, Camp, and Scotch creeks) may be found to provide important holding, spawning, or rearing habitat. It is anticipated that any tributaries supporting anadromous fishes, via direct observations or signs of habitat use, would be included, as appropriate, in annual monitoring efforts.

CDFW in-river snorkel surveys, CDFW Photo.

6.2 PHASE II: ESTABLISHMENT

Monitoring for establishment is the second phase in the monitoring framework and builds upon Phase I monitoring. Establishment is based on population persistence and requires survival of founders and breeding by founders and their offspring (Seddon et al. 2012). Monitoring for establishment will be species specific and will focus on determining where populations persist in the monitoring reach. The effort seeks to identify the spatial and temporal occupancy of stream reaches and habitats by life-stages. This includes identifying spawning areas, adult holding locations, and juvenile seasonal rearing habitats (e.g., tributary confluences, cold water refugia). Determining whether species have become established in a particular reach or tributary will take into consideration the generational time frame of the species and presence of multiple cohorts over time. For example, the presence of adult coho salmon and coho salmon redds in years four, five and six would suggest the three cohorts F2 generations have likely become established in the reach, at least in the near term, and additional monitoring can help confirm establishment. Monitoring for establishment is also expected to help inform future habitat restoration opportunities within the monitoring reach.

Monitoring for establishment will be species and life-stage specific and the performance objective is an increase over time in the distance of mainstem and tributary reaches a given species is reasonably expected to become established given habitat and environmental conditions in the monitoring reach.

The monitoring performance metrics will be based on F2 fish presence, years 4, 5 and 6 and are as follows:

- Chinook salmon, coho salmon, steelhead, and Pacific lamprey are generally trending toward or have become established in available habitats (species and life stage specific) in the mainstem Klamath River within the monitoring reach; and,
- Chinook salmon, coho salmon, steelhead, and Pacific lamprey are generally trending toward or have become established in available habitats (species and life stage specific) in tributary reaches within the monitoring reach.

6.3 PHASE III: ABUNDANCE AND PRODUCTIVITY

Monitoring for abundance and productivity in the mainstem Klamath and the tributaries is Phase III in the conceptual framework. This data will be used to inform management of Klamath River salmon and steelhead fisheries stocks as well as for the conservation of anadromous salmonids and Pacific lamprey. Phase III monitoring builds upon the earlier two phases. Performance objectives include the following:

- Determining annual adult abundance, age structure, distribution, hatchery component (percent hatchery origin fish on the spawning grounds (pHOS)), and pre-spawning mortality (e.g., mortality due to poor water quality, disease) of Chinook salmon and coho salmon;
- Determining annual Chinook salmon smolt production, spatial and temporal smolt abundance, and movement patterns (timing of downstream movement);
- Determining annual coho salmon smolt production, spatial and temporal smolt abundance, movement patterns (timing of downstream movement), and age structure. In addition, the relative abundance by reach/tributary and seasonal habitat use of juvenile coho salmon;
- Determining annual relative abundance and distribution of adult steelhead in the monitoring reach; and,
- Determine annual relative abundance and distribution of the Pacific lamprey population, observations of adults and juveniles. Although identification is expected to be difficult given the presence of non-anadromous lampreys.

The natural production of fall-run Chinook salmon is of critical importance to Tribal, commercial, and recreational fisheries and therefore Phase III monitoring of fall-run Chinook salmon is expected to begin in year one, immediately following confirmation of initial volitional reintroduction, Phase I. The monitoring performance metric under consideration for fall-run Chinook salmon and steelhead is for these fisheries to generally trend toward and eventually reach sufficient distribution, productivity, and abundance to initiate and maintain a regulatory phase for harvest.

The performance metric under consideration for spring-run Chinook salmon, coho salmon and Pacific lamprey is based on recovery and rebuilding of populations. The proposed metric is a general increase over time in distribution, diversity, productivity, and abundance trending toward reaching carrying capacities within the monitoring reach, and for coho salmon and spring-run Chinook salmon contributing to recovery.

Phase III monitoring will generally begin following confirmation of reintroduction (Phase I) and will coincide with Phase II monitoring efforts. Initiation of Phase III will be species specific but monitoring for multiple species will likely occur concurrently. For example, Phase III monitoring efforts for adult fall-run Chinook salmon could extend through the adult coho salmon migration season. Data and information collected during Phase III monitoring will need to be compatible and comparable with current monitoring efforts downstream of Iron Gate Dam and future monitoring efforts in Oregon.

6.4 PHASE IV: SPATIAL STRUCTURE AND DIVERSITY

Phase IV monitoring further advances the understanding of spatial structure and diversity information collected in Phase III monitoring and similar to Phase III, data collected under Phase IV will need to be compatible with data collected from other areas in the Klamath Basin to examine and track the spatial structure and diversity of anadromous fishes, especially for coho salmon and spring-run Chinook salmon.

Based on other dam removal efforts and large restoration efforts in other western rivers, it is anticipated that monitoring spatial structure by examining occupancy patterns of adults (e.g., holding areas, spawning), juveniles (e.g., over-summer rearing, over-winter rearing), and locations of smolt production will be critical and are likely to be dynamic throughout the first several generations (e.g., 3-4 generations) of each species, and as previously stated, contingent on environmental conditions, ecological processes, and the efficacy of habitat restoration efforts. This effort will build upon all three monitoring phases.

In addition to monitoring the spatial structure, it will also be important and informative to monitor life-history diversity. Many of the early measures of diversity are associated with the spatial structure and include run-time and spawning time, age distribution of spawners, origin of spawners (i.e., natural- or hatchery-origin), redistribution of juveniles, emigration timing, and size of out-migrants throughout mainstem reaches and tributaries in the monitoring reach.

Other measures of spatial structure and diversity include various genetic measures. These measures will inform our short-term understanding of the evolving distribution and movement of fish among both natal and non-natal habitats upstream and downstream of dam removals. Another important genetic consideration will be a longer-term understanding of genetic population structure within and among tributaries, mainstem reaches, and throughout the Klamath River Basin, and the West Coast. Other items of interest include identifying the locations of source populations of fish dispersing into newly accessible habitats (e.g., tributaries or mainstem areas downstream of Iron Gate Dam, hatchery-origin fish, fish from outside the Klamath Basin) and spatial and temporal distribution of various genotypes of fish within the Klamath River with specific interest in newly accessible areas upstream of Iron Gate Dam.

6.5 FISH HEALTH

In addition to Phases I-IV, this Monitoring Plan identifies the need to monitor fish health in the monitoring reach. Efforts would focus on identifying and tracking pathogens of anadromous fish in the monitoring reach, determining if there are differences in pathogens and rates of infection between the monitoring reach and lower Klamath River, and assess changes in pathogens and infection rates over time. This effort should be closely coordinated with monitoring partners and include developing a baseline pathogen prevalence in returning hatchery- and natural-spawned fish as well as identifying any pre-spawn mortality that may be associated with pathogens. Additionally, the health and pathogen prevalence in juvenile out-migrants should be closely monitored.

6.6 GENERAL MONITORING METHODS AND SAMPLING OPTIONS

This section identifies the monitoring methods and sampling options currently under consideration for short- and long-term monitoring of anadromous fishes in the monitoring reach. Specific methods to be used will be determined through coordination with our basin partners; follow the phased approach to monitoring; and by specific questions of interest given habitat conditions and fish response, and available funding and staffing capacity. Identifying the question, life stage, spatial and temporal scale is critical to our approach, advances in technology and analysis will be used when available. Many of the monitoring methods described below are currently used downstream of Iron Gate Dam, and elsewhere, and flexibility is built into this Monitoring Plan to allow for other methods to be used to answer specific questions as fish populations volitionally move into and reestablish in habitats within the monitoring reach and as habitat processes evolve based on environmental conditions. To ensure monitoring efforts are adequate and appropriate, and to avoid potential overlap in efforts, monitoring will occur through careful planning and coordination with basin partners.

CDFW held a coordination meeting with basin partners in early November 2023 to discuss proposed monitoring efforts following removal of the dams and to identify potential monitoring gaps. Stemming from this meeting are the proposed monitoring efforts provided in Attachment A. These efforts are specific to 2024 and 2025 monitoring and may be constrained by funding, staffing, or other unforeseen circumstances.

6.6.1 Freshwater Adult/Spawner Life Stage

Methods for consideration include foot and boat-based surveys (i.e., live adult fish surveys, carcass surveys, redd surveys), sonar surveys, sampling weirs, aerial surveys, and environmental DNA sampling. Each is discussed in more detail below.

6.6.1.1 Foot and Boat-Based Surveys

Foot and boat-based surveys may include surveying for live adult fish, carcasses, and/or redds depending on species. Methods employed under foot and boat-based surveys are expected to be cost-effective and are anticipated to be implemented beginning Phase I (Reintroduction) to document volitional reintroduction. They would also likely be used to collect data during subsequent monitoring phases.

Chinook salmon and coho salmon carcass surveys gather information on fish that otherwise cannot typically be obtained at the scale needed to better derive overall adult spawning presence, distribution, and abundance. Data collection could include age, length, sex, origin (natural- or hatchery-origin), spawning success, and prevalence of certain pathogens. Carcass surveys also allow for the collection of tissues, scales, otoliths for genetic analysis and analysis of other life-history parameters; and can be used to generate abundance estimates using a mark-recapture strategy.

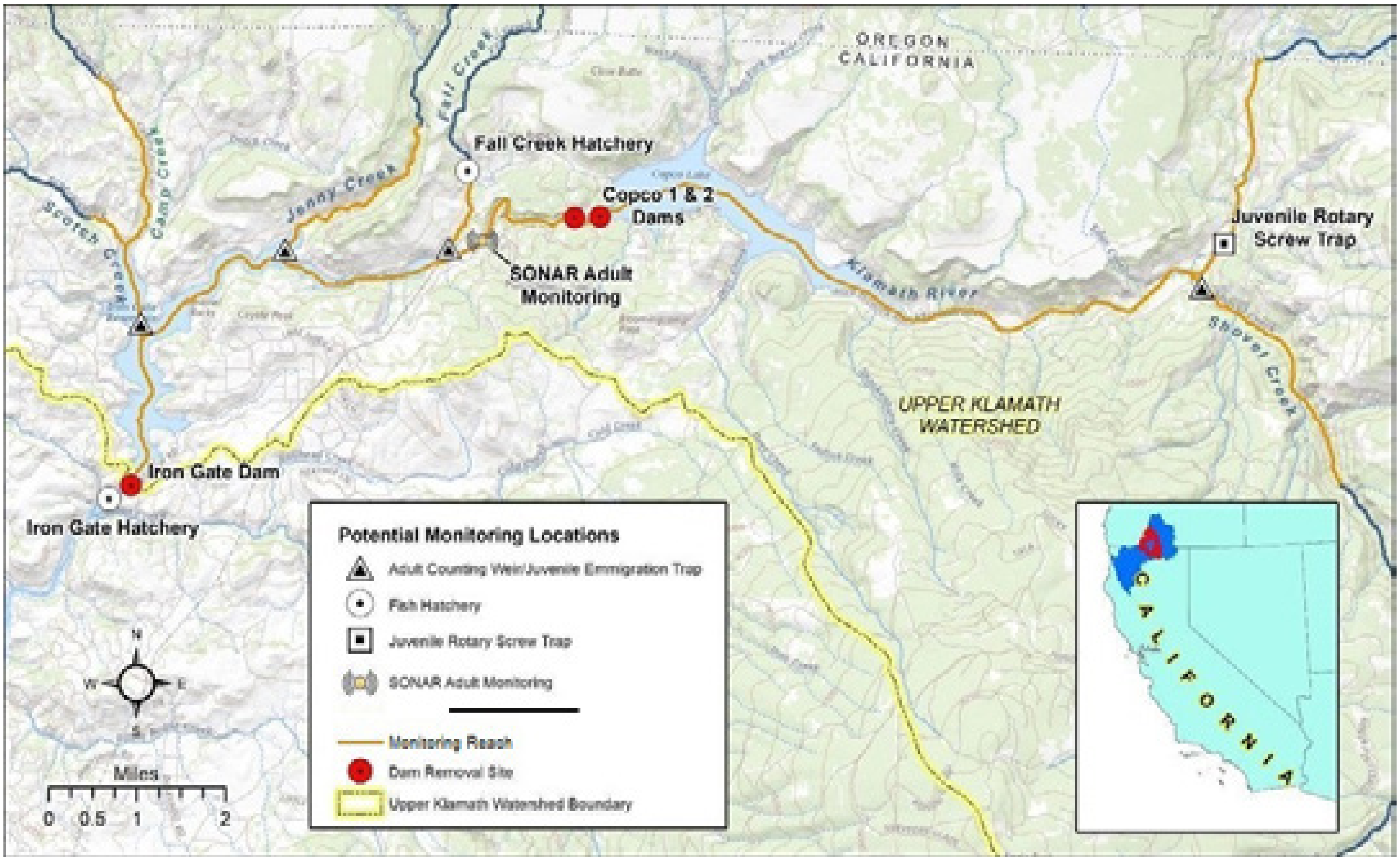
Redd counts provide information on redd abundance, the spatial and temporal distribution of redds in the system and allow for estimations of escapement. Surveying for redds and spawning fish can be conducted concurrently along with carcass surveys or other survey methods.

Once volitional passage is achieved and the river and riverbanks are safe to navigate, foot and boat-based surveys could be conducted within the monitoring reach as shown in Figure 8. Consistency among datasets will be important, therefore methods are expected to be similar to those used by the USFWS and Yurok Tribe as described in Gough and Som (2017). These methods are also consistent with those proposed in Oregon by ODFW and The Klamath Tribes (2021).

6.6.1.2 Sonar Survey

Over the last decade, active hydro-acoustic techniques have proven to be an effective method of unobtrusively evaluating anadromous fish populations in freshwater and marine environments (CDFW 2020c). Sonar surveys would ideally be implemented beginning Phase I to monitor the reintroduction. Hydro-acoustic devices can be hand-held, boat-mounted, or fixed to the shore or a structure. Software developed for the devices process characteristic acoustic signals to identify salmonids; however, additional sampling is required to determine species. In the appropriate conditions and locations sonar could be used to estimate abundance of anadromous fish. An initial preferred location for this tool, if site conditions are appropriate, would be at or in the immediate vicinity of Iron Gate Dam to document volitional dispersal into upstream historical habitats. Another potential location if conditions are suitable would be downstream of Ward's Canyon where there is a natural pinch point (Figure 8). This location would minimize the detection and influence of Fall Creek Hatchery-origin fish on escapement numbers. Use and placement of hydro-acoustic devices will be dependent on the specific questions that need to be addressed and would be coordinated with monitoring partners to optimize location and data collection.

Figure 8. Conceptual approach to monitoring anadromous species following the removal of the four mainstem Klamath River dams.



6.6.1.3 Sampling Weirs

Sampling weirs have long been used to capture migrating fish and are frequently used to count fish to determine status and trends of populations (Johnson et al. 2007). CDFW currently operates video weirs on the Scott River, Shasta River, and Bogus Creek as part of the escapement data collection effort for adult fall-run Chinook salmon, coho salmon, and steelhead (CDFW 2017). Additionally, two weirs are operated on the Trinity River for collection of salmonid escapement data. A similar effort would likely be suitable for several tributaries within the monitoring reach but not necessarily for the mainstem Klamath River. Tributary streams where weirs could be installed include Camp Creek below the confluence of Scotch Creek and Jenny, Fall, and Shovel creeks (Figure 8.) A video weir that is also designed to capture fish would be ideal for tributary monitoring. Weirs provide the opportunity to collect biological data (e.g., fish health, pathogens, tissue samples) or to tag individual fish to track reintroduction and habitat use. Weirs are also well suited for use at life-cycle monitoring (LCM) sites, of particular value are estimates of freshwater vs marine survival, productivity, and immigration and emigration patterns of all life stages (CDFW 2016). However, one overarching concern with weirs is the impact on fish movement. Impediments to upstream and downstream movement of all life stages of all species can cause delayed movement or exacerbate predation and disease. Impeding adult spawners from dispersing upstream into newly available habitat is something that should be avoided, particularly for the first 12-15 years. Use of weirs would only occur through careful planning and coordination with monitoring partners.

6.6.1.4 Aerial Surveys

Aerial surveys of salmon are essential tools in Pacific salmon management (Johnson et al. 2007) and recent development of unmanned aircraft systems (UAS) may provide a useful tool for adult surveys in the Klamath River. In California, fisheries biologists have used aerial photographs of the American River taken multiple times during the spawning season to identify where and when salmon spawn (Brown 2001, Harrison et al. 2020). Aerial surveys are best suited for river systems that are broad, shallow, contain clear water, and have limited overhanging vegetation, undercut banks, and canopy cover (Johnson et al. 2007). Surveys can be conducted by fixed-wing aircraft, helicopter, or small unmanned aircraft systems (UAS). Provided survey conditions are adequate, aerial surveys could be used to survey adult salmon (live fish or carcasses), redds, and to assess habitat conditions. Due to the initial lack of canopy cover and overhanging vegetation, these efforts could be best suited for the restored stretch of river provided there is sufficient visibility. Aerial surveys could also be used for radio telemetry monitoring of tagged individuals including adult, juvenile, and smolt life stages.

6.6.1.5 Environmental DNA Sampling

Environmental DNA (eDNA) sampling is another tool that can be used to monitor the presence of fish of all life stages. As organisms move through an environment, they shed material that contains genetic information. Environmental DNA is defined as "genetic material obtained directly from environmental samples without any obvious signs of biological source material" (Thomsen and Willersley 2015). Samples of eDNA are most commonly collected by sampling water, soil, or sediment, or through surface swabs (Biomeme 2018) and is non-invasive and typically used to sample for presence or absence of a species. However, caution should be exercised as detections may not be localized or very localized and can occur a long distance from the target organism. To infer location or microhabitat preference, an improved understanding of how water currents redistribute eDNA is needed (Wildlife Management Institute 2016; Spence et al. 2020).

Humboldt State University (HSU) began a study in 2019 to test the efficacy of using eDNA to estimate weekly abundance of out-migrating Chinook salmon smolts in the Klamath River (Coyne and Kinziger 2020). Fifteen water samples were collected per week over a 16-week period from March to June while at the same time the rotary screw trap near the Kinsman Creek confluence with the Klamath River at RKM 237.6 (RM 147.5) was in operation. The two data sets (eDNA and rotary screw trap) were compared, and the authors concluded that "to utilize eDNA for standardized monitoring, further improvements of eDNA methods are needed for estimating smolt abundance" (Coyne and Kinziger 2020).

The sampling and analysis of eDNA could be a useful tool to determine presence alongside other methods or used independently, particularly in tributaries where access may be difficult, and presence/absence is the primary metric being assessed. This method could be paired with pathogen and/or water chemistry testing as these methods also require collecting water samples (Hallett et al. 2012; SWRCB 2018).

6.6.2 Juvenile and Smolt Life Stages

Methods currently under consideration to monitor juvenile and smolt life stages include snorkel surveys, juvenile emigration traps (e.g., rotary screw traps, fyke nets), electrofishing, and tagging fish. Each is discussed in more detail below.

6.6.2.1 Snorkel Surveys

Underwater (direct) observation with snorkeling gear is a valuable tool for studying fish populations and habitat use and can be used in tandem with other survey methods. Snorkel surveys would likely be implemented during Phase I. They are widely used in streams to monitor fish populations and are especially well suited for surveys of juvenile anadromous salmonids, particularly over-summering coho salmon. Unlike methods that capture or handle fish, direct observation can be conducted in warmer water without harming fish. Additionally, snorkel surveys can be cost effective, quickly done with small teams, and can provide critical information on distribution and relative abundance, and in conjunction with other methods, estimates of juvenile abundance. Snorkel surveys can be particularly effective where it is difficult to access streams such as in steep canyon reaches. Snorkel surveys could be conducted annually following the removal of the dams, where appropriate and where access is permitted as with all sampling efforts. Both qualitative and quantitative data can be collected by direct observation. There are various well-developed protocols for direct observations including Thurow (1994) which is currently used in the watershed to answer specific questions related to coho salmon. The use of a certain protocol would be determined based on the specific questions that need to be addressed and the ability of the protocol to address those questions. Winter juvenile snorkel surveys for instance, may require unique or modified techniques in streams with increased velocity, turbidity, and very cool temperatures.

6.6.2.2 Juvenile Emigration Traps

Downstream migrant traps can be used to estimate the number, timing, size, and age of downstream migrating fish as well as provide opportunities to collect biological information (e.g., size, weight, tissue samples, scale samples) on juvenile fish including information on tagged (e.g., PIT tag) fish to assess fish movement and other parameters of interest. There are various types of downstream migrant traps, many in use elsewhere in the Klamath Basin. Rotary screw traps and fyke traps are frequently used to collect data on downstream migrating juvenile anadromous salmonids. Rotary screw traps are often used in larger rivers, such as the mainstem Klamath River, while fyke nets are more often deployed in smaller streams. Use of rotary screw traps on smaller tributaries may be feasible in some cases, all locations and stream sizes will require testing and evaluation of efficiency across the anticipated range of flows.

Potential locations for a rotary screw trap will be prioritized based on information gained through implementation of Phase I and II monitoring. On the mainstem Klamath River, a location may be selected in the vicinity of Iron Gate Dam to track outmigration past the former dam location. Alternatively, the USFWS's current rotary screw trap location just upstream of the Interstate 5 Bridge over the Klamath River could continue to be used to collect outmigration data. Another possible location could be upstream of Shovel Creek to collect outmigration data on fish moving down river from Oregon. Placement and operation of a mainstem rotary screw traps would only occur through careful planning and coordination with monitoring partners.

Fyke traps would likely be appropriate for use in the monitoring reach tributaries, including Camp Creek below the confluence of Scotch Creek, and in Jenny and Shovel creeks (Figure 8). A fyke trap may also be suitable for Fall Creek, although traps would need to be pulled during Fall Creek Hatchery juvenile releases. They could be installed below primary spawning areas or just above tributary confluences with the Klamath River, where access and safety allow. Similar to a mainstem rotary screw trap, placement and operation would only occur through careful planning and coordination with monitoring partners.

CDFW crews electrofishing in river, CDFW Photo.

6.6.2.3 Electrofishing

Electrofishing is a common sampling method in fisheries management (NOAA Fisheries 2000). It is one of the most widely used methods for sampling salmonid fish and is particularly useful in situations where other techniques are not effective in capturing fish or when handling fish is necessary (e.g., tissue samples, tagging/marking). Electrofishing can be performed using a backpack electrofishing unit or a boat- or raft-mounted electrofishing unit. The backpack units are better suited for small streams while boat or raft units can be used in larger streams and rivers.

Both qualitative and quantitative data can be collected by electrofishing. Qualitative sampling includes the capture of representative individuals and is used for such things as determining presence or absence, distribution, species assemblage, and fish health. Quantitative data can be used for such things as estimating fish species abundance, productivity, biomass, and age composition (Barony College 2007).

Electrofishing is better suited for monitoring juvenile fish in tributaries rather than in the mainstem, although it can possibly be used for sampling habitat along the margins of the mainstem or off channel habitats. In addition, there are well developed sampling designs (e.g., Hankin and Reeves 1988) that combine direct observation with electrofishing that reduce potential issues of stress associated with shocking and handling of fish.

6.6.2.4 Tagging Fish

There are a range of different types of fish tags available to mark individual fish or cohorts. Telemetry tags include acoustic and radio tags (transmitters) that serve a wide range of purposes and can be detected from relatively long distances, although can be limited by battery lifetime. Passive integrated transponder (PIT) tags do not have batteries and allow for the tagging of smaller fish, although they require relatively close distance for detection. Additionally, with no battery life issues, fish that are PIT tagged may be detected for the remainder of their lifetime. Regardless of tag type, questions concerning reach specific movement, survival, and abundance are well suited for tagging studies.

Adult fish tagging efforts at CDFW Hatchery, CDFW Photo.

Existing acoustic and radio telemetry receivers and PIT tag detection arrays in the upper and lower Klamath Basin provide opportunities for collaboration and require coordination (e.g., signal frequency, HDX or FDX PIT tags). Following the removal of the four dams, fish tagging efforts and/or the installation of receivers and detection arrays could be expanded to include the monitoring reach. An existing Klamath PIT tag database has been developed and is managed by USGS. Integration of the upper and lower basin PIT tag data is currently in progress and, depending on available funding, could potentially expand the database to include telemetry information as well. Any expansion of these efforts would be developed and coordinated with Klamath Basin monitoring partners.

6.7 DATA MANAGEMENT AND REPORTING

To centralize data from multiple sources, monitoring data from all projects will ideally be housed in a master database. Data from secondary projects, which do not directly inform management and recovery but provide inference regarding mechanisms influencing recovery, may also be added to this master database. The Klamath Basin Integrated Fisheries Restoration and Management Plan (IFRMP), discussed in more detail in Section 7.2.2, explores the possibility of developing a master database for the Klamath Basin. One existing standardized approach to data management and reporting that could be followed or potentially expanded upon is the one developed for the California Coastal Salmonid Monitoring Plan (CMP) (Adams et al. 2011). The CMP provides scientifically reliable information on the status and trends of California's coastal salmonid populations (Burch et al. 2015) and includes a standardized fish population database and reporting structure. Whether through the IFRMP, CMP, or by other means, it will be important to secure a long-term manager or managers and designate a standard approach to fish data management.

In addition to data management, record keeping is important to long-term adaptive management, including archiving decisions throughout the process (Medema et al. 2008). To manage data and maintain monitoring records across agencies and states, CDFW, through this Monitoring Plan, proposes the following:

- Continue to use the Klamath River Technical Advisory Team (KRTT) Age Composition report and expand the *Klamath Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest, and Run Size Estimates* (CDFW 2019), also referred to as the "Megatable," to include the geographic area from the Iron Gate Dam site to the Stateline. This could also be expanded to include Oregon. Reporting for this Monitoring Plan and for Oregon could include separate sections in the KRTT Age Composition report but would allow for a single population estimate to be passed on to the KRTT for inclusion into the *Ocean Abundance Projections and Prospective Harvest Levels for Klamath River Fall Chinook*;
- Use CDFW's existing data management guidelines that are employed for the KRP and the Klamath Watershed Program to compile, conduct quality assurance/quality control (QA/QC), and store data;
- Regularly update and maintain the metadata layer within the larger CDFW database management system;
- Consider identifying a dedicated individual or individuals and/or entity that would be responsible for creating, maintaining, and performing QA/QC on the database;
- Specific to the recovery of SONCC coho salmon, provide data to NOAA Fisheries and the Salmon Technical Team (technical team modeling for PFMC) for their master database; and,
- Utilize existing database, the CMP database, or if necessary, develop a separate database to track monitoring data that will be used to prepare yearly summary reports. In general, these annual reports would identify the fisheries management actions that were implemented, monitoring activities and data that were collected, and provide recommendations for future adaptive management actions, as appropriate. This annual reporting will likely include separate reports for adults and juveniles and will be critical to tracking management actions over the long term.

6.8 MONITORING COORDINATION AND COLLABORATION

The KRRC and their contractors, PFMC, NOAA Fisheries, USFWS, USGS, CDFW, ODFW, Yurok Tribe, Karuk Tribe, The Klamath Tribes, Quartz Valley Indian Reservation, and many other important entities have been working closely on planning for the removal of the four dams and the restoration activities to follow. Close coordination will need to continue prior to, and once fish passage is restored to successfully monitor anadromous fish migration and populations in the Klamath River Basin. Monitoring programs between state, federal, and Tribal fish managers in Oregon and California will need to be complementary to maximize efficiency and to ensure consistency amongst collected data.

In addition to dam removal related coordination, numerous other existing partnerships exist and can be used to enhance monitoring efforts. One such partnership is the Klamath River cooperative spawner survey. As discussed in Section 4.1.1, members of this partnership have been conducting fall-run Chinook salmon spawning ground surveys on the Klamath River and tributaries since 1986 (CDFW 2017). The main purpose of this survey effort is to provide data integral to estimating age-specific escapement of fall-run Chinook salmon. These survey efforts could be expanded upstream of Iron Gate Dam and include existing partners as well as regionally important new partners.

One other such partnership is the USFWS's Pacific Lamprey Conservation Initiative (PLCI), a National Fish Habitat Partnership (NFHP). The PLCI is a collaborative effort to achieve long-term persistence of Pacific lamprey and their habitats and support traditional Tribal use of Pacific lamprey throughout their historic range in the United States. Partners of the PLCI include Native American Tribes, federal, state, municipal, and local agencies from California, Oregon, Washington, Idaho, and Alaska. This partnership helps implement Pacific lamprey research and conservation actions throughout the range of the species.

CDFW operated rotary screw trap on Scott River, CDFW Photo.

7.0 HABITAT RESTORATION POST DAM REMOVAL

7.1 RESTORATION EFFORTS ASSOCIATED WITH DAM REMOVAL

Following reservoir drawdown and dam removal, the reservoir areas will become exposed and require restoration and stabilization of bare sediment deposits for long-term water quality and ecological benefits, and restoration of natural river functions and processes (KRRC 2018). The KRRC has prepared a Reservoir Area Management Plan (RAMP) that will be implemented following drawdown and dam removal. The RAMP describes anticipated conditions following drawdown and facility removal and describes restoration activities including sediment evacuation and stabilization, tributary restoration, wetland and off-channel habitat restoration, revegetation of bare soils, and management of invasive vegetation. Restoration activities that will be important to implement include:

- Measures to encourage sediment evacuation during drawdown;
- Reconstructing the river channel through the former dam footprints;
- Selective post-drawdown grading of mainstem near-channel areas and key tributaries as needed to provide volitional fish passage, remove large, unstable residual sediment deposits, and, where feasible, improve hydrologic connectivity to off-channel and floodplain areas to establish and sustain native riparian vegetation and enhance aquatic habitat;
- Installing large wood and boulder clusters to enhance habitat;
- Installing willow baffles to provide floodplain roughness and to encourage vegetation establishment and selectively stabilize sediments;
- Revegetating formerly inundated areas primarily through seeding to slow erosion and re-establish native plant communities;
- Planting and irrigating locally salvaged and/or nursery-sourced plants, including wetland sod, willow cuttings, bareroot trees, and shrubs and acorns;
- Controlling high priority invasive exotic vegetation (IEV) prior to, during, and following construction where feasible; and,
- Fencing select locations to protect restored reservoir areas from trampling and herbivory by cattle and horses.

Restoration actions specifically associated with dam removals will focus on the mainstem Klamath River and high-priority tributaries and natural springs. The main physical constraints limiting the extent of restoration actions are inaccessibility due to steepness or other unsafe conditions and presence of culturally sensitive resources which following drawdown will need to be identified and avoided for preservation.

The application of several of the above restoration actions depends on the distribution and amount of residual sediment in each reservoir following drawdown. Modeling of reservoir sediment deposits has been conducted; however, the location and thickness of residual sediments remains somewhat uncertain. Residual sediment will vary, and sediment evacuation will primarily depend on water year type, water management from Upper Klamath Lake, drawdown rates, river flows during drawdown, and, to a lesser degree, by the effectiveness of supplemental sediment evacuation methods.

Reservoir restoration is designed to be flexible and adaptable to address actual field conditions following drawdown and target actions on priority restoration areas. Restoration priorities are driven by the primary project goals of volitional fish passage, residual sediment stabilization, native plant establishment, and the secondary goal of enhancing native fish habitat. These priorities take into consideration the challenging natural environment for plant establishment, including variable soil quality, low rainfall, high summer temperatures, and competition with invasive species.

The active demolition of Copco 2 Dam in the summer of 2023, Swiftwater Films Photo.

Based on the Definite Decommissioning Plan (KRRC 2020), complete removal of the dams and associated facilities is scheduled to occur within an approximately 20-month period. The current construction schedule includes the removal of Copco 2 Dam in the summer/fall of 2023, followed by drawdown of Iron Gate, Copco, and J.C. Boyle reservoirs in early 2024 and removal of Iron Gate, Copco 1, and J.C. Boyle dams and associated facilities by mid- to late fall 2024.

7.2 KLAMATH RIVER RESTORATION PLANS

7.2.1 Klamath Reservoir Reach Restoration Prioritization Plan

NOAA Fisheries in partnership with Trout Unlimited and PSMFC developed the Klamath Reservoir Reach Restoration Prioritization Plan (NOAA Fisheries et al. 2022) which assesses existing baseline habitat conditions and diversion structures in the Klamath River and tributaries from Link River Dam downstream to Iron Gate Dam (excluding the reservoir footprints). The plan identifies specific locations where anadromous fish habitats could be improved and prioritizes restoration based on specific criteria. The scope includes identifying cold-water refugia, unscreened water diversions, baseline habitat conditions and restoration opportunities. Information contained in this plan will be used by federal and state agencies, Tribes, and basin partners to prioritize restoration actions. This will be particularly important for reintroduction of anadromous fishes post dam removal.

7.2.2 Klamath Basin Integrated Fisheries Restoration and Monitoring Plan

The Klamath Basin Integrated Fisheries Restoration and Monitoring Plan (IFRMP) is a planning document that brings existing Klamath Basin restoration plans and planning efforts together and addresses key gaps using an adaptive management strategy (Environmental and Social Systems Analysts [ESSA] 2023). The IFRMP provides a unified framework for planning the restoration and recovery of native fishes from the Klamath headwaters to the Pacific Ocean while improving flows, water quality, habitat, and ecosystem processes (ESSA 2023). The IFRMP serves as a blueprint for potential restoration and monitoring actions in the Klamath Basin by identifying the highest priority watershed restoration actions and providing a general strategy to restore the basin. CDFW as well as ODFW assisted with development of the IFRMP and share a common understanding with the IFRMP in terms of recognizing the importance of restoring processes and habitat as critical to improving fish populations in the Klamath Basin.

7.3 RESTORATION PROGRAMS AND FUNDING OPPORTUNITIES

This section summarizes some of the major river restoration programs and restoration funding sources in the Klamath Basin that are focused on improving anadromous fish habitat. This is by no means an exhaustive list and there are many other important contributors to fish habitat restoration in the basin.

7.3.1 Trinity River Restoration Program

The Trinity River Restoration Program (TRRP) implements the 2000 U.S. Department of Interior Record of Decision to restore the fisheries of the Trinity River impacted by dam construction and related diversions of the Trinity River Diversion of the Central Valley Project (Trinity River Restoration Program [TRRP] 2021). The TRRP is a multi-agency program with eight partners forming the Trinity Management Council including the U.S. Bureau of Reclamation, USFWS, Hoopa Valley Tribe, Yurok Tribe, California Natural Resources Agency, NOAA Fisheries, USFS, and Trinity County. The TRRP also includes many other collaborators. The TRRP Focal Reach for restoration includes the Trinity River from Lewiston Dam downstream to the confluence of the North Fork Trinity River (TRRP 2021).

7.3.2 NOAA Fisheries Restoration in the Klamath Basin

NOAA Fisheries plans, implements, and funds Klamath Basin restoration projects including fish passage barrier modifications, sediment stabilization, and invasive species removal for the purposes of increasing access to habitat and improving river habitat for Federally listed species (NOAA Fisheries 2019c). Since the agency's involvement, over 65 acres of habitat have been restored and 30.6 miles of stream have been reopened for anadromous fish (NOAA Fisheries 2019c).

The Pacific Coastal Salmonid Recovery Fund established by Congress in 2000 is a restoration funding source administered by NOAA Fisheries through a competitive grant process that aims to reverse declines in Pacific salmon and steelhead. The program supports conservation projects in California, Oregon, Washington, Idaho, and Alaska (NOAA Fisheries 2020b). As of October 2019, NOAA Fisheries has awarded states and tribes over $1.4 billion (NOAA Fisheries 2020b). In addition, the NOAA Restoration Center has been allocated $891,000,000 nationwide for fiscal years 2022 through 2026 to restore marine, estuarine, coastal, and ecosystem habitat, and to restore fish passage by removing instream barriers as part of the Infrastructure Investment and Jobs Act of 2021.

7.3.3 U.S. Bureau of Reclamation Klamath Coho Habitat Restoration Program

The goal of the U.S. Bureau of Reclamation Klamath Coho Habitat Restoration Program is to support restoration activities that have a direct benefit to SONCC coho salmon and/or design, planning, or monitoring projects that can demonstrate direct benefits for coho salmon (National Fish and Wildlife Foundation [NFWF] 2021a). Since 2016, the program has funded 21 projects totaling $2.5 million (NFWF 2021a).

7.3.4 Fisheries Restoration Grant Program

The CDFW established the Fisheries Restoration Grant Program (FRGP) in 1981 in response to rapidly declining populations of wild salmon and steelhead trout and deterioration fish habitat in the state (CDFW 2021b). The FRGP is primarily funded through the National Oceanic and Atmospheric Administration's Pacific Coastal Salmonid Recovery Fund. The program is a competitive grant program that invests millions of dollars to support projects that lead to process-based restoration, enhancement, or protection of anadromous salmonid habitat.

7.3.5 Wildlife Conservation Board

Wildlife Conservation Board (WCB) was created in 1947 within the California Department of Natural Resources then later placed with the CDFW. The WCB mission is to protect, restore, and enhance California's spectacular natural resources for wildlife and for the public's enjoyment in partnership with conservation groups, government agencies and the people of California (Wildlife Conservation Board 2021). The WCB provides competitive grant opportunities for primarily land acquisition, habitat restoration, and development of wildlife oriented public access facilities.

7.3.6 Klamath River Coho Enhancement Fund

The Klamath River Coho Enhancement Fund is a component of PacifiCorp's Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for SONCC Coho Salmon. It was developed to fund projects that will restore, enhance, and improve habitat, flows, and fish passage for SONCC coho salmon in the Klamath River and associated tributaries downstream of Iron Gate Dam (NFWF 2021b). Each year PacifiCorp provides $510,000 in grant funds to fund projects with direct benefits to SONCC coho salmon. The grant cycle began in 2009 and as of 2019, 51 grants have been selected totaling a combined value of $5.2 million (PacifiCorp 2020).

7.3.7 USFWS Restoration Grants

The Pacific Southwest Region, Wildlife and Sport Fish Restoration Program administers grants to other entities, primarily state fish and wildlife agencies to conserve, protect and enhance fish, wildlife, their habitats, and the hunting, sport fishing and recreational boating opportunities they provide. The program administers ten primary grant programs which total approximately $91 million in grants annually within California, Nevada, and the Klamath Basin area. Grant programs and each program's requirements are highly diverse (USFWS 2020a).

The Klamath Basin Restoration Program is a partnership with the USFWS to support Klamath Basin restoration projects to protect and benefit native resident and anadromous fish. The goal of the program is to address limiting factors facing anadromous fishes; support restoration actions to benefit resident fish populations of Lost River sucker, shortnose sucker, bull trout (*Salvelinus confluentus*), and redband trout (*O. mykiss*); and to undertake activities that will ultimately lead to successful reintroduction of anadromous fish to the upper Klamath Basin (NFWF 2021c).

The USFWS's National Fish Passage Program works with communities on a volunteer basis to remove or bypass barriers to fish passage and restore river ecosystems. Through the program the USFWS provides financial and technical assistance in planning, design, implementation, and monitoring of select fish passage projects (USFWS 2022). Over the past 23 years the program has worked with over 2,000 local communities, tribes, and private landowners; removed or bypassed over 3,400 barriers to fish passage; and reopened access to over 61,000 miles of stream habitat for fish and wildlife (USFWS 2022).

The USFWS's Coastal Program is one of the agencies' most effective resources for restoring and protecting fish and wildlife habitat on public and private lands (USFWS 2020b). Working with partners, the USFWS provides technical assistance for habitat conservation design and planning, and financial assistance for habitat restoration and protection projects (USFWS 2020b).

The Partners for Fish and Wildlife Program is the USFWS's habitat restoration cost-sharing program for conservation minded farmers, ranchers and other private landowners who wish to restore fish and wildlife habitat on their land (USFWS 2018). The goals of the program include:

- Implementing voluntary on-the-ground habitat restoration projects that benefit fish and wildlife on private and tribal lands.
- Provide technical and financial assistance to landowners interested in providing habitat for fish and wildlife on their property.
- Provide leadership and promote partnerships using the USFWS's and others expertise.
- Conduct public outreach to broaden understanding of fish and wildlife habitats while encouraging and demonstrating conservation efforts.

Since 1990, the Partners for Fish and Wildlife Program has restored and enhanced over 62,000 acres of wetlands and wildlife habitat in California for the benefit of ESA-listed species, migratory birds, and anadromous fishes (USFWS 2018).

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Attachment A. Proposed monitoring activities, monthly monitoring schedule, and funding status for years 2024 and 2025. Months highlighted tan indicate when monitoring would be implemented for each monitoring type, and months highlighted teal indicate potential earlier implementation months by monitoring type. Months marked with an X indicate monitoring necessary to inform fisheries management under Magnuson-Stevens Fishery Conservation and Management Act.

Monitoring Type(s)[1]	Location	Entity[2]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Funding Status 2024-2025[3]
Adult carcass & redd surveys	Scotch/ Camp creeks	CDFW, Karuk	X									X	X	X	1,4
Adult carcass & redd surveys	Jenny Creek	CDFW, Karuk	X									X	X	X	1,4
Adult carcass & redd surveys	Fall Creek	CDFW, Karuk	X									X	X	X	1,4
Adult carcass & redd surveys	Shovel Creek	CDFW, Karuk	X									X	X	X	1,4
Adult carcass & redd surveys	Other tributaries in the monitoring reach	CDFW, Karuk	X									X	X	X	1,4
Adult carcass & redd surveys	Mainstem Klamath River	Karuk	X									X	X	X	2,3
Adult video counting weir	Scotch/ Camp creeks	CDFW	X								X	X	X	X	1
Adult video counting weir	Jenny Creek	CDFW	X								X	X	X	X	1
Adult video counting weir	Shovel Creek	CDFW	X								X	X	X	X	1
Adult sonar	Mainstem Klamath River	CalTrout	X												5
Adult sonar	Mainstem Klamath River	CDFW/ TBD	X							X	X	X	X	X	6
Juvenile rotary screw trap	Mainstem Klamath River	USFWS													1
Juvenile fyke net trap	Scotch/ Camp creeks	CDFW													1
Juvenile fyke net trap	Jenny Creek	CDFW													1

Monitoring Type(s)[1]	Location	Entity[2]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Funding Status 2024-2025[3]
Juvenile fyke net trap	Fall Creek	CDFW													1
Juvenile fyke net trap	Shovel Creek	CDFW													1
Snorkel surveys	Scotch/ Camp creeks	CDFW													1
Snorkel surveys	Jenny Creek	CDFW													1
Snorkel surveys	Fall Creek	CDFW													1
Snorkel surveys	Shovel Creek	CDFW													1
Snorkel surveys	Mainstem Klamath River	CDFW													1
Snorkel surveys	Other tributaries in the monitoring reach	CDFW													1
PIT tag array	Shovel Creek	CDFW/ ODFW													1
PIT tag array	Bogus Creek	CDFW													1

[1]**Monitoring Type(s):** **Adult carcass & redd surveys** collect data to inform reintroduction, run timing, sex ratios, age structure though scale analysis, tissue samples, otoliths, fork length frequency, spawning distribution, number of redds, hatchery composition, escapement estimates, and hatchery composition including coded wire tag recovery; **Adult video counting weir** collects data to inform reintroduction, run timing, fork length frequency, species composition, escapement estimates, and hatchery composition; **Adult sonar** collects data to inform reintroduction, run timing, fork length frequency, species composition, and escapement estimates; **Juvenile rotary screw trap /Juvenile fyke net trap** collects data to inform juvenile salmonid production, outmigration estimates by age class, PIT tagging and detection; **Snorkel surveys** collect data to inform reintroduction, occupancy, species composition, habitat use, distribution, and estimates of abundance; and **PIT tag array** collects data on spatial and temporal distribution of PIT tagged fish and habitat use.

[2]**Entity:** CDFW = California Department of Fish and Wildlife; Karuk = Karuk Tribe; CalTrout = CalTrout led collaborative with support from National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, Yurok Tribe, Karuk Tribe, California Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and others; TDB = To be determined.

[3]**Funding Status 2024-2025**: 1= Funded for California Department of Fish and Wildlife; 2= Karuk Tribe funded by U.S. Fish and Wildlife Service for fall-run Chinook salmon redd survey only, funding for fall-run Chinook salmon carcass survey pending; 3 =Karuk Tribe funded by U.S. Bureau of Reclamation for coho salmon redd surveys only; 4= Karuk Tribe funding pending U.S. Fish and Wildlife Service Proposal for Bipartisan Infrastructure Law funding; 5= Currently unfunded but seeking funding; 6= Partially funded by California Department of Fish and Wildlife.