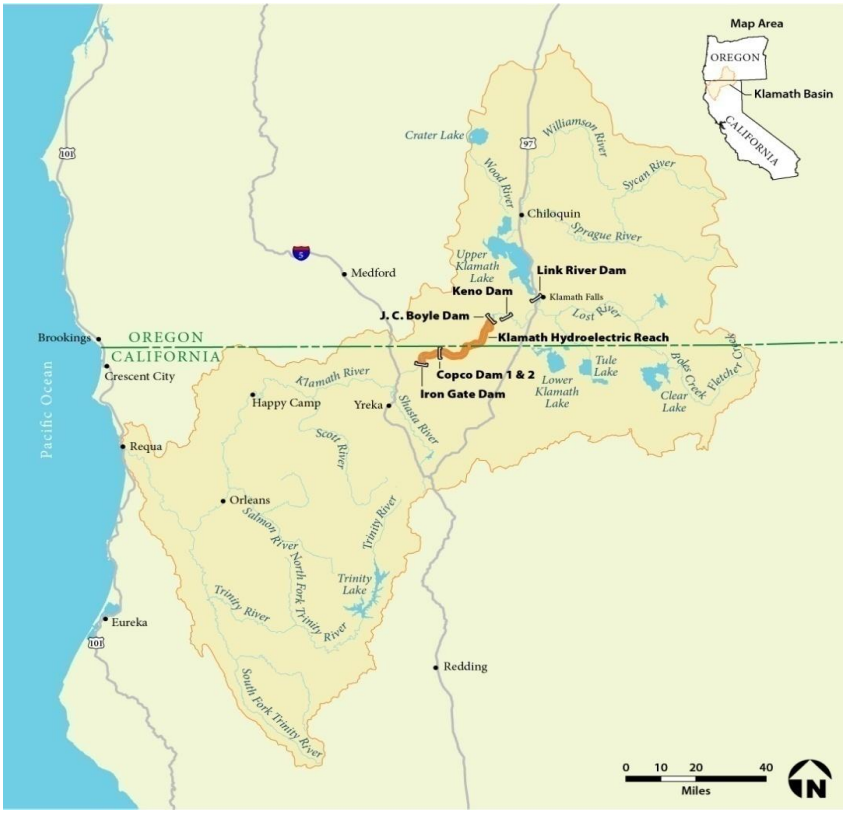
Executive Summary

ES.1 INTRODUCTION

The Klamath Basin covers over 12,000 square miles in southern Oregon and northern California (see Figure ES-1) and contains many natural resources and economic opportunities related to fisheries, farming, ranching, timber harvest, mining, and recreation. Each of these resources and opportunities has economically sustained communities throughout the basin for many decades. The Klamath Basin is also home to six federally recognized Indian tribes who have depended on many of these same natural resources for thousands of years to support their way of life and spiritual wellbeing. Natural resources in the basin, including clean water, abundant and reliable supplies of fish, and terrestrial plants and animals, are central to their cultural identity.

Figure ES-1: Klamath River Basin Map. The Klamath Basin covers over 12,000 square miles and includes PacifiCorp's J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams on the main stem of the Klamath River.



The construction of PacifiCorp's[1] hydroelectric dams on the Klamath River combined with the development of irrigated agriculture, both beginning in the early 1900s, contributed to declines in fisheries and water quality as well as to detrimental impacts to tribal resources and culture throughout the Klamath Basin. Crises in agricultural water availability and fish populations, discussed in more detail below, combined with challenges and uncertainties involved in obtaining a new long-term Federal Energy Regulatory Commission (FERC) license for PacifiCorp's Klamath Hydroelectric Project 2082 (inclusive of the J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams) led willing basin stakeholders to come to agreement on the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA) (see Section ES.1.3, *The KHSA and KBRA*).

[1] PacifiCorp refers to the current utility and all previous owners.

ES.1.1 Purpose of this Report

This report, the *Klamath Dam Removal Overview Report for the Secretary of the Interior: An Assessment of Science and Technical Information* (Overview Report), presents a synthesis of new peer-reviewed scientific studies conducted by a multi-agency Technical Management Team (TMT), as well as other relevant existing reports. The Overview Report address the following four questions in the KHSA for the Secretary of the Interior to make a fully informed determination (Secretarial Determination) on whether or not to remove four Klamath Hydroelectric Project dams (J.C. Boyle, Copco 1, Copco 2, and Iron Gate) also referred to as the Four Facilities, on the main-stem of the Klamath River. Table ES-1 summarizes these questions and where each is analyzed in this Executive Summary.

Table ES-1: Four Questions of the Secretarial Determination

Question	Section
Will dam removal and KBRA implementation advance salmonid and other fisheries of the Klamath Basin over a 50-year time frame?	ES.2
What would dam removal entail, what mitigation measures may be needed, and what would these actions cost?	ES.3
What are the major potential risks and uncertainties associated with dam removal?	ES.4
Is dam removal in the public interest, which includes, but is not limited to, consideration of potential effects on local communities and tribes?	ES.5

Figure ES-2: Thousands of adult salmon died in the lower Klamath River during September 2002. Causative factors included low flows, high concentration of returning Chinook salmon, warm water temperatures, and disease.

This Overview Report focuses on addressing these four KHSA-derived questions and thus is not a comprehensive synthesis of all the literature available on the Klamath Basin. Findings and conclusions addressing the first three questions are contained in this report; the fourth question, as to whether dam removal and KBRA implementation is in the public interest, is not directly answered since that determination will be made by the Secretary of the Interior. The Overview Report, however, does summarize findings in subject areas relevant to a public interest determination, including the potential effects of dam removal and KBRA implementation on

- National and regional economic development,
- Tribal communities,
- PacifiCorp customers,
- Cultural resources,
- Real estate values,
- National Wildlife Refuges,
- Wild and Scenic River values,
- Recreational opportunities,
- Water quality, and
- Greenhouse gas emissions, among other subject areas.

This report also provides some indicators of individuals' and households' views regarding declining fisheries and fish populations in the Klamath Basin and whether the KHSA and KBRA should be implemented. These views were obtained with surveys collected at a national level, a two-state area (Oregon and California), and in a 12-county region in northern California and southern Oregon, as well as advisory votes in Siskiyou County, California, and Klamath County, Oregon, regarding dam removal and KBRA, respectively.

ES.1.2 Klamath Basin Background

There are multifaceted issues in the Klamath Basin including water scarcity, environmental degradation, and declining fish populations, each of which adversely affects agricultural and fishery communities, their respective economies, and tribal communities. These issues reached a crisis point in the early 2000s, with drastic reductions in irrigation water deliveries to farms in the upper Klamath Basin in 2001, and a major salmon die-off in the lower Klamath River in 2002 due, in part, to reduced river flows that would have supported anadromous fish species. Weak Klamath River salmon stocks resulted in the closure of commercial salmon fishing in 2006 in the Klamath Management Zone (KMZ) on the California coast, and severely curtailed the commercial fishing season along the Oregon coast. Since 2005, growth of toxic algae behind two Klamath River dams (Copco 1 and Iron Gate) resulted in posted warnings against water contact in the two reservoirs and the lower Klamath River.

Long-term declines in Klamath Basin fisheries have been estimated at 92 to 96 percent for wild fall-run Chinook salmon, 98 percent for spring-run Chinook salmon, 67 percent for steelhead trout (since 1960), 52 to 96 percent for coho salmon, and 98 percent for Pacific Lamprey. These declines, which are attributable to the cumulative effects of dam construction, hydrologic modifications, changing ocean conditions, agricultural development, timber harvest, overfishing, and mining, have created hardships for commercial fisheries and tribal communities. Of particular note, the Klamath Tribes in the upper Klamath Basin have been without a Chinook salmon fishery for about 90 years (since the completion of Copco 1 Dam in 1922), adversely affecting their way of life. The declines in coho salmon in the Klamath Basin have contributed to their listing as threatened under the Endangered Species Act (ESA) (see Table ES-2).

Table ES-2: Declines in Klamath River Anadromous Fish

Species	Historical Level	Percent Reduction from Historical Levels (estimates of individual runs)	Source
Pacific Lamprey	Unknown	98% (Represents reduction in tribal catch per effort)	Petersen Lewis 2009
Steelhead	400,000[1]	67% (130,000)	Leidy and Leidy 1984; Busby et al. 1994
Coho salmon	15,400–20,000	52% to 95% (760–9,550)	Moyle et al. 1995; Ackerman et al. 2006
Fall-run Chinook salmon	500,000[2]	92% to 96% (20,000–40,000)[3]	Moyle 2002
Shasta River Chinook salmon[4]	20,000–80,000	88% to 95% (A few hundred to a few thousand)	Moyle 2002
Spring-run Chinook salmon	100,000[2]	98% (2,000)[2]	Moyle 2002

[1] This estimate is from 1960. Anadromous fish numbers were already in decline in the early 1900s (Snyder 1931).
[2] Includes Klamath River and Trinity River Chinook.
[3] Excludes hatchery-influenced escapement.
[4] Shasta River is a subset of the overall Klamath River Chinook population.

Coincident with these ongoing crises in the Klamath Basin, the 50 year FERC license for PacifiCorp's Klamath Hydroelectric Project 2082 including the Four Facilities (J.C. Boyle, Copco 1, Copco 2, and Iron Gate, shown on Figure ES-1) expired in 2006. PacifiCorp pursued relicensing Project 2082; however, the large cost and liability involved in relicensing encouraged PacifiCorp to enter into collaborative discussions with other basin stakeholders to identify ways to improve basin fisheries, including the possibility of decommissioning the Four Facilities, while protecting the interests of their customers. The high costs of Klamath Hydroelectric Project relicensing are related to Federal Power Act (FPA) regulations which would ultimately required fish passage facilities at the dams and Clean Water Act (CWA) 401 Water Quality Certification which would ultimately require changes to the Four Facilities to improve poor water quality created by the reservoirs. The technical complexities of fish passage and the severity of the water quality problems at the Four Facilities generated substantial uncertainty surrounding the opportunities of success on both factors. In addition, relicensing would result in reduced power generation at the Four Facilities which, together with fish passage and water quality improvements costs and risks, would reduce the economic viability of the Klamath Hydroelectric Project to PacifiCorp and its customers.

ES.1.3 The KHSA and KBRA

The combination of long-term declines in fisheries, recent fishery and water availability crises in the Klamath Basin, and the potentially high cost and risk of relicensing the Four Facilities, led to the realization among many stakeholders in the basin that the status quo was unacceptable and the only sustainable option for solving these basin-wide challenges would be a collaborative and mutually beneficial agreement among willing stakeholders. This realization culminated in the February 10, 2010 signing of the KHSA and KBRA in Salem, Oregon, after several years of negotiation.

The KHSA is a multi-party agreement that, if fully implemented, would result in the removal of the Four Facilities within the Klamath Hydroelectric Project 2082. Their removal would allow fish passage to the upper basin, improve flow and water quality below the dams, and likely reduce juvenile salmon fish disease, all of which will improve tribal, commercial, and sport salmonid fisheries. Table ES-3 provides general information and dimensions of the Four Facilities and Figures ES-3 through ES-6 show the major features of each of the Four Facilities.

Table ES-3: General Information on the Four Facilities on the Klamath River

	J.C. Boyle	Copco 1	Copco 2	Iron Gate
Year Operational	1958	1922	1925	1962
Location (RM)	224.7	198.6	198.3	190.1
Dam Type	Concrete & Earthfill Embankment	Concrete	Concrete	Earthfill Embankment
Dam Maximum Height	68 feet	135 feet	33 feet	189 feet
Dam Crest Length	692 feet	410 feet	335 feet	740 feet
Reservoir Surface Area	420 acres	1,000 Acres	N/A	944 Acres
Reservoir Storage Volume	2,629 acre-feet	40,000 acre-feet	73 acre-feet	53,800 acre-feet
Spillway Type	Overflow Spillway with Control Gates & Diversion Culvert	Overflow Spillway with Control Gates & Diversion Tunnel	Overflow Spillway with Control Gates	Uncontrolled Overflow Spillway and Diversion Tunnel
Power Capacity (Megawatts)	98	20	27	18

Figure ES-3: J.C. Boyle Dam and Powerhouse

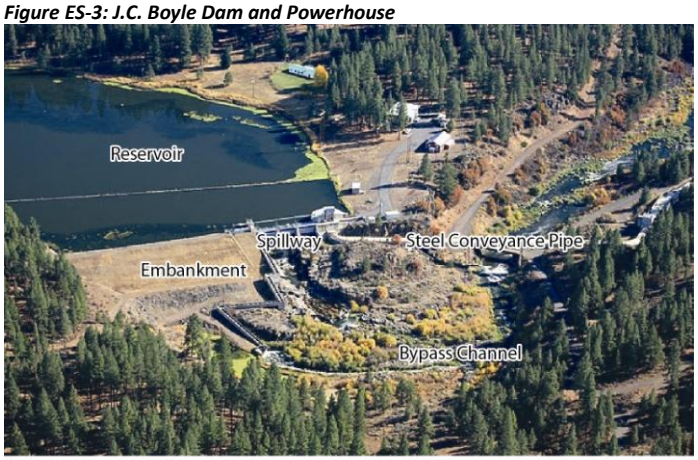


Image from Klamath Riverkeeper

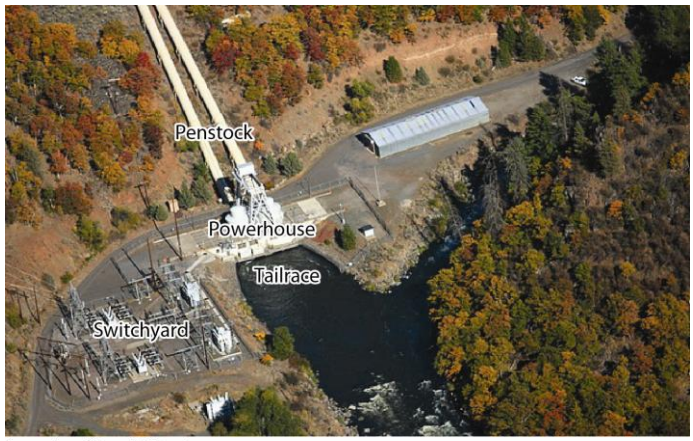
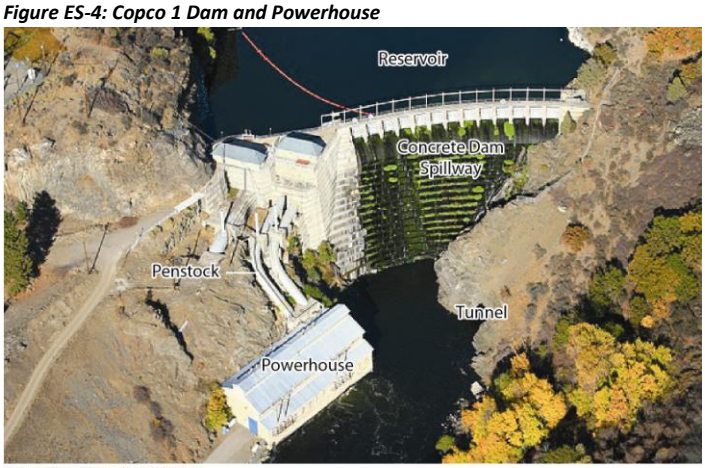


Image from Klamath Riverkeeper

Figure ES-4: Copco 1 Dam and Powerhouse



Images from Klamath Riverkeeper

Figure ES-5: Copco 2 Dam and Downstream Powerhouse

Images from Klamath Riverkeeper

Figure ES-6: Iron Gate Dam and Powerhouse

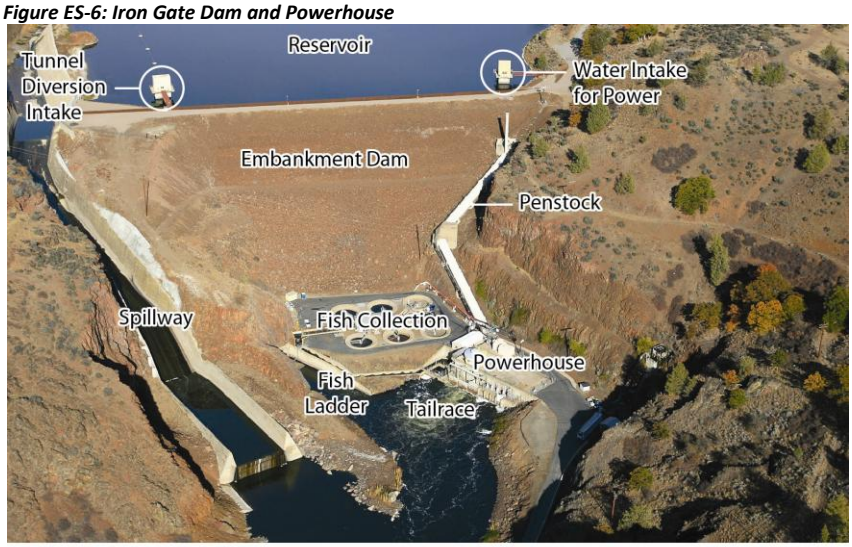


Image from Klamath Riverkeeper

Signatories of the KHSA, with the exception of the Federal government and PacifiCorp, also signed the KBRA. The Federal government is not able to sign the KBRA until Congress passes Federal legislation authorizing the agreement. The KBRA includes interrelated plans and programs intended to benefit fisheries throughout the basin, water and power users in the upper basin, counties, Indian tribes, and basin communities. KBRA fisheries programs include extensive habitat restoration, improvements to water flow and quality, and a fish reintroduction program in the upper basin. Since the KBRA would be fully implemented under an Affirmative Secretarial Determination on the removal of the Four Facilities, implementation of the KBRA was evaluated together with the KHSA.

The following sections summarize the analysis and conclusions relative to the four questions in the KHSA.

ES.2 WILL DAM REMOVAL AND KBRA ADVANCE RESTORATION OF SALMONID AND OTHER FISHERIES OF THE KLAMATH BASIN OVER A 50-YEAR TIME FRAME?

The TMT concluded that dam removal and KBRA implementation would improve salmonid fish (salmon, steelhead, and redband trout) populations and associated fisheries primarily by increasing access to historical habitat and thermal refuge areas in the upper basin, restoring mainstem and tributary habitat, and improving key biological and physical factors heavily influencing the health and survival of these fish populations (e.g. hydrology, sediment transport, water temperature, and water quality). The following two sub-sections discuss the short-term and long-term effects of dam removal on fisheries.

ES.2.1 Short-Term Effects of Dam Removal

In the short-term, reservoir drawdown associated with dam removal would result in the release of high suspended sediment concentrations (SSCs). Figure ES-7 shows the modeled SSCs immediately downstream of Iron Gate Dam resulting from removal of the Four Facilities.

Although short in duration, this suspended sediment release is expected to result in lethal and sub-lethal effects on a specific part of fish populations, in particular, coho salmon smolts and steelhead trout in the mainstem Klamath River (see Figure ES-8) during the peak sediment release from early January through March 15. Estimates of mortality for all life stages of salmon (Chinook and coho) are expected to be less than 10 percent from high SSCs during dam removal. Estimated mortality for adult and juvenile steelhead would be about 10 to 15 percent; in a worse case situation, mortality of adult steelhead could reach 28 percent.

The timing of reservoir drawdown was selected to coincide with periods of naturally high SSCs in the Klamath River, as aquatic species have already adapted to higher winter SSCs. In addition, based on the distribution and life-history timing of aquatic species in the basin, only a portion of some populations are likely to be present in the mainstem Klamath River during the period of peak SSCs (See Figure ES-9). Most salmon and steelhead life stages would be in tributaries, further downstream where SSCs would be diluted by tributary streams and rivers, or in the Pacific Ocean.

Figure ES-7: Modeled suspended sediment concentrations (SSC) immediately downstream of Iron Gate Dam for dam removal in dry, median, and wet water years. Background concentrations are modeled using data from all water year types for 1961–2008.

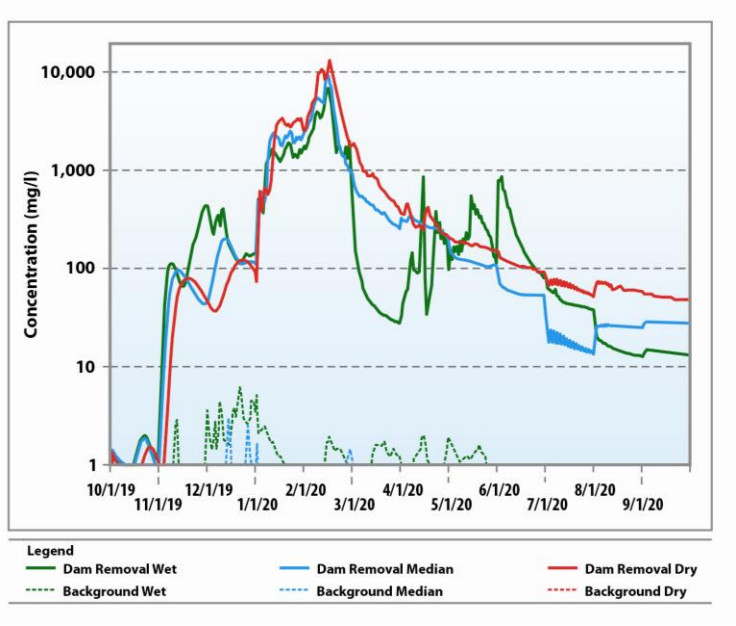


Figure ES-8: Estimated mortality impacts on basin-wide production (number of adults or juveniles) resulting from dam removal for key salmonid species for both median (most likely) and low flow (worst case) water years.

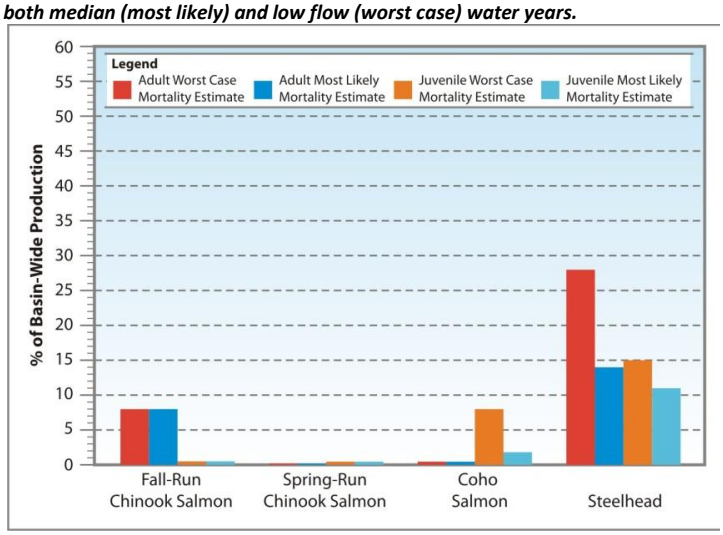
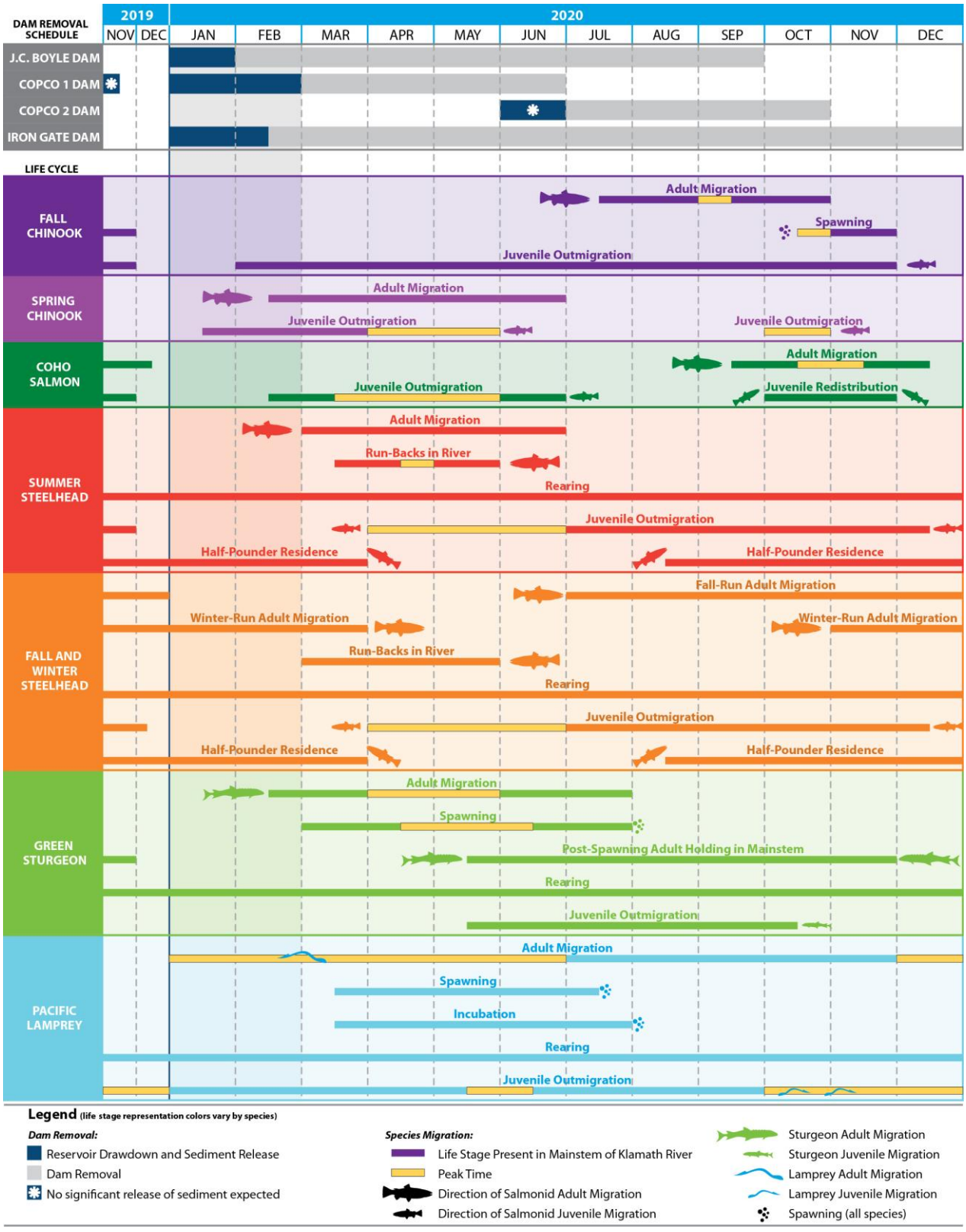


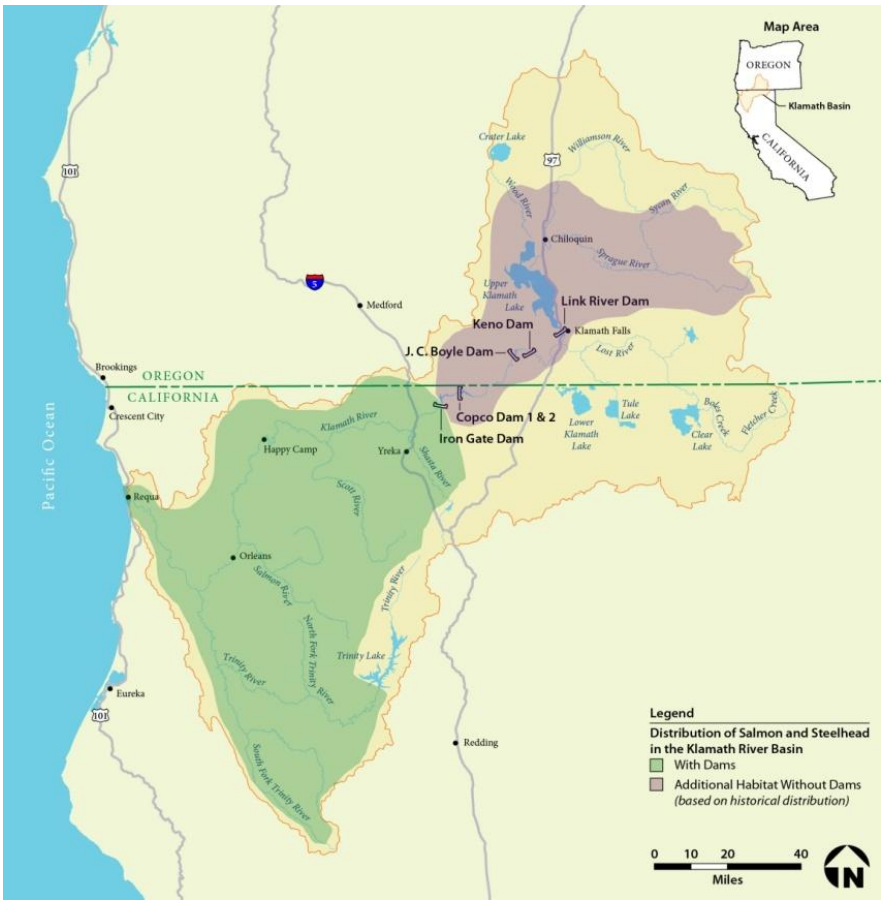
Figure ES-9: Timeline depicting the timing of migratory fish lifecycles in the mainstem of the Klamath River coinciding with dam removal plans.



ES.2.2 Long-Term Effects of Dam Removal

Improvements to the resiliency of the Klamath Basin ecosystem would likely occur from the integrated benefits of (1) increased habitat area related to the reconnection of 420 miles of river by removal of the Four Facilities (see Figure ES-10); (2) coordinated basin-wide improvements to aquatic habitat through active restoration; (3) a real-time water management program that incorporates key elements of the natural hydrograph; (4) an active salmon reintroduction program; and (5) a fisheries monitoring and evaluation program that supports adaptive management. Dam removal and KBRA implementation are anticipated to improve the quality of currently accessible fish habitat, provide access to historical interior habitats that are currently unavailable due to the dams, and improve the viability of native fish populations by increasing their abundance, life history diversity, productivity, and spatial distribution.

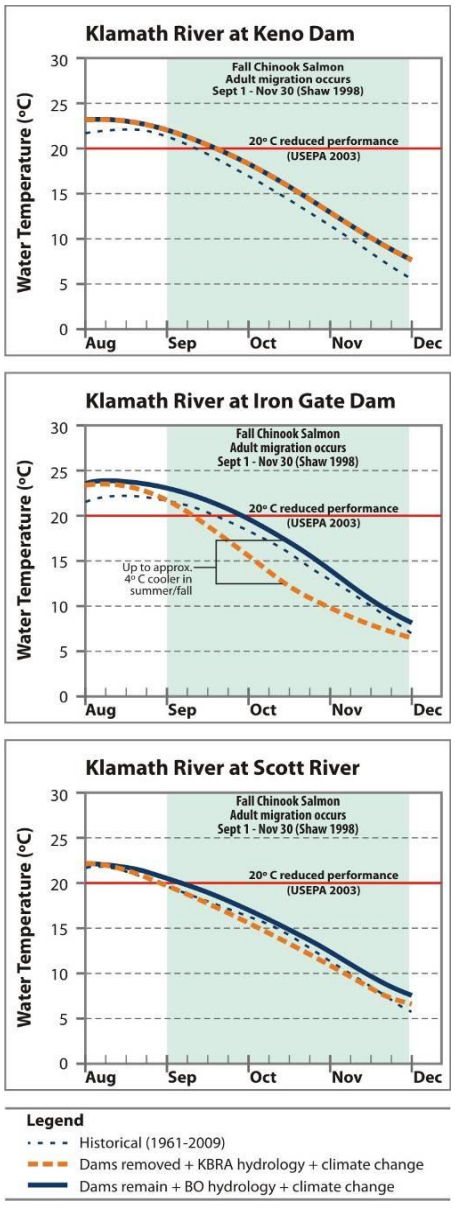
Figure ES-10: Increased salmon and steelhead distribution in Klamath Basin under current conditions (with dams) compared to historical conditions (without dams).



Fish modeling results show that dam removal, combined with restoration of aquatic habitats as anticipated in the KBRA, is expected to increase the annual production of adult Chinook salmon by an average of 83 percent beginning in 2020 with dam removal. The ocean commercial and sport harvests of Chinook salmon are also forecasted to increase by an annual average of 50 percent, the in-river tribal harvest would increase by an annual average of 59 percent, and the in-river recreational fishery would increase by an annual average of 9 percent after dam removal. A fisheries expert panel convened to independently assess whether dam removal would advance Klamath Basin Chinook fisheries concluded that dam removal and KBRA implementation would better address the core factors that affect fish populations and would have a much higher likelihood of success than progressing under current conditions with the dams remaining in place.

With dam removal, coho salmon would be expected to rapidly recolonize habitat upstream of Iron Gate Dam. Assuming coho salmon distribution would extend up to Spencer Creek after dam removal, coho salmon from the upper Klamath River population would reclaim 68 miles of habitat: approximately 45 miles in the mainstem Klamath River and tributaries and 23 miles currently inundated by the reservoirs. Dam removal and KBRA implementation are also expected to result in significant improvements to mainstem Klamath River hydrology, instream habitat, water quality, and decrease the incidence of

Figure ES-11: Modeled water temperatures during the fall Chinook salmon migration period for the Klamath River indicate that future (2020–2061) water temperatures will be 1–3°C greater than historical (1961–2009) temperatures due to climate change. Dam removal would decrease summer and fall temperatures downstream of Iron Gate Dam, with diminishing effects further downstream. Water temperatures in the Keno Reach would not be affected by dam removal. Simplified patterns from Perry et al. (2011) use standard "GFDL" Global Climate Model output.



disease downstream of Iron Gate Dam thereby improving coho populations throughout the Klamath Basin. Populations currently in the vicinity of Iron Gate Dam are most affected by dam-related factors, and these populations would receive the most benefits from dam removal. The benefits of dam removal and KBRA implementation for coho salmon go beyond increased abundance. Colonization of the Klamath River between Keno and Iron Gate dams by the upper Klamath coho salmon population would likely improve the viability of the Southern Oregon/Northern California Coast Evolutionary Significant Unit (ESU) by increasing its diversity, productivity, and spatial distribution. In general, as habitat availability, quality, and diversity increase for an ESU, so does the resilience of the population, reducing the risk of extinction and increasing chances for recovery.

Dam removal would reestablish steelhead upstream of Iron Gate Dam and increase habitat available to this species by 420 stream miles. Because of their ability to navigate steeper gradient channels and spawn in smaller, intermittent streams, and their ability to withstand a wide range of water temperatures, steelhead distribution in the basin would be expected to expand to a greater degree than that of any other anadromous salmonid species, thereby increasing steelhead abundance in the Klamath Basin. This conclusion is based on the likelihood of steelhead having access to substantial new habitat that will undergo restoration, the fact that other similar species (resident redband trout) are doing well in the upstream habitat, and that steelhead are currently at lower abundances than historical values but not yet rare. In general, removing dams and implementing KBRA would likely support a greater number of spawning areas, increase genetic diversity, and allow for a wider variety of life history patterns, which could increase the population's resilience.

Dam removal would increase free-flowing redband/rainbow trout habitat downstream of Keno Dam by restoring river channel habitat inundated by reservoirs, eliminating extreme daily flow and water temperature fluctuations in the J.C. Boyle Peaking Reach, and increasing flows in the J.C. Boyle Bypass Reach. This would expand the total distribution of a resident trophy-trout fishery by approximately seven times in this area. Benefits to redband/rainbow trout in tributaries to Upper Klamath Lake would be realized by habitat improvements stemming from implementation of the KBRA, and are expected to increase trout productivity upstream of Upper Klamath Lake.

Overall, dam removal and KBRA implementation would be a major step forward to restoring anadromous fish and in the conservation of native fish populations in the Klamath Basin. Table ES-4 summarizes the main long-term benefits for salmonid species as a result of dam removal and implementation of the KBRA. When estimates of mortality and sublethal effects in the short-term from sediment discharge are considered in conjunction with potential increases in habitat area and improvements in water quality, it is expected that populations would fully recover from any adverse effects from high SSCs within one to five years following dam removal. Dam removal and implementation of the KBRA would have substantial and important benefits for other fish species in the Klamath Basin as summarized in Table ES-5.

Table ES-4: Major Long-Term Benefits for Salmonid Restoration from Dam Removal and Implementation of the KBRA

Water Quality Benefits
Accelerates when the river meets Oregon and California water temperature, nutrient, dissolved oxygen, pH, and chlorophyll-a TMDL allocations (see Figure ES-11).
Largely eliminates in 2020 elevated late summer/fall river water temperatures in and below the Hydroelectric Reach (See Figure ES-11).
Largely eliminates in 2020 algal toxins, low dissolved oxygen, and high pH that are produced in Copco 1 and Iron Gate reservoirs and transported downstream.
Habitat Benefits
Provides anadromous fish with up to 420 miles of currently blocked riverine habitat in the upper basin.
Provides access to thermal refuge areas (springs and cool-water tributaries) in the upper basin that would help buffer increased water temperatures associated with future climate change.
Provides for natural recruitment of spawning gravel and river processes within and below the Hydroelectric Reach.
KBRA Fisheries Restoration Plan accelerates restoration of fish habitat throughout the basin starting in 2012.
Expands opportunity to create springtime flushing flows (KBRA Environmental Water Program) to increase flow variability and sediment bed movement, which are anticipated to reduce juvenile salmonid disease (see Figure ES-12).
Reduces incidence of salmon disease by decreasing crowding of adult salmon through expanded migration and spawning areas.
KBRA Fisheries Reintroduction and Management Plan accelerates the effective use of the upper basin by salmonids.
Improves base flows for salmonids, particularly in drought years, through KBRA Water Resources Program.
Eliminates adverse effects of hydroelectric peaking and stranding of fish in the Hydroelectric Reach.

Figure ES-12: Fish diseases are widespread in the mainstem of the Klamath River during certain time periods and in certain years and have been shown to adversely affect freshwater abundance of Chinook and coho salmon, which are an intermediate host to one prevalent Klamath River fish disease caused by the myxozoan C. Shasta. Habitat conditions which support C. Shasta and its polychaete host caused by the dams include: stable river flows; relatively stable streambed; crowding of adult salmon at barriers to fish passage; and plankton-rich discharge from reservoirs.

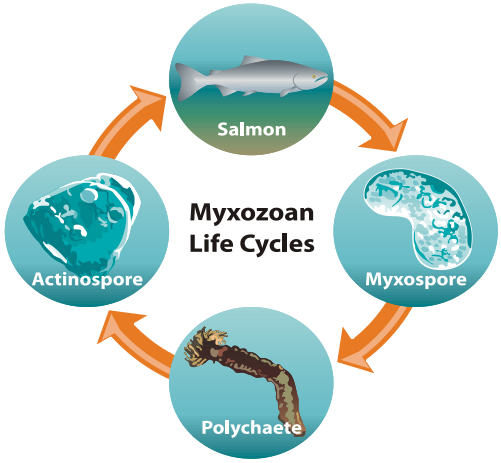


Table ES-5: Benefits to Other Fish Species from Dam Removal and KBRA Implementation

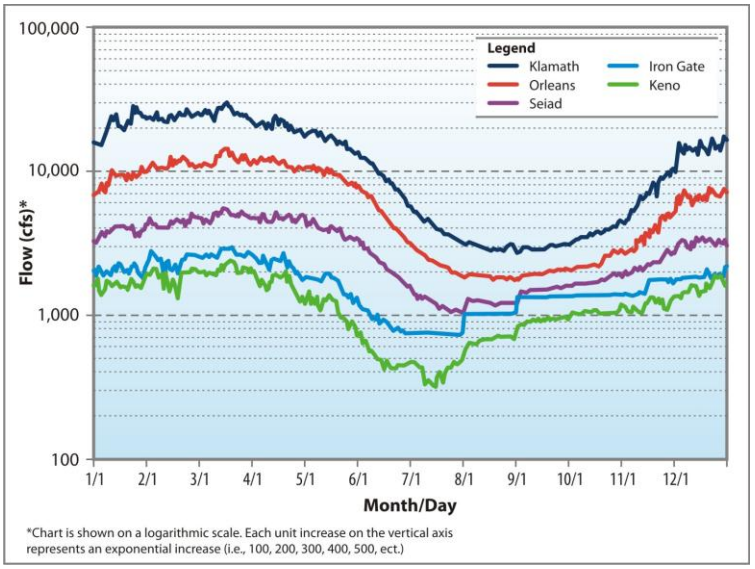
Species	Current Status	Benefits of Dam Removal and KBRA
Short nose and Lost River Suckers in the Upper Klamath Basin	Both species are listed as endangered under ESA and are declining under current conditions. Both species could become extinct in the Klamath Basin unless substantial recruitment events occur.	KBRA implementation would provide greater promise for preventing extinction of these species, and for increasing overall population abundance and productivity, than would occur if the dams were left place and KBRA was not implemented. Implementation of KBRA would improve sucker habitat in Upper Klamath Lake, its tributaries, and wetlands that support multiple life stages of these species.
Bull Trout in the Upper Klamath Basin	Bull trout are currently listed as threatened under the ESA. In the upper Klamath Basin, this species is confined to the far upper reaches of the watershed. Bull trout populations in the Klamath Basin face a high risk of extirpation and are considered extinct in California. Threats to bull trout in the Klamath Basin include habitat loss and degradation caused by reduced water quality, land use, water diversions, roads, and non-native fishes.	KBRA implementation would likely accelerate compliance with TMDL water quality objectives in the upper basin, thereby improving conditions for this species and increasing overall population abundance and spatial distribution.
Pacific Lamprey in the Klamath Main stem	Pacific lamprey have experienced sharp declines in the Klamath River and was petitioned for listing under the ESA in 2003. The Four facilities have blocked the range of Pacific lamprey to areas upstream of Iron Gate Dam.	Removal of the dams is considered to be the only feasible method for expanding the current range of Pacific lamprey above Iron Gate Dam. Dam removal with KBRA implementation could increase Pacific lamprey production by up to 14 percent compared with dams remaining in place. The increase production could potentially be more if habitat in the upper Klamath Basin is accessible and suitable.
Native Lamprey present in the mainstem and upper basin (five resident species)	Native lamprey has experienced sharp declines in the Klamath River and upper basin with three species petitioned for listing under the ESA in 2003.	Dam removal would eliminate the adverse effects of power peaking on resident lamprey species in the Klamath Hydroelectric Reach. Dam removal and KBRA implementation would likely increase lamprey populations as physical, chemical, and biological processes of the Klamath River were restored. Capacity for the freshwater-resident lamprey species in the upper Klamath Basin may increase with implementation of the KBRA aquatic habitat restoration measures.
Eulachon in the Klamath estuary	Eulachon were historically abundant, but currently are rarely observed in the lower Klamath River and Estuary. The Southern Distinct Population Segment of eulachon, which includes the Klamath River, is ESA listed as threatened.	With dam removal and KBRA implementation, and implementation of the TMDLs, water quality will improve in the estuary. It is anticipated that habitat restoration efforts under KBRA and water quality improvements could directly contribute to recovery of any remnant eulachon populations in the estuary.
Green Sturgeon- in the lower 67 miles of the Klamath River	Green sturgeon is designated as a Species of Concern by NOAA Fisheries Service. Their habitat has been affected by the dams' alteration of river temperature and flow regime.	Dam removal and KBRA implementation would return the Klamath River water temperatures and flow regime to a condition that more closely mimics historical patterns and would likely benefit green sturgeon populations.

ES.3 WHAT WOULD DAM REMOVAL ENTAIL, WHAT MITIGATION MEASURES MAY BE NEEDED, AND WHAT WOULD THESE ACTIONS COST?

The TMT developed a detailed deconstruction plan, titled *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2011b). This plan integrated requirements in the KHSA for hydroelectric operations through 2019; considered the full range of flow conditions that could be encountered during dam removal; considered the unique features of each dam and each reservoir; and, considered reservoir drawdown rates that minimize bank slumping and address the need to minimize impacts on the ecosystem.

Reservoir drawdown and facilities removal was designed to minimize impacts on fish species and to protect threatened coho salmon. These goals resulted in the formation of a plan that calls for drawdown of the three larger reservoirs in the winter of a single year (2020). The plan ensures that the majority of reservoir sediments are transported downstream in January through March 15 when coho salmon, along with several other native fish species, are not present in large numbers in the Klamath River mainstem. This time period also corresponds to higher river flows needed to erode and transport the fine-grained reservoir sediments to the Pacific Ocean (see Figure ES-13).

Figure ES-13: Chart of the median monthly flows in the Klamath River at specific USGS gages. Reservoir drawdown is planned to occur from January through March 15 (2020), coinciding with typically high flows in the Klamath River.



Source: Reclamation 2011b

The dam embankments and structures would be removed over the remainder of 2020, taking into account river hydrology and safety considerations. Primary among these factors is the removal of the Iron Gate Dam embankment starting in June 2020 when flows in the Klamath River significantly decrease providing additional protection against the risk of the dam overtopping during its deconstruction.

With dam removal, and the associated drawdown of the reservoir, the reservoir bottoms would be exposed. The DRE would undertake revegetation efforts with the goal of establishing sustainable riparian, wetland, and upland habitats on the newly exposed reservoir bottoms as early as feasible after reservoir drawdown (spring time) and again in the fall. Hydroseeding would be employed with a mixture of native grasses; riparian and wetland plantings would also be established.

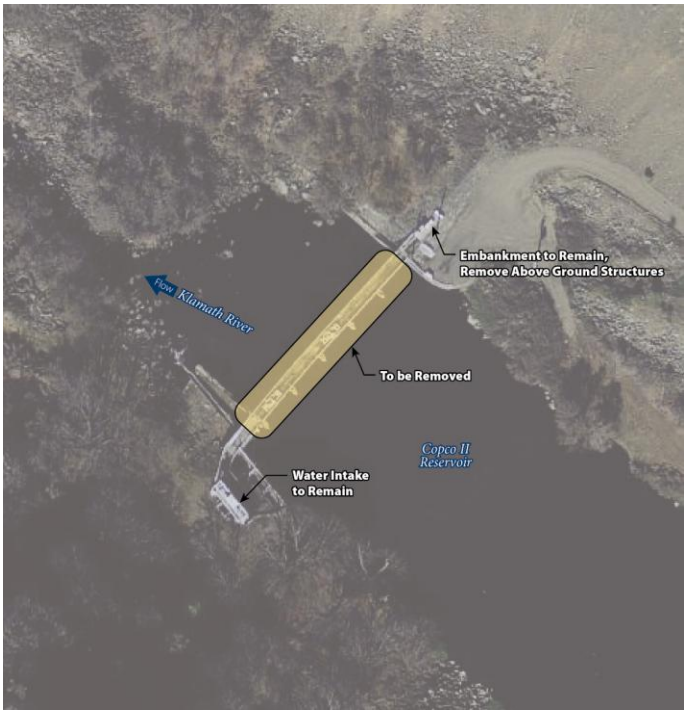
Figure ES-14: Partial removal of J.C. Boyle Dam would include removal of embankment dam and fish ladder, providing a free flowing river and allowing full volitional fish passage. However, certain structures, including the steel pipeline and supports, would be retained.

Partial Dam Removal

The TMT also evaluated partial removal of the Four Facilities to achieve a free flowing river (see Figure ES-14 through 17). Partial facilities removal would remove most if not all portions of the Four Facilities while some other portions of the Four Facilities (e.g. pipelines, penstocks, and

Figure ES-15: Partial removal of Copco 1 Dam would include removal of the concrete dam, providing a free flowing river and allowing full volitional fish passage. Certain structures, including the penstocks and powerhouse, would be retained.

Figure ES-16: Partial removal of Copco 2 Dam would include removal of spillway gates, providing a free flowing river and allowing full volitional fish passage. Certain structures, including the water intake and embankments, would be retained.



powerhouses) would remain in place. Leaving a portion of the Four Facilities in place would result in the same aquatic effects (short-term and long-term) as full facility removal but would require long-term maintenance (primarily to limit public access for safety) in exchange for reduced construction and mitigation costs.

The removal of Iron Gate Dam would compromise the existing water supply pipeline to the City of Yreka. Under terms of the KHSA, the DRE would modify the pipeline to allow continued water supply service to the City of Yreka. Preliminary designs for an elevated pipeline and steel pipeline bridge, as well as modifications to the water supply intake at Fall Creek, were prepared in order to estimate costs. If dam removal proceeds, final designs for the Yreka pipeline would be prepared in consultation with the City of Yreka.

Figure ES-17: Partial removal of Iron Gate Dam would include removal of embankment dam, providing a free flowing river and allowing full volitional fish passage. Certain structures, including the spillway and powerhouse, would be retained.

ES.3.1 Mitigation Measures

Several mitigation measures were identified to help reduce the effects of dam removal as listed in Table ES-6. Additional mitigation actions may be identified at a later date in a "Definite Plan" for dam removal if there is an Affirmative Secretarial Determination. Moreover, a Record of Decision (ROD) on removal of the Four Facilities could include additional mitigation actions. Additional mitigation actions would likely increase the estimated cost of dam removal.

Table ES-6: Dam Removal Mitigation Measures

Mitigation Measure	Action of the DRE
Aquatic Species Relocation	Capture out-migrating juvenile salmonids and Pacific lamprey from several tributaries and release them at locations to avoid the effects of high SSCs. Mussels in the Hydroelectric Reach and in the lower Klamath River downstream of Iron Gate Dam would be relocated to tributary streams or upstream of J.C. Boyle Reservoir.
Protection of Downstream Water Intakes	Modify any intake and pump sites in the lower Klamath River to reduce the temporary effects of high suspended sediment from dam removal.
Protection of Culturally Significant Sites	Protect cultural resource sites eligible for inclusion on the National Register of Historic Places and California Register through construction measures. Protect tribal artifacts or grave sites if encountered.
New or Modified Recreation Facilities	Identify new recreational facilities and river access points to replace facilities removed with the dams and reservoirs.
Bridge and Culvert Relocation	Replace or relocated the Jenny Creek Bridge (Iron Gate Reservoir) and some culvert crossings along Copco Road that could be compromised by reservoir removal.
Bat Habitat Replacement	Construct bat habitat near each dam site to replace bat habitat lost by removing the structures associated with the Four Facilities.
Replace or Deepen Groundwater Wells	Deepen or replace groundwater wells to restore production rates affected by groundwater level declines around Copco 1 and Iron Gate reservoirs.
Reservoir Bottom (Parcel B Land) Fencing	Install fencing around newly exposed reservoir bottoms to protect revegetation and restoration efforts.
Replace Lost Wetlands	Mitigate or replace wetlands, estimated at less than 20 total acres.
Changes in the 100-year Floodplain Downstream of Iron Gate Dam (River Miles 190-172)	Work with willing land owners to flood proof, relocate, or protect against the increase in flood risk at affected structures (estimated to be less than six residences).
Flood Warning System	Inform FEMA of a planned major hydraulic change to the Klamath River that could affect the 100-year floodplain. Inform the National Weather Service's River Forecast Center of the potential change in the system so they could develop new flood-routing models for their flood-warning system.

ES.3.2 Estimated Dam Removal Costs

Table ES-7 presents a summary of the total costs for the full facilities removal scenario. The most probable cost is estimated at $291.6 million (2020 dollars). The partial facilities removal scenario was estimated to be $234.6 million, with an additional life cycle cost (annual maintenance through 2061) of $12.4 million (2020 dollars) (see Table ES-8). A Monte Carlo-based simulation process was used to determine the one percent probability minimum and maximum cost ranges. The Monte Carlo-based simulation is a problem-solving technique used to approximate the probability of certain outcomes by running multiple trials using random variable simulations. It is based on a computerized mathematical technique that accounts for risk in quantitative analysis and decision-making.

Table ES-7: Summary of Costs for Full Removal of all Four Facilities (2020 dollars)

	Forecast Range		Most Probable[1]
	Minimum (Less than a 1% Chance the Actual Cost will be Below this Estimate)	Maximum (Less than a 1% Chance the Actual Cost will be Above this Estimate)	
Dam Facilities Removal			76,618,994
Reservoir Restoration			21,728,000
Recreational Facilities Removal			797,305
Yreka Water Supply Modifications			1,765,910
Mobilization and Contingencies[2]			50,728,393
Escalation to January 2020			36,461,398
Subtotal (Field Costs)	**157,600,000**	**301,200,000**	**188,100,000**
Engineering (20%)[3]			37,600,000
Mitigation (35%)[4]			65,900,000
Total Construction Cost	**238,000,000**	**493,100,000**	**291,600,000**

1 The most probable costs were used in the economic analysis.
2 Mobilization and contingencies includes the mobilization of construction equipment to the dam site, design and construction contingencies.
3 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.
4 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table ES-8: Summary of Costs for Partial Removal of all Four Facilities (2020 dollars)

	Forecast Range		Most Probable[1]
	Minimum (Less than a 1% Chance the Actual Cost will be Below this Estimate)	Maximum (Less than a 1% Chance the Actual Cost will be Above this Estimate)	
Dam Facilities Removal			52,096,172
Reservoir Restoration			21,728,000
Recreational Facilities Removal			797,305
Yreka Water Supply Modifications			1,765,910
Mobilization and Contingencies[2]			38,830,385
Escalation to January 2020			27,582,228
Subtotal (Field Costs)	**116,600,000**	**230,200,000**	**142,800,000**
Engineering (20%)[3]			28,400,000
Mitigation (45%)[4]			63,400,000
Total Construction Cost	**185,100,000**	**403,600,000**	**234,600,000**
Total Life Cycle Cost	**9,000,000**	**26,800,000**	**12,350,000**

1 The most probable costs were used in the economic analysis.
2 Mobilization and contingencies includes the mobilization of construction equipment to the dam site, design and construction contingencies.
3 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.
4 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

The States of Oregon and California collectively agreed to fund dam removal at a cost of up to $450 million (2020 dollars) as defined in the KHSA. PacifiCorp customers in Oregon and California would pay $200 million of this amount via a surcharge. The most probable cost estimates for full and partial facilities removal fall beneath this cost cap. The maximum projected cost for full facilities removal would exceed the cost cap by $43 million (total $493 million) (2020 dollars).

ES.4 WHAT ARE THE MAJOR POTENTIAL RISKS AND UNCERTAINTIES ASSOCIATED WITH DAM REMOVAL?

Large dam removals involve inherent risks and uncertainties. Through the Detailed Plan and other studies, the TMT has identified four primary risks that could result in changes to the expected effects of dam removal or anticipated construction activities. Other project uncertainties, as described elsewhere in this Executive Summary, have been successfully quantified or studied to an extent that they are no longer categorized as risks. The four remaining dam removal risks are summarized below along with measures or plans to reduce the risk and uncertainty.

ES.4.1 Effects to Aquatic Species and Fisheries from Extended Downstream Sediment Transport

Downstream sediment transport could result in risks to aquatic resources beyond those already anticipated (see ES 2.1) if mitigation, engineering and/or technical difficulties during dam removal extend the reservoir drawdown period. If the planned timeline for reservoir drawdown (January 1 through February 1) is not achieved, aquatic species would be exposed to high suspended sediment concentrations (SSCs) potentially extending into critical fish migratory periods. Extended exposure to SSCs could negatively affect fish in consecutive year classes and could have corresponding effects on commercial, tribal, and recreational fisheries.

Due to the uncertainty regarding the length of time over which high SSCs would occur if a problem arose during dam removal, the exact effects on aquatic resources and on basin fisheries is not known. To reduce this uncertainty, the Definite Plan for dam removal (to be developed if there was an Affirmative Secretarial Determination) would place an emphasis on provisions, planning, and extensive preparation to ensure high SSCs associated with reservoir drawdown would not extend past March 15. Aquatic species relocation mitigation measures (briefly described in Table ES-6) could be expanded or lengthened to remove fish from effects of high SSCs if they extend beyond March 15.

ES.4.2 Cost Exceedence to a Federal DRE

The large and complex construction activities associated with removal of the Four Facilities have the potential to include unexpected changes or unforeseen events, which could result in project costs greater than those originally estimated. Also, project challenges could impede the dam removal process or extend the project timeline, and could result in the accrual of additional project costs.

Risk to a Federal DRE would occur during facilities removal if the DRE anticipated exceeding the state cost cap for dam removal but was unable to stop a portion of facilities removal due to safety considerations. Under these conditions, the Federal DRE could be incurring dam-removal expenses without a known source

of funding. As stated in the KHSA, the Federal government is not responsible for any dam removal costs. To reduce this potential risk, the DRE construction management team would utilize construction cost forecasting continuously during facilities removal to determine early whether cost overruns were likely and to give the Parties to the KHSA time to address funding issues in a timely manner.

ES.4.3 Short-term Flooding

Small flooding risks during dam removal are associated with initial reservoir drawdown and dam excavation at either Iron Gate or J.C. Boyle dams stemming from (1) an overly rapid drawdown rate resulting in embankment instability and failure, or slumping of the exposed dam face; or (2) the possibility of flows from a large event exceeding the available water bypass capacity and overtopping the earthen dam embankment during dam removal.

To address this risk, the *Detailed Plan for Dam Removal - Klamath River Dams* specifies that the embankment sections at Iron Gate and J.C. Boyle dams be removed beginning June 1, 2020, with the full removal completed by September 15, 2020. This period corresponds to the lowest river flows and would allow for the construction of coffer diversion dams to route flows around the earthen embankments greatly reducing the risk of overtopping. The *Detailed Plan for Dam Removal- Klamath River Dams* also specifies the maximum reservoir drawdown rates to reduce the chance of embankment failure.

ES.4.4 Cultural and Historic Resources

Dam removal and reservoir drawdown could affect five sites reported to be submerged in the reservoirs, as well as other unknown sites that may be submerged in the reservoirs, and any human remains associated with these sites. Culturally sensitive sites, artifacts, or human remains could be exposed when the reservoirs are drained as a result of (1) the river cutting a new channel, (2) decades of wind and wave action along the reservoirs' shores that caused localized scour, or (3) slumping of reservoir banks. Once exposed, these sites would need to be documented and protected from vandalism or looting. In addition, applicable Federal and state laws regarding cultural resources, historic preservation, and burials would be followed.

While every precaution would be taken to avoid disruption of these resources, in the case that they are discovered during dam removal and other construction activities, they pose a risk. Encountering traditional cultural properties or other culturally sensitive resources could affect the timeline and cost of dam removal.

ES.5 IS FACILITIES REMOVAL IN THE PUBLIC INTEREST, WHICH INCLUDES, BUT IS NOT LIMITED TO, CONSIDERATION OF POTENTIAL EFFECTS ON LOCAL COMMUNITIES AND TRIBES?

Dam removal and KBRA implementation would provide substantial social and economic benefits to the Klamath Basin. However, dam removal would also alter or change the availability or quality of some resources and would negatively affect specific recreational resources, jobs, and real estate values closely associated with the dams and reservoirs. Provided below is a summary of the potential effects of dam removal and KBRA implementation on national, regional, tribal, and local communities, including economic and non-economic effects.

ES.5.1 Summary of Effects to National Economic Development (NED)

The National Economic Development (NED) account evaluates the net economic benefits of dam removal with implementation of the programs in KBRA. The period of analysis is 50 years, beginning in year 2012 with the first KBRA activity, and continuing through 2061. All benefits and costs were discounted back to year 2012 using the 2011 Federal water resources planning rate of 4.125 percent. Economic benefits were quantified for the following categories for the Dams In (current conditions without the KBRA) and Dams Out (dam removal with KBRA implementation) scenarios.

1. **Commercial fishing** – The Four Facilities affect stocks of SONCC coho salmon ESU and Klamath River fall- and spring-run Chinook salmon. Under dam removal, coho retention would likely continue to be prohibited in the California and Oregon troll fisheries south of Cape Falcon. Troll harvest of Klamath Chinook salmon is expected to increase by an average 43 percent (2012 to 2061 time period)[2] with dam removal. Annual net revenue associated with total Chinook salmon harvest (all stocks) would increase under dam removal. The difference in annual net revenue between the dams remain and dam removal scenarios would be an increase of $7.296 million (2012 dollars) or a total of $134.5 million for the 50-year period of analysis.

2. **In-river sport fishing** – The Four Facilities affect stocks for in-river recreational fisheries, including salmon, steelhead and redband trout, and the recreational sucker fishery, which has been closed since 1987. Dam removal would result in increased fish harvests, which would increase net economic values of in-river sport fishing. In-river recreational harvest of Klamath Chinook salmon is expected to increase by 8 percent (2012 to 2061 time period)[2]. The resulting average annual net economic value would

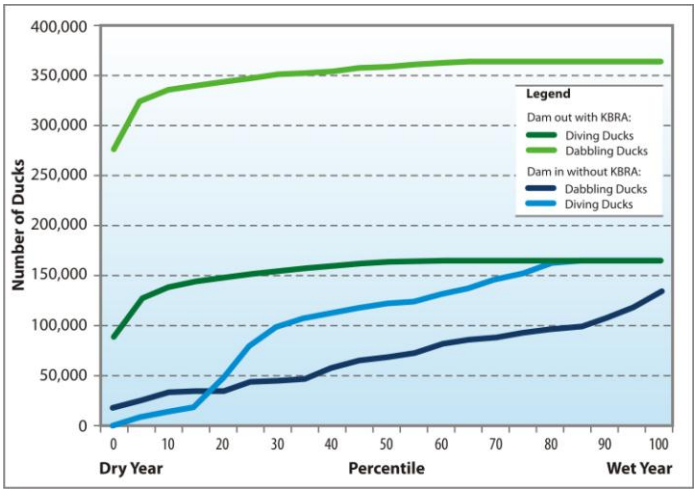
[2] These values include on average the improvement to the fisheries that would occur from 2012 to 2020 prior to dam removal with the implementation of the KBRA measures. These averages would have been larger, as reflected in Section ES.2.2, if the 42-year period following dam removal was used.

increase $126,000 per year (2012 dollars). The incremental river sport fishery benefits for dam removal equates to a discounted present value of $1.75 million (2012 dollars) for the 50-year period of analysis. The prospects for restoration of the recreational sucker fishery appear limited for either a dams remain or dam removal scenario. The in-river sport fishing economic value does not include likely increases in steelhead and redband/rainbow trout fisheries, which was not quantified.

3. **Ocean sport fishing** - The ocean recreational harvest of Klamath Chinook salmon is expected to increase by 43 percent (2012 to 2061 time period)[2] under dam removal. Increased Klamath Chinook salmon availability would result in increased annual net economic values related to ocean sport fishing. Existing regulations for the recreational coho salmon fishery in California and Oregon are expected to continue in the future under both the dams remain and dam removal scenarios. The average annual increase in net economic value (for all areas combined) under a dam removal scenario is $2.865 million (2012 dollars). The incremental ocean sport fishery benefits for dam removal equates to a discounted present value of $52.9 million (2012 dollars) for the 50-year period of analysis.

4. **Irrigated agriculture –** Increased water supplies during dry and drought years under the dam removal and KBRA implementation would increase gross farm revenues from irrigated agriculture, which would result in economic benefits in about one out of every 10 years. The difference in net revenue between the dams remain and dam removal scenarios would be an increase of $29.89 million (2012 dollars) over the 50-year period of analysis.

Figure ES-18: On the Lower Klamath NWR, the fall carrying capacity for dabbling and diving ducks (migratory waterfowl) would be greater with dam removal and implementation of the KBRA in both wet and dry years although the difference is more pronounced in dry years.



5. **Refuge recreation** – Dam removal and KBRA implementation are estimated to increase waterfowl abundance at refuges and hunting trips to the refuges (see Figure ES-18). Increased hunting trips would result in increased economic value related to waterfowl hunting activities. The difference in net revenue between the dams remain and dam removal scenarios would be an increase of $4.3 million (2012 dollars) over the 50-year period of analysis.

6. **Nonuse values** – Nonuse values were estimated using a stated preference (SP) survey. The survey collected information from households in three strata: the 12-county Klamath area; the rest of Oregon and California; and the rest of the nation. Through their stated willingness to pay for specific scenarios for ecosystem restoration within the Klamath Basin, survey respondents indicated they placed significant value on the KBRA, the KHSA, and the restoration of Klamath Basin resources. Overall, the study results indicated that the majority of respondents in the Klamath 12-county area, in the two states, and throughout the rest of the nation, are concerned about declines of Chinook salmon and steelhead trout that return to the Klamath River, are concerned about the extinction of fish species in the Klamath Basin; and, they agree that restoration should be guided by an

action plan that includes Klamath dam removal, water sharing agreements, and basin restoration. Using a conservative methodology for determining the nonuse value associated with Klamath dam removal and restoration of Klamath Basin resources, the survey identified $15.6 billion in nonuse benefits.

Table ES-9 summarizes estimated economic benefits for the above categories. Some economic benefits, including in-river steelhead fishing, redband trout fishing, and refuge wildlife viewing could not be readily quantified and monetized because sufficient data for an analysis was not available. Improved Klamath Basin fisheries would also provide benefits that cannot be quantified to tribes because of the expansive and integral value of fish to tribal members and tribal culture. Given the positive effects of dam removal on fishery resources and refuge recreation, it is expected that tribal benefits associated with these categories would also be positive. The NED analysis compares economic benefits and costs of the dam removal with KBRA Implementation scenario with dams remain without the KBRA (see Table ES-9). Costs include construction costs related to dam removal, site mitigation, and KBRA implementation. In addition to costs incurred from dam removal, there would be some costs savings related to lowered operation, maintenance and replacement (OM&R) costs of the Four Facilities following dam removal.

Dam removal would also result in some foregone benefits which occur when the dam removal scenario provides fewer benefits than the dams remain scenario. Foregone benefits occur in the following categories:

1. **Hydropower** – The Four Facilities would generate an average of 895,847megawatt hours of electricity annually over the period 2012-2061 if the existing dams were left in place and planned efficiency upgrades were completed. Under the dam removal scenario, the Four Facilities would operate normally during 2012–2019 (8 years). After this time period, the production of electrical energy and capacity at the Four Facilities would be zero from January 1, 2020 through the end of 2061 (42-years). Under a dam removal scenario, the estimated mean present value of hydropower economic benefits was approximately $289.2 million (2012 dollars), over the 50-year period of analysis. Relative to the dams remain scenario, this represents a mean reduction in economic benefits of approximately $1.32 billion (2012 dollars).

2. **Whitewater boating -** With dam removal, whitewater boating activity on the upper Klamath River would decrease beginning in 2020 because of the dependence of water releases from the J.C. Boyle Dam to provide sufficient and predictable flows, primarily for whitewater boating in the heavily used Hell's Corner Reach. The average number of days with acceptable flows for whitewater boating on the Hell's Corner Reach would decline by 47 percent during the five month period from May through September. The total discounted loss in economic value associated with whitewater boating recreation with dam removal is estimated at $6.1 million for the 50-year period of analysis.

3. **Reservoir recreation** - With dam removal, the use of reservoirs for flat-water boating, fishing and other uses would be lost. The dam removal scenario results in a loss of 2.03 million total recreation days. The total discounted loss in economic value associated reservoir recreation is $35.4 million for the 50-year period of analysis.

Table ES-9: Total Net Benefits and Costs Summary for Dam Removal and Implementation of the KBRA

Benefit and Foregone Benefit Categories	Period of Analysis (2012-2061) Discounted Value – Difference between Dams Out and Dams In ($ millions; 2012 dollars)
Commercial Fishing (Klamath Chinook Salmon Harvest)	134.5
In-River Sport Fishing (Chinook Salmon Fishery)	1.8
Ocean Sport Fishing	52.8
Irrigated Agriculture	29.9
Refuge Recreation	4.3
Hydropower (foregone)	-1,320.1
Whitewater Boating (foregone)	-6.1
Reservoir Recreation (foregone)	-35.4
Nonuse Values[1]	
12-county Klamath Area in OR and CA	
Total Nonuse Value	67.0
Total Economic Value	217.0
Rest of OR and CA	
Total Nonuse Value	2,091.0
Total Economic Value	9,071.0
Rest of the U.S.	
Total Nonuse Value	13,487.0
Total Economic Value	74,983.0
Unquantified Benefits	
Tribal Commercial Fisheries	Insufficient data to quantify benefits.
Tribal Cultural Values (including ceremonial and subsistence uses)	Applying a traditional economic framework is not appropriate.
In-river Steelhead and Redband trout Sport Fishing	Insufficient data to quantify benefits
Refuge Wildlife Viewing	Insufficient data to quantify benefits
Cost Categories (Total Quantified Costs)	**Period of Analysis (2012-2061) Discounted Value – Difference between Dams Out and Dams In ($ millions; 2012 dollars)**
KBRA Restoration	474.1
Facility Removal	129.1
Site Mitigation	37.7
OM&R (cost savings)	-188.9
Unquantified Costs	
Real Estate Values	Insufficient data to quantify costs
Hydropower Ancillary Services	Explicit consideration of ancillary services was outside the scope of this analysis.
Regional Powerplant Emissions	The hydropower analysis described in this document does not fully consider the effect, if any, of changing hydropower production levels on system-wide powerplant emissions or regional air quality.

The NED benefit cost analysis (BCA) indicates that the net economic benefits of Dam Removal and Implementation of the KBRA are strongly positive. For both partial and full facilities removal the NED BCA ranges from approximately nine to

one to forty-eight to one (see Table ES-10). This implies that dam removal and KBRA implementation (including the partial facilities removal option) is justified from an economic perspective.

Table ES-10: Benefit Cost Analysis Summary for Dam Removal and Implementation of the KBRA[1]

	Costs		Benefits		Net Economic Benefits		Benefit/Cost Ratio	
	Low	High	Low	High	Low	High	Low[2]	High[2]
Full Facilities Removal	1,772.1	1,813.6	15,868.3	84,435.4	14,054.7	82,663.3	8.7 to 1	47.6 to 1
Partial Facilities Removal	1,746.4	1,787.9	15,868.3	84,435.4	14,080.4	82,689.0	8.9 to 1	48.3 to 1

[1] The costs and benefits presented here represent quantifiable costs and benefits; there are also unquantifiable costs and benefits (as shown in Table ES-9) that are not possible to include in the calculation of total costs and benefits. The most probable dam removal costs as shown in Tables ES-7 and ES-8 were used in the economic analysis.

[2] Low estimate (Low Benefit Estimate divided by High Cost Estimate: these estimates are based on nonuse value including recreation use benefits and forgone recreation use values). High estimate (High Benefit Estimate divided by Low Cost Estimate: these estimates are based on total economic value adjusted by removing recreation use benefits and forgone recreation use values).

ES.5.2 Summary of Effects to Regional Economics (RED)

Dam removal actions have short-term and long-term positive and negative effects on jobs in the regional economy. Construction activities associated with dam removal, mitigation actions, and implementation of KBRA programs would add jobs, labor income, and economic output to the region in the short-term (2012 -2026). For example, jobs associated with KBRA implementation spending would span 15 years, jobs associated with dam removal would likely span just a single year, and jobs associated with mitigation measures would span about 8 years. Over the longer term, dam removal and KBRA programs would result in the addition of jobs in the region related to irrigated agriculture, commercial fishing, in-river sport fishing, ocean sport-fishing, and refuge recreation. Added jobs in these areas would increase regional labor income and economic output; producing a long-term positive effect on regional economic development.

Dam removal would eliminate long-term jobs related to annual operation and maintenance (O&M) expenditures associated with the Four Facilities. In addition, changes to whitewater boating opportunities and loss of open-water and flat-water recreation activities at the Klamath Hydroelectric Project reservoirs would also result in lost regional jobs.

Implementation of the KHSA and KBRA would add regional short-term and long-term jobs and would increase labor income and regional economic output. Added jobs include full time, part time, and temporary positions. Table ES-11 summarizes the changes in jobs, labor income, and regional output for the specific region modeled (color coding is used to differentiate the regions) and the timeframe of the jobs. This regional economic analysis compares two scenarios: dam removal and implementation of the KBRA, and leaving the dams in place without implementation of the KBRA. Jobs, labor income, and regional output were generated using IMPLAN, which estimates regional impacts based on the makeup of the economy at the time of the underlying IMPLAN data

Figure ES-19: Jobs and Regional Economic Output would increase in all of the five Commercial Fishing Management Areas with Dam Removal.

(2009). It is important to note that regional impacts were analyzed by scenario specific definitions, periods of occurrence, and other factors; therefore, the potential impacts (such as jobs) should not be summed across a category or region.

The largest decrease in annual average jobs (estimated at 49) and average annual regional output (- $5 million) associated with dam removal would occur because of reduced spending on Operation and Maintenance of the Four Facilities between 2020 and 2061 (Table ES-11). The largest increases in jobs and regional output would be associated with dam decommissioning, implementation of mitigation actions associated with dam decommissioning, implementing the KBRA programs, and the resultant improvements in agricultural (during drought years) and commercial fishing. Dam decommissioning would result in an estimated 1,400 regional jobs and a regional output of $163 million; these would occur during the single year of dam decommissioning in 2020. Implementing mitigation measures would result in an estimated 217 short-term jobs and regional output of $30.86 million between 2018 and 2025; annual jobs and annual regional output would vary year by year proportionate to actual regional spending. Implementation of KBRA programs would result in about 300 annual jobs (4,600 jobs over 15 years) and $29.6 million in average annual regional output from 2012 through 2026. Jobs and regional output estimates would also vary year by year proportionate to actual KBRA regional spending. Through the KBRA Water Program, agriculture would not decrease as markedly during drought years (which occur about once every 10 years) and would result in an estimated 70 to 695 more jobs (depending on the severity of the drought) than would occur without KBRA. The corresponding range of the estimated increase in regional output would be $9 to $84 million. Implementation of the two agreements would improve commercial fishing in five management areas along the Oregon and California coastlines. The three largest average annual increases would be in the San Francisco Management Area (219 jobs and $6.6 million), Central Oregon Management Area (136 jobs and $4.07 million), and Fort Bragg Management Area (69 jobs and $2.41 million) (Table ES-11).

Table ES-11: Average Annual Change in Jobs (Full Time, Part Time, or Temporary), Regional Labor, Income, and Regional Output for Dam Removal and Implementation of the KBRA (by Region, Activity, and Timeframe)[1]

Economic Region	Activities under Dams Out with KBRA Scenario	Regional Full Time, Part Time or Temporary Jobs - Dams Out with KBRA Scenario (Incremental Change in Jobs from Dams In Scenario)	Regional Labor Income (Incremental Change in Million $; 2012 dollars)	Regional Output (Incremental Change in Million $; 2012 dollars)	Timeframe[2]
Klamath County OR; Siskiyou County CA	Dam Decommissioning	1,400[3]	60	163	2020
Klamath County OR; Siskiyou County CA	O&M	-49	-2.05	-5	2020 – 2061
Klamath County OR; Siskiyou County CA	Mitigation	217[4] (total jobs 2018 to 2025)	10.01	30.86	2018 – 2025
San Francisco Management Area (San Mateo, San Francisco, Marin and Sonoma Counties CA)	Commercial Fishing	218	2.56	6.6	2012 – 2061
Fort Bragg Management Area (Mendocino County CA)	Commercial Fishing	69	1.05	2.41	2012 – 2061
KMZ-CA (Humboldt and Del Norte Counties CA)	Commercial Fishing	19	0.07	0.19	2012 – 2061
KMZ-OR (Curry County OR)	Commercial Fishing	11	0.06	0.13	2012 – 2061
Central Oregon Management Area (Coos, Douglas and Lane Counties OR)	Commercial Fishing	136	1.74	4.07	2012 – 2061
Klamath County OR; Siskiyou County CA	Reservoir Recreation	-4	-0.13	-0.31	2021 – 2061
Klamath County OR; Del Norte, Humboldt, and Siskiyou Counties CA	In River Sport Salmon Fishing	3	0.07	0.15	2012 – 2061
KMZ-CA (Humboldt and Del Norte Counties CA)	Ocean Sport Fishing	5.5	0.18	0.48	2012 – 2061
KMZ-OR (Curry County OR)	Ocean Sport Fishing	1.2	0.02	0.09	2012 – 2061
Klamath and Jackson counties OR; Humboldt and Siskiyou counties CA	Whitewater Boating	-14	-0.43	-0.89	2021 – 2061

Table ES-11: Average Annual Change in Jobs (Full Time, Part Time, or Temporary) for Dam Removal and Implementation of the KBRA (by Region, Activity, and Timeframe)[1]

Economic Region	Direct KBRA Activities	Regional Full Time, Part Time or Temporary Jobs - Dams Out with KBRA Scenario (Incremental Change in Jobs from Dams In Scenario)	Regional Labor Income (Incremental Change in Million $; 2012 dollars)	Regional Output (Incremental Change in Million $; 2012 dollars)	Timeframe[3]
Klamath County OR; Siskiyou and Modoc Counties CA	Irrigated Agriculture[5]	2027: 112 2043: 695 2045: 397 2051: 187 2059: 70	2027: 2 2043: 11 2045: 7 2051: 4 2059: 2	2027: 13 2043: 84 2045: 41 2051: 20 2059: 9	2027, 2043, 2045, 2051, 2059
Klamath County OR; Siskiyou County CA	Refuge Recreation	5	0.12	0.27	2012 – 2061
Klamath County OR; Siskiyou, Modoc, Humboldt, and Del Norte Counties CA	KBRA Fisheries Program	261	12.4	25	2012 – 2026
Klamath County OR; Siskiyou, Modoc, Humboldt, and Del Norte Counties CA	KBRA Water Resources Program	16	0.7	1.6	2012 – 2026
Klamath County OR; Siskiyou, Modoc, Humboldt, and Del Norte Counties CA	KBRA Regulatory Assurances	10	0.5	1	2012 – 2026
Klamath County OR; Siskiyou County CA	KBRA County Programs	Klamath County: $3.2 million would increase jobs, labor income and output. Siskiyou County: $20 million would increase jobs, labor income and output.	--	--	
Klamath County OR; Siskiyou, Modoc, Humboldt, and Del Norte Counties CA	KBRA Tribal Programs	Karuk: 8 Klamath: 8 Yurok: 10	Karuk: 0.35 Klamath: 0.39 Yurok: 0.45	Karuk: 0.55 Klamath: 0.64 Yurok: 0.81	2012 – 2026

[1] It is not appropriate to add jobs across years, as the job estimates provided represent average annual changes rather than annual changes that accumulate in each year of the study period. Jobs for the Direct KBRA Activities were averaged over the 15 year timeframe and could be higher or lower in any year.

[2] These employment impacts are anticipated to occur on the first day of the timeframe identified and persist over the period. For example, dam decommissioning is estimated to have an employment impact of 1,400 jobs. These jobs would start on January 1, 2020 and persist until December 31, 2020. Similarly, the loss of 49 operation and maintenance jobs would be anticipated to start on January 1, 2020.

[3] Jobs created during dam removal would occur for one year in 2020.

[4] Jobs reported related to mitigation spending are reported as a total over the mitigation period of 2018-2025.

[5] Regional economic impacts stemming from irrigated agriculture were estimated to be equal in all years except for the years in the hydrologic model that correspond with the drought years of 1975, 1992, 1994, 2001, and 2008. The values presented are annual totals for the modeled drought years.

LEGEND:
Klamath County OR; Siskiyou County CA
San Francisco Management Area
Fort Bragg Management Area
KMZ-CA
KMZ-OR
Central Oregon Management Area
Klamath County OR; Del Norte, Humboldt, and Siskiyou Counties CA
Klamath and Jackson counties OR; Humboldt and Siskiyou counties CA
Klamath County OR; Siskiyou and Modoc Counties CA
Klamath County OR; Siskiyou, Modoc, Humboldt, and Del Norte Counties CA

ES.5.3 Tribal

Dam removal and implementation of the KBRA would help protect tribal trust resources and address various social, economic, cultural, and health problems identified by the six federally recognized Klamath Basin tribes (Klamath, Karuk, Yurok, Resighini Rancheria, Quartz Valley, and Hoopa Valley) (See Table ES-12). Dam removal would have beneficial effects on water quality, fisheries, terrestrial resources, and traditional cultural practices. Primary among these are greater anadromous fish harvests for some tribes in the lower basin, a return of salmon and steelhead to the upper basin for the Klamath Tribes, and a restoration of Klamath Tribes sucker fisheries. In addition, dam removal would enhance downstream water quality and the ability of Indian tribes in the Klamath Basin to conduct traditional ceremonies and other traditional practices. Implementation of the KBRA would provide funds to the signatory tribes (Klamath, Yurok, and Karuk) for restoration and monitoring projects which would create jobs for tribal members.

Figure ES-20: Dense summer and fall blue-green algae (Cyanobacteria) blooms in Iron Gate Reservoir produce toxic microcystin resulting in poor water quality for fish and public health posting by the State of California. Known and/or perceived concerns over health risks associated with seasonal algal toxins have resulted in the alteration of traditional cultural practices, such as gathering and preparation of basket materials and plants, fishing, ceremonial bathing, and ingestion of river water (Photo courtesy of Karuk Tribe.)

Table ES-12: Common Benefits to all Indian Tribes with Dam Removal and Implementation of the KBRA

Major Water and Aquatic Resource Benefits of Dam Removal and KBRA Implementation	
Water Resources	
Hydrology	More natural river hydrology. Natural flushing flows would benefit aquatic species and riparian vegetation.
Water Quality	Natural temperature regime and improved water quality would benefit aquatic life.
Toxic Blue Green Algae	Free flowing river segments would deter conditions that lead to toxic algal blooms and reduce human health concerns.
Aesthetics	Improvements in water quality would improve aesthetics and ceremonial opportunities that require a healthy river.
Aquatic Resources	
Traditional Lifestyle	Greater fisheries abundance would bolster opportunities for transmitting traditional knowledge to successive generations, including the important practice of giving fish to elders. Improved social cohesion and function among Indian populations through strengthened sense of tribal identity.
Cultural and Religious Practices	Improved fish abundance would facilitate the tribes' ability to reinstate and continue to practice ceremonies in their historic, complete forms at the appropriate times of the year, thereby improving tribal identity.
Standard of Living	Increased fish abundance would contribute to greater food supply and food security for the Indian population, enhancing standard of living.
Health	Greater opportunity for healthy food consumption associated with increased subsistence fishing opportunities, which would improve overall health conditions.

ES.5.4 Previous PacifiCorp Analyses of Relicensing versus Removal of the Four Facilities and Public Utility Commission Rulings

A prerequisite to the $200 million (2020 dollars) customer surcharges necessary for KHSA implementation was concurrence from the California Public Utility Commission (CPUC) and the Oregon Public Utility Commission (OPUC) with PacifiCorp's conclusion that implementing the KHSA would be in the best interest of their customers and that the incremental increases were fair and reasonable. PacifiCorp's records and testimony before both commissions compared two scenarios: (1) customers' cost and risks under the KHSA dam removal, and (2) customers' cost and risks from relicensing the Four Facilities. (It is important to note that the TMT did not evaluate the potential costs or risks to PacifiCorp customers for relicensing the dams.)

PacifiCorp reported that relicensing would require implementing new mandatory flow conditions for the project (decreasing power generation by 20 percent and reducing peaking-power opportunities), constructing and operating fish passage at the dams, and addressing water-quality issues in and below the reservoirs. PacifiCorp estimated these actions would cost in excess of $460 million (2010 dollars) in capital and operating expenses. PacifiCorp also reported that these are uncertain and uncapped costs and thus represent a substantial financial risk to its customers. For example, if fish passage measures installed at the Four Facilities were unsuccessful, upgraded facilities, altered operations, and/or dam decommissioning may be required, and these additional uncapped expenses would likely be borne by PacifiCorp customers.

In PacifiCorp's analysis of the financial impacts of dam removal, they assumed that customer costs associated with dam removal would be capped at $172 million in 2010 dollars (or $200 million in 2020 dollars). Implementing Interim Measures (as defined in KHSA Appendix C and D) would cost about $79 million (2010 dollars); these costs would be largely capped and would carry only a small financial risk for its customers. In addition, PacifiCorp customers would also have to pay for replacement power after removal of the Four Facilities in 2020.

Table ES-13 provides a summary of PacifiCorp's analysis of the above two scenarios in terms of operational changes, costs, risks, and liabilities to their customers. PacifiCorp's analysis submitted to the CPUC and OPUC demonstrated that the KHSA resulted in less cost and less risk for its customers as compared to FERC relicensing, even with the inclusion of costs associated with replacement power. The CPUC concluded that if "the KHSA surcharge is not instituted….ratepayers would be exposed to an uncertain amount of costs" associated with relicensing. The OPUC concluded that the KHSA "mitigates the risks associated with decommissioning and removal of the [four] facilities for PacifiCorp, and is therefore the least risky alternative for customers compared to relicensing" (OPUC 2011). Based on PacifiCorp's analysis and testimony, both PUCs agreed with the company's analysis and approved collection of the customer surcharges necessary to fund the removal of the Four Facilities in 2020, as described in KHSA.

Table ES-13: Operations, Costs, Risks, and Liabilities for FERC Relicensing and Removal of the Four Facilities, Based on PacifiCorp Analyses

PacifiCorp's Future Hydroelectric Project Scenario	Operations, Risks, and Liabilities		
	Operations at the Four Facilities	**PacifiCorp's Estimated Customer Costs**	**PacifiCorp Customer Risks and Liabilities**
FERC Relicensing	Four Facilities continue to operate, but mandatory conditions would require construction and operation of fish passage facilities (screens and ladders), 20 percent loss of hydropower. Substantial loss of power peaking at J.C. Boyle, and requirements to remedy water temperature quality issues below Iron Gate Dam.	In excess of $400 million in capital costs; in excess of $60 million in O&M over a 40-year license term.	Uncapped financial liability. Costs could exceed $460 million, particularly if fish passage proves ineffective or if water quality does not meet OR or CA state standards. FERC could require PacifiCorp to decommission the facilities if it's unable to issue a new license with costs borne by PacifiCorp customers.
KHSA Removal of the Four Facilities	Continue operation under annual FERC licenses through 2019. Power generation would cease in January 2020 with transfer of the Four Facilities to a DRE. Interim Measures (Appendix C and D of KHSA) would be implemented between 2012 and 2020 to enhance flow variability, water quality, fish habitat/health, and fund specified research and monitoring.	$172 million for dam removal ($200 million in 2020 dollars). Funds would be collected with a 9-year, 2 percent (or less) surcharge on OR and CA customers. Customers would be responsible for KHSA Interim Measures at $9 million in capital costs and $70 million in O&M; and the costs for replacement power.	Customer financial liability for dam removal is capped at $172 million ($200 million in 2020 dollars). Costs for Interim Measures are largely capped at $79 million (2010 dollars).

ES.6 OTHER SOCIAL AND ENVIRONMENTAL EFFECTS FROM DAM REMOVAL

In addition to the effects of dam removal on fisheries, national and regional economic development, tribal resources, and PacifiCorp's customers, there are several other important social and environmental resource considerations addressed in the Overview Report that will inform a determination on whether implementation of the KHSA and KBRA is in the public interest. Table ES-14 summarizes these additional resource considerations and the effects of dam removal and KBRA implementation on each.

Table ES-14: Summary of Other Social and Environmental Effects of Dam Removal and KBRA Implementation

Issue	Effect of Dam Removal/KBRA
Prehistoric and Historic Cultural Resources: Numerous Indian tribal and early settler development sites in the Klamath River Basin are potentially eligible for inclusion on the National Register of Historic Places. These sites are part of the cultural and historic heritage of the area. Specifically, the Klamath Hydroelectric Project dams and facilities are recommended for inclusion on the National Register.	Removal of dams and associated hydroelectric facilities would permanently remove these resources from eligibility to the National Register. Additionally, dam removal could affect other sites. Consultations under Section 106 of the National Historic Preservation Act (NHPA) are being conducted and would continue, as appropriate, throughout planning and implementation if dam removal were to proceed in order to identify and protect these resources.
Wild and Scenic River: The US Forest Service, BLM and the National Park Service are responsible for Klamath Wild and Scenic River (WSR) management and are required by the WSR Act to make a determination whether dam removal is consistent with its river-resource protection requirements on the two components of the Klamath WSR.	Federal projects such as the proposed removal of the Four Facilities are consistent with the WSRA's Section 7(a) protections when they do not "invade", or intrude within, the WSR boundary, nor "unreasonably diminish" its scenery, recreation, fish and wildlife values as they existed at the date of WSR designation. The Oregon component of the WSR below J.C. Boyle Powerhouse would experience a loss in whitewater boating opportunities as a direct result of dam removal. Overall, dam removal would improve scenery, recreation, and fish and wildlife values associated with the Oregon and California components of the Klamath WSR.
Recreation: The Four Facilities' reservoirs (excluding Copco 2) provide recreational opportunities including whitewater boating below J.C. Boyle powerhouse, power boating, waterskiing, lake swimming, flat-water boat angling, sightseeing, camping, and wildlife viewing.	The removal of the Four Facilities would result in a change to recreation opportunities. Open water recreation and camping at J.C. Boyle, Copco 1, and Iron Gate reservoirs would be permanently lost following dam removal. These losses could be partially replaced by other regional recreation resources. Whitewater boating would be reduced in the popular Hell's Corner Reach. Flat-water fishing opportunities would be lost at the reservoirs, while habitat improvements and dam removal would likely increase in-river fishing opportunities for salmon, steelhead and redband trout basin-wide.
Real Estate: Private development around Copco 1 and Iron Gate reservoirs occurred largely as a result of proximity to the reservoirs and their recreational/scenic values. Dam removal would change this important value attached to property values.	Existing lake recreational opportunities and scenic quality would change following dam removal and some property owners around Copco 1 and Iron Gate reservoirs would lose their reservoir views and reservoir access. Public access to the newly created river channel would be provided, and recreational opportunities would be available on and along the river. Scenic, recreational, and accessibility changes following dam removal would decrease the value of privately-owned parcels around Iron Gate and Copco 1 reservoirs in the near term. This decrease in value could not be quantified; a supplemental analysis is underway to provide additional information on the potential effect of reservoir removal on these property values and will include evaluations with a date of value of 2004 and 2006. Dam removal has the potential to increase the value of property near and adjacent to the Klamath River downstream of Iron Gate Dam due to improved water quality and more robust runs of anadromous fish.

Table ES-14: Summary of Other Social and Environmental Effects of Dam Removal and KBRA Implementation

Issue	Effect of Dam Removal/KBRA
Refuges: The Lower Klamath National Wildlife Refuge does not have a water allocation and experiences water delivery uncertainty and shortages in the critical April through October time period, particularly in dry years, which reduces wildlife species diversity and abundance.	Dam removal and KBRA implementation would allow the refuges within Reclamation's Klamath Project to have greater certainty about water allocations and flexibility in water deliveries. Full refuge needs would likely be met in 88 percent of years. Historically, full refuge water needs in the April through October period have only been met in less than 10 percent of the years. Dam removal with KBRA implementation would also define and maintain the habitat benefits of "walking wetlands" and provide the refuges revenues from lease lands. Additional water deliveries with increased predictability, would improve bird numbers. • Waterfowl carrying capacity of fall migrating ducks would increase by 147,000 to 336,000. • Estimated additional wetland habitat for more than 8,000 additional nongame waterbirds (shorebirds, gulls, terns, cranes, rails, herons, grebes, egrets, and ibis) in an average water year, and 20,000 in drier years. • Greater waterfowl numbers will provide a larger and more reliable food resource base for wintering bald eagles.
Chemicals in Reservoir Sediments: Reservoir sediments contain low levels of contaminants that needed to be evaluated to determine if they could be eroded and transported downstream without adverse impacts to humans or other biota. In addition, the impact of human exposure to sediments not eroded downstream needed to be evaluated.	Impounded sediments were generally found to contain low levels of contaminants and can be considered relatively clean. Contaminant levels do not preclude their downstream release during dam removal. A screening level evaluation found that long-term adverse effects in the downstream areas and new river channel are unlikely for humans and aquatic and terrestrial biota.
Algal Toxins: Large algal blooms occur in Copco 1 and Iron Gate reservoirs during the summer months and produce the algal toxin microcystin; these reservoirs have posted health advisories warning against recreational use (water contact), drinking, and fish consumption. These health advisories extend to the lower Klamath River and at times, into the Klamath Estuary. Algal toxins in the Klamath River have impaired the ability of the Klamath, Resighini Rancheria, Karuk, Hoopa, Quartz Valley and Yurok Indian tribes to use the river for cultural purposes.	Dam removal would eliminate large, seasonal blooms of nuisance toxic algae in Copco 1 and Iron Gate reservoirs and facilitate the use of the Klamath River for multiple human health related beneficial uses, including traditional Indian cultural practices, recreation, agriculture, shellfish harvesting, and commercial, tribal, and sport fishing.
Green House Gasses: Dam removal would require power replacement in 2020 that would result in a net increase of greenhouse gas (GHG) emissions.	The Four Facilities would generate on average 909,835 MWh annually in 2020 through 2061 that would need to be replaced by other power sources if dams are removed. If PacifiCorp meets its California's Renewable Portfolio Standard (RPS) goal in 2020 of 33% renewable, the metric tons of carbon dioxide equivalent ($MTCO_2e$) emitted from replacement power, is approximately 451,000 $MTCO_2e$ per year. Removal of the reservoirs would reduce these emissions by approximately 4,000 to 14,000 $MTCO_2e$ per year (less than 1 percent) based on the reduction of methane gas emitted from reservoir bottom sediments.

Table ES-14: Summary of Other Social and Environmental Effects of Dam Removal and KBRA Implementation

Issue	Effect of Dam Removal/KBRA
Societal views on dam removal and the KBRA: Klamath dam removal and basin restoration (KBRA) could only move forward with fiscal resources from PacifiCorp customers, California taxpayers, and US taxpayers. What value do individuals and households place on Klamath Basin fisheries recovery and restoration?	<u>Local Ballot Measures</u> Local voting (November 2, 2010) results in Klamath County and Siskiyou County appear to be mixed, with a slight majority of Klamath County supporting participation in KBRA (52 %) and a large majority of Siskiyou County not supporting dam removal (79%). <u>Non-use Value Survey Responses</u> Responses to the nonuse value survey questions indicate a majority of respondents place a relatively high level of importance on improving the fisheries in the Klamath River Basin. This importance was indicated at the 12-county Klamath area level, statewide for Oregon and California, and for the rest of the nation. In response to a question inquiring about the level of concern with declines in the number of Chinook salmon and steelhead trout that return to the Klamath River each year, the majority of respondents expressed concern. • From the 12-county Klamath area, 73.8% expressed concern. • For the rest of Oregon and California, 82.5% expressed concern. • For the rest of the United States, 78.8% expressed concern. Respondents surveyed indicated that an action plan to remove the dams and restore the basin was preferred to no-action. No-action was defined as not implementing an agreement that includes dam removal, fish restoration, and a water sharing agreement. • From the 12 county Klamath area, 54.7% favored an action plan • For the rest of Oregon and California, 71.3% favored an action plan • For the rest of the United States, 66.3% favored an action plan