Section 4
Secretarial Determination Findings of Technical Studies

This section of the Overview Report summarizes available information as well as the technical studies (see Table 3-1) completed by the TMT to address the four questions before the Secretary of the Interior. Information is organized in Sections 4.1 through 4.4 to address these four questions. The fourth question regarding whether dam removal and implementation of KBRA is in the public interest is not answered in this report. Rather Section 4.4, *Analysis of Information to Inform a Decision on Whether Dam Removal and KBRA are in the Public Interest*, summarizes relevant information in many subject areas that could be important for a public interest determination on dam removal.

Table 4-1: Organization of Chapter 4 of the Overview Report

Question	Section
Will dam removal and KBRA implementation advance salmonid and other fisheries of the Klamath Basin over a 50-year time frame?	4.1 - Expected Effects of Dam Removal and KBRA on Physical, Chemical, and Biological Processes that Support Salmonid and Other Fish Populations
What would dam removal entail, what mitigation measures may be needed, and what would these actions cost?	4.2 - Dam Removal Detailed Plan and Estimated Cost
What are the major potential risks and uncertainties associated with dam removal?	4.3 - Risks and Uncertainties of Dam Removal
Is dam removal and implementation of the KBRA in the public interest, which includes but is not limited to consideration of potential effects on local communities and tribes?	4.4 - Analysis of Information to Inform a Decision on Whether Dam Removal and KBRA are in the Public Interest

The TMT used two scenarios to analyze information pertaining to the four questions: *dam removal and implementation of the KBRA* to restore Klamath Basin fisheries over a 50-year time period, and for comparison, the continuation of the status quo in a *dams remain without implementation of the KBRA* scenario. For both scenarios, the period of analysis was 50 years (2012 through 2061). In certain instances, this Overview Report makes reference to "historic conditions;" historic conditions relate to past activities and are presented for historical context only. Major assumptions associated with these scenarios are presented below.

Dams Remain Without Implementation of the KBRA

For the purposes of this analysis, this scenario assumes the Four Facilities would remain in place and without Implementation of the KBRA (also referred to as "dams remain" or "dams in"). This scenario also assumes that PacifiCorp continues current operations under annual FERC licenses, without installation of fish passage facilities. The expired license had no requirements for fish passage around the Four Facilities and it is not known when fish passage facilities would be completed if the Four Facilities were given a long-term licensed by FERC. Operations of the Four Facilities includes passing water through the dams in accordance with two ESA Biological Opinions that (1) maintain Upper Klamath Lake levels to protect two endangered sucker species (USFWS 2008), and (2) maintain flow conditions downstream of Iron Gate Dam to protect threatened coho salmon (NOAA Fisheries Service 2010). The dams remain scenario assumes, for purposes of this analysis, that these two biological opinions would remain in effect during the study period (2012 – 2061), agency funding for fish habitat restoration actions would continue at current levels, and the Iron Gate Fish Hatchery would continue to operate.

A dams remain scenario also includes other regulatory conditions that would affect the environment and circumstances in the Klamath Basin. To improve water quality, the Oregon Department of Environmental Quality (ODEQ) and California's North Coast Regional Water Quality Control Board (NCRWQCB) collaborated to develop Total Maximum Daily Loads (TMDLs) for impaired water bodies within the basin. TMDLs are water pollution control plans that identify the pollutant load reductions that are necessary to meet water quality standards. The California and Oregon Klamath River TMDLs focus on reducing elevated water temperatures, increasing dissolved oxygen levels, and reducing nutrient concentrations in the mainstem Klamath River over a 50-year time period (NCRWQCB 2010b, ODEQ 2010).

Dam Removal and Implementation of the KBRA

The dam removal and implementation of the KBRA scenario (also referred to as "dams out with KBRA" or "dams out") includes the removal of the Four Facilities as described in the KHSA and full implementation of the KBRA. Dam removal would create a free flowing river from Keno Dam to the Pacific Ocean, would restore bedload and sediment transport processes, and would allow volitional fish passage to potential habitat in the upper basin. This scenario includes the complete or partial removal of the Four Facilities but leaves in place Link River and Keno dams, which are critical for delivery of water to farms and the National Wildlife Refuges. Link River Dam stores water in Upper Klamath Lake for Reclamation's Klamath Project. Keno Dam maintains water elevations necessary for gravity-feed delivery of irrigation water from the Klamath River between Link River and Keno dams. Both Link River and Keno dams are relatively small and have fish passage facilities. Under the KHSA, Keno Dam ownership would be transferred from PacifiCorp to the Department of the Interior. Under this scenario it is also assumed the Iron Gate Fish Hatchery would continue to operate through 2028, but would be discontinued thereafter. The actual decision to close or to continue the hatchery would be made based on the progress of fisheries restoration.

KBRA implementation in this scenario includes the many programs and actions listed in Section 1.2.8 *Klamath Basin Restoration Agreement* and Table 4-1 as well as a commitment to "adaptive management" when administering the KBRA. Adaptive management is an approach to resource management that readily adjusts plans and restoration actions as environmental conditions change or as new information is obtained. Monitoring the outcomes and effectiveness of current restoration actions is essential for a successful adaptive management program. The KBRA includes large fisheries and water-quality monitoring programs and research to inform this management process. The KBRA also includes basin-wide fish habitat and water quality restoration programs, except for the Trinity River Basin which has a separate restoration program (Trinity River Restoration Program) that would be implemented in either a dams in or a dams out scenario. It is expected that TMDL goals would be met more quickly in this scenario owing to planned KBRA restoration actions aimed at improving water quality, particularly in the upper basin. KBRA also includes programs for reintroducing salmonids to the upper basin; increasing the certainty of water deliveries to farms; increasing the certainty and volume of water deliveries to National Wildlife Refuges; reducing agricultural water use, particularly in dry years; increasing opportunities for creating beneficial peak-flow events below Link River Dam and increasing flow variability that more closely mimics a natural hydrograph; and assisting local communities. For this scenario, it is assumed that flows under the KBRA would occur as modeled and described in Reclamation 2012g, which includes planned changes in the operation of Reclamation's Klamath Project, voluntary reductions (30,000 acre feet) in off-project irrigation water use, and increased water deliveries to National Wildlife Refuges.

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4.1 EXPECTED EFFECTS OF DAM REMOVAL AND KBRA ON PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES THAT SUPPORT SALMONID AND OTHER FISH POPULATIONS

Dam removal and the KBRA together embody a large scale, integrated approach to restoration of what was once a premier salmon-producing watershed on the west coast of the United States. The Klamath Basin was once the third largest producer of salmon in the United States outside of Alaska. Historically, the basin produced substantial runs of steelhead, Chinook salmon, coho salmon, green sturgeon, eulachon, and Pacific lamprey, and was an important contributor to regional commercial, recreational, and tribal fisheries. Most of these species have undergone long-term population declines (see sidebar and Table 4.1-1) caused by the cumulative effects of a variety of factors, including changing ocean conditions, hydrologic modifications, dam construction, agricultural development, timber harvesting, overfishing, and mining (DOI, Klamath River Basin Fisheries Task Force 1991). The summary of expected biological impacts presented in this section is described in more detail in the *Synthesis of Effects to Fish Species of Two Management Scenarios for the Secretarial Determination on Removal of the Lower Four Dams on the Klamath River* (Hamilton et al. 2011). Table 3-1 (in Section 3, *Science and Engineering Process*) includes the biological analysis conducted for the Secretarial Determination, among many other studies.

Table 4.1-1: 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.

Status of Anadromous Fish in the Klamath Basin

The abundance of anadromous fish populations in the basin have declined substantially compared to historical conditions.

Chinook salmon: The fall run may have numbered 400,000 to 600,000 fish in the early 1900s (Moyle 2002; NOAA Fisheries Service 2009). Between 1978 and 2006 escapement of fall-run Chinook salmon (fish returning to spawn) has averaged about 120,000 fish (Moyle et al. 2008). The National Marine Fisheries Service recently formed a Biological Review Team to review the biological status of Chinook salmon in the Upper Klamath and Trinity rivers to determine if listing under the Endangered Species Act was warranted. The results of the review found the majority of populations have not declined in spawner abundance over the past 30 years (i.e., from the late 1970s and early 1980s to 2010) except for in the Scott and Shasta rivers where there have been modest declines (Williams et al 2011). The Biological Review Team also noted that the recent abundance levels of some populations are extremely low, especially in the context of historical abundance estimates. This was most evident with respect to two of the three spring-run population units that were evaluated (Salmon River and South Fork Trinity River). Although current levels of abundance are generally low compared with historical estimates of abundance, the current abundance levels do not constitute a major risk in terms of extinction.

Historically, spring-run Chinook salmon in the Klamath Basin were very important (National Research Council [NRC] 2004; Snyder 1931), and, according to some sources, substantially outnumbered fall run Chinook salmon (Gatschet 1890; Spier 1930), but the runs have been extirpated from a large portion of their historical range (NRC 2004; Moyle et al. 2008). Total numbers from the Klamath and Trinity rivers now range from less than 300 fish to 1,000 fish (Moyle et al. 2008), with the only remaining viable wild population in the Salmon River. With minimal access to appropriate habitat, the spring run will likely remain at a fraction of historical levels (Moyle et al. 2008).

Figure 4.1-1: Chinook salmon are important for tribal, commercial, and sport fisheries in the Klamath Basin.

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Status of Anadromous Fish in the Klamath Basin (cont.)

Coho salmon: Coho salmon in the Southern Oregon Northern California Coast Evolutionarily Significant Unit (ESU) are listed as threatened under both the ESA and CESA. In addition, less than 70 percent of streams historically inhabited by coho salmon in the Klamath Basin still contain populations (NRC 2004). In the Shasta River, two of the three year classes have declined to the point that they are considered to be functionally extinct (NRC 2004). In the Trinity River, wild coho salmon stocks are estimated to be at only 4 percent of their former abundance (NRC 2004).

Figure 4.1 2: Coho salmon in the Klamath Basin are threatened with extinction.

Steelhead: Klamath Basin summer and winter steelhead populations belong to the Klamath Mountain Province ESU. In 2001, NOAA Fisheries Service determined that steelhead in the Klamath River Basin did not warrant listing under the ESA, despite acknowledging that their numbers were declining (Busby et al. 1994, NOAA Fisheries Service 2001).

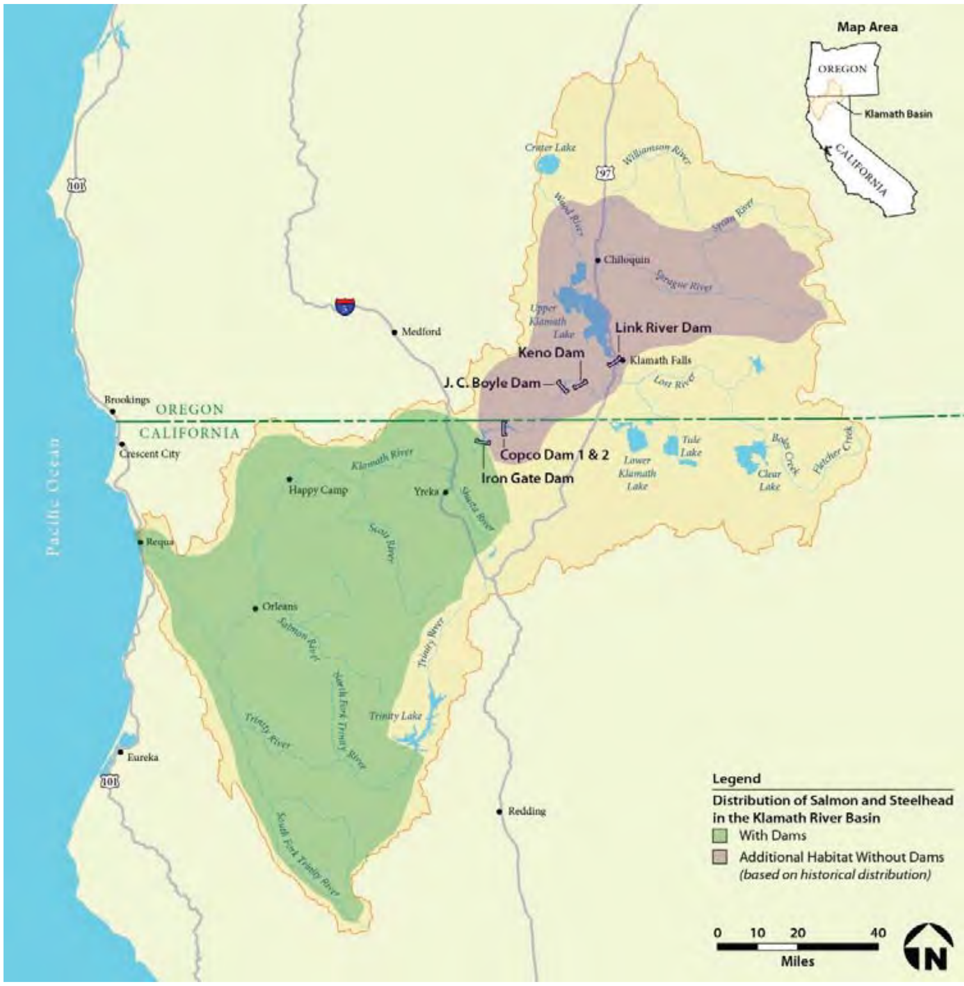
Figure 4.1-3: Summer and winter steelhead in the Klamath Basin have declined.

Lamprey and Eulachon: Anadromous lampreys in the basin appear to have declined to low levels (Larson and Belchik 1998) and eulachon are now rarely observed in the Klamath River.

Green sturgeon: Based on available abundance information, NOAA Fisheries Service (2006) determined that green sturgeon in the Klamath Basin did not warrant listing as threatened or endangered, although uncertainties in the population structure and status led NOAA Fisheries Service to designate them as a Species of Concern.

As part of the Secretarial Determination studies, the TMT used a variety of analytical tools, both qualitative and quantitative, to assess the expected effects of dam removal with KBRA on salmonids and other fish populations in the Klamath River. Dam removal, subsequent reestablishment of fish migration and basin connectivity, and reestablishment of stream flows and sediment transport (bedload, gravels, sands, and fines) that more closely mimic natural conditions in the Klamath River are expected to contribute towards restoration of the physical, chemical, and biological processes that are essential to a functional aquatic ecosystem. Improvements to the resiliency of the Klamath Basin ecosystem would likely occur from the integrated benefits of (1) increased habitat area as a result of the reconnection of 420 miles of streams in the upper basin by removal of four dams (see Figure 4.1-4); (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.

Figure 4.1-4: Salmon and steelhead distribution in the Klamath Basin under current conditions (with dams) compared to historical conditions (prior to dam construction).



4.1.1 Fish Population Factors Affected by Dam Removal and KBRA

The Klamath Hydroelectric Project affects fish populations by blocking migration to formerly available habitat, fragmenting populations, and altering physical and ecological processes (such as sediment transport and instream flows). The reservoirs also alter nutrient cycling, water quality, and water temperatures. In the Klamath River, removal of J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams and implementation of the KBRA would have significant implications for fish populations by influencing the following key factors:

- Hydrology
- Climate change effects
- Habitat access and quality including sediment transport

Risk to Fish Populations from Dams Remaining in Place

Based on a review of existing conditions for aquatic species, Hamilton et al. (2011) concluded that, in general, the diversity, productivity, and abundance of Federally listed, and other depressed fish populations in the Klamath Basin under existing conditions would continue to be severely impacted due to one or more of the following factors:

- Continued blockage from over 420 miles of historical spawning and rearing habitat upstream of Iron Gate Dam.
- Altered flow regimes and sediment transport downstream of Iron Gate Dam.
- Negative impacts on redband trout due to hydropower peaking operations.
- Lack of access to cold springs and tributaries in the Upper Klamath Basin that would provide thermal refugia for migrating salmonids and buffer the potential effects of climate change.
- Altered geomorphic and riparian processes that limit creation and maintenance of diverse fish habitats downstream of Iron Gate Dam.
- Continued poor habitat quality throughout many tributaries to the Klamath River.
- Poor water quality in the Klamath River, particularly during summer months.
- High incidence of disease in the Klamath River for juvenile salmon downstream of Iron Gate Dam.

Current, Ongoing Beneficial Activities in Relation to KBRA

Considerable efforts are underway to improve fish habitat in the Klamath Basin. Improved habitat would continue to support the recovery of salmon and steelhead stocks (NOAA Fisheries Service 2010). Once implemented, TMDLs and their associated implementation plans are expected to improve water quality (see sidebar on *Beneficial Uses and TMDLs in the Klamath Basin* in Section 4.1.1.4, *Water Quality*), reduce stress on salmonids, and contribute to their recovery (NOAA Fisheries Service 2010). Activities to aid recovery of salmonid populations within the Klamath Basin would continue through flow management and habitat restoration.

These activities are included in the dams remain scenario; however, their likelihood of prompt implementation when compared to the dam removal with KBRA scenario is lower. This is because KBRA-related actions are complementary to existing restoration activities, and would accelerate implementation of these restoration actions.

- Water quality including water temperature
- Salmon disease

Each of these key factors is discussed below.

4.1.1.1 Hydrology

A universal feature of the hydrographs of the Klamath River and its tributaries is a spring pulse flow followed by recession to a base flow condition by late summer (NRC 2004). This main feature of the hydrograph has undoubtedly influenced the adaptations of native organisms, as reflected in the timing of their key life-history features (NRC 2004). The natural flow regime of a river is the characteristic pattern of flow quantity, timing, rate of change of hydrologic conditions, and variability across time scales (hours to multiple years). It is this diverse hydrology, with the range of flow conditions and resulting aquatic habitats, which dictated the long-term evolution of the life-history strategies of anadromous fish in the Klamath River (see Figure 4.1-41). Therefore, to understand the habitat preferences of anadromous fish in the Klamath Basin, it is important to understand the historical flow patterns under which they evolved. To understand possible stresses to these fish, and why fish populations have declined, it is important to understand how critical flow patterns have changed, particularly those associated with human activities in the basin (e.g. irrigated agriculture and dam construction).

There is a long history of water development in the Klamath Basin dating back to the late 1800's and early 1900's. A major development in the Upper Klamath Basin that affect flow patterns, including the construction of dams and development of irrigated agriculture, began after Congress authorized Reclamation's Klamath Project in 1905. Diversion of irrigation water through Reclamation's A Canal began as early as 1907, but it was not until Link River Dam was completed in 1921 that the largest deliveries began. Link River Dam was built at the outlet of Upper Klamath Lake to store upper basin runoff for release during the irrigation season to Reclamation's Klamath Project serving up to 235,000 acres of farmland. In addition to Reclamation's Klamath Project, there are many other smaller irrigation districts and individual operations in the upper basin (often referred to as "off project users"), that have a combined acreage similar to Reclamation's Klamath Project. These smaller irrigation operations also affect flow patterns in the upper basin and downstream of Iron Gate Dam.

The majority of irrigated agricultural in the upper basin relies on surface water diversions, but groundwater withdrawals are a primary or backup source for some irrigators. Irrigated agriculture and ranching in the upper basin includes some upland areas, valley floors, and hundreds of thousands of acres of former wetlands (including major lakes) that were drained and converted to farming and ranching operations (see Figure 1-5), including tens of thousands of acres of former wetlands near and around Upper Klamath Lake.

In the Hydroelectric Reach, the first major power peaking hydroelectric facility, Copco 1, was constructed in 1918, followed by construction of Copco 2 in 1925. J.C. Boyle Dam was completed in 1958 followed by Iron Gate Dam in 1962. Iron

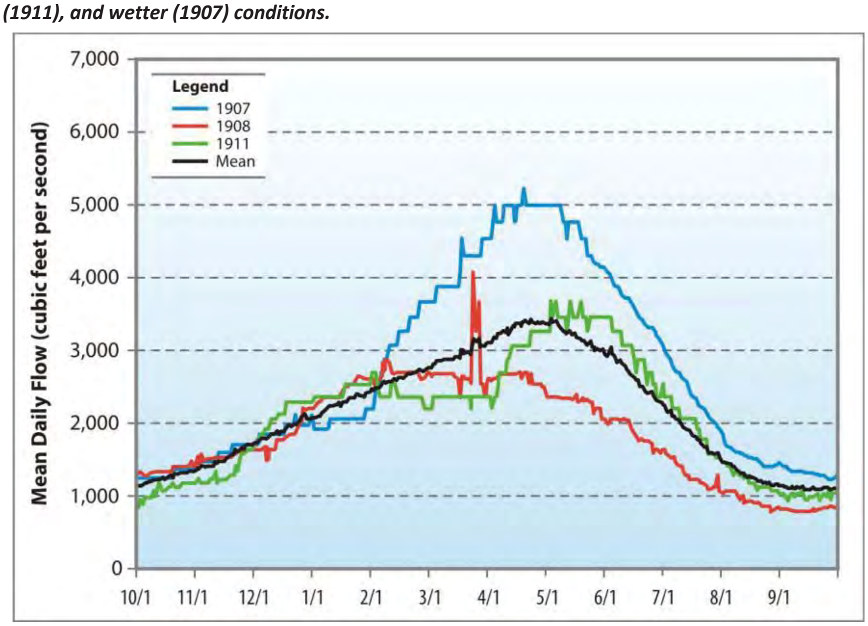
Gate Dam was built to produce hydropower and to re-regulate flow releases from Copco 1 and Copco 2 dams; releases from the Copco dams produced hourly fluctuations unsafe for downstream users (e.g. fisherman and boaters), and created poor habitat conditions for aquatic resources.

The following sections provide brief descriptions of Klamath River hydrology, including: "natural" hydrology (pre 1913), conditions during the period where irrigated agriculture was stable and the Four Facilities were completed (1961 to 2000), hydrologic changes related to the NOAA Fisheries Service (2010) and USFWS (2008) biological opinions (i.e. dams remain without implementation of KBRA), and how these flows would likely differ under dam removal and implementation of KBRA.

Pre 1913 hydrology - Given the early development of water and terrestrial resources within the basin, little hydrologic data exists to describe the natural historical flow patterns that existed in the basin. The U.S. Geological Survey (USGS) began operating a stream gage on the Klamath River at Keno (11509500) on June 1, 1904; data from this gage are available for water years 1905 through 1913, and 1930 to the present. Data from 1905 through 1913 provide the best representation of flow conditions in the upper basin under which fish evolved and prior to the construction of major dams or the full development of irrigated agriculture. It is important to note that 1905 to 1913 was wetter-than-average and therefore is not directly comparable to periods of record that include more dry years.

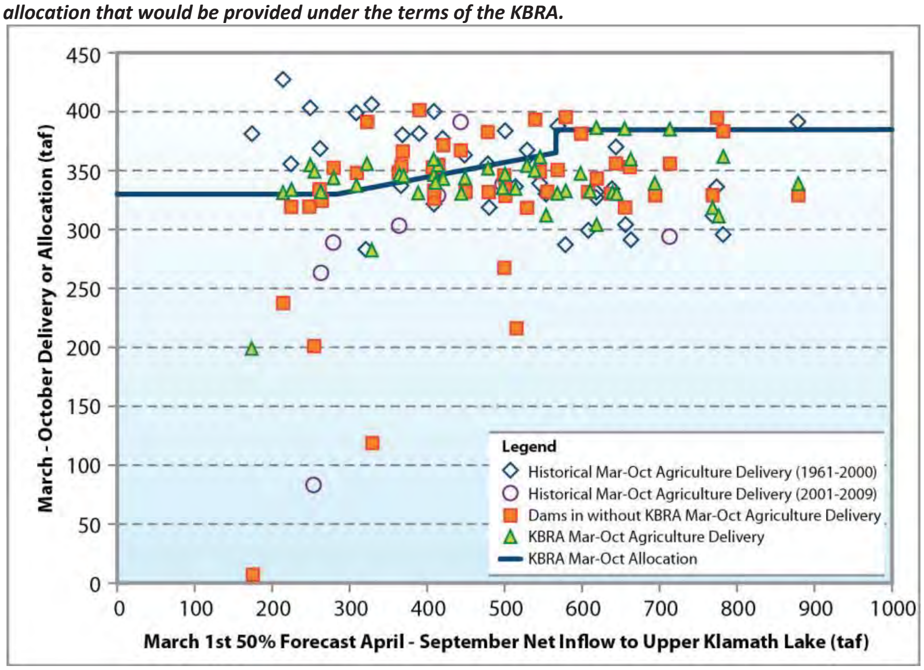
Hydrographs for three different water years during this 1905-1913 period (see Figure 4.1-5), illustrates flow variability at several scales (annual, seasonal, and daily). Mean annual discharge at Keno ranged from 1,860 cubic feet per second (cfs) to 2,696 cfs, and averaged 2,146 cfs. Seasonally all three years show a pattern of steadily increasing flows during the fall and winter and peaking around April when snowmelt at higher elevations is at a maximum. Recession from peak flow was very slow during the spring and summer, not reaching a yearly minimum of about 1,000 cfs until September. A large component of flow during the spring and summer was from groundwater and large wetland complexes, accounting for this slow recession. Daily flow variability was remarkably small in the upper basin; this phenomenon also reflected a hydrologic system dominated by discharge from large groundwater aquifers and wetland

Figure 4.1-5: Mean daily flows at Klamath River at Keno (USGS gage 11509500) for the period 1905 to 1913 and for three separate water years generally representing drier (1908), average (1911), and wetter (1907) conditions.



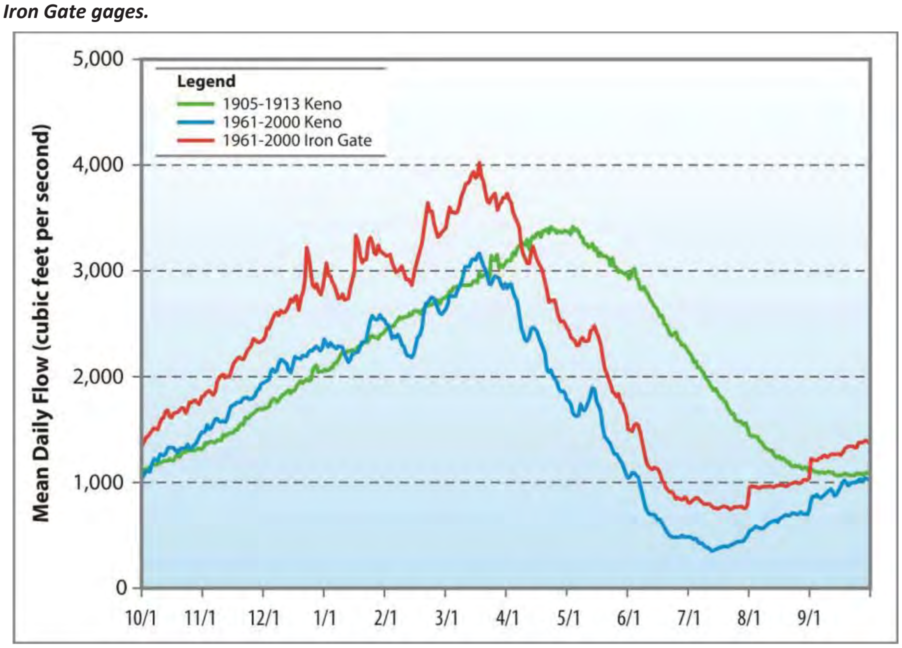
complexes. However, even in relatively dry years (1908 in Figure 4.1-5) rapidly changing flow conditions did occur, owing to snowmelt and/or a large rainfall event.

Figure 4.1-6: Historical water deliveries to Reclamation's Klamath Project relative to the maximum water allocation that would be provided under the terms of the KBRA.



Source: Reclamation 2012g, Hetrick et al. 2009

Figure 4.1-7: Comparison of mean daily flows at Klamath River at Keno (USGS gage 11509500) for the periods 1905 to 1913 (historical) and 1961 to 2000 (more recent conditions). Mean daily flows below Iron Gate Dam (USGS gage 11516530) are shown to depict the accretion of water between Keno and Iron Gate gages.



1961 to 2000 Hydrology - When Iron Gate Dam was completed in 1962, the following minimum flows below the dam were stipulated by the FERC as part of a long-term license agreement: September 1 through April 30, 1,300 cfs; May 1 through May 31, 1,000 cfs; June 1 through July 31, 710 cfs; and August 1 through August 31, 1,000 cfs. These minimum flow requirements had a large influence on water use and dam operations in the upper basin, and they provided for more stable flow conditions than in earlier decades. However, they also altered the timing of when the lowest flows occurred in the year (typically June and July) and they did not significantly restore other features of a more natural flow regime coming from the upper basin. Under FERC requirements, minimum fall flows were slightly increased over what was observed naturally (i.e. prior to 1913) while minimum spring and summer flows were substantially reduced compared to more natural flows.

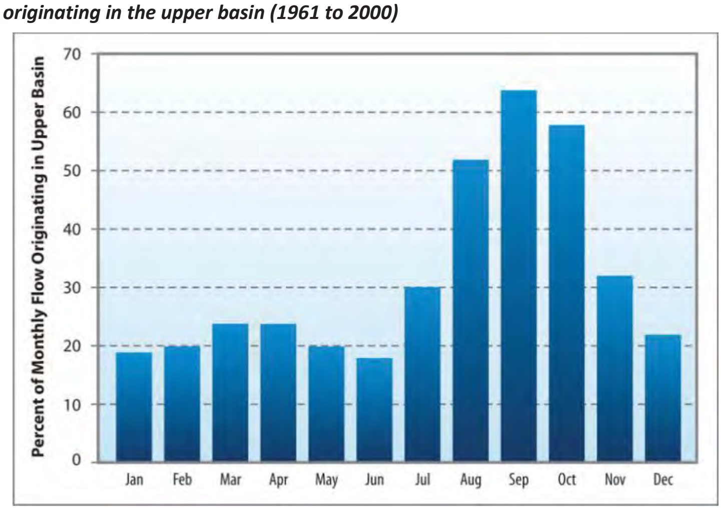
One of the largest impacts on the hydrology of the upper basin during this period has been the presence of hundreds of thousands of acres of irrigated agriculture. Reclamation's Klamath Project is the largest irrigation project in the upper basin, receiving annual deliveries from 280,000 to 430,000 acre feet for this period (see Figure 4.1-6). As noted earlier, there are other smaller irrigation districts and individual operators that are similar in combined acreage to Reclamation's Klamath Project.

These changes in land and water use in the upper basin have affected the hydrologic response. Figure 4.1-7 compares mean daily flows at the Keno gage for the pre-1913 period to the period 1961 to 2000. Again, because 1905 to 1913 was wetter-than-average, these two time periods are not directly comparable. However, it can be concluded from this comparison that: (1) mean annual flows have decreased (but perhaps less than this figure indicates) owing to agricultural diversions; (2) annual peak discharges are less and they have been shifted from late April to the middle of March (about 6 weeks); (3) the recession from the seasonal peak is steeper, reaching yearly minimum flows in July rather than September; and (4) spring and summer flows are less, again owing to agricultural diversions and water storage in Upper Klamath Lake.

Figure 4.1-7 also shows the effect of the PacifiCorp Four Facilities on mean daily streamflows. All four of these dams are between the Keno and Iron Gate Dam gages and none of these dams are operated for flood control or to store irrigation water; these dams are operated near full pool to maximize hydroelectric production and power peaking. The difference between the mean daily flows at Keno (1961 to 2000) and Iron Gate Dam (1961 to 2000) reflect the daily accretions from groundwater (about 250 cfs) and tributaries entering the Hydroelectric Reach. Operation of these dams, however, do affect hourly flow fluctuations due to power peaking within stretches of the Hydroelectric Reach, creating adverse conditions for terrestrial and aquatic resources in parts of the Hydroelectric Reach. In addition, PacifiCorp's operation of the Four Facilities also dampens flow variability downstream of Iron Gate Date. Without dams, the natural variability of tributary inflows to the Hydroelectric Reach would produce more flow variability downstream of Iron Gate Dam. With dams in place, these tributary inputs are dampened by the presence of the large reservoirs as well as the upward and downward adjustments in releases from Link River and Keno dams to create stable flows for hydroelectric power generation and to meet minimum flow requirements at Iron Gate Dam.

As noted in Section 1.2.1, *Hydrologic Setting*, the upper basin (above Iron Gate Dam) produces less than 20 percent of the Klamath River annual flow reaching the ocean (see Figure 1-4). This is primarily explained by relatively arid conditions in the upper basin compared to the lower basin; however, agricultural diversions in the upper basin also contribute to reduced runoff. While runoff from the upper basin is not large on an annual basis, groundwater discharge from large groundwater aquifers is important for sustaining summer and fall flows in the lower basin (see Figure 4.1-8). Upper basin flows make up nearly 60 percent of the flow at Klamath River at Orleans (USGS gage 1523000) in the months of August through October, which is an important time for the upstream migration of adult salmon (see Figure 4.1-41).

Figure 4.1-8: Percent of monthly flow at Klamath River at Orleans (river mile 60) originating in the upper basin (1961 to 2000)



Hydrology with Dams Remain Without Implementation of KBRA – From 2008 to 2010, flow requirements in the Klamath River and lake level requirements in Upper Klamath Lake were updated. NOAA Fisheries Service (2010) biological opinion on Reclamation's Klamath Project established

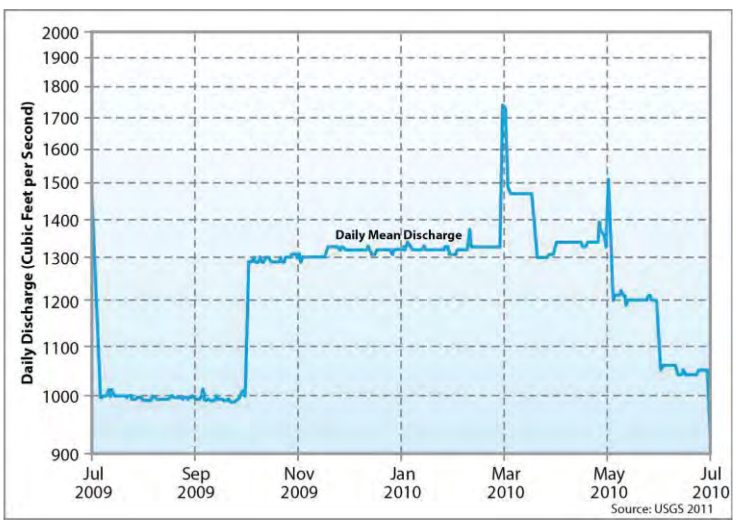
Table 4.1-2: Minimum instantaneous flows at Iron Gate Dam (NOAA Fisheries Service 2010)

Month	Minimum flows at Iron Gate Dam (cfs)
October	1000
November	1,300
December	1,260
January	1,130
February	1,300
March	1,275
April	1,325
May	1,175
June	1,025
July	805
August	880
September	1,000

Table 4.1-3: Minimum end-of-month lake elevations in Upper Klamath Lake (USFWS 2008)

Month	Minimum lake level (ft)
February	4141.5
March	4142.2
April	4142.2
May	4141.6
June	4140.5
July	4139.3
August	4138.1
September	4137.5

Figure 4.1-9: USGS graph of flows below Iron Gate Dam (July 1, 2009 through June 30, 2010). Flows below Iron Gate Dam typically do not vary from day to day or month to month, particularly during dry periods.



Source: USGS 2011

new flow requirements below Iron Gate Dam to protect ESA threatened coho salmon (see Table 4.1-2 for minimum instantaneous flows). In addition, a USFWS (2008) biological opinion to maintain Upper Klamath Lake water elevations to protect two ESA listed sucker species (Lost River and shortnose) was also established (see Table 4.1-3). Both biological opinions are the basis of flows and Upper Klamath Lake elevations assumed for the dams remain without implementation of KBRA scenario.

These biological opinions strive to strike a balance between protecting ESA listed fish while maintaining other beneficial uses of water on Reclamation's Klamath Project. The NOAA Fisheries Service 2010 Biological Opinion restores some critical flow patterns important for fish, such as increasing minimum flows in the periods from October through November, and May through July, and increasing fall and winter flow variability. NOAA Fisheries Service (2010) determined that the lack of fall and winter flow variability has reduced the effectiveness of environmental cues for juvenile coho salmon to redistribute in the mainstem river, resulting in individuals using less favorable habitat throughout the winter. In addition, they determined that this lack of fall and winter flow variability increased disease risk for juvenile salmon by creating optimal steady flows for the proliferation of *C. shasta* and *P. minibicornis*. Previous minimum flow requirements resulted in very stable conditions, particularly in dry years, varying little from day to day or month to month. As an example, for three months in the summer of 2009, daily flows remained steady at 1,000 cfs (see Figure 4.1-9), followed by a period of five months (October 2009 through February 2010) where daily flows at Iron Gate Dam were held steady at 1,300 cfs to maintain instream minimum flows.

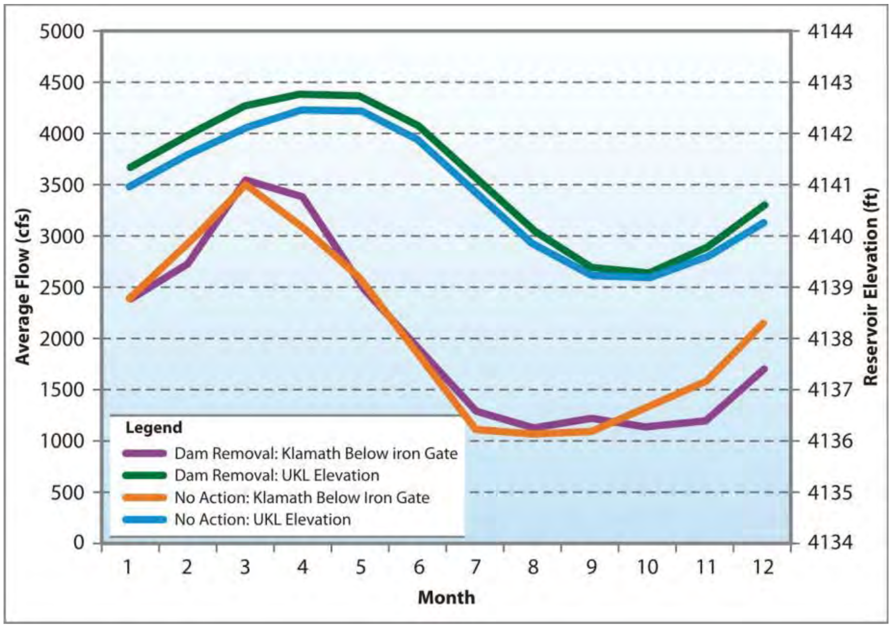
NOAA Fisheries Service (2010) creates an opportunity in their biological opinion to increase fall and winter flow variability by making available 18,600 acre-feet of water in Upper Klamath Lake to mimic important natural hydrographic features, such as maintaining higher base flows following extended periods of precipitation to reflect the natural ascension from peak flows or increasing the magnitude of peak flow events (flushing flows). The use of this 18,600 acre-feet was first used in February 2011 to create a "high-flow" event. Relatively high flows were maintained for six days at Iron Gate Dam, peaking at around 4,100 cfs and topping any flows at this gage since the spring of 2006. While this "high flow" event was successful, the presence of the Four Facilities made it logistically difficult. Moreover, releases from Upper Klamath Lake had to be scheduled in advance and thereby limited opportunities to time this additional release of water from Upper Klamath Lake to correspond with a natural high-flow event in order to produce even a larger peak flow.

NOAA Fisheries Service (2010) also calls for increased springtime discharges in certain years (typically average and wetter than average years) to improve habitat quantity and quality for coho salmon in multiple critical mainstem reaches. The existing habitat conditions reduce the fitness of rearing coho and smolts that would otherwise experience beneficial habitat conditions and improved survival.

Comparison of Dam Removal with KBRA to Dams Remain without KBRA – Modeling likely KBRA flows in the Klamath River is challenging. Requirements of the KBRA flow model (WRIMS Run 32 Refuge as referenced in Reclamation 2012g) include: (1) delivering water to farms and refuges as prescribed in KBRA, (2) being protective of flow needs for ESA listed coho salmon in the Klamath River, (3) being protective of Upper Klamath Lake elevation needs for ESA listed suckers, and (4) meeting requirements 1-3 for the range of hydrologic conditions experienced in the past. The resulting KBRA flow model contains several assumptions, including estimates of variability associated with using imperfect forecasts of inflows into Upper Klamath Lake and estimates of the outcome of future water management decisions (e.g. distributing pulse flows, administering a drought plan, or redistributing water deliveries to farms and refuges during dry years). Consequently, the KBRA flow model is a reasonable manifestation of likely KBRA flows based on fulfilling the requirements above and the assumptions listed below (Reclamation 2012g):

- Minimum flow requirements of 100 and 300 cfs at the Link River and Keno dams, respectively, to meet salmon and steelhead fish passage needs.
- Minor adjustment of KBRA flow targets for use in the hydrology model for several time steps in the period July through September to improve flow conditions for adult salmon migration and to reduce the potential for fish die off.
- Incorporation of minimum Ecological Base Flow (EBF) levels during the period of March through June and during the months of August and September. The EBF volumes are those proposed by the Hardy Phase II 95% exceedence flow levels (Hardy et. al. 2006).
- Minor downward adjustment to the flow targets for March in wetter water years.
- Incorporation of minimum base flows of 800 cfs for October through February.
- Minor adjustments were made to Upper Klamath Lake elevation criteria in association with shortage adjustments.

Figure 4.1-10: Average monthly flows at Iron Gate Dam and Upper Klamath Lake (UKL) elevations for two scenarios: dams remain without KBRA and dam removal with KBRA (Reclamation 2012g).



Hydrographs of modeled KBRA flows (dam removal with KBRA) and modeled biological opinion flows (dams remain without KBRA) do not differ markedly (Reclamation 2012g). This is expected because the NOAA Fisheries Service 2010 Biological Opinion incorporated several of the important strategies and targets in KBRA. Figure 4.1-10 compares the 50-year average monthly flows at Iron Gate Dam and 50-year average monthly lake elevations at Upper Klamath Lake for these two scenarios; differences in the modeled hydrology are summarized below:

- The monthly average water surface elevations in Upper Klamath Lake are slightly higher (but generally less than 0.5 feet) under dam removal with KBRA than the dams remain without KBRA for every month of the year.
- In general, the average monthly flows at Iron Gate are similar between the two scenarios. The exceptions to this are the months of October through December, where the average flows are about 200 to 400 cfs less under the dam removal with KBRA scenario, and in April, where average flows are about 300 cfs higher under dam removal with KBRA.
- For extremely dry years, July through November flows at Iron Gate Dam are commonly around 800 cfs under dam removal with KBRA whereas flows are more commonly between 1,000 and 1,300 cfs under dams remain without KBRA.
- The daily variability in flow is generally greater under the dam removal with KBRA because of the ability to incorporate pulse flows into the operational rules under the KBRA. In addition, without the dampening effect produced by the Four Facilities, the tributary inflows between J.C. Boyle and Iron Gate would create more flow variability in the Klamath River.
- Removal of Iron Gate and Copco 1 dams would result in the removal of a relatively small storage volume that slightly attenuates flood peaks. It is estimated that the peak discharge of the 100-yr flood would increase by about seven percent immediately downstream of Iron Gate under dam removal with KBRA. This increased flood potential downstream of Iron Gate Dam under dam removal with KBRA is discussed in detail in Section 4.2.1.4, *Iron Gate Dam – Mitigation Actions*.

The major differences of these two scenarios is less evident when comparing average flows and lake levels (Figure 4.1-10) and more evident when comparing other hydrologic factors. These other factors include quantities and assurances of water deliveries to farms and refuges, ability to adjust flows in real time to maximize benefits for fish and fisheries, and restoring natural sediment and streambed transport within and downstream of the Hydroelectric Reach to improve fish habitat and reduce incident of fish disease. The NOAA Fisheries Service 2010 and USFWS 2008 biological opinions were designed to improve conditions for listed fish, but they do not address the many other water issues in the basin or necessarily resolve water conflicts among stakeholders. Through long negotiations, the KBRA Water Resources Program (Part IV), together with KHSA dam removal, were developed to simultaneously address water issues related to depressed fisheries; water shortages for agriculture, ranching, and National Wildlife Refuges; and flow and lake-level requirements for the three ESA listed fish species. Important programs and plans in the KBRA that differ from flow management plans under dams remain without KBRA scenario (i.e. NOAA Fisheries Service 2010 and USFWS 2008 biological opinions) are discussed below.

Water demand from Reclamation’s Klamath Project has typically been greater during drier water years than in wetter years (see Figure 4.1-6). These high demands for irrigation water in dry years have led to direct conflicts with environmental requirements to maintain critical habitats for fishery resources in Upper Klamath Lake and the river downstream (Hetrick et al. 2009). Under KBRA, there would be March through October limitations on Reclamation’s Klamath Project irrigation deliveries based upon water availability (see Figure 4.1-6), ranging from 330,000 acre-feet in dry years to 385,000 acre-feet in wet years. Compared to 1961 to 2000, this would reduce deliveries about 10 to 25 percent in dry years. In exchange for delivery limitations, KBRA provides much higher certainty of irrigation water deliveries of 330,000 acre-feet or more in all year types. In contrast, curtailment of deliveries would likely occur in about 1 in 10 years with dams remain without KBRA and with possible deliveries less than 100,000 acre-feet (Reclamation 2012g).

Implementation of KBRA would, for the first time in more than 100 years, provide a water allocation[1] for the Lower Klamath National Wildlife Refuge, thereby increasing the certainty of water deliveries even in most dry years (see Section 4.4.8, *Refuges*). The critical April through October water deliveries to this refuge would equal or exceed 48,000 acre-feet in nearly 9 out of 10 years, an amount that meets the needs of the refuge. Currently, water needs of the refuge are met in less than 1 out of 10 years, with deliveries typically less than

[1] An allocation is generally referred to as a contractual or agreed upon quantity of water that could be diverted to a water user, typically over a defined period of time such as an irrigation season or contract year. A demand for water is the quantity of water a particular user needs to supply a particular water use scenario. Assumptions about land use and information about historical management practices are often used to develop demand data for modeling purposes. Delivery is the actually amount of water diverted to the water user. This can be lower than an allocation amount or demand under certain circumstances.

20,000 acre-feet. Deliveries for the November through February time period would be 35,000 acre-feet in all years under dam removal with KBRA scenario; they currently average about 12,000 acre-feet.

The Off-Project Program increases the annual inflow of water to Upper Klamath Lake by 30,000 acre-feet through the voluntary sale or retirement of valid surface water rights for irrigation, forbearance agreements, or by other means. Under dams remain without KBRA, this water would remain in agricultural and ranching production.

As noted above, the differences in monthly average flows between the two scenarios are relatively small; however, management of river flows would be greatly simplified without the operational and logistical limitations that currently exist with the Four Facilities in place. Dam removal with KBRA would allow for real-time management of peak and low flows that better reflect the duration, timing, and magnitude of flows that would occur under more natural conditions.

In the Klamath Hydroelectric Reach (see Figure 1-2), dam removal and KBRA flows would re-establish geomorphic and riparian channel-forming processes responsible for creation and maintenance of habitat important to anadromous and resident fish. Reestablishment of riverine habitats throughout this reach would eliminate evaporation losses and solar warming that is currently associated with the two larger reservoirs (Copco 1 and Iron Gate). Flow and water temperature regimes would return to more natural conditions both from a daily and seasonal perspective. As sediment transport within the river channel reaches equilibrium, natural channel features (point bars, alternating channels, and islands) and a functional riparian system would evolve and restore more diverse fish and wildlife habitats.

The more effective management of variable flows resulting from dam removal and implementation of KBRA would be expected to enhance natural processes downstream of Iron Gate Dam that maintain active stream channels and transport coarser sediments, create channel bars, flush fine sediment from the streambed, scour vegetation encroaching on the channel, and reestablish riparian dynamics, such as supplying the channel with large wood (NRC 2008).

The frequency of bank-full flow events is expected to increase under the KBRA because management of flows will place additional emphasis on filling Upper Klamath Lake earlier in the year. This would be accomplished by decreasing fall/winter releases from Upper Klamath Lake along with using a real-time lake-release strategy that reflects lake-inflow patterns rather than maintaining constant “flat-line flows” experienced with minimum flow requirements. When Upper Klamath Lake is full earlier in the water year, critical winter spawning habitat for endangered suckers improves and the ability to create larger spring peak flows for salmon and steelhead is enhanced.

If dams are removed and larger spring peak flows are created under KBRA, sediment transport to the lower river would increase. The transported sediment would decrease the particle size of the streambed, improve salmon spawning habitat, and reduce the magnitude of flows required to mobilize and "cleanse" the streambed in the future (Reclamation 2012g).

Peak flows that mobilize streambed sediment and carry a sediment load may disrupt the life cycle of the juvenile salmon fish pathogen *Ceratomyxa shasta* (*C. shasta*) by disrupting the habitat of its intermediate host (a polychaete) that lives in the streambed and on attached algae. More frequent bed mobilization and scour events would dislodge infected polychaetes, decrease infection rates of out-migrating juvenile salmon, and increase their survival (Hamilton et al. 2011; see Section 4.1.1.5, *Salmon Disease*).

The KBRA required development of a Drought Plan to fulfill the need for additional water management options in critically dry years that are similar to the 1992 and 1994 extreme drought years. This plan was completed in July 2011. The Drought Plan established a Klamath Drought Fund, which would be used to implement relief measures in a given year, while also taking into consideration the availability of funds for subsequent years (Drought Plan Lead Entity 2011). A technical advisory team would monitor hydrological conditions and water supply in the Upper Klamath Basin to allow for early detection of drought conditions so that water would be conserved for lake, river, refuge, agricultural, and other uses. In the instances of drought and extreme drought, the KBRA provides that water and resource management actions be taken such that no Klamath Basin interest would bear disproportionate burden or risk.

KBRA includes plans to optimize the use of groundwater for augmenting irrigation supplies in dry years. This plan calls for extensive monitoring to prevent excessive drawdown of groundwater levels and to protect flows in spring complexes that sustain streams and provide thermal refugia for fish.

KBRA provides more flexibility to manage flows and lake levels to respond to real-time climatic and biological conditions important to fishery resources. It is important to note that while the KBRA commits to implement adaptive and real-time water management, it is difficult to predict (or model) precisely how Environmental Water available under the KBRA (Section 20) would be managed in the future. But commitment of the signatory parties to adaptive management of flows offers promise for making rapid and ecologically beneficial changes to flow management based on new research findings (e.g. connections between salmon disease and flows), ideas for resolving future problems (e.g. preventing the die off of a large salmon return), or responding to unique climatic conditions to create beneficial peak flows or to store water for use at a later date for farm, fisheries, refuges, or ESA listed species.

4.1.1.2 Climate Change Effects on the Klamath Basin

Climate change is expected to result in a wide variety of effects in the Klamath Basin. In general, climate model predictions for the Pacific Northwest and Northern California include the following (U.S. Global Climate Change Research Program [USGCRP] 2009, Salathe et al. 2010, Barr et al. 2010, Federal Highway Administration [FHWA] 2010, Oregon Climate Change Research Institute [OCCRI] 2010, Reclamation 2011i):

Figure 4.1-11: Climate change projections indicate that by the end of the 21st century, more precipitation will fall as rain than snow throughout northern California and the Pacific Northwest, affecting seasonal hydrology in the Klamath Basin.

Water Quality Changes Due to Climate Change

Effects on water quality in the Klamath Basin due to increasing air temperatures and changing precipitation patterns under climate change will vary by location. In general, the physical, chemical, and biological processes responsible for controlling the quality of surface waters are likely to be affected; however, the timing, magnitude, and consequence of these impacts are not well understood (Lettenmaier et al. 2008, Reclamation 2011i). Impacts to water quality in the Klamath Basin may include the following (Barr et al. 2010):

- Decreased and fluctuating dissolved oxygen content from more rapid cycling of detritus.
- Increased nutrients, turbidity and organic content from increased runoff and wildfires.
- Earlier, longer, and more intense algae blooms due to warmer water temperatures and increased nutrient availability.

Vegetation Changes Due to Climate Change

In general, an increased risk of watershed vegetation disturbance is anticipated due to increased wildfire potential (Reclamation 2011i). An estimate by Barr et al. (2010) indicates that by the end of the 21st century the percentage of the Klamath Basin burned annually by wildfires will increase 11 to 22 percent compared to current levels.

Figure 4.1-12: Wildfire incidence in the Klamath Basin will increase under climate change.

Warmer winters and longer growing seasons may also increase the frequency and intensity of insect and pest attacks (Reclamation 2011i), such as those of the mountain pine beetle, and disrupt plant pollinator life cycles. Under climate change, vegetation types may shift as conditions favoring one type (e.g., oak/madrone assemblages) are replaced by conditions favoring another type (e.g., conifer assemblages) (Barr et al. 2010). In addition, decreased soil moisture and increased evapotranspiration may result in the loss of wetland and riparian habitats (Barr et al. 2010).

Along with projected changes to air temperature, precipitation, and hydrology patterns, the above vegetation-related changes could also affect agricultural and grazing practices in the Klamath Basin, requiring additional irrigation and/or pesticide use for cropland and livestock.

- Increased average air temperature
- Increased number of extreme heat days
- Changes to annual and seasonal precipitation, including diminished snow pack, more winter rain, and lower summer flows
- Increased heavy precipitation events
- Changes to annual and seasonal stream flow and groundwater levels
- Changes in water quality (see sidebar)
- Vegetation changes (see sidebar on next page)

The primary effects of climate change at the scale of the Klamath Basin are discussed further below, as well as the anticipated ecosystem responses to climate change under both dams remain and dam removal scenarios.

Air Temperature

Numerous climate change models predict that air temperatures in the Pacific Northwest and the Klamath Basin will increase over the next 50 to 80 years, such that by the middle of the 21st century average annual air temperatures in the basin will increase by approximately 1.1 to 2.2°C (2 to 4°F), and by the end of the century, they will increase by approximately 2.2 to 3.9°C (4 to 7°F). An example set of model results is shown in Table 4.1-4. As part of efforts to identify the risks and impacts associated with current and future climate on long-term water supply in the Klamath Basin, Reclamation predicts annual air temperature increases during the 21st century of approximately 2.8 to 3.3°C (5 to 6°F) (Reclamation 2011i), falling within the somewhat broader end-of-century range reported by other studies.

Table 4.1-4: Projected Increases in Average Annual Air Temperature

Region	Next Two Decades	Mid-21st Century	End of 21st Century
Pacific Northwest	+1.7 °C[1] (+3.0 °F)	+2 to 2.8 °C[1] (+3.6 to 5.0 °F)	+2.8 to 4.6 °C[1] (+5.1 to 8.3 °F)
Klamath Basin	---	+1.2 to 2 °C[2] (+2.1 to 3.6 °F)	+2.6 to 4 °C[2] (+4.6 to 7.2 °F)

Source: [1]USGCRP 2009, [2]Barr et al. 2010

Precipitation and Hydrology

Mean precipitation is also projected to change gradually from existing precipitation averages, although uncertainty is high, resulting in mixed results for precipitation projections from existing climate models. By the end of the 21st century, projections in the Klamath Basin exhibit a wide range, from an 11 percent reduction of annual precipitation levels to a 24 percent increase, depending on the climate model (see Table 4.1-5). While the change in annual precipitation projected for the Pacific Northwest may increase or decrease (Salathe et al. 2009, OCCRI 2010), the seasonal changes in precipitation type are more certain. In the Klamath Basin, some winter snows will be replaced by winter rains and result in earlier and higher winter and spring (December–March) stream flows and lower late spring and summer (April–July) stream flows (USGCRP 2009; Barr et al. 2010, Reclamation 2011i). Simulated changes in decade-mean runoff in the Klamath Basin follow this same pattern, but vary by sub-watershed (Reclamation 2011i). Projected changes to groundwater hydrology under climate change may also decrease late summer stream flows in the Klamath Basin, including alterations of the timing and amount of recharge, increases in evapotranspiration, declines in the groundwater table, and increases in pumping demand (OCCRI 2010, Reclamation 2011i). As with stream flow predictions, climate change effects on groundwater are expected to vary by sub-watershed (Reclamation 2011i).

Table 4.1-5: Projected Seasonal and Annual Changes in Precipitation

Region	Season	Next Two Decades	Mid-21st Century	End of 21st Century
Pacific Northwest	Winter	+3 to +5%[1]	+5 to +7%[1]	+8 to +15%[1]
	Spring	+3%[1]	+3 to +5%[1]	+5 to +7%[1]
	Summer	-6%[1]	-8 to -17%[1]	-11 to -22%[1]
	Fall	+3 to +5%[1]	+5%[1]	+7 to +9%[1]
Klamath Basin	Summer	---	-15 to -23%[2]	-3 to -37%[2]
	Winter	---	+1 to +10%[2]	-5 to +27%[2]
	Annual	---	-9 to +2%[2]	-11 to+24%[2]

Source: [1]USGCRP 2009, [2]Barr et al. 2010

Water Temperature

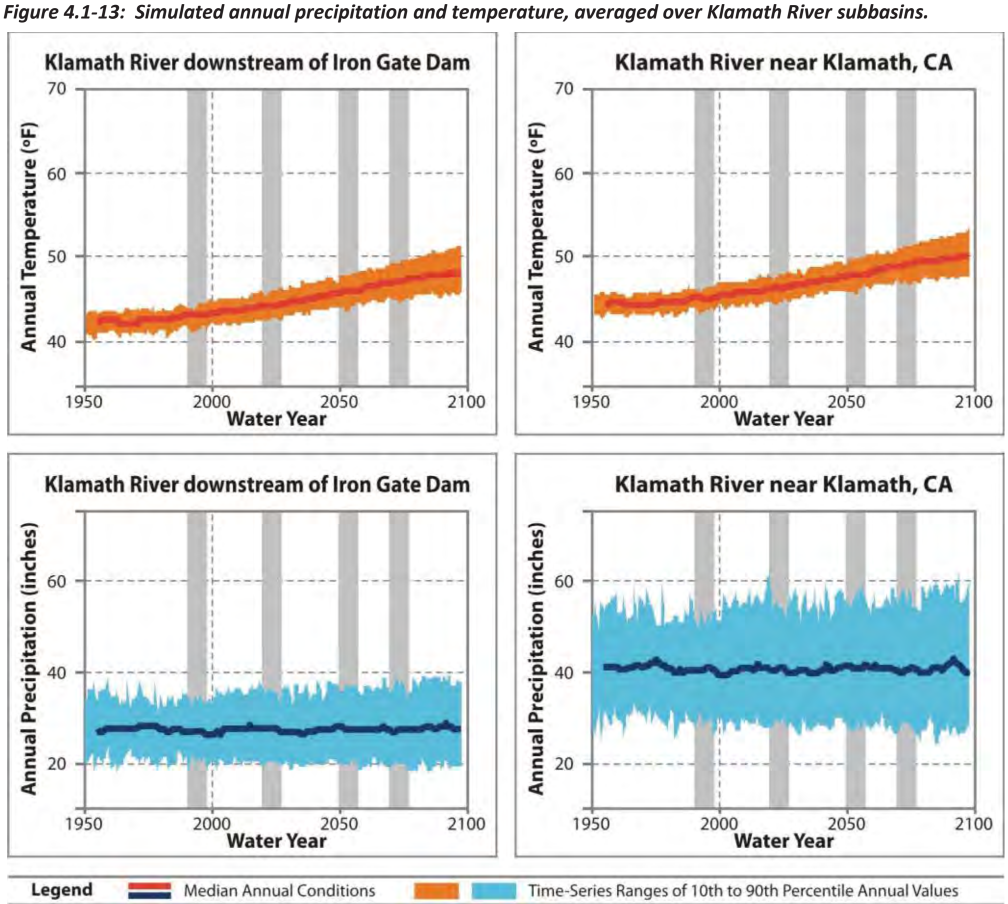
Changes to air temperatures, precipitation, and flow patterns will result in corresponding changes to water temperatures in the Klamath Basin. As discussed in Section 4.1.1.4, *Water Quality*, water temperature is a fundamental aspect of fish habitat and health, affecting the timing of migration and spawning; egg incubation and hatching; feeding and growth rates; responses to predation or susceptibility to disease; and growth of aquatic vegetation and invertebrates. Increasing air temperatures and decreasing summer flows in the Klamath Basin would be expected to cause annual increases in water temperatures. Bartholow (2005) estimates that the basin-wide increase in water temperatures would be 0.5°C per decade, or 2.5°C over the next 50 years. This estimate is based on current conditions (i.e., dams in place); modeling conducted as part of the Secretarial Determination studies includes consideration of dam removal (Perry et al. 2011) and is discussed further below.

Ecosystem Response to Climate Change as Affected by Dams In and Dams Out Scenarios

Broader climate change predictions (i.e., air temperature, precipitation, general hydrology, and annual average water temperature) are generalized for the Klamath Basin such that the anticipated ecosystem response would not be appreciably different under either dams remain or dam removal scenarios. Since climate change predictions are based largely on comparisons to current conditions, ecosystem response to climate change under a dams remain scenario would be similar to the information presented above for impacts related to hydrology, water temperature, water quality, and vegetation changes.

In contrast, dam removal and KBRA implementation would improve ecosystem resilience to climate change by offsetting some of the associated impacts. This is particularly important for water temperatures during the late summer/early fall. As described in Section 4.1.1.4, *Water Quality*, dam removal would increase spring water temperatures by approximately 1 to 2.5°C (1.8 to 4.5°F) and decrease late summer/early fall water temperatures by approximately 2 to 10°C (3.6 to 18°F), returning approximately 160 miles of the Klamath River, from J.C. Boyle Reservoir (RM 224.7) to the Salmon River (RM 66), to a more natural thermal regime. The return of cooler water temperatures during the late summer and early fall would more closely mimic natural daily and seasonal conditions favorable for rearing, migration, spawning, and incubation for anadromous salmonids, particularly fall-run Chinook salmon. This effect would begin immediately upon removal of the dams. In the longer-term (i.e., 50 years into the future), modeling studies including the effects of climate change indicate that removal of the reservoirs would result in up to a 4°C (7.2°F) decrease in late-summer/fall water temperatures immediately downstream of Iron Gate Dam (Perry et al. 2011) (see also Section 4.1.1.4, *Water Quality*). A decrease in water temperatures during this critical period is expected to moderate the long-term anticipated stream temperature increases due to climate change (1–3°C [1.8–5.4°F]) (see Figure 4.1-13).

Figure 4.1-13: Simulated annual precipitation and temperature, averaged over Klamath River subbasins.



Source: Reclamation 2011i

As part of the expert panel review process for the Secretarial Determination, the Coho salmon and Steelhead Expert Panel stated that dam removal would also provide thermal refuge from generally increasing water temperatures under climate change by allowing fish to access mainstem cold groundwater springs and spring-dominated tributaries in the Upper Klamath Basin (Dunne et al. 2011). Water temperatures in these groundwater areas will be buffered from the effects of climate change (Hamilton et al. 2011). Similarly, the Chinook Expert Panel stated that dam removal offers greater potential than current conditions to improve habitat and water quality conditions for fish and would help them to better tolerate climate change (Goodman et al. 2011). As described in Section 4.1.1.4, *Water Quality*, water temperatures in the Keno Reach (including Lake Ewauna) would still be overly warm during summer and fall months.

Dam removal with KBRA implementation would expand floodplain and riparian wetland habitat throughout the Klamath Basin and allow the river system to better accommodate projected changes in seasonal precipitation, including an increased frequency of heavy precipitation events from climate change (Dinse et al. 2009). This would decrease the potential for greater flooding frequency and severity anticipated under climate change. Relative to historical conditions, implementation of the KBRA Drought Plan would help to offset diminished flow during summer dry periods, which may occur more frequently and with more intensity and duration under climate change.

Dam removal and KBRA implementation would also allow sediment transport to move toward natural background conditions, increasing the mobility of the river bed material downstream of the dams and increasing its habitat value. Re-vegetation of sensitive areas in the watershed would eventually contribute new large woody debris to stream courses, increasing habitat complexity and improving habitat quality for aquatic species (see Figure 4.1-14). Further, the removal of the reservoirs would eliminate large quiescent surface waters that are subject to summer warming, evaporation, and incidence of toxic algae blooms; all of which would otherwise be exacerbated under future climate change conditions.

Figure 4.1-14: Re-vegetation projects under KBRA would help to replace large woody debris in riparian zones, improving fish habitat and ecosystem resilience to climate change.

Overall, dam removal with KBRA implementation would improve ecosystem resilience to climate change by offsetting a variety of anticipated impacts such as decreased summertime flow, increased water temperature, and negative effects on water quality, and would therefore be a benefit to aquatic species in the Klamath Basin. In particular, dam removal would moderate anticipated increases in water temperatures immediately downstream of Iron Gate Dam by returning the mainstem river to relatively cooler natural temperatures during the critical late summer/early fall period and would restore fish access to cool water springs and tributaries upstream of the Iron Gate Dam, providing long-term refuge from increases in water temperatures.

Figure 4.1-15: Map of the Klamath River indicating the rivermile markers.

4.1.1.3 Habitat Access and Quality

Iron Gate Dam at river mile (RM) 190 (see Figure 4.1-15) blocks access to Upper Klamath Basin for three anadromous salmonid species and Pacific lamprey. Prior to the construction of Iron Gate Dam in 1962, the construction of Copco 1 Dam in 1918 was the first structure to form a barrier to anadromous fish migration.

Historically, the Klamath Basin upstream of Iron Gate Dam provided spawning and rearing habitat for large populations of salmon and steelhead (Snyder 1931; FERC 1990). Based on the historical distribution of anadromous fish in the basin (Hamilton et al. 2005; Butler et al. 2010), and an assessment of the current conditions of habitat upstream of Iron Gate Dam (Huntington 2006), there are over 420 stream miles of potential habitat upstream of this migration barrier (see Figure 4.1-4). Within the Klamath Hydroelectric Reach, dam removal would allow anadromous salmonids to gain access to approximately 81 miles of additional suitable riverine, side channel, and tributary habitat (Administrative Law Judge 2006; Cunanan 2009). Anadromous fish would also gain access to historical habitats along the mainstem Klamath River upstream of J.C. Boyle Dam, as well as Upper Klamath Lake and tributaries to Upper Klamath Lake, including the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). (See "blue box" on page 108 that describes fish passage facilities at Keno and Link River dams.) Overall, there would be a potential increase in access to 49 significant

Figure 4.1-16: Dam removal would increase available habitat upstream of Iron Gate Dam including areas in the Wood River upstream of Upper Klamath Lake. (Photo courtesy of Thomas Dunklin)

tributaries in the Upper Klamath Basin (Huntington 2006). In some locations, various factors (e.g., diversions, livestock grazing, and loss of riparian vegetation) may limit use by salmonids; KBRA is aimed at improving the quality of these habitats. The Chinook Expert Panel assessment indicated that dam removal plus KBRA implementation offers greater potential than the current conditions in improving conditions for recolonization (Goodman et al. 2011).

In addition to increasing the quantity of available habitat for fish, dam removal would provide access to unique habitat features upstream of Iron Gate Dam (see Figure 4.1-17 and Table 4.1-6). These include coldwater springs and largely groundwater fed tributaries that would provide thermal refugia during summer months (Dunne et al. 2011; Goodman et al. 2011; Hamilton et al. 2011) and resilience to the potential future effects of climate change (see Section 4.1.1.4, *Water Quality*). FERC (2007) considered the Copco 2 Bypass Reach, and reaches inundated by Iron Gate and Copco reservoirs, to be low gradient. For these reaches, they estimated that the density of Chinook salmon spawners per mile for mainstem habitat was twice that of high gradient habitat. Dam removal would provide access for salmonids to this low gradient habitat. Downstream of Iron Gate Dam, the most notable improvements in habitat quality for fish populations from dam removal with KBRA would include a hydrograph that more closely matches natural flows (Hetrick et al. 2009); increasing spawning habitat (FERC 2007) by restoring gravel recruitment and a mobile streambed below Iron Gate Dam (Reclamation 2012g); increasing habitat complexity through river processes that create point bars, islands, and side channels; enhancing tributary habitat; improving water quality conditions; and reducing incidence of juvenile salmon disease (see Section 4.1.1.5, *Salmon Disease*).

Figure 4.1-17: Dam removal would provide access to cold water tributaries upstream of the Four Facilities (Tecumseh Springs).

Table 4.1-6: Estimated groundwater discharge (springs) into Upper Klamath River systems

River System	Section	Groundwater Flow (cfs)
Lower Williamson River and tributaries	Mouth of Williamson River up to Kirks Reef	350
Wood River and tributaries	Crooked Creek Confluence to headwaters	490
Sevenmile Creek and tributaries	Crane Creek Confluence to headwaters	90
Sprague River	South Fork Sprague to Sprague River	202
Upper Klamath Lake	Springs in Upper Klamath Lake Including Malone, Crystal, Sucker, and Barclay	350
Klamath River	Keno Dam to J.C. Boyle Powerhouse	285
Klamath River and Fall Creek	J.C. Boyle Powerhouse to Iron Gate Dam	128
Total		**1,895**

Source: Buchanan et al. 2011; USGS 2010

Benefits of Streambed Mobility

Bed load movement is vital to create and maintain functional aquatic habitat. Coarse sediment, in the form of sand, gravels, cobbles, and boulders is naturally delivered to and transported in undammed streams and rivers. Natural sediment pulses that result from heavy rainfall and snowmelt events are incorporated by stream and river processes into spawning beds, gravel bars, side channels, pools, riffles and floodplains that provide habitat and support food chains of aquatic species. These periodic inputs of coarse sediments are necessary for the long-term maintenance of aquatic habitats.

It is anticipated that implementation of the KBRA would further improve habitat access and quality for other native aquatic species throughout the Klamath Basin, excluding the Trinity River Basin upstream of its confluence with the Klamath River, which has a separate program and funding for habitat restoration (Trinity River Restoration Program). The KBRA provides for development of plans to reintroduce anadromous salmonids into the Upper Klamath Basin, excluding the Lost River or its tributaries and the Tule Lake Basin. KBRA programs would also improve water quality; increase flow variability; improve opportunities for peak flow events; improve water elevations in Upper Klamath Lake for endangered suckers; and provide specific water allocations for the Lower Klamath Lake NWR, thereby increasing likely water deliveries in most years (Mauser and Mayer 2011).

Existing Fish Passage at Link River and Keno Dams

Link River Dam: Reclamation completed construction of the new Link River Dam fish ladder in 2004 to replace an existing State of Oregon fish ladder which was long considered inadequate to allow listed suckers and native fishes to effectively find the ladder and migrate over the dam back into Upper Klamath Lake. The new ladder is a 360 foot long serpentine structure designed with a low gradient slope, slotted vertical baffles, and an entrance oriented in the center of the Link River channel to facilitate passage of bottom oriented fish species (like suckers) that are more feeble swimmers than salmonids. This ladder would provide ample passage for trout and anadromous salmonids if the Four Facilities were removed. It would also provide passage for lamprey. Based upon the first three years of preliminary sampling, it appears suckers and other native fish species are able to successfully migrate through the ladder and return to Upper Klamath Lake (Korson et al. 2008).

Keno Dam: The existing dam includes a pool and weir type fish ladder on the left abutment running from the dam crest to the left side of the spillway stilling basin, with 24 pools. The existing fish ladder is reinforced concrete with concrete baffles. A 30 inch-diameter pipe with an upstream control gate supplies attraction water to the fish entrance, with an estimated flow rate between 40 and 50 cfs. The entrance includes two fish entry openings, one perpendicular to flow and the other parallel to flow and a short distance upstream in the stilling basin sidewall. Sluice water up to 100 cfs is released from the reservoir into the stilling basin through a 36 inch-diameter pipe with an exit just upstream of the fish entrance in the sidewall. The fish exit at the dam crest includes a gated opening with trashrack and has a discharge capacity between 10 and 15 cfs.

With dam removal, a state of the art fish ladder would be proposed by Reclamation for Keno Dam, which would be comparable to the upstream fish ladder at Link River Dam. The new fish ladder would be an 8 foot-wide reinforced concrete flume with 35 pools, with adjustable steel baffles, and 23 feet of lift. To accommodate larger quantities of fish, each baffle would have two 1 foot-wide slots. The ladder would have a design flow depth of 6 feet and a design flow of 60 cfs. The TMT assumed that a new fish ladder at Keno Dam would not be designed for sucker species because the river gradient below Keno Dam would be too steep for suckers to migrate through.

A fish collection facility is included with the new fish ladder design primarily for removal (trap and haul) of fish during seasons of poor water quality in the Klamath River upstream of Keno Dam and Upper Klamath Lake. The facility would provide features for holding and sorting fish.

4.1.1.4 Water Quality

Multiple water quality constituents important to fish health would be affected by dam removal, KBRA implementation, and associated regulatory-mandated programs (i.e., TMDLs [see sidebar] and non-point source reduction programs) in support of the Clean Water Act (CWA). Following dam removal, water temperature, algal toxins, dissolved oxygen, and pH would improve downstream of the current location of Iron Gate Dam and throughout the entire Hydroelectric Reach. Over subsequent decades, additional improvements are expected elsewhere as KBRA restoration activities are implemented (Water Quality Sub-team [WQST] 2011). In general, improvements to water quality in Upper Klamath Lake and the Klamath River under dam removal with KBRA implementation would more fully support fish health and the numerous designated beneficial uses associated with fish.

Water Temperature

Water temperature is a fundamental aspect of fish habitat and health, affecting the timing of migration and spawning; egg incubation and hatching; feeding and growth rates; responses to predation; and susceptibility to disease. Throughout the mainstem Klamath River, water temperatures can be warm in the summer (>20°C [68 °F] with peak values >25°C [>77°F]; Kirk et al. 2010, NCRWQCB 2010b). With dam removal, groundwater springs upstream of Iron Gate Dam would provide cool water refugia for fish during summer months, as well as winter water temperatures conducive to the growth of reintroduced salmonids (Hamilton et al. 2011). As described above in Section 4.1.1.3, *Habitat Access and Quality*, access to groundwater habitat areas would help buffer the adverse impacts of climate change and contribute to the resilience of salmonid populations.

The KBRA includes restoration measures that would also improve water temperatures in the Upper Klamath Basin. Improved streamside shading under Phases I and II of the Fisheries Restoration Plan would decrease summer and fall water temperatures, and the KBRA Water Diversion Limitations, Water Use Retirement Program, and Interim Flow and Lake Level Program would reduce surface water withdrawals in tributaries to Upper Klamath Lake, increasing stream flows and decreasing summer and fall water temperatures in some years. While these measures would improve water temperatures in the lake's tributaries, reduced water temperatures in most open water areas, such as Upper Klamath Lake, are not anticipated (Buchanan et al. 2011), nor are temperature reductions expected just downstream of the Keno Impoundment (including Lake Ewauna), which receives discharge from Upper Klamath Lake.

Beneficial Uses and TMDLs in the Klamath Basin

Section 303(d) of the CWA requires states to identify water bodies that do not meet established water quality objectives and are not supporting designated beneficial uses. These water bodies are considered to be "impaired" with respect to water quality. The Klamath River is included on the 303(d) lists for both California and Oregon and does not meet the following fisheries related beneficial uses:

- Cold Freshwater Habitat
- Warm Freshwater Habitat
- Rare, Threatened, or Endangered Species
- Migration of Aquatic Organisms
- Spawning, Reproduction, and/or Early Development
- Estuary Habitat
- Marine Habitat

Numerous other beneficial uses related to aesthetics, cultural, agricultural, commercial, water supply, navigation, recharge, and recreation are also established, and in many cases they are impaired for the Klamath River (see Section 4.4.10, *Algal Toxins*, for additional discussion of beneficial uses).

Nine pollutant total maximum daily loads (TMDLs), which are basin wide waterbody specific water quality improvement plans, have been established to protect and restore impaired beneficial uses in the Klamath River and its tributaries by decreasing summer and fall water temperatures, nutrients, chlorophyll-a, algal toxins, and pH, and by increasing summer and fall dissolved oxygen concentrations.

(continued on next page)

Beneficial Uses and TMDLs in the Klamath Basin (cont.)

Implementation measures are outlined by the states and included in the TMDLs to attain the defined limits. The TMDLs and their implementation measures utilize an adaptive management process; as additional scientific knowledge is gained regarding factors affecting water quality in the Klamath Basin, TMDL-related management approaches may be changed. The ability to fully meet TMDL targets during the analysis period (2012 2061) remains unknown; however, dam removal with implementation of the KBRA is expected to accelerate their attainment compared to dams remain without implementation of the KBRA (WQST 2011).

Current operations at J.C. Boyle Powerhouse divert relatively warm reservoir discharges around the J.C. Boyle Bypass Reach, leaving groundwater to dominate the flows in this reach. This maintains water temperatures between 5-15°C (41-59°F) (BLM 2003; Kirk et al. 2010) in this short reach throughout the year, and provides summer and fall coldwater refugia for fish (PacifiCorp 2006). Removing J.C. Boyle Dam and restoring the use of the main channel as the primary conduit for flow would mix more upstream surface water with the spring discharges, producing warmer water temperatures from spring to fall. The Resident Fish Expert Panel (Buchanan et al. 2011) calculated that groundwater in the J.C. Boyle Bypass Reach would make up 30 to 40 percent of the total summer flow if dams were removed and that these groundwater inputs would continue to have a positive effect on water quality and temperature, and continue to enhance rearing and harvest for redband/rainbow trout.

Further downstream in the Klamath River, water temperatures are currently influenced by the presence of the two largest reservoirs, Copco 1 and Iron Gate. Temperature modeling conducted in previous studies (PacifiCorp 2005, NCRWQCB 2010b) indicates that these reservoirs delay the natural warming and cooling of riverine water temperatures on a seasonal basis such that spring temperatures immediately downstream of Iron Gate Dam are generally 1–2.5°C cooler than would be expected under natural conditions, and summer and fall water temperatures are generally 2–10°C warmer. The presence of the reservoirs exerts less influence with distance downstream, where water temperatures are progressively more influenced by the natural heating and cooling regime of surrounding air temperatures and tributary inputs. By the time water reaches the Salmon River (RM 66), the effects of the reservoirs on water temperature are not discernable (PacifiCorp 2005, NCRWQCB 2010b).

Figure 4.1-18: Removing J.C. Boyle Dam would increase summer water temperatures in the 4-mile reach just downstream of J.C. Boyle Dam, but it would not affect groundwater springs that would continue to serve as refuge habitat for coldwater fish.

Similar trends are apparent when climate change is included in model projections; results of a more recent water temperature modeling effort using the U.S. Environmental Protection Agency's (USEPA's) RBM10 model indicate that by the end of the 50-year analysis period (2012 to 2061), climate change will increase water temperatures throughout the Klamath Basin by 1–2°C over historical values (Perry et al. 2011). While this temperature range is slightly lower than that suggested using prior estimates of basin-wide climate change (i.e., 0.5°C per decade or 2.5°C over 50 years [Bartholow 2005]), the predictions of Perry et al. (2011) suggest that water temperatures in the Upper Klamath Basin could increase on the order of 1–3°C during the period of analysis. Despite the long-term warming anticipated under climate change, the primary effect of dam removal would be to restore a more natural thermal regime to the Klamath River from J.C. Boyle Reservoir downstream 160 miles to the confluence of the Salmon River (Perry et al. 2011).

The RBM10 results (including climate change) also indicate that the annual temperature cycle downstream of Iron Gate Dam would shift earlier by approximately 18 days within the first year following dam removal, with 1–2°C warmer temperatures in spring and early summer and up to approximately 4°C cooler temperatures in late summer and fall immediately downstream of the dam (Perry et al. 2011) (see Figure 4.1-19). The return of cooler water temperatures during the late summer and early fall will more closely mimic natural daily and seasonal conditions favorable to support rearing, migration, and earlier spawning and incubation for anadromous salmonids, particularly fall-run Chinook salmon. Available information suggests that re-establishment of a natural thermal regime with diel fluctuation would result in faster growth and earlier outmigration of rearing salmon (Bartholow et al. 2005; FERC 2007; Hoar 1988; Sykes 2009). This change in timing of emigration is likely to decrease the probability of large-scale outbreaks of disease in juvenile salmon populations that have occurred in the Klamath River during late spring to summer when ambient air temperatures increase and tributary and mainstem flows decrease. At the confluence with the Scott River (RM 143), the differences from dam removal would be diminished, but there would still be a slight warming (<1°C) in the spring and cooling (1–2°C) in the late summer and fall (see Figure 4.1-19). Further downstream, at the confluence with the Salmon River (RM 66), water temperature changes would not be discernable (not shown). The Chinook Expert Panel (Goodman et al. 2011) assessment indicated that dam removal plus KBRA implementation offers greater potential than the current conditions for improving conditions for water quality.

Figure 4.1-19: Modeled water temperatures during the fall-run 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 and KBRA implementation 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.

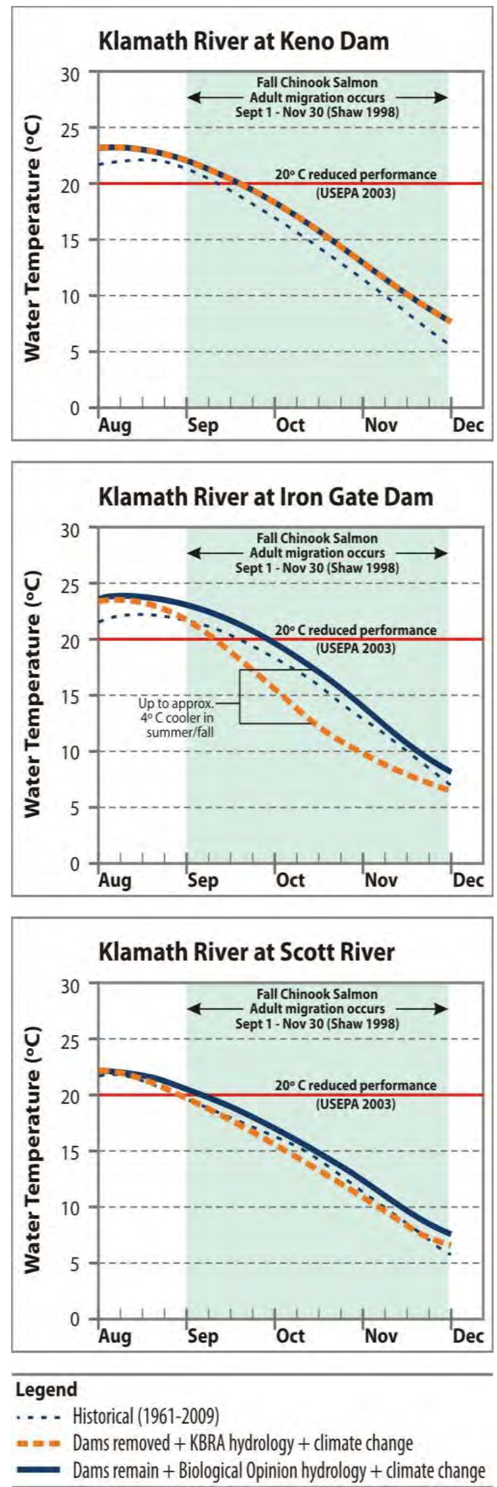
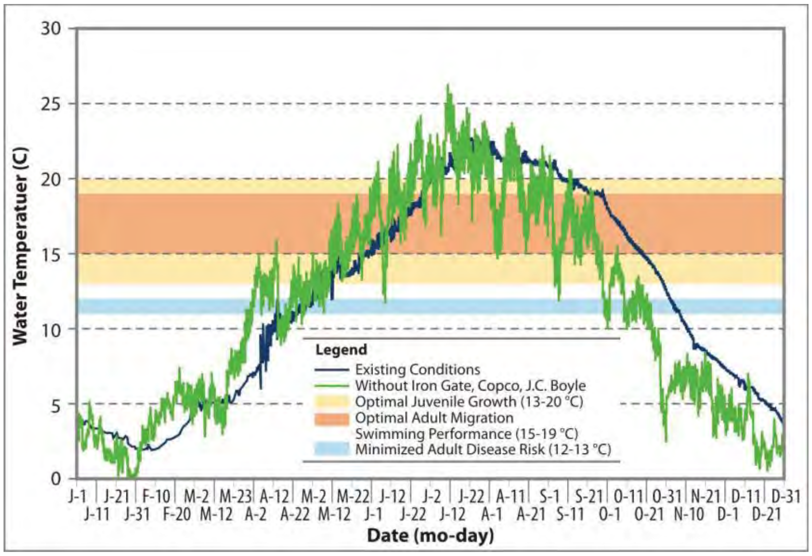


Figure 4.1-20: PacifiCorp (2005) simulated hourly water temperatures below Iron Gate Dam during critical life history periods for Chinook salmon. Modeled temperatures are based on a dry water year (WY 2002) for existing conditions compared to dam removal, and USEPA (2003) water temperature criteria for salmonid growth and migration.



Removal of the reservoirs would also return water temperatures below Iron Gate Dam to a more natural pattern of wider hourly fluctuations (see Figure 4.1-20). This effect would be most pronounced just downstream of Iron Gate Dam, decreasing with distance downstream. By the confluence of the Salmon River (RM 66), the river would have similar hourly water temperature fluctuations with or without the dams in place.

The highest temperatures experienced by aquatic species in the mainstem river would increase during summer (June through August) if dams were removed, which has the potential to increase physiological stress, reduce growth rates, and increase susceptibility to disease during summer (see Figure 4.1-20). However, FERC (2007) states that an increase in average and maximum daily temperatures may be compensated for by lower temperatures at night. NRC (2004) and Huntington and Dunsmoor (2006) conclude that cooler water temperatures at night and in the morning may allow rearing fish to move out of temperature refugia to forage, allowing growth to occur even when ambient day time temperatures are above optimal. Foott et al. (2012) observed positive growth and no overt effect of elevated water temperature on immune function or fitness in Klamath River juvenile Chinook salmon held over a 23-day period under laboratory conditions that simulated fluctuating diurnal water temperatures similar to what would occur under more natural conditions in the Klamath River near and immediately downstream of the site of Iron Gate Dam if the Four Facilities were removed. Salmon in the Klamath River have been observed to use cooler hours to migrate between thermal refugia (Belchik 2003), and the decrease in minimum daily temperatures during the spring, summer, and fall if dams were removed would be a benefit for fish (see Figure 4.1-20). Nighttime cooling of water temperatures has been shown to be important to salmon in warm-water systems, providing regular thermal relief and time for repair of proteins damaged by thermal stress (Schrank et al. 2003, NRC 2004). Overall, reductions in minimum daily temperatures associated with dam removal would benefit salmon in the Klamath River mainstem, helping them to tolerate the warmer periods of the year when dwelling in the mainstem, but also allowing feeding excursions when confined to refugia during the warmer times of the day.

Nutrients

Nutrients, especially nitrogen and phosphorus, are a fundamental and normal component of any aquatic ecosystem. At sufficient levels, nutrients stimulate primary productivity (i.e., algal or plant growth), thereby supporting the base of the food web. When present in excess, nutrients can contribute to degradation of water quality and impairment of beneficial uses. However, except in extreme cases, nutrients alone do not impair fish health. Rather, high levels of nutrients can cause indirect impacts on water quality and fish health through their biostimulatory effect on algal growth, which in turn can result in low dissolved oxygen and high pH conditions.

In the Klamath Basin, relatively high levels of phosphorus present in volcanic rocks, soils, and groundwater have been identified as a major source of phosphorus loading to Upper Klamath Lake (ODEQ 2002). Phosphorus in the soil can be released to surface waters naturally (e.g. from groundwater discharge) and during land disturbing activities, such as farming, grazing, timber harvest, and road building. One large source of both phosphorus and nitrogen has come from tens of thousands of acres of former wetlands near Upper Klamath Lake that were drained and converted to farmland and pasture land. Annual cycles of flooding, draining, and agricultural/grazing activities oxidized the peaty soils, causing many feet of land subsidence, and exporting large nutrient loads to the lake and to the downstream river for nearly a century (Snyder and Morace 1997). Inputs of nutrients from all these sources have been linked to degradation of water quality (e.g., cyanobacteria blooms, low dissolved oxygen, and high pH) in Upper Klamath Lake (Figure 4.1-21) and the Klamath River.

Figure 4.1-21: Schematic of general nutrient inputs, internal loading, and algal growth in Upper Klamath Lake. As the lake is relatively shallow (mean depth of 8 feet at mean summer elevation [Wood et. al. 1996]), seasonal separation of warmer surface waters from colder bottom waters (thermal stratification) is typically intermittent.

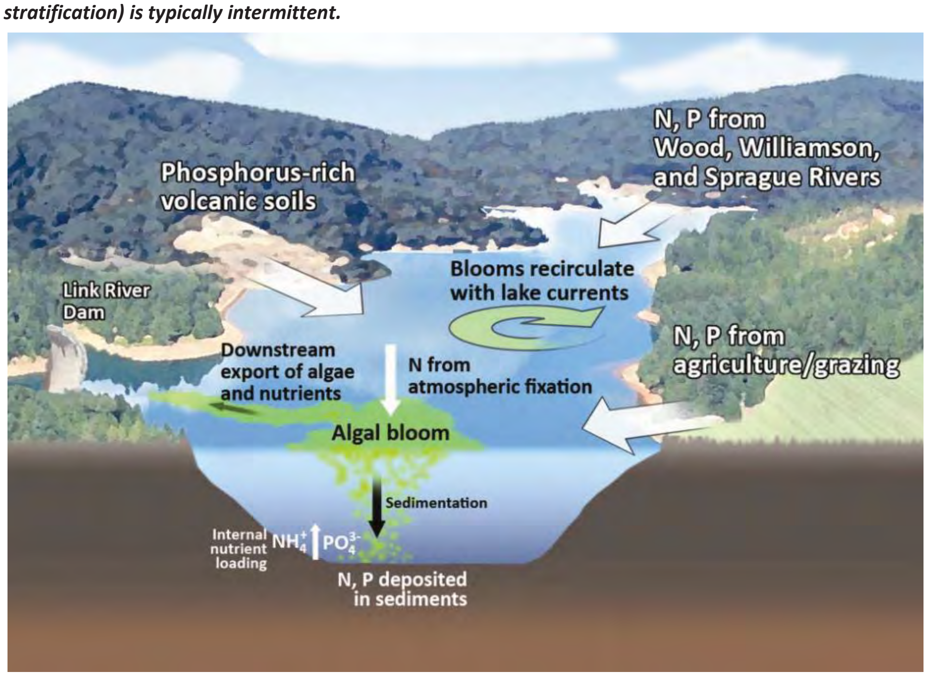
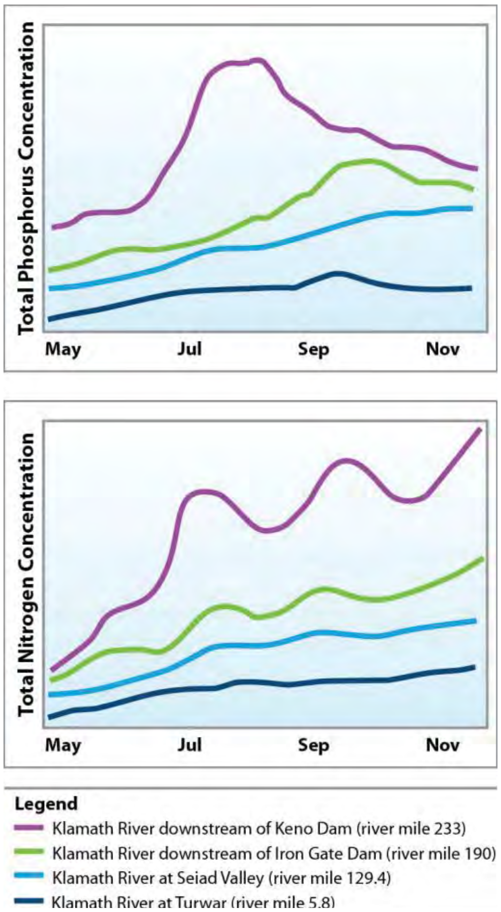


Figure 4.1-22: Total phosphorus and total nitrogen concentrations tend to decrease from upstream to downstream in the Klamath River, with the most pronounced peaks occurring downstream of Keno Dam during summer and fall months. Simplified spatial and temporal patterns illustrate generalized trends reported for 2001-2005 in Asarian et al. (2010).



Large phosphorus loads entering Upper Klamath Lake have enriched bottom sediments by roughly a factor of two for total phosphorus in the upper 5 to 15 centimeters (Simon and Ingle 2011). Internal loading of phosphorus from these bottom sediments occurs during late spring through summer and typically exceeds 50 percent of the total annual load (Kann and Walker 1999). The observed relationship between internal phosphorus loading and water temperature in the lake suggests that a biological mechanism is driving seasonal phosphorus dynamics, such as microbial decomposition and high densities of invertebrates in the lake sediments (Kuwabara et al. 2010). Internal sources of nitrogen to Upper Klamath Lake, primarily atmospheric fixation by the cyanobacteria (blue-green algae) *Aphanizomenon flos-aquae*, exceed the external sources (Kann and Walker 1999), which include upland soil erosion, runoff, and irrigation return flows from agriculture (ODEQ 2002).

Water quality in the Keno Impoundment is strongly influenced by outflows from Upper Klamath Lake, as well as agricultural return flows. Extensive monitoring and research conducted in the Upper Klamath Basin show that Upper Klamath Lake is a major summertime source of dissolved and particulate nitrogen and phosphorus to the Keno Impoundment. Particulate nutrients are primarily due to large amounts of *A. flos-aquae* that are transported downstream during summer and fall (ODEQ 2002; Sullivan et al. 2011). However, habitat for *A. flos-aquae* is poor in the Keno Impoundment, likely due to reduced hydraulic mixing (Sullivan et. al. 2011). As a result, algae transported from Upper Klamath Lake in the summer and fall generally settle and die in the Keno Impoundment, followed by bacterial decomposition of the algae and associated consumption of dissolved oxygen. Given access to this reach of the Klamath River, the combination of warm summer water temperatures and low dissolved oxygen could act to seasonally block migration of fall-run adult Chinook salmon through the Keno Impoundment (DOI 2007; NOAA Fisheries Service 2007). Restoration aimed at reducing the severity of these conditions is addressed in the TMDL standards for this reach (ODEQ 2010), a restoration component of the KBRA, and is also a subject of the Interim Measures under KHSA (WQST 2011). Seasonal trap and haul of migrating fall-run adult Chinook around Keno Reach is an envisioned component of the KBRA in some years following dam removal until water quality improves.

Total phosphorus (TP) and total nitrogen (TN) levels in the Klamath River generally decrease with distance downstream of Upper Klamath Lake due to particulate trapping in the Keno Impoundment. Nonetheless, nutrient and organic matter exported from the Keno Impoundment are a major source of TP and TN to the reservoirs in the Klamath Hydroelectric Reach (Asarian et al. 2010). On an annual basis, nutrients typically continue to decrease through the Klamath Hydroelectric Reach due to the settling of particulate matter and associated nutrients in the relatively deep Copco 1 and Iron Gate reservoirs (see Figure 4.1-22). Internal loading of nutrients occurs in these reservoirs with dissolution and release of ortho-phosphate (PO_4^{3-}) and ammonium (NH_4^+) occurring during periods of thermal stratification and hypolimnetic anoxia. Because Copco 1 and Iron Gate reservoirs are relatively deep (47 feet and 62 feet mean depth, respectively), seasonal stratification is stable and lasts for months. On a seasonal basis, TN and TP can therefore increase downstream of the reservoirs due to the release (export) of dissolved forms of nitrogen and phosphorus to the water column (see Figure 4.1-22).

Analyses of the long-term effects of dam removal on nutrients have been conducted by PacifiCorp (FERC 2007), NCRWQCB (2010b), and the Yurok Tribe (Asarian et al. 2010). While an earlier analysis by Asarian et al. (2009) suggested similar levels of net retention of TN and TP by the dams on an annual basis (11-12 percent) and emphasized the seasonal release of TP and TN with respect to nutrient budgets in the river, results of the later evaluation (Asarian et. al. 2010) indicate that dam removal would result in a relatively larger increase in long-term TN concentrations in the Klamath River immediately downstream of Iron Gate Dam. Based on this analysis, TP concentrations just downstream of the dam would increase 2–12 percent for the June through October period, while increases in TN concentrations would be larger, at an estimated 37–42 percent increase, for this same time period (Asarian et al. 2010). Anticipated increases in nutrient concentrations downstream of the Klamath Hydroelectric Reach would diminish with distance from Iron Gate Dam due to tributary dilution and nutrient assimilation (nutrient retention), which includes both uptake of nutrients by periphyton [attached algae] and microbial denitrification.

Despite the overall increases in absolute nutrient concentrations anticipated with dam removal, the amount of primary productivity (i.e., growth of periphyton) in the river downstream of Iron Gate Dam may not change substantially because nutrients may not be limiting primary productivity in this portion of the Klamath River (FERC 2007, Hoopa Valley Tribe Environmental Protection Agency (HVTEPA) 2008, Asarian et al. 2010). Further downstream, the periphyton species in the lower reaches of the Klamath River include species that obtain nitrogen directly from the atmosphere (Asarian et al. 2010), indicating nitrogen limitation in that reach and confirming that in-river retention can reduce river nutrient concentrations significantly. While nutrient dynamics of the reservoirs may be too uncertain to predict in detail, associated pH and dissolved oxygen problems (driven by high nutrient concentrations) are manifested differently in rivers than in reservoirs. Nonetheless, it is likely that the river would continue to experience high primary productivity (and associated wide diel fluctuations in dissolved oxygen and pH) during the summer months until restoration efforts can reduce nutrient exports from the upper basin (above Keno Dam).

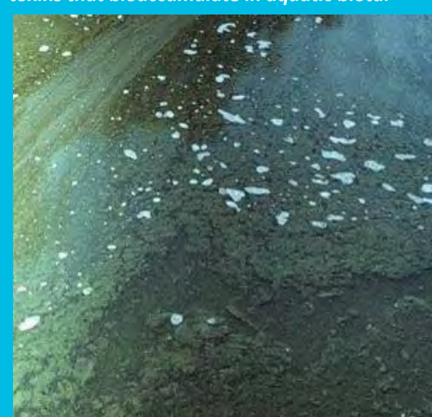
In addition to dam removal, multiple interim measures stipulated in the KHSA could affect water quality, either directly or indirectly (WQST 2011). Under Interim Measures 10 and 11 in the KHSA, a number of consensus-based nutrient treatment project options for the Upper Klamath Basin were identified and retained for further evaluation using criteria developed by experts and participants at a Sacramento, California workshop in September 2012. These projects include wetland treatment systems, wastewater treatment systems, algae/biomass removal, ambient water treatment systems, sediment nutrient sequestration, sediment removal, wetland restoration, oxidation technologies,

Algal Toxins and Aquatic Biota

Cyanobacteria (blue-green algae), like other species of algae, can be a nuisance aquatic species, occurring as large seasonal blooms in lakes and reservoirs and altering surrounding water quality. Some cyanobacteria species, such as *Microcystis aeruginosa*, can produce toxins (microcystin) in concentrations that cause public health concerns (see Section 4.4.10, *Algal Toxins*) and build up ("bioaccumulate") in the tissue of aquatic biota, such as mussels.

Summertime blooms of cyanobacteria occur in Upper Klamath Lake, which include some instances of *M. aeruginosa* presence (see Section 4.4.10, *Algal Toxins*). The U.S. Geological Survey (USGS) conducted a study of the presence, concentration, and dynamics of microcystin in Upper Klamath Lake, particularly as related to Lost River sucker (*Deltistes luxatus*) and short nose sucker (*Chasmistes brevirostris*) exposure (Vanderkooi et al. 2010).

Figure 4.1 23: Summertime blooms of cyanobacteria (blue green algae) can produce toxins that bioaccumulate in aquatic biota.



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Algal Toxins and Aquatic Biota (cont.)

Large blooms of *M. aeruginosa* occur during summer months in Copco 1 and Iron Gate reservoirs and have been documented as the cause of high microcystin concentrations in the reservoirs themselves and in the Klamath River downstream of Iron Gate Dam (see Section 4.4.10, *Algal Toxins*).

Although it is not yet known the extent to which microcystin in fish and/or invertebrate tissues adversely affects the aquatic organisms themselves, 85 percent of fish and mussel tissue samples collected during July through September 2007 in the Klamath River, including Iron Gate and Copco 1 reservoirs, exhibited microcystin bioaccumulation (Kann 2008; Kann et al. 2011). Estuarine and marine nearshore effects (e.g., sea otter deaths) from cyanobacteria exposure have been reported in other California waters; however, none have been documented to date for the Klamath Estuary or the marine nearshore environment (Miller et al. 2010).

Under a dam removal with KBRA implementation scenario, the production of algal toxins in Copco 1 and Iron Gate reservoirs would be eliminated. The algae producing these toxins do not grow in a free flowing river.

and diffuse source treatment systems (WQST 2011). This preliminary set of projects creates a framework for planning long-term, sustainable improvements in water quality in the Klamath Basin, despite inherent uncertainties such as climate change. Multiple resource management actions implemented under the KBRA, such as fence construction, off-stream livestock watering, and grazing management in the upper basin, as well as floodplain rehabilitation, livestock exclusion, and road decommissioning in the lower basin (Barry et al. 2010; Stillwater Sciences 2010), would accelerate the pace of water quality improvements and increase the likelihood of approaching TMDL nutrient targets by the end of the analysis period (i.e., 2061) (WQST 2011).

In summary, although TN and TP may increase in the Klamath River downstream of the Klamath Hydroelectric Project Reservoirs under a dam removal with KBRA implementation scenario, changes to periphyton growth in the river may not occur to a degree that would increase daily fluctuations in dissolved oxygen and pH or adversely affect fish health. Over the analysis period, implementation of the KBRA and TMDLs would decrease nutrient concentrations in the Klamath River and decrease the potential for indirect effects of periphyton on fisheries-related beneficial uses.

Dissolved Oxygen

Dissolved oxygen concentrations are critical to fish health, with values of 8-10 milligrams per liter (mg/L) typically optimal (Figure 4.1-24), values less than 5 mg/L chronically stressful, and values less than 3 mg/L typically lethal (USEPA 1986). Dissolved oxygen in rivers and lakes is influenced by several factors, including water temperature, water depth and volume, stream velocity (as related to mixing and reaeration), atmospheric pressure, salinity, photosynthetic production, and respiratory consumption by aquatic organisms. The last two factors are strongly influenced by the availability of nutrients, which fuel algal and aquatic plant growth and the production of organic matter.

In Upper Klamath Lake, dissolved oxygen concentrations exhibit high seasonal and spatial variability, ranging from less than 4 mg/L to greater than 10 mg/L (Walker 2001, ODEQ 2002; Kannarr et al. 2010; Kann 2010a). High nutrient loading is the primary cause of low dissolved oxygen levels in the lake, with the lowest concentrations occurring most frequently in August, when water temperatures are high and algal blooms are declining. Downstream in the Keno Impoundment, dissolved oxygen often reaches very low concentrations (from less than 1 mg/L to 2 mg/L) during the July through October period as algae transported from Upper Klamath Lake settle out of the water column and decay (Sullivan et al. 2009; Kirk et al. 2010). Immediately downstream of Keno Dam, improvements to dissolved oxygen are substantial due to reaeration, particularly in higher gradient portions of the Klamath River downstream of J.C. Boyle Reservoir.

For fall-run Chinook salmon, increases in low summer and fall dissolved oxygen concentrations (from less than 1 mg/L to 2 mg/L) in the Keno Impoundment (including Lake Ewauna) would need to be achieved for optimal migration to occur. Until water quality improvements are realized, fall-run adult Chinook salmon would be seasonally transported around this area as needed. For the most part, transport would not be needed for other Chinook life stages (i.e., outmigrating juveniles) or for spring-run Chinook salmon. As described above in the *Nutrients* section, KBRA implementation would provide additional resources and opportunities for water quality projects to be initiated in the Upper Klamath Basin, with associated decreases in TN, TP, and organic matter loading to Upper Klamath Lake and the Keno Impoundment. Achievement of summer and fall dissolved oxygen standards in these reaches is presumed to be dependent on significant progress towards reducing nutrient and organic matter loads, which would be accelerated under the KBRA (WQST 2011).

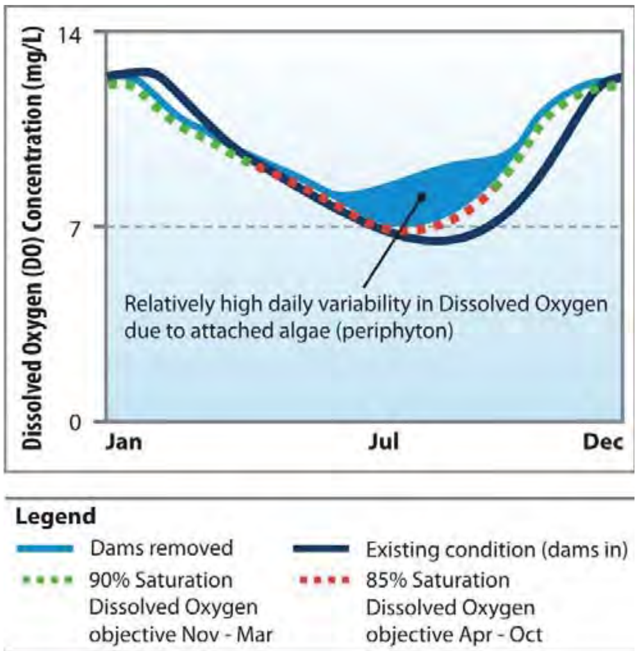
Figure 4.1-24: Optimum levels of dissolved oxygen for salmonids range from 8 to 10 mg/L.

Modeling conducted for development of the Oregon and California Klamath River TMDLs indicates that dam removal would result in increased dissolved oxygen concentrations in the Klamath Hydroelectric Reach downstream of J.C. Boyle Dam and at the Oregon-California state line during summer and fall (NCRWQCB 2010b). This Klamath TMDL model also predicts that daily fluctuations in dissolved oxygen at these locations during these same seasons may be greater following dam removal due to colonization by periphyton (attached algae), and photosynthesis (producing oxygen) and respiration (consuming oxygen) by the periphyton mats. The effect of periphyton growth in free-flowing reaches of the Klamath River following dam removal is not well quantified, but it is expected that the river would not exhibit the extreme low dissolved oxygen values that currently occur in Copco 1 and Iron Gate reservoirs during the summer and fall. As with upstream reaches, significant progress towards reducing TN and TP loading under the KBRA and the TMDL implementation programs would decrease the likelihood of extreme periphyton growth in this reach and the associated variability in summer and fall dissolved oxygen levels (WQST 2011).

Figure 4.1-25: The relatively deep Copco 1 Reservoir experiences thermal stratification and results in low dissolved oxygen (from less than 1 mg/L to 5 mg/L) in reservoir bottom waters during summer and fall months. This poor water quality affects the Klamath River downstream of Copco 1 Dam.

Surface heating of the deeper Copco 1 (see Figure 4.1-25) and Iron Gate reservoirs in the late spring and summer results in the formation of a warmer, less dense water layer on the reservoir surface (the epilimnion), which overlies colder, denser water (the hypolimnion). This process is called thermal stratification and often persists through the summer and mid-to-late fall. Thermal stratification results in dissolved oxygen conditions that range from super-saturation (i.e., greater than 100 percent saturation) in reservoir surface waters due to good light conditions and high rates of photosynthesis by planktonic algae, to hypolimnetic oxygen depletion in reservoir bottom waters due to microbial decomposition of settling algae. As a result, the dams can release water downstream with low dissolved oxygen concentrations, particularly at times in the fall when reservoir thermal stratification breaks down and the oxygen-depleted deeper water mixes with the entire water column.

Figure 4.1-26: With dam removal, dissolved oxygen in the Klamath River immediately downstream of Iron Gate Dam would more consistently achieve California North Coast Basin Plan percent saturation objectives and would be greater than dissolved oxygen under existing conditions from April through November. Dam removal may also result in greater variability in dissolved oxygen from June through October due to photosynthesis and respiration of attached algae (periphyton) that would establish in the free-flowing river. Lines on the graph represent simplified TMDL model output of hourly values.



Source: NCRWQCB 2010a

Modeling conducted for the FERC relicensing process (PacifiCorp 2005) and TMDL development (NCRWQCB 2010a) indicates that dam removal would increase seasonal dissolved oxygen concentrations in the Klamath River downstream of Iron Gate Dam, as compared with existing conditions (dams remain without KBRA). Specifically, model output indicates that with dam removal, dissolved oxygen concentrations immediately downstream of Iron Gate Dam during July through November would be greater than those under existing conditions (see Figure 4.1-26). This condition would result from the lack of stratification and oxygen depletion in bottom waters in the upstream reservoirs, combined with the improved reaeration that occurs in a free-flowing river. As with the river downstream of J.C. Boyle Reservoir, the TMDL model also predicts that daily fluctuations in dissolved oxygen just downstream of Iron Gate Dam during June through October would be greater following dam removal than under existing conditions, a condition linked to periphyton establishment in the free-flowing reaches of the river that are currently occupied by reservoirs.

Additionally, the TMDL model (NCRWQCB 2010b) indicates that following dam removal, dissolved oxygen would more consistently meet the California North Coast Basin Plan water quality objective of 85 percent saturation during April through October (see Figure 4.1-26), especially as TMDL and KBRA-related restorations are implemented (WQST 2011). Winter time (January–March) dissolved oxygen concentrations would be slightly lower with dam removal than existing conditions, but would not fall below Basin Plan minimum criteria for the winter season (90 percent saturation; see Figure 4.1-26). Differences in long-term dissolved oxygen concentrations between the two scenarios diminish with distance downstream of Iron Gate Dam, with similar predicted dissolved oxygen concentrations and daily fluctuations at Seiad Valley (RM 129.4) and no differences predicted by the confluence with the Trinity River (RM 42.5) (NCRWQCB 2010b).

pH

Optimal pH levels for fish typically range from 6.5 to 8.5 pH units. As with dissolved oxygen, pH levels in Upper Klamath Lake, the Keno Impoundment, and the Klamath Hydroelectric Reach exhibit seasonal and spatial variability. Copco 1 and Iron Gate reservoirs currently experience seasonal and daily variability, with diel (daily) fluctuations (1 to 2 pH units) occurring in reservoir surface waters during periods of intense algae blooms. Dam removal would reduce high summer and fall pH levels (i.e., levels that exceed 9 pH units) in the Klamath Hydroelectric Reach and the Klamath River downstream of Iron Gate Dam due to the elimination of in-reservoir phytoplankton blooms (NCRWQCB 2010b). As with dissolved oxygen, summer and fall colonization of attached algae (periphyton) in the free-flowing Klamath Hydroelectric Reach may result in some daily variability in pH due to photosynthesis and respiration; however, it is expected to occur to a lesser degree than under current conditions.

As with nutrients and dissolved oxygen, KBRA projects would indirectly decrease summer maximum pH values (greater than 9 pH units) in Upper Klamath Lake, the Keno Impoundment (including Lake Ewauna), and the Klamath Hydroelectric Reach (WQST 2011).

4.1.1.5 Salmon Disease

Fish diseases are widespread in the mainstem Klamath River during certain time periods and in certain years and have been shown to adversely affect freshwater abundance of Chinook and coho salmon. High infection rates have been documented in emigrating juvenile Chinook and coho salmon downstream of Iron Gate Dam during the spring and summer in some years, primarily by one or both myxozoan parasites *C. shasta* and *Parvicapsula minibicornis* (see sidebar and Figure 4.1-27). Abnormally high infection prevalence (up to 44 percent of natural origin juvenile fall-run Chinook salmon) within the native salmon population indicates that a host-parasite imbalance exists downstream of Iron Gate Dam. Evidence suggests that disease levels are adversely affecting production of juvenile Chinook and coho salmon in the lower Klamath River in some years (Nichols and True 2007; Nichols et al. 2007; Hetrick et al. 2009). While in recent years (2010 and 2011) infection prevalence was less than 30 percent, disease impacts on Chinook and coho salmon can be large. Steelhead are generally resistant to or less affected by *C. shasta* (Hamilton et al. 2011).

Other diseases known to affect salmon in the Klamath Basin include the external protozoan parasite *Ichthyophthirius multifiliis* (Ich), and the bacterial pathogen *Flavobacterium columnare* (columnaris disease). In the fall of 2002, an epizootic outbreak of Ich and columnaris disease was associated with the largest salmon die-off ever recorded in the western United States, which resulted in the mortality of tens of thousands of adult salmon (see Figure 4.1-28) (USFWS 2003; California Department of Fish and Game [CDFG] 2004). It appears that conditions favoring explosive growth of Ich and columnaris were created that year due to high densities of returning Chinook salmon, low September flows and warm water temperatures (Lynch and Risely 2003) that likely delayed and inhibited migration of adult fish further upstream (USFWS 2003).

Salmonids and their associated pathogens historically migrated to the Upper Klamath Basin; both salmon and these pathogens are native to the upper basin (Administrative Law Judge 2006) and available information suggests that the risk of potential reintroduction of pathogens to Klamath River native fish upstream of the dams would be low. Movement of recently discovered *C. shasta*

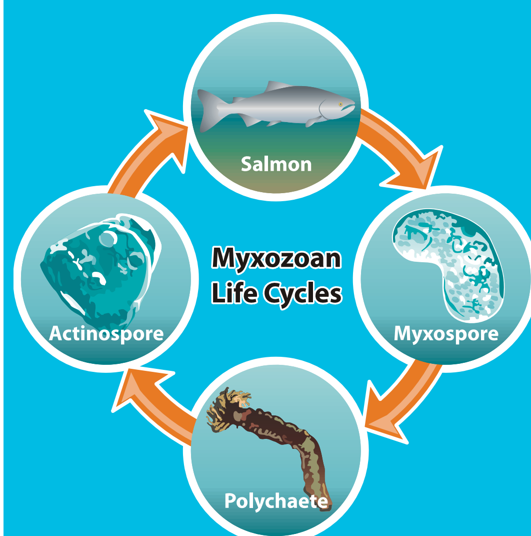
Conditions Supporting Fish Disease Downstream of Iron Gate Dam

The following habitat conditions, maintained by the presence of the dams, support salmon disease, such as *C. shasta*, downstream of Iron Gate Dam (Hetrick et al. 2009):

- Low flow variability and minimal scour from high suspended sediment concentration
- A relatively stable streambed
- Concentration of adult salmon carcasses downstream of a migration barrier
- Plankton-rich discharge from reservoirs

Highly infectious disease zones for fish are associated with dense populations of the invertebrate host (an annelid polychaete worm) in low-velocity habitats with *Cladophora* (a type of green algae), sand-silt, and fine benthic organic material in the substrate (Stocking and Bartholomew 2007).

Figure 4.1-27: Salmon are an intermediate host within the myxozoan life cycle.



genotypes upstream of the dams would affect only the host species that transported the genotype (Hamilton et al. 2011).

While it is possible that the current infectious nidus (river reaches with the high levels of infectivity) for *C. shasta* and *P. minibicornis* may move upstream where salmon spawning congregations occur, and there is associated uncertainty, the likelihood of this happening appears remote. Any creation of an infectious zone (or zones) would be the result of the synergistic effect of several factors, such as those that currently occur (with dams in place) within the disease zone in the Klamath River between Shasta River and Seiad Valley (factors noted by FERC [2007]). Under dam removal and implementation of KBRA, reestablishment of flows that more closely mimic important natural conditions, and reestablishment of natural sediment transport rates, would restore natural geomorphic channel forming processes (Hetrick et al. 2009) and create diverse habitats less favorable for disease development above Iron Gate Dam.

Figure 4.1-28: Thousands of adult salmon in the lower Klamath River died during 2002. Causative factors were low September flows, high concentration of returning Chinook salmon, and warm water temperatures, all contributing to disease.

FERC (2007) concluded that dam removal would enhance water quality and reduce the cumulative water quality and habitat effects that contribute to disease-induced salmon die-offs in the Klamath River downstream of Iron Gate Dam. There remains some uncertainty associated with the effects of dam removal, conversion of the reservoir areas to free-flowing river, and the elimination of hydropower peaking that could result in long-term increases in habitat for the intermediate host of *C. shasta* and *P. minibicornis* due to increases in available habitat along the low-gradient channel margins in the Hydroelectric Reach below J.C. Boyle Dam. However, with dam removal and KBRA implementation, improved water quality, increased variability of flows, elimination of a water temperature thermal lag caused by the reservoirs, reduced concentration of adult salmon carcasses below migration barriers, increased frequency of bedload movement, and reduced planktonic drift from reservoirs would likely alleviate many of the conditions that stimulate disease outbreaks (Hetrick et al. 2009; Hamilton et al. 2011; Bartholomew and Foott 2010). In particular, disease conditions for outmigrants from tributaries downstream of Iron Gate Dam, such as the Scott and Shasta rivers, would be improved under dam removal, whereas *C. shasta* and *P. minibicornis* would remain an issue with dams remaining. The Chinook Expert Panel concluded that dam removal with KBRA implementation offered greater potential for improving infection rates as compared with current conditions (Goodman et al. 2011).

4.1.2 Species-Specific Effects

While there is some uncertainty associated with predicting the effects of any management action, information to date indicates that the dam removal with implementation of the KBRA scenario would improve population viability for most anadromous and resident fish species (Hamilton et al. 2011). Salmon and steelhead would be able to migrate to habitat that was historically available to them (see Figure 4.1-4), increasing their production and viability in the Klamath Basin. Until summer and fall water quality is improved in the Keno Impoundment and Lake Ewauna, however, fall-run adult Chinook salmon may be dependent on seasonal trap-and-haul operations to move them around areas of low dissolved oxygen in some years (DOI 2007; NOAA Fisheries Service 2007; see also Section 4.1.1.4, *Water Quality*). Dam removal would likely benefit other native fish species, such as redband/rainbow trout, by providing additional habitat, improving habitat quality, eliminating entrainment and stranding, and increasing habitat connectivity. Dam removal itself would only minimally impact endangered Lost River and shortnose suckers because the Hydroelectric Reach reservoirs do not contribute significantly to the recovery of these species (USFWS 2006, Buchanan et al. 2011). Suckers may benefit from improved water quality in the upper basin from the programs and actions included in the KBRA.

Dam removal would change reservoir habitat to a free-flowing river, which would adversely affect non-native fishes in the Klamath River between Keno Dam and Iron Gate Dam. Abundances of largemouth bass, yellow perch, bluegill, and brown bullhead would significantly decline or be eliminated because their preferred reservoir habitat would be gone. The decline of these non-native fishes would improve conditions for native fishes, including trout, to the extent that there are adverse interactions at present from predation or competition for food (Buchanan et al. 2011). The minimal occurrence of non-native fishes in catches downstream of Iron Gate Dam provides evidence that non-native reservoir fishes would not become abundant in a newly formed free-flowing river if dams were removed (Buchanan et al. 2011).

Anticipated effects of dam removal and KBRA implementation on key native species are described in more detail below.

4.1.2.1 Chinook Salmon

Dam removal would benefit fall-run Chinook salmon (see Figure 4.1-29) by restoring access to hundreds of stream miles of historical habitat, improving water quality, improving existing spawning and rearing habitat, increasing flow variability below Iron Gate Dam, and reducing disease. It is anticipated that through natural reintroduction processes, Chinook salmon would recolonize areas upstream of Iron Gate Dam in a short period of time as was observed after barrier removal at

Figure 4.1-29: Chinook salmon would benefit from the increase in habitat and improved water quality as a result of the removal of the Four Facilities.

Major Conclusions from Chinook Salmon Expert Panel

The Chinook Salmon Expert Panel (Goodman et al. 2011) assessment was that the scenario of dam removal with implementation of the KBRA appears to be a major step forward in conserving target fish populations compared with decades of vigorous disagreements, obvious fish passage barriers, and continued ecological degradation. They concluded that a substantial increase in Chinook salmon is possible in the reach between Iron Gate Dam and Keno Dam; an increase above Keno Dam could be large but was less certain. Achieving substantial gains in Chinook salmon abundance and distribution in the Klamath Basin would be contingent upon resolving key factors, including the following:

- Limitations on access to the upper basin due to water quality problems in Upper Klamath Lake and the Keno Impoundment are resolved.
- Juvenile disease is reduced.
- Free migration into the upper basin and successful completion of their life cycle is provided.
- Harvest is managed appropriately.
- Hatchery salmon do not overwhelm genetics of colonizing populations.
- Predation in newly accessible habitat is sufficiently low.
- The buffering effect of upper basin access to groundwater springs is not overwhelmed by climate change.
- Any reduced productivity associated with lower fall flows is small.
- Impacts from dam removal do not have substantial multi-year adverse impacts on mainstem Chinook salmon.

The panel did voice strong reservations, based on their experience or knowledge of other large restoration programs, as to whether KBRA would be implemented effectively.

Overall, the panel indicated that most available information indicates that dam removal is likely to increase the abundance of naturally spawned Klamath River Chinook above that expected without dam removal. In their opinion, dams out with KBRA offers greater potential than the current conditions to improve conditions for water quality, disease, recolonization, increased harvest and escapement, predation, and tolerating climate change and changes in marine survival.

Finally, the panel concluded with certainty that if the dams are not removed, Klamath Chinook salmon would continue to decline.

Landsburg Dam in Washington (Kiffney et al. 2009). In addition, through the Fish Reintroduction Plan elements of the KBRA, Chinook salmon would be actively reintroduced into the Upper Klamath Basin so that the first returns would occur the year of dam removal.

The Chinook Salmon Expert Panel noted that the increase in Chinook salmon upstream of Keno Dam could be large, but remaining uncertainties precluded the panel from attaching a probability to the prediction based on the information provided to them (Goodman et al. 2011). The panel identified four categories of uncertainties: 1) the wide range of variability in salmon runs in near-pristine systems, 2) lack of detail and specificity about the KBRA, 3) uncertainty about an institutional framework for implementing the KBRA in an adaptive fashion, and 4) outstanding ecological uncertainties in the Klamath River system that appear not to have been resolved by the available studies to date. The panel concluded that predicted increases in abundance would be contingent upon addressing these uncertainties through resolving key factors (see sidebar on previous page, *Major Conclusions from Chinook Expert Panel*). However, the panel stated that successfully rehabilitating runs may not require resolving all factors; the more of the factors addressed, the greater the chances of success. The panel also noted that formal quantitative modeling is the preferred approach for estimating probabilities of uncertain outcomes.

Because the current low abundance and productivity of spring-run Chinook salmon are believed to limit colonization of habitats upstream of Iron Gate Dam, the Chinook Expert Panel concluded that prospects for dam removal to provide a substantial positive effect for spring-run Chinook salmon would be much more remote than for fall-run Chinook salmon (Goodman et al. 2011). However, Phase I of the Fisheries Reintroduction and Management Plan of the KBRA calls for active reintroduction of Chinook into habitats upstream of Upper Klamath Lake, which the panel did not fully consider. It is assumed that this reintroduction would include stock from both spring- and fall-runs, thus dam removal would likely also benefit spring-run Chinook salmon. Historically, adult spring-run Chinook migrated upstream of the current location of Iron Gate Dam, perhaps as early as March and likely held over the summer in large deep pools, tributaries fed by cool water, and headwater habitat upstream of Upper Klamath Lake (Snyder 1931; CDFG 1990; Moyle 2002). Dam removal provides an opportunity for spring-run Chinook salmon to become reestablished in the Upper Klamath Basin. Holding areas with suitable temperatures exist upstream of Iron Gate Dam in locations such as Big Springs in the J.C. Boyle Bypass Reach (BLM 2003), groundwater-influenced areas on the west side of Upper Klamath Lake (Gannett et al. 2007), the Wood River (Gannett et al. 2007), and the Williamson River. The Williamson River, both upstream and downstream of its confluence with the Sprague River, continues to provide deep, coldwater holding habitat (Hamilton et al. 2010). It is also likely that holding habitat exists under the reservoirs where tributaries would join the mainstem. Dam removal would make these habitats available to migrating spring-run Chinook salmon adults. The removal of dams and improvement of water quality would likely provide optimal conditions for outmigrating juveniles (Buchanan et al. 2011).

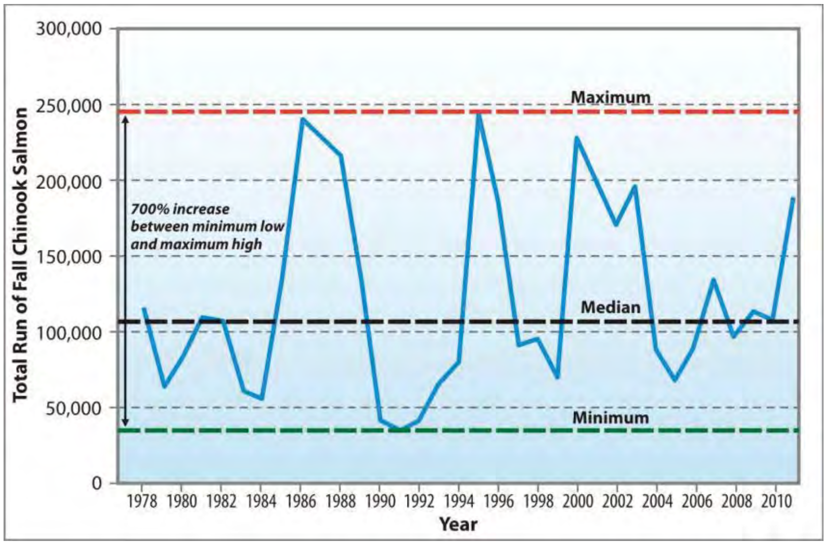
To assess whether current conditions would physiologically impair Iron Gate Hatchery Chinook salmon reintroduced into the Upper Klamath Basin, juveniles were held in test cages in Upper Klamath Lake and the Williamson River in 2005 and 2006. These juveniles showed normal development as smolts in Upper Klamath Lake and survived well in both locations (Maule et al. 2009). The authors concluded that there was little evidence of physiological impairment or significant vulnerability to *C. shasta* that would preclude this stock from being reintroduced successfully into the Upper Klamath Basin. Under a scenario of potential dam removal, it is likely that a greater diversity of salmon life histories would evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall (Bartholomew and Foott 2010).

Quantitative Model Response of Chinook Salmon Populations

Several investigations have estimated the potential response of Chinook salmon populations under conditions that would exist if the Four Facilities were removed. Oosterhout (2005) used the Klamath Risk Assessment Simulation (KlamRAS) model to evaluate thirteen different fish passage options during PacifiCorp's FERC relicense proceedings. Although the KlamRAS model structure was not adequate for predicting adult abundance, the model structure was adequate to rank-order the thirteen fish passage alternatives of which removal of the Four Facilities, as proposed in the KHSA, ranked highest for the potential to increase fall-run Chinook salmon abundance from the upper basin. Additional studies to estimate Chinook salmon population response or habitat availability upstream of Iron Gate undertaken by Huntington (2006), Dunsmoor and Huntington (2006), Lindley and Davis (2011), and Hendrix (2011) also support this conclusion. Presented below is a discussion of results from the Hendrix (2011) Chinook model that was undertaken for the Klamath Secretarial Determination. This life-cycle model estimates relative changes in Chinook salmon adult production as a result of dam removal and implementation of the KBRA, as well as changes in commercial, tribal, and sport harvest opportunities.

The Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) life-cycle production model was developed by Hendrix (2011) specifically to address the potential response of Chinook salmon populations under conditions with dam removal (removal of the Four Facilities) with KBRA relative to current conditions with dams remaining. The EDRRA model forecasts the total adult relative abundance of Chinook salmon over a 50-year period (2012-2061). The EDRRA model was based on a statistical analysis of an existing set of annual Chinook salmon field recruitment data from the Klamath Basin between 1979 and 2000 that consisted of: 1) number of natural spawners, 2) number of natural three year old recruits (progeny of the natural spawners); and 3) hatchery survival rate of out migrating juveniles. This field recruitment data set explicitly incorporated annual fish production variability into the model. The field recruitment data set was used to define future productivity in the Klamath Basin below Iron Gate Dam. Because Chinook recruitment data was not available for the Klamath watershed above Iron Gate Dam, the EDRRA model used information presented in Liermann et al. (2010) that relies on watershed and stream characteristics to develop Chinook salmon stock-production relationships (number of spawners compared to age three adults).

Figure 4.1-30: Total In-River Run Size Estimate for Fall-Run Chinook Salmon for the Klamath Basin



Chinook salmon exhibit a high degree of annual variability in production, which is a result of the large variability that exists both in environmental cycles (e.g. ocean conditions and stream flows) and within the Chinook salmon lifecycle. Total returns of fall-run Chinook spanned a range of about 700 percent from the years 1979 to 2000 because on this annual variably (see Figure 4.1-30). To account for this range of annual variability in the EDRRA model, 1000 paired annual simulations over a 50-year time period were run, producing a total of 50,000 simulation that capture the median difference between dams remain (with KBRA) and dam removal scenarios and the full range of possible outcomes. Each simulation used a different set of model parameters to generate a full range of possible responses in Chinook stock production. Results are presented on a relative basis, namely as a percent change in total adult Chinook salmon for dam removal with KBRA versus dams remain and include yearly variance estimates (uncertainty in relative abundance that could occur in any one year).

Table 4.1-7: Median annual percent increase (and 95% Credible Intervals) in total annual production of adult Chinook salmon predicted by the EDRRA life cycle production model for dams out with KBRA relative to dams remain. The years 2012-2020 are prior to dam removal, years 2021-2032 correspond to reintroduction efforts and effects of continued production from Iron Gate Hatchery, and years 2033-2061 represent natural production after reintroduction efforts and effects of Iron Gate Hatchery releases have ended.

Year	Median	95% CrI		
2012	7%	-76%	—	290%
2013	5%	-78%	—	362%
2014	1%	-83%	—	457%
2015	6%	-82%	—	429%
2016	7%	-82%	—	471%
2017	8%	-80%	—	599%
2018	12%	-81%	—	641%
2019	11%	-80%	—	542%
2020	22%	-75%	—	582%
2021	38%	-74%	—	571%
2022	72%	-68%	—	694%
2023	85%	-58%	—	727%
2024	106%	-46%	—	868%
2025	107%	-49%	—	894%
2026	67%	-64%	—	812%
2027	77%	-62%	—	981%
2028	110%	-54%	—	987%
2029	104%	-60%	—	918%
2030	61%	-65%	—	738%
2031	62%	-64%	—	666%
2032	60%	-64%	—	837%
2033	55%	-61%	—	652%
2034	52%	-62%	—	620%
2035	82%	-58%	—	715%
2036	189%	-31%	—	1252%

Year	Median	95% CrI		
2037	177%	-21%	—	1363%
2038	98%	-51%	—	974%
2039	62%	-66%	—	926%
2040	50%	-74%	—	574%
2041	56%	-66%	—	700%
2042	67%	-61%	—	758%
2043	65%	-67%	—	814%
2044	60%	-68%	—	772%
2045	51%	-68%	—	612%
2046	78%	-60%	—	869%
2047	79%	-52%	—	840%
2048	83%	-54%	—	872%
2049	94%	-45%	—	773%
2050	84%	-58%	—	795%
2051	123%	-48%	—	1126%
2052	160%	-32%	—	1279%
2053	116%	-48%	—	1021%
2054	68%	-64%	—	839%
2055	54%	-66%	—	729%
2056	67%	-63%	—	701%
2057	65%	-62%	—	614%
2058	69%	-61%	—	907%
2059	80%	-54%	—	748%
2060	78%	-53%	—	842%
2061	76%	-56%	—	751%

As expected, the EDRRA model results show substantial within-year variability in Chinook salmon stock relative abundance forecasts as indicated by the 95% credible intervals (CrI) (see Table 4.1-7). In some years, the minimum 95% CrI and the maximum 96% CrI can range over 1000%, similar to the range observed in actual salmon runs from 1979 to 2000 (see Figure 4.1-30). A negative minimum value for the 95% credible interval in Table 4.1-7 indicates that for some individual model runs the dams remain scenario outperforms the dam removal scenario. There are two primary factors that account for this: (1) the EDRRA model manages the Chinook salmon spawner distribution sub-optimally between the upper and lower basin for the dams out with KBRA (see Footnote 4 in Table 4.1-8); and (2) the random pairing process of the EDRRA model assigns some model parameters representing poor historical salmon conditions to the dam removal scenario (e.g. a return of 34,000 Chinook in 1991, Figure 4.1.-30) and compares those to exceptional historical salmon conditions for the dams remain scenario (e.g. a return of 250,000 Chinook in 1995). These types of random pairings can result in a very wide range of possible outcomes in individual model runs. When taken as a group of 50,000 model runs, however, the model predicts with 97 percent confidence that Chinook salmon production under dam removal and implementation of KBRA scenario outperforms the dams remain scenario (Hendrix 2012).

Table 4.1-8: Percent increase in Chinook salmon production and harvest due to dam removal with implementation of KBRA versus dams remain for three time periods: 1) prior to dam removal (2012-2020); 2) during active reintroduction in the upper basin and 8 years of Iron Gate hatchery mitigation releases (2021-2032); and, 3) after active reintroduction and releases from Iron Gate hatchery cease (2033-2061). CrI defines the central 0.95 probability interval of the distribution.

Metric	2012-2020		2021-2032		2033-2061	
	Median	95% CrI	Median	95% CrI	Median	95% CrI
Total Adult Production	10.8%	-79.7% 492.6%	81.8%	-61.7% 836.5%	81.4%	-59.9% 881.4%
Ocean Commercial Harvest	9.2%	-86.7% 836.2%	63.0%	-61.9% 1618.9%	46.5%	-68.7% 1495.2%
Ocean Recreational Harvest	9.2%	-86.7% 836.2%	63.0%	-61.9% 1618.9%	46.5%	-68.7% 1495.2%
In-River Sport Harvest	0.0%	-92.3% 1519.7%	8.7%	-73.4% 2778.1%	9.1%	-77.4% 2753.7%
Tribal Harvest	10.3%	-88.6% 1009.8%	71.5%	-65.0% 1948.2%	54.8%	-71.0% 1841.0%

Important EDRRA assumptions affecting Chinook salmon abundance projections

1. The EDRRA model includes the release of Chinook salmon from both Iron Gate and Trinity River hatcheries. All hatchery Chinook salmon are assumed to return to the hatchery and do not contribute to naturally spawning populations.
2. The EDRRA model forecasts the total adult abundance of Chinook salmon exhibiting both Type I and Type II life history strategies. Type I Chinook salmon emigrate downstream in the spring following emergence and Type II Chinook salmon emigrate in the fall or early winter following emergence.
3. The EDRRA model also assumes that Chinook salmon reintroduction efforts described in the KBRA fully seed available fry habitats upstream of Iron Gate Dam, including the tributaries upstream of Upper Klamath Lake prior to dam removal.
4. The EDRRA model assumes that Pacific Fishery Management Council (PFMC) fishery management rules which establishes annual goals for the number of Chinook salmon spawners and allocation provisions of the salmon harvest among different groups of fishers (i.e. commercial, recreational, tribal) remain in place throughout the 50 year period of analysis. The fishery control rule attempts to optimize Chinook salmon production target (i.e., produce the maximum number of returning adults per spawner (maximum sustained yield): too few or too many returning adult spawners can both lead to reduced production and recruitment. For current habitat conditions the optimum escapement target has been set at 40,700 adults after fisheries harvest (STT 2005). The EDRRA model uses the same escapement target for both dams in and dams out. Ideally, this escapement target would be increased for the dams out scenario to account for the additional 420 miles of habitat that would be available upstream of Iron Gate Dam should the dams be removed. Consequently, the EDRRA model manages the Chinook salmon population optimally at its maximum sustainable yield under the dams in scenario. For the dams out and KBRA scenario, the model manages the Chinook salmon population sub-optimal with too few returning adults in an expanded watershed. If dams were removed, the PFMC would increase the Chinook salmon escapement target to account for the new habitat; a change that would likely increase EDRRA model predictions of Chinook salmon abundance.

Table 4.1-7 shows the median increase in Chinook adult production for each year modeled. Three distinct phases occur with dam removal that affects Chinook salmon adult production, and they are grouped accordingly with summary statistics in Table 4.1-8. These three phases include:

1. **From 2012 to 2020,** including initiation of KBRA habitat restoration actions prior to dam removal to improve upper basin habitat conditions prior to reintroduction and continuation of habitat restoration efforts to improve conditions in the lower basin. During this phase, implementation of KBRA produces an 11 percent median increase in Chinook adult production, ranging from 1 to 22 percent for individual years modeled.

2. **From 2021 to 2032,** immediately following dam removal, it is assumed that Iron Gate Hatchery would continue to release Chinook salmon for eight years and active reintroduction of Chinook salmon is occurring. (See "blue box" on page 127, The *Future of the Iron Gate Hatchery,* for assumptions regarding this hatchery's operation under a scenario of dam removal.) During this phase, EDRRA predicts a median increase of about 82 percent in total adult production. Annual median increases range from 38 to 110 percent for individual years modeled.

3. **From 2033 to 2061,** it is assumed that all production of Chinook salmon, with the exception of releases from Trinity River Hatchery, is of natural origin. During this phase, the median increase in production is about 81 percent, which is very similar to the previous phase (2021 to 2032 time period). Annual median increases range from 50 to 189 percent for individual years modeled.

Figure 4.1-31: Median annual percent increase in the harvest of Klamath River Chinook salmon in the ocean (commercial and sport), tribal, and in river sport fisheries as predicted by the EDRRA life cycle production model for dam removal and KBRA implementation (Hendrix 2011).

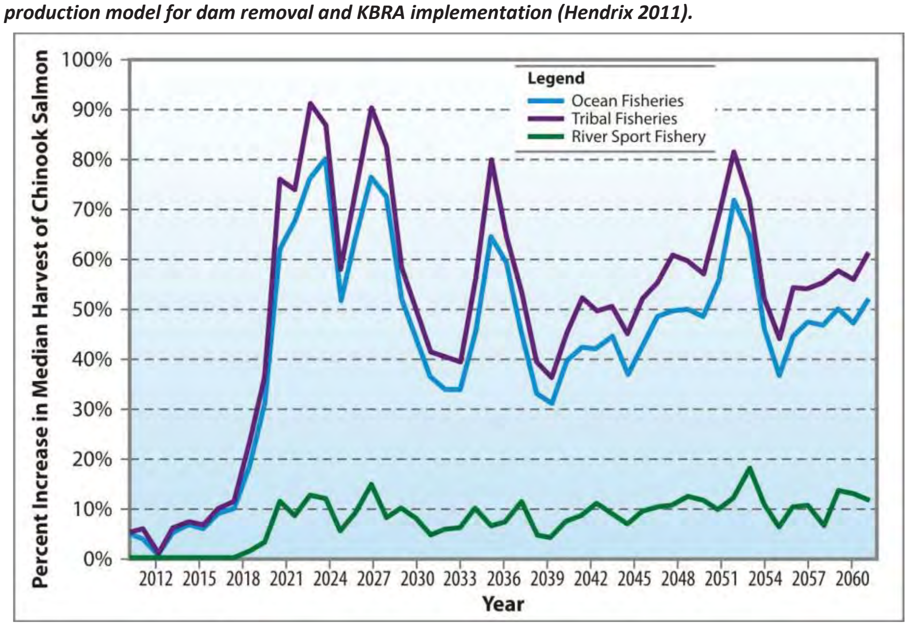


Table 4.1-8 also provides estimates of median increases in fisheries (commercial, tribal, and sport) for these three time intervals, and Figure 4.1-31 provides the range of fisheries for individual years. For those years after full natural Chinook salmon production is assumed (2033-2061), the EDRRA model estimates that median ocean fisheries (both commercial and sport) would increase by 47 percent, ranging from 31 to 72 percent in individual years. Median tribal harvest would increase by 55 percent, ranging from 36 to 82 percent in individual years. In-river sport fishery would increase by 9 percent, ranging from 4 to 18 percent in individual years.

Although there is large variability among years modeled, owing to the large variability in Chinook salmon cycles and environmental conditions, in all years following dam removal (after 2020), EDRRA predicts an increase in adult Chinook production and an increase in Chinook fisheries (commercial, tribal, and sport) for dam removal and implementation of KBRA versus dams remain. This result is very consistent with earlier studies, both quantitative and qualitative, that predict that dam removal would increase Chinook salmon abundance in the Klamath Basin.

The Future of Iron Gate Hatchery

Future management of the Iron Gate Hatchery (see Section 1.2.4.1, *Klamath Basin Hatcheries*) is considered a part of the KHSA. If the dams remain, it is assumed that Iron Gate Hatchery would continue to operate at current levels of production to meet mitigation requirements and PacifiCorp would continue to fund 100 percent of operational costs. If dam removal occurred, removal of Iron Gate Dam would require the elimination of the water supply pipeline from the penstock intake structure to the fish hatchery and the fish handling facilities at the base of the dam, but Iron Gate Hatchery would remain in place. Within six months of an Affirmative Determination by the Secretary of the Interior, PacifiCorp would propose a post Iron Gate Dam Mitigation Hatchery Plan that would ensure hatchery mitigation goals are met for eight years following dam removal (Interim Measure [IM] 19 of the KHSA). Under IM 20 of the KHSA, PacifiCorp would also be required to provide funding to Iron Gate Hatchery or "other hatcheries necessary" to meet current mitigation requirements for eight years after dam removal. Hatchery goals would focus on Chinook salmon production, with consideration for steelhead trout and coho salmon, and may be adjusted downward from current mitigation requirements by the CDFG, NOAA Fisheries Service, and the USFWS in consultation with other Klamath River fish managers, in response to fish monitoring trends.

After eight years, continued hatchery operations would depend largely on: 1) realized and projected benefits of restored access to additional habitat above the current location of Iron Gate Dam; 2) the success of habitat restoration efforts through the KBRA; and, 3) success of the reintroduction program identified in the KBRA. Due to this uncertainty, CDFG, in consultation with NOAA Fisheries Service, USFWS, and other Klamath River fish managers would evaluate the need for continued hatchery operations. Funding for continued hatchery operations would need to be identified. For purposes of this analysis, it is assumed that Iron Gate Hatchery would not be needed beyond 2028 if dams were removed and KBRA was implemented.

In addition to the Interim Measures under the KHSA described above, the KBRA also provides for development of a conservation hatchery (Section 11.4.4 Conservation Hatchery of the KBRA) to assist in reintroduction efforts if the need is identified in the Fisheries Reintroduction Plan. Iron Gate Hatchery, or another facility, could serve to meet this purpose provided it satisfies the requirements to operate as a conservation hatchery. The development of guidelines for the use of the conservation hatchery would be outlined in the Phase I Fisheries Reintroduction and Management Plan and would support the establishment of naturally producing anadromous salmonid populations in the Klamath Basin following implementation of the KHSA.

Major Conclusions of the Coho Salmon and Steelhead Expert Panel on Coho

The Coho Salmon and Steelhead Expert Panel's (Dunne et al. 2011) assessment was that current conditions will likely continue to be detrimental to coho salmon. The Panel also concluded that while there would be an increase in coho salmon due to dam removal and KBRA, it would likely be small, especially in the short term (0 10 years following dam removal).

The Panel concluded that larger (moderate) responses would be possible under a dam removal scenario contingent on the following:

- The KBRA is fully and effectively implemented.
- Mortality caused by the pathogen *C. shasta* is reduced.

Coho salmon recolonization of the Klamath Hydroelectric Reach between Keno and Iron Gate dams would likely increase the abundance and distribution of the ESU by some amount, which are key factors used by NOAA Fisheries Service to assess viability of the ESU.

The panel indicated that under a dams out with KBRA, newly established coho salmon populations upstream of Iron Gate Dam reduce risks to long-term viability in the face of continuing stresses from land and water resource use, as well as climate change. This may be particularly relevant for populations that may be able to access sources of cold groundwater discharge, which would allow coho salmon to persist in spite of possible water temperature increases.

(Continued on next page)

4.1.2.2 Coho Salmon

Coho salmon (see Figure 4.1-32) in the Klamath Basin are part of the Southern Oregon/Northern California Coast Evolutionary Significant Unit (ESU). Williams et al. (2006) described nine coho salmon populations in the Klamath Basin, including the upper Klamath River, Shasta River, Scott River, Salmon River, mid-Klamath River, lower Klamath River, and three population units within the Trinity Basin (Upper Trinity River, Lower Trinity River, and South Fork Trinity River).

With dam removal, coho salmon would be expected to rapidly recolonize habitat upstream of Iron Gate Dam, as observed after barrier removal at Landsburg Dam in Washington (Kiffney et al. 2009) and dam removal at Little Sandy Dam in Oregon (Strobel, Portland Water Bureau, pers. comm.). Assuming coho salmon distribution will extend up to Spencer Creek after dam removal, coho salmon from the upper Klamath River population will reclaim approximately 76 miles of habitat: approximately 53 miles in the mainstem Klamath River and tributaries (DOI 2007; NOAA Fisheries Service 2007) and approximately 23 miles currently inundated by the reservoirs (Cunanan 2009).

Figure 4.1-32: Coho salmon are expected to recolonize upstream habitat with the removal of the Four Facilities.

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 disease (see Section 4.1.1.5 *Salmon Disease*) downstream of Iron Gate Dam and these improvements will benefit coho salmon 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.

Investigations assessing the benefits and risks of dam removal and the KBRA on coho salmon have resulted in a range of viewpoints. For example, the Coho Salmon and Steelhead Expert Panel (Dunne et al. 2011) concluded that coho salmon would receive relatively small improvements from dam removal, especially in the short-term (0 to 10 years following dam removal); however, the benefits would likely be greater if the KBRA were fully and effectively implemented and juvenile mortality from disease is reduced (see sidebar, *Major Conclusions of the Coho Salmon and Steelhead Expert Panel on Coho*). Stillwater Sciences (2010) noted that the KBRA provides greater opportunities for restoration than a dams in scenario, and concluded that coho salmon would receive additional benefits to their long-term viability through increases in population abundance, productivity, spatial structure, and genetic diversity. The NRC concluded that "removal of Iron Gate Dam could open new habitat, especially by making available tributaries that are now completely blocked to coho" (NRC, 2004, p. 310).

The Coho Salmon and Steelhead Expert Panel (Dunne et al. 2011) and Hamilton et al. (2011) concluded that the benefits of dam removal for coho salmon go beyond increased abundance. While noting uncertainties, the panel acknowledged that colonization (see sidebar, *Major Conclusions of the Coho Salmon and Steelhead Expert Panel on Coho*) 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 ESU by increasing abundance, diversity, productivity and spatial distribution. In general, as habitat availability and diversity increase for an ESU, so does the resilience of the population, reducing the risk of extinction (McElhany et al. 2000) and increasing chances for recovery.

4.1.2.3 Steelhead Trout

Dam removal would reestablish steelhead (see Figure 4.1-33) upstream of Iron Gate Dam and increase habitat available to this species (FERC 2007). Because of their ability to navigate steeper gradient channels and spawn in smaller, intermittent streams (Platts and Partridge 1978), and their ability to withstand a wide range of water temperatures (Cech and Myrick 1999; Spina 2007), steelhead distribution in the basin could expand to a greater degree (over 420 miles) (Huntington 2006) than that of any other anadromous salmonid species. FERC (2007) concluded that implementing fish passage would help to reduce the adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that restored access to historical habitat above the dams would benefit steelhead runs.

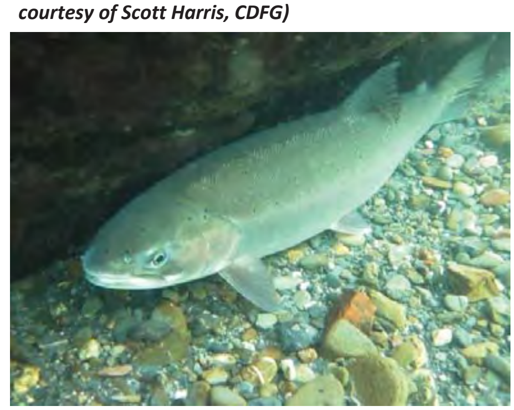
If dam removal and the KBRA were implemented effectively, the assessment of the Klamath River Coho/Steelhead Expert Panel was that steelhead could result in increased spatial distribution and population numbers would increase. This is based on the likelihood of steelhead being given access to substantial historical habitat, steelhead being more tolerant than coho salmon to warmer water, the fact that other similar sub-species (resident redband/rainbow trout) are doing well in the upstream habitat, and that steelhead are currently at lower abundances than historical values but not yet rare (Dunne et al. 2011). In general, dam removal with KBRA implementation 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 in the face of climate change (Hamilton et al. 2011). The movement of native steelhead trout upstream of Iron Gate Dam presents a low risk of residualization (i.e., reverting to a resident rainbow trout life history strategy) (Administrative Law Judge 2006).

Major Conclusions of the Coho Salmon and Steelhead Expert Panel on Steelhead (cont.)

The Coho Salmon and Steelhead Expert Panel's assessment was optimistic that dam removal paired with the KBRA would increase the abundance and distribution of steelhead in the basin relative to current conditions (Dunne et al. 2011).

If dam removal and KBRA are implemented effectively, and the other related actions occur (e.g., full attainment of TMDLs), then the response of steelhead may include broader spatial distribution and increased numbers of individuals within the Klamath Basin. The panel indicated that key issues affecting success would depend on how the KBRA is implemented, the degree of colonization of the upper watershed by steelhead, the success of passage through the unfavorable summer and fall water quality conditions in Keno Impoundment and Upper Klamath Lake, how reliant the current population is on hatchery fish, the outcome of interactions between steelhead and resident *rainbow trout (Oncorhynchus mykiss),* and the influence of hatchery releases on the fitness of wild fish.

Figure 4.1-33: With dam removal steelhead trout would have access to over 420 miles of historical habitat. (Photo courtesy of Scott Harris, CDFG)



4.1.2.4 Lamprey

Pacific lamprey (see Figure 4.1-34) is the only anadromous lamprey species in the Klamath Basin, although five other resident lamprey species are also present. Access to habitat upstream of Iron Gate Dam could benefit Pacific lamprey populations by increasing their viability through 1) extending the range and distribution of the species; 2) providing additional spawning and rearing habitat; 3) increasing genetic diversity; and 4) increasing their abundance (Administrative Law Judge 2006). Removal of the dams is considered to be the only feasible method for expanding the current range of Pacific lamprey to areas upstream of Iron Gate Dam (FERC 2007). Pacific lamprey, along with three other lamprey species, was petitioned for listing under the ESA in 2003 (Nawa 2003). Although the USFWS halted species status review in December 2004 due to inadequate information (USFWS 2004), efforts to list Pacific lamprey may resume as more information is obtained. No current status assessments are available for any Klamath lamprey species and little is known regarding their biology or sensitivity to environmental changes in the Klamath Basin (Hamilton et al. 2011).

Major Conclusions of the Lamprey Expert Panel

The Lamprey Expert Panel's (Close et al. 2010) assessment was that dam removal and the KBRA could eventually increase Pacific lamprey carrying capacity in the Klamath Basin by a maximum of 14 percent (based on an analysis of mainstem habitat), and potentially more if the Upper Klamath Basin is accessible and contains suitable habitat. Adult Pacific lamprey would be expected to recolonize newly accessible habitat following dam removal, but in the absence of active reintroduction measures, recolonization could take decades.

Should the release of sediment from dam removal result in short-term mortality of lamprey downstream of Iron Gate Dam, the panel expects that larval lamprey from tributaries would recolonize this habitat during normal downstream movements.

Pacific lamprey larval rearing capacity downstream of Iron Gate Dam would likely increase for a short time after dam removal because of fine sediment released from dam removal. This habitat would decrease over time, but likely remain higher than under current conditions because sediment transport would no longer be interrupted by the presence of the dams and reservoirs.

The panel indicated that the carrying capacity for freshwater resident lamprey species would not likely change significantly with dam removal; but implementation of the KBRA could result in modest increases.

Figure 4.1-34: Pacific Lamprey Expert Panel (Close et al. 2011) predicted increased carrying capacity for Pacific lamprey with dam removal. (Photo courtesy of Abel Brumo)

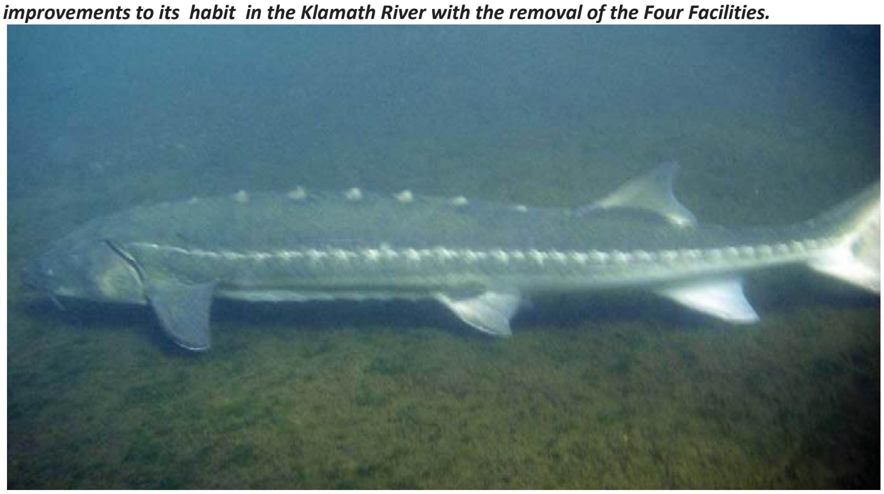
The Lamprey Expert Panel compared the potential effects of dam removal versus leaving dams in place on Pacific lamprey populations (Close et al. 2011). They concluded that a dam removal with KBRA implementation scenario could increase Pacific lamprey habitat by up to 14 percent compared with dams remaining and could increase production by 1 to 10 percent. The increase could potentially be more if habitat in the Upper Klamath Basin is accessible and suitable (see sidebar, *Major Conclusions of the Lamprey Expert Panel*).

Dam removal would eliminate the adverse effects of power peaking on endemic resident lamprey species in the Klamath Hydroelectric Reach. Conditions with dams removed and implementation of the KBRA could increase populations as physical, chemical, and biological processes of the Klamath River are restored. Capacity for the freshwater-resident lamprey species in the Upper Klamath Basin would not be expected to change significantly with dam removal, but might increase somewhat with implementation of the KBRA aquatic habitat restoration measures (Close et al. 2011).

4.1.2.5 Green Sturgeon

Green sturgeon is a long-lived anadromous species that can attain large size (see Figure 4.1-36). The green sturgeon in the Klamath River belongs to the Northern Green Sturgeon Distinct Population Segment; the green sturgeon is designated as a Species of Concern by NOAA Fisheries Service. Green sturgeon occur within the lower 67 miles of the Klamath River, downstream of Ishi Pishi Falls, and would be affected by dam removal and KBRA effects that extend downstream past these falls. Dam removal and the KBRA would return the Klamath River mainstem within the habitat of green sturgeon to a temperature and flow regime that more closely mimics historical patterns and would likely benefit green sturgeon (Hamilton et al. 2011), however, these flow and temperature changes may be relatively small in the reach of the river used by green sturgeon. Overall, dam removal and associated KBRA actions would be expected to accelerate TMDL water quality benefits for this species, including the elimination of algal toxins produced in the Hydroelectric Reach reservoirs.

Figure 4.1-36: Green sturgeon, a species of concern, would experience relatively small improvements to its habit in the Klamath River with the removal of the Four Facilities.



Stranding and Habitat Loss Due to Hydropower Peaking

Flows in the J.C. Boyle power peaking reach undergo rapid and extreme daily fluctuations that can strand and displace fish, cause large temperature fluctuations, increase energetic demands upon fish, and reduce productivity of the aquatic insect and invertebrate communities that provide food for fish.

In one stranding event along 225 feet of the peaking reach, about 5,000 fish of various species, more crayfish, and an order of magnitude more aquatic insects, perished in a single peaking cycle. Peaking operations that cause high mortality such as this likely only happen a few times a year. However, peaking can result in severe cumulative impacts to fish populations (Administrative Law Judge 2006). Under existing operations, J.C. Boyle peaking has been shown to eliminate effective habitat for redband trout fry (BLM 2003).

Figure 4.1 35: Stranded fish and macroinvertebrates in the J.C. Boyle Peaking Reach.

4.1.2.6 Eulachon

Eulachon are anadromous fish that occur in the lower portions of larger rivers draining into the northeastern Pacific Ocean, including the Klamath River. Eulachon were historically abundant, but currently are rarely observed in the lower Klamath River and Estuary, and NOAA Fisheries Service listed the Southern Distinct Population Segment of eulachon as threatened under the ESA (NOAA Fisheries Service 2010). With dam removal, KBRA implementation, and implementation of the TMDLs, water quality would improve throughout the Klamath River, including the estuary (WQST 2011). Habitat restoration efforts under the KBRA and water quality improvements will have an uncertain contribution to recovery of any remnant eulachon populations that still exist.

4.1.2.7 Bull Trout

Bull trout are currently listed as threatened under the ESA. The current abundance, distribution, and range of bull trout in the Klamath Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002). Bull trout populations in the Klamath interim recovery unit face a high risk of extirpation (USFWS 2002). Bull trout are considered extinct in California (Rode 1990).

In the Upper Klamath Basin, this species is confined to the far upper reaches of the watershed. Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed (USFWS 2002).

Factors considered threats to bull trout in the Klamath Basin at the time of listing include habitat loss and degradation caused by reduced water quality, past and present land use, water diversions, roads, and non-native fishes. All of these factors continue to be threats today.

The KBRA would likely accelerate compliance with TMDL water quality objectives (WQST 2011; Dunne et al. 2011) thereby providing benefits to bull trout. The implementation the KBRA therefore provides promise for increasing overall population abundance and distribution of bull trout (Buchanan et al. 2011).

4.1.2.8 Redband and Rainbow Trout

Redband and rainbow trout are a relatively abundant native species of the Klamath Basin and they support an important trophy trout recreational fishery (see Figure 4.1-37). 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 resident trophy trout in the fishery approximately seven times from downstream of Keno Dam to the Iron Gate Reach (Buchanan et al. 2011).

Figure 4.1-37: Redband trout, a native species in the Klamath River, would benefit from the free-flowing river with dam removal.

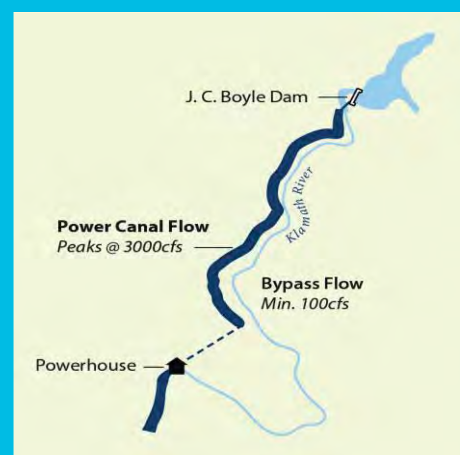
Removal of the dams and improved management of flows under the KBRA would improve spawning and rearing flows for resident trout. The Expert Panel on Resident Fish concluded that following dam removal, the abundance of redband/rainbow trout in the free-flowing reach between Keno Dam and Iron Gate Dam could increase significantly (Buchanan et al. 2011). Because about 23 miles of this habitat is currently inundated by the reservoirs (Cunanan 2009), the degree to which this action would improve habitat for different life stages of resident trout is uncertain, but it is expected that the total reach should continue to produce large trout up to 23 inches long (Buchanan et al. 2011). Assuming that spawning habitat is not limiting, the panel estimated that the new free-flowing reaches could increase harvest up to seven-fold and concluded that it is possible that the trophy fishery would likewise expand in the new free-flowing reaches (Buchanan et al. 2011). Redband could be affected by increased predation from reintroduced salmonids, but this loss would likely be offset by an increase in available food sources (e.g., eggs, fry, and juveniles of reintroduced salmonids) (Hamilton et al. 2011).

Benefits to redband/rainbow trout in tributaries to Upper Klamath Lake would be realized indirectly by implementing the KBRA (Buchanan et al. 2011). Improving water quality, increasing summer flows, and restoring riparian habitat are expected to increase trout productivity in these areas (Buchanan et al. 2011). Redband trout are not, or are only minimally, susceptible to *C. shasta* or other diseases that could be carried upstream by anadromous fish (Administrative Law Judge 2006, Bartholomew and Courter 2007). Because habitat improvement measures in the KBRA have not yet been planned in detail, the population benefits will depend on how these measures ultimately affect redband/rainbow trout habitat.

Operations for peaking power (see *J.C. Boyle Power Peaking* sidebar) within the reach between J.C. Boyle Powerhouse and Copco 1 Reservoir currently causes chronic stress to trout and results in mortality, stranding and turbine entrainment (Gutermuth et al. 2000) of fry, juvenile, and adult redband/rainbow trout (summarized in Buchanan et al. 2011). Removing the dams would eliminate the effects of power peaking and would restore more natural water temperature, flow, and sediment transport regimes, which are anticipated to reverse declines in abundance and size of adult redband trout that utilize habitats downstream of J.C. Boyle Dam and may also restore life history strategies conducive to maintaining the population's viability over the long-term.

J.C. Boyle Power Peaking

The J.C. Boyle powerhouse operates to produce peaking power. Peak power is generated during peak power demand which typically occurs during the morning and evening hours. During peaking periods, flows up to 3,000 cfs are passed through the power canal and powerhouse turbines which results in a rapid rise and fall of river water levels below the powerhouse extending down to Copco 1 Reservoir. During the off peak periods, flows are reduced and water is stored in the reservoir for the next peaking period. Rafters enjoy the predictability of the high peaking power flows, particularly during the late summer months, but the rapid rise and fall of river water levels can negatively affect aquatic resources.



4.1.2.9 Endangered Sucker Species

Removal of the dams and implementation of the KBRA would accelerate water quality improvements for both shortnose and Lost River suckers (Dunne et al. 2011). Although the endangered suckers would not benefit directly from dam removal, habitat restoration and improvements in water quality are likely to improve their status.

Figure 4.1-38: Both Lost River (below) and shortnose suckers are endangered species that would likely benefit from KBRA habitat and water quality improvements in the upper Klamath Basin.

Based on available information, the Resident Fish Expert Panel (Buchanan et al. 2011) concluded that both Lost River and shortnose suckers are declining under current conditions and that they could become extinct in the near future unless a major recruitment event occurs soon. While there is some uncertainty in this regard, the panel indicated that dam removal and 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. The panel cited major habitat improvements in Upper Klamath Lake and its tributaries that support these fishes as the key factors likely to benefit Lost River and shortnose suckers with implementation of the KBRA.

Dam removal would eliminate habitat for adult shortnose and Lost River suckers in the existing reservoirs (FERC 2007). However, reservoir populations and habitat downstream of Keno Dam are not considered to contribute significantly to sucker recovery (USFWS 2006). Analysis by FERC suggests that the population of Lost River and shortnose suckers in Copco 1 Reservoir is supported primarily by recruitment of juvenile and adult suckers from Upper Klamath Lake and J.C. Boyle Reservoir (FERC 2007). The USFWS has proposed to designate critical habitat for Lost River and shortnose suckers (76 FR 76337) in Upper Klamath Lake and the Lost River Basin. This designation would remove the Four Facilities from previous proposed critical habit listing.

4.1.3 Effects of Sediment Release on Fish Following Dam Removal

Dam removal would have short-term effects on fish habitat due to the transport of sediments currently deposited behind the dams and water quality effects associated with that sediment transport. Dam removal would also have long-term benefits to fish species through more effective river bed mobility and substrate movement. The short and long-term effects to fish from sediment release and sediment transport are further described below.

4.1.3.1 Reservoir Sediment Volume, Composition, and Erosion Potential

Distribution of sediment depth varies within each of the reservoirs and between the three reservoirs that have significant accumulation of sediment. The retention of sediment in Copco 2 Reservoir is negligible. In J.C. Boyle Reservoir, sediment primarily resides in the areas nearest to the dam, with thicknesses up to 20 feet. Both Copco 1 and Iron Gate reservoirs have a more even distribution of sediment but also have increasing thicknesses closer to the dams. The maximum thickness of the Copco 1 Reservoir sediment is about 10 feet. The maximum thickness within the main stem of Iron Gate Reservoir is about 5 feet, with deposition thickness of nearly 10 feet in the Jenny Creek arm of Iron Gate Reservoir.

Maps of the thickness of bottom sediments in the reservoirs were drawn based on information derived from 28 to 31 drill holes (core samples) in each reservoir (Reclamation 2012g). These core samples were analyzed to characterize bottom sediment physical properties, including thickness, silt and clay percentage, porosity, and dry bulk density. Drawing maps by interpolating sediment thicknesses from discrete drilling locations creates some statistical uncertainty when estimating the sediment volumes and dry weights shown in Table 4.1-9. While this statistical uncertainty is measurable, using the higher estimates or lower estimates of sediment volume did not affect the Detailed Plan for dam removal further described in Section 4.2, *Dam Removal Detailed Plan and Estimated Cost*. Moreover, using the high estimate or low estimate of sediment volume resulted in only slight differences in the analyses of impacts to aquatic resources.

Table 4.1-9: Estimated existing volumes, dry weights, and physical characteristics of sediment in the upper and lower reaches of the reservoirs.

Reservoir	Location	Volume (yd^3)	Silt and Clay (% by mass)	Porosity (-)	Dry Bulk Density (lb/ft^3)	Estimated Dry Weight (tons)
J.C. Boyle	Upper	380,000	44	0.82	29.5	151,000
	Lower	620,000	88	0.90	16.3	136,000
Copco 1	Upper	810,000	73	0.88	19.2	210,000
	Lower	6,630,000	88	0.88	18.7	1,674,000
Iron Gate	Upper	830,000	78	0.83	27.0	303,000
	Lower	2,780,000	86	0.88	19.8	743,000
	Upper Tributary Arm	300,000	75	0.73	44.4	180,000
	Lower Tributary Arm	800,000	94	0.88	19.3	208,000
All Reservoirs		**13,150,000**	**85**	**0.87**	**20.3**	**3,605,000**

(Source: Reclamation 2012g)

Based on maps of sediment thickness, the current volume of sediment in J.C. Boyle, Copco 1, and Iron Gate reservoirs is about 1.0, 7.4, and 4.7 million cubic yards, respectively. The total sediment volume for the three reservoirs is about 13.2 million cubic yards, having a dry weight of about 3.6 million tons (see Table 4.1-9). Assuming current sedimentation rates continue into the future, the total volume of sediment in the three reservoirs would increase to about 15.1 million cubic yards in 2020 (date of potential dam removal).

The physical characteristic of sediment varies considerably within the three reservoirs (see Table 4.1-9). Sand and gravel carried by the Klamath River and its tributaries tends to settle out early in a reservoir, preferentially in upper reaches of the reservoirs and tributary arms, thereby decreasing the percentage of silt and clay in these areas. This effect can be seen most prominently in J.C.

Boyle Reservoir where the silt and clay content averages 44 and 88 percent in the upper and lower reservoir reaches, respectively. Overall, the mass of silt and clay averages about 85 percent in the three reservoirs, with the lesser amounts composed primarily of sand and gravel.

The *Detailed Plan for Dam Removal* (Reclamation 2012e), establishes provisions for reservoir sediment to naturally erode by the river's action prior to removal of the four dam's embankments. Dredging of reservoir sediments was considered but found to provide only marginal benefits with substantial negative environmental effects (see Section 4.1.3.4, *Evaluation of Dredging Reservoir Sediments to Reduce Short-term Impacts on Fisheries*). During reservoir drawdown and return to riverine conditions, an estimated 5.3 to 8.6 million cubic yards of reservoir sediment would be eroded downstream (a range of 36 to 57 percent of the 2020 total volume of sediment in the reservoirs, respectively). The range in erosion volumes for each reservoir is shown in Table 4.1-10 along with the percentage of reservoir sediments that would be eroded. Copco 1 Reservoir has the largest percentage of erodible sediment (45 to 76 percent), followed by J.C. Boyle Reservoir (27 to 51 percent), and followed by Iron Gate Reservoir (24 to 32 percent).

This modeled range in erosion volume is primarily driven by water-year type, with larger erosion amounts occurring in wet (high-flow) years. The vast majority of the erosion would occur during reservoir drawdown and would be dominated by processes of scouring a new river channel and slumping of the fine sediment into this newly formed channel.

After the reservoir drawdown process is complete, the remaining reservoir sediments will consolidate and reduce their volume by approximately two thirds, sediment cracks will develop, and the sediment will harden significantly. This drying process is expected to occur in the spring and early summer. The resistance to erosion will increase markedly during this period and the sediment will progress from highly erodible soon after reservoir drawdown to very resistant to erosion by the summer. However, because of the cracking, some erosion could continue as gully formation occurs during rainstorms. The reservoir area will be mulched and seeded with native grasses soon after drawdown to protect these sediments from additional erosion during rain and high flow events. The revegetation plan is described in Reclamation (2011g).

Table 4.1-10: Estimate of Erodible Sediment Volume by Reservoir

	Volume of Sediment (yd^3)		
	J.C. Boyle	**Copco**	**Iron Gate**
Current Reservoir Sediment	1,000,000- 1,300,000	7,440,000- 8-940,000	4,710,000- 6,040,000
Estimated Reservoir Sediment Volume in 2020	1,200,000	8,200,000	5,600,000
Estimated Range of Erosion Volume	320,000 to 590,000	3,700,000 to 6,200,000	1,300,000 to 1,800,000
Estimate of Percent of Volume that would be eroded	27 to 51%	45 to 76%	24 to 32%

Source Reclamation 2012g

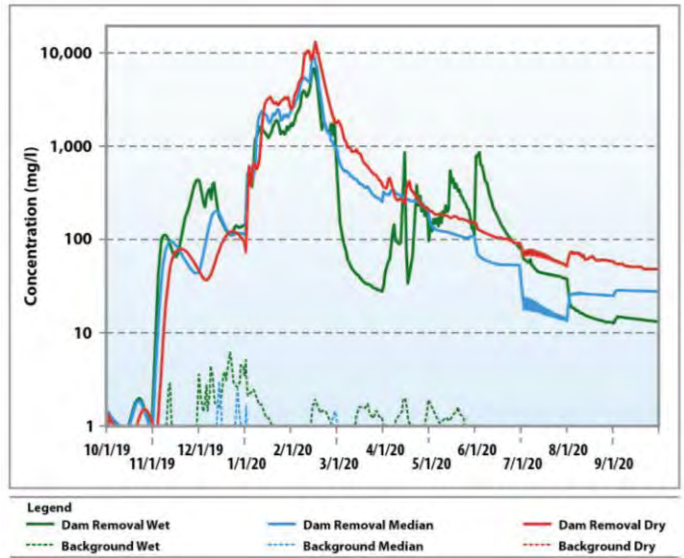
4.1.3.2 Water Quality Effects from Suspended Sediment

The dam deconstruction process would have short-term adverse effects on water quality and aquatic species. Dam removal would increase suspended sediment concentration (SSC) downstream of the dams due to the transport of large quantities of fine sediment that have been deposited in the reservoirs (see Figures 4.1-39 and 4.1-40). Several mitigation measures would be employed to minimize these short-term effects as described in Section 4.1.3.5, *Mitigation Actions*.

In the short-term, resuspension of reservoir bottom sediments during dam removal would increase oxygen demand (immediate oxygen demand and biological oxygen demand), resulting in temporary reductions in dissolved oxygen in the Klamath Hydroelectric Reach and the Klamath River downstream of Iron Gate Dam due to microbial decomposition of the high fraction of organic matter present in these sediment deposits (Shannon and Wilson Inc. 2006, Stillwater Sciences 2011b). Depending on the flow patterns during the year of dam removal and the associated SSC, modeling studies predict that short-term (two months) increases in oxygen demand following dam removal would likely not decrease dissolved oxygen concentrations below the chronically stressful level (5 mg/L; USEPA 1986) for salmonids. However, exceptions to this could occur for four to eight weeks following drawdown of J.C. Boyle and Iron Gate reservoirs (i.e., in February 2020), when dissolved oxygen would remain between 3 and 5 mg/L (typical lethal threshold for fish) for a distance of approximately 12.5-15.5 miles downstream of Iron Gate Dam (near the confluence with the Shasta River). Conditions will vary depending on water year type. In a dry year (worst conditions), predicted concentrations in February 2020 could decrease to lethal levels for fish (near 1 mg/L) for about 0.5 miles downstream of Iron Gate Dam, and values less than 5 mg/l for about 12 miles downstream of Iron Gate Dam for a period of 2 to 3 weeks (Stillwater Sciences 2011b).

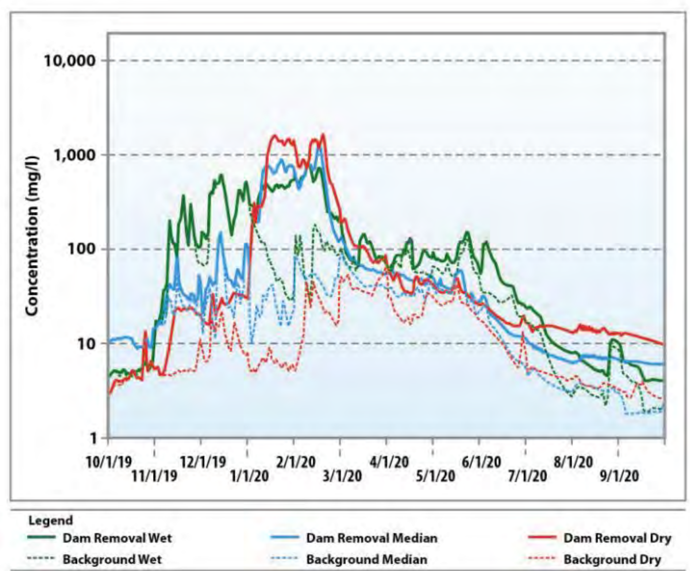
Dissolved oxygen impacts on fish would be anticipated to be secondary to the impacts of suspended sediment itself. Sediment transport modeling predicts that, depending on hydrology during the year of dam removal, peak SSC immediately downstream of Iron Gate Dam would range from 9,000 to 13,600 mg/L, (see Figure 4.1-39) with the highest peak concentrations likely to occur in dry years. During reservoir drawdown SSC in excess of 1000 mg/L would last for 2 to 3 months (see Figure 4.1-39 and Table 4.1-11) (Reclamation 2012g, Stillwater Sciences 2008). Note

Figure 4.1-39: Modeled suspended sediment concentration 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.



Source: Reclamation 2012g

Figure 4.1-40: Modeled suspended sediment concentration at Klamath, CA (river mouth) for dam removal in dry, median and wet water years. Background concentrations are modeled using data from all water year types for 1961–2008.



Source: Reclamation 2012g

however, the prediction error associated with the sediment transport calculations is considered to be at least a factor of 2 for the best estimate. Further downstream of Iron Gate Dam, SSC would decline because of dilution by tributary inputs. Concentrations near Seiad Valley (RM 129.4) and Orleans (RM 59) would be 60–70 percent and 40 percent of those below Iron Gate Dam, respectively. Wintertime effects would be more severe during a dry year, when low reservoir levels expose more sediment in January and there are smaller water volumes to carry the sediment load. Effects during spring (when smolt outmigration generally occurs) could be more severe during a wet year, when it is predicted that the reservoirs could partially refill during winter, delaying the release of suspended sediments until they drop again during spring (Reclamation 2012g). Daily SSC was modeled assuming dam removal occurred during each of the 48 years in the available hydrology record since 1961. The results of modeling all potential years were summarized for each life-stage of each species assessed (Chinook and coho salmon, and steelhead trout). To compare the range of results and impacts that might occur, the two scenarios (dams out and dams in), were analyzed to predict the potential impacts on fish that has either a 50 percent (likely to occur) or 10 percent (unlikely, or worst case) probability of occurring.

As shown in Table 4.1-11, typical dry year conditions are predicted to result in the highest peak concentrations for the longest duration directly downstream of Iron Gate Dam. Despite uncertainty in model predictions, it can be conservatively assumed that SSC would be sufficiently high (greater than 30 mg/L) to adversely affect fish throughout the Klamath River for 6 to 10 months following drawdown, especially during dry years, and especially directly downstream of Iron Gate Dam (Stillwater Sciences 2011a).

Table 4.1-11: Summary of Model Predictions for SSC in the Klamath River Downstream of Iron Gate Dam

Water Year Type	Peak SSC (mg/L)	SSC≥1,000 mg/L		SSC≥100 mg/L		SSC≥30 mg/L	
		Duration (Months)	Time Period	Duration (Months)	Time Period	Duration (Months)	Time Period
Dry (WY2001)	13,600	3	January–March 2020	6	January–June 2020	10	January–October 2020
Median (WY1976)	9,900	2	January–February 2020	5	January–May 2020	6	January–June 2020
Wet (WY1984)	7,100	2	January–February 2020	7	November 2019–February 2020 and April– June 2020	9	November 2019–July 2020

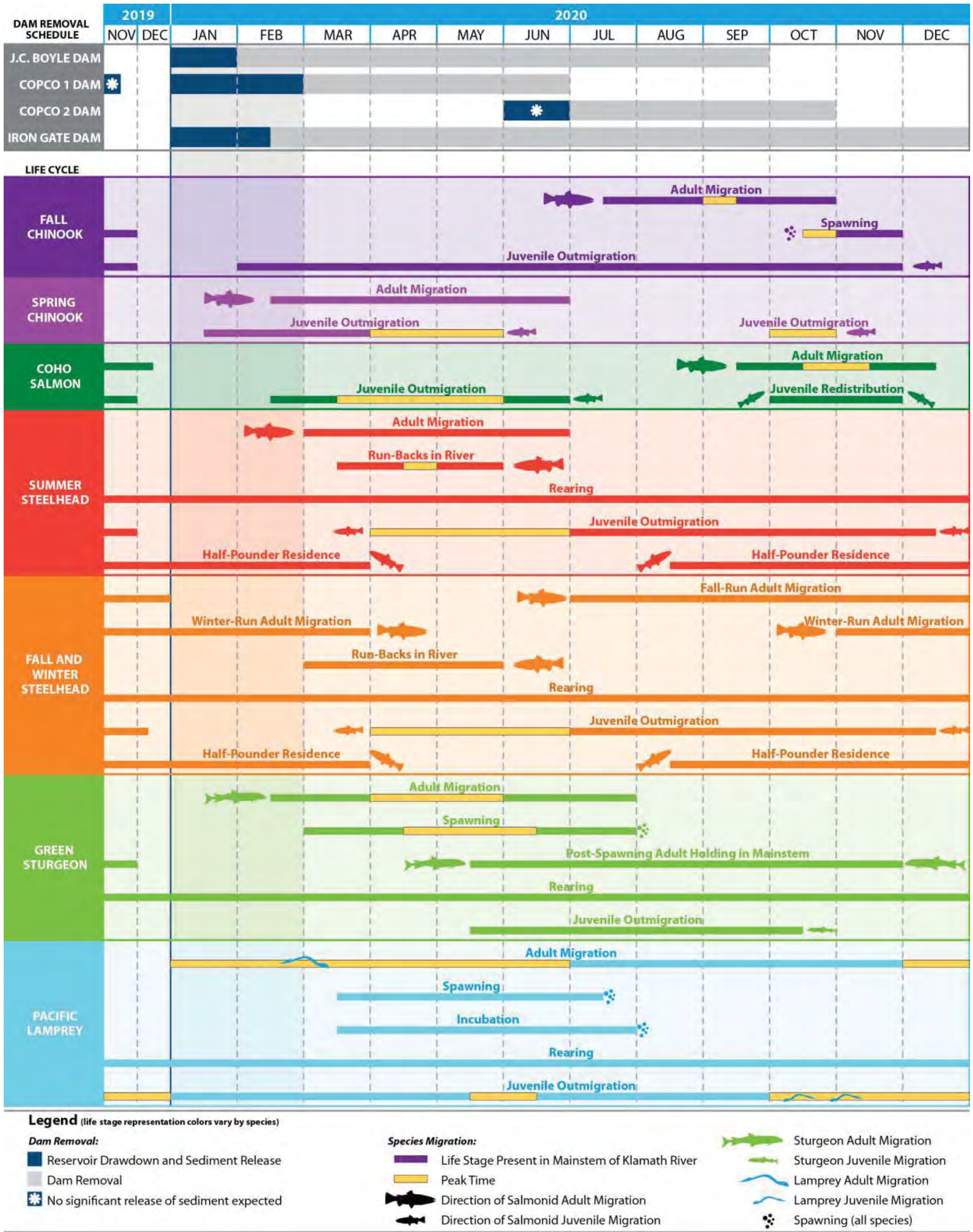
Source: Reclamation 2012g
Key:
WY = Water Year
SSC = suspended sediment concentration
mg/L = milligrams per liter

The high SSC anticipated in the Klamath River during dam deconstruction are likely to reach lethal levels for fish during the winter and early spring of the first year following drawdown. The timing of drawdown (early January) was selected to coincide with periods of naturally high SSC in the Klamath River, to which aquatic species have adapted by avoiding or tolerating. Based on Figure 4.1-41, 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 greatest SSC (January through March), with most species located in tributaries or further downstream where concentrations would be diluted by accretion flows or in the Pacific Ocean. However, some mortality is predicted to occur. Figure 4.1-42 illustrates the basin-wide mortality to several salmonid species that are likely to be affected by high SSC with dam removal. In addition to direct mortality, sublethal impacts are also predicted, including physiological stress, impaired homing rates for adults, and reduced growth rates for juveniles. These sublethal effects, in association with other stressors such as high water temperature and disease, might act cumulatively to increase mortality for some species in the mainstem in the short-term (within 6 months) following dam removal.

Although Figure 4.1-42 summarizes impacts only for salmonids, some mortality and sublethal impacts are also predicted for green sturgeon, eulachon and Pacific lamprey. Data for these species were insufficient to estimate the overall mortality within the basin (Stillwater Sciences 2011a)

It is expected that the short-term impacts of dam removal on fish populations due to high SSC would be significant for some species (most notably, steelhead). However, in general, fish populations in the Klamath Basin have a wide spatial distribution (including the marine environment for adult life stages) and diversity of life history timing that would result in exposure of only a portion of the population to suspended sediments released during dam removal (see Figure 4.1-41). For example a proportion of fall-run Chinook salmon spawn in the mainstem Klamath River downstream of Iron Gate Dam, while the remainder spawn in tributaries and would be unaffected by sediments released during dam removal. As summarized in Figure 4.1-42, under either a low flow (worst case) or median flow (most likely) year, eight percent basin-wide mortality of fall-run Chinook salmon adults is predicted in the year of dam removal. Negligible impacts on spring-run adult and juvenile Chinook salmon are predicted regardless of water year type during dam removal. Under worst-case conditions (dam removal during a dry year), lethal conditions are predicted for less than one percent of adult coho salmon and eight percent of juvenile coho salmon basin wide. Steelhead would be most impacted of the salmonids in the year following dam removal, with predicted basin-wide mortalities of up to 28 percent and 19 percent for adult and juvenile steelhead, respectively, under worst-case conditions. Under the most likely conditions (dam removal during a median flow year), however, basin-wide mortalities are predicted to be 14 percent for both adult and juvenile steelhead (Figure 4.1-42).

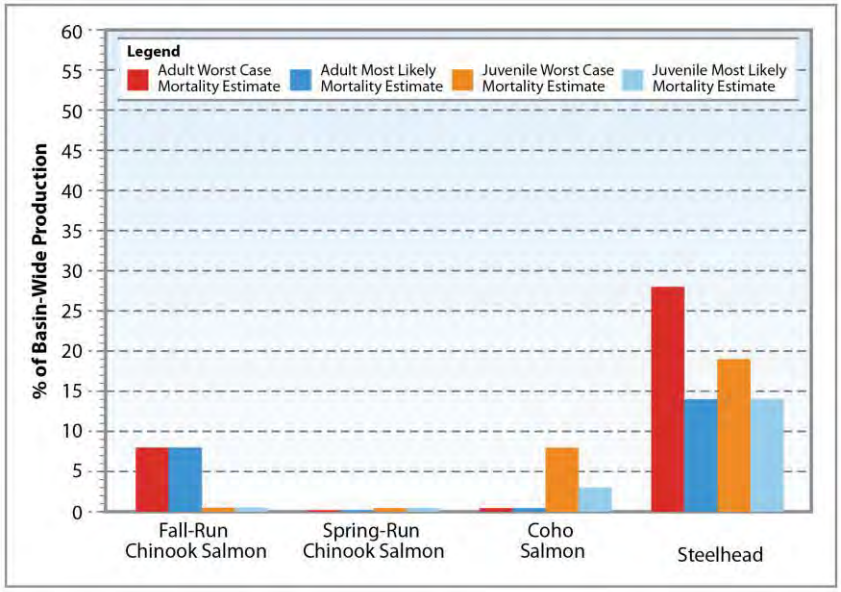
Figure 4.1-41: Timeline depicting the timing of salmon lifecycles in the mainstem of the Klamath River coinciding with dam removal plans.



Source: Stillwater Sciences 2010

Short-term (within two years) adverse effects to habitat features such as spawning gravels are also anticipated directly downstream of Iron Gate Dam. Eventually, the channel would return to its pre-dam form, reestablishing processes that provide suitable habitat (i.e., spawning gravels). When estimates of mortality and sublethal effects in the short-term are considered in conjunction with the long-term beneficial effects described above, it is expected that populations would recover to pre-dam removal levels within one to two years following dam removal (Stillwater Sciences 2011a).

Figure 4.1-42: Estimated basin-wide mortality of salmon and steelhead (adults and juveniles) resulting from dam removal during median (most likely) and low flow (worst case) water years.



4.1.3.3 Sediment Transport

During Dam Removal (short-term)

Sediment transport modeling predicted that 1.5 to 2.3 million tons of sediment (5.3 to 8.6 million cubic yards) would be eroded from the reservoir areas upon dam removal (Reclamation 2012g). A large proportion of the sediments, 85 percent by dry weight, are characterized as small particle diameter silts and clays that would remain in suspension and would be largely transported through the Klamath River and estuary and into the Pacific Ocean where it would be dispersed by ocean currents (Reclamation 2012g, Stillwater Sciences 2008). A small portion of the eroded silts and clays would remain as overbank deposits along the river channel or in temporary storage in deeper river pools. The potential impact to humans and aquatic biota of chemicals associated with these deposits is discussed in Section 4.4.9 *Chemicals in Reservoir Sediments*. The pattern of silt and clay deposition would be dependent upon flow conditions during the year of dam removal. High flow years would leave a larger proportion of overbank deposits but would leave very little deposition in deeper pools. Low flow years would leave little to no overbank deposits but temporary deposition of silts and clays would occur to a limited degree in deeper pools and slack water areas.

The remaining 15 percent of the sediment is composed of sand and larger size material that would be transported through the Klamath River system more slowly, over a period of years and largely depending on flow conditions during and after dam removal. Based upon sediment transport simulations, about 1.5 feet of coarser sediment is expected to deposit between Iron Gate Dam (RM 190) and Willow Creek (RM 185), and less than 1 foot of deposition of coarser sediment is expected between Willow Creek (RM 185) and Cottonwood Creek (RM 182) soon after dam removal. From Cottonwood Creek (RM 182) to the Shasta River (RM 177) less than 0.25 feet of deposition is expected. It may take 5 to 10 years to return the sand content in the river bed to equilibrium levels from Iron Gate to Cottonwood Creek. Downstream

Mitigating for Short-term Dam Removal Impacts

Several mitigation measures would reduce short term impacts on aquatic species, including the following:

- Capture of migrating adult fish in the mainstem Klamath River prior to dam removal and relocation to suitable habitat
- Release of fall pulse-flows to enhance migration out of the mainstem prior to dam removal
- Collection of juvenile salmonids and lamprey before they enter areas of the mainstem with high SSC and release to downstream areas where concentrations are lower (see Figure 4.1-46)
- Adjustments in hatchery management to protect smolt releases
- Relocation of Pacific lamprey rearing in mainstem locations that may be most affected by sediment released during dam removal
- Relocation of suckers from reservoir habitat prior to dam removal
- Relocation of freshwater mussels from areas that may be most affected by sediment releases

of the Shasta River, model results indicate that dam removal will have no significant effect on bed material gradations in riffle sections (Reclamation 2012g). Sand moving through the Klamath River following dam removal as part of natural transport process will distribute throughout the 190 mile reach of the river with no measureable increase in the sand concentrations reaching the Pacific Ocean. The amount of sand released from dam removal is estimated to be on the order of 230,000 to 370,000 tons; the annual natural supply of sand to the Klamath River from all tributaries is approximately 1.8 million tons per year (Stillwater Sciences 2010; Reclamation 2012g).

Fine suspended sediment that moves through the river system in the weeks to months following dam removal will exit the Klamath River mouth and form a surface plume of less dense, turbid, water floating on denser ocean water (Mulder and Syvitski 1995). No detailed investigations of the size and dynamics of an ocean sediment plume resulting from dam removal have been conducted. Thus, the sediment deposition pattern in the near-shore environment is uncertain.

Other studies on sediment plume dynamics in northern California show that plume zones are primarily north of river mouths because alongshore currents and prevailing winds are northward during strong storm events (Geyer et al. 2000). Fine sediment plumes occurring during periods of northerly winds will thin and stretch offshore, while in the presence of southern winds, the plume may hug the coastline and mix extensively (Geyer et al. 2000; Pullen and Allen 2000; Borgeld et al. 2007). River plume area, location, and dynamics are also affected by the magnitude of river discharge, tides, and regional climatic and oceanographic conditions such as El Niño-Southern Oscillation and Pacific Decadal Oscillation climate cycles (Curran et al. 2002).

Since the majority of the sediment discharge from dam removal would occur over a number of weeks to months and are not directly associated with a particular storm event, the sediment plume in the ocean could be influenced by a range of meteorological and ocean conditions (e.g., storm and non-storm periods, and differing wind directions). Therefore, at times, the plume could be constrained to shallower near-shore waters and have more local deposition, while at other times it could extend further offshore and deposition would spread more widely.

A USGS overview report on the sources, dispersal, and fate of fine sediment delivered to California's coastal waters (Farnsworth and Warrick 2007) found that fine sediment deposition is a natural and dynamic element of the California coastal system and all California coastal rivers discharge fine sediment episodically, with large proportions of their annual sediment loads delivered over the course of only a few winter days.

Following Dam Removal (long-term)

In the long-term, bedload sediment movement is vital to anadromous fish habitat. In the Hydroelectric Reach downstream to the confluence of the Shasta River, more frequent bedload movement would create spawning habitat and create more complex habitat to support juvenile rearing. Under current conditions, with reduced flow variability and reduced loads of coarser sediment transport because of the presence of dams, stream beds downstream of Iron Gate Dam are rarely mobilized and they are poor habitat for spawning or rearing salmon.

Sediment transport modeling predicts that resupply of bedload sediment (consisting of sands, gravels, and cobbles) after dam removal would increase the river bed mobility in the Hydroelectric Reach and in the reach from Iron Gate Dam to Cottonwood Creek (8 miles). In this reach, the flow needed to mobilize sediment (mobilization flow) would drop from approximately 10,000 cfs to 6,000 cfs, increasing the frequency of bed mobilization from every fourth year to every other year. Downstream from Cottonwood Creek, overall the bed is expected to be more mobile to a distance beyond the Shasta River due to the transport of sand as bedload from the upstream reservoirs.

4.1.3.4 Evaluation of Dredging Reservoir Sediments to Reduce Short-term Impacts on Fisheries

Recognizing the short-term adverse impact on fisheries if dams are removed and reservoir sediments are transported downstream, the feasibility of mechanically dredging reservoir sediments prior to dam removal was investigated (Lynch 2011). A feasibility determination was made based on considerations of dredging technologies to remove sediments, their potential effectiveness, potential impacts on terrestrial and cultural resources, potential cost of dredging, and whether it would significantly reduce short-term impacts on fish and fisheries.

Total reservoir sediment volumes were estimated at 17.6 million cubic yards in J.C. Boyle, Copco 1, and Iron Gate reservoirs. Of this total, about 6.5 million cubic yards of sediment would be eroded and released if dams were removed (CDM 2011c). Copco 2 Reservoir does not contain appreciable bottom sediments (Reclamation 2010b). Several dredging technologies were evaluated to remove potentially erodible reservoir sediments. A significant factor in the evaluation was the nature of the sediments which are composed of between 44 to 94 percent [an average of 85 percent by weight] silt and clay, varying by location in the reservoirs and proximity to river and tributary inputs. This sediment also has a high water and organic matter content. The flocculent, fine-grained sediment present in the reservoirs is not conducive to efficient dredging operations with traditional equipment (e.g. crane and clam shell) (CDM 2011c).

The most viable technology for removing sediment with these characteristics was identified as a barge-mounted hydraulic dredge working during reservoir drawdown. As water levels drop, dredging would be concentrated along the former river and tributary channels, and adjacent terraces that may eventually slump into these channels, to remove as much of the potentially erodible sediment as possible. When and where possible, dredges would operate in less than 25 feet of water where they are most efficient, reliable, and cost effective. This type of dredging operation would remove a maximum of 43 percent of the erodible sediment (2.8 million cubic yards); this number could be less if mechanical problems developed, weather slowed operations (e.g. reservoir ice cover), or disturbance of cultural resources during dredging (CDM 2011c).

With this technology, dredged material would be transported via a slurry pipeline to nearby diked containment areas. The volume of sediment dredged would require about 300 acres of containment areas and approximately 20-foot high dikes, assuming water could be decanted back into the reservoirs, or nearly twice that amount of land area if decanting was not permissible (CDM 2011c). Regardless of the sediment dewatering system used, construction of sediment containment areas would disturb terrestrial resources and could disturb cultural resources.

Figure 4.1-43: Comparison of suspended sediment concentration at Iron Gate Dam with and without sediment dredging.

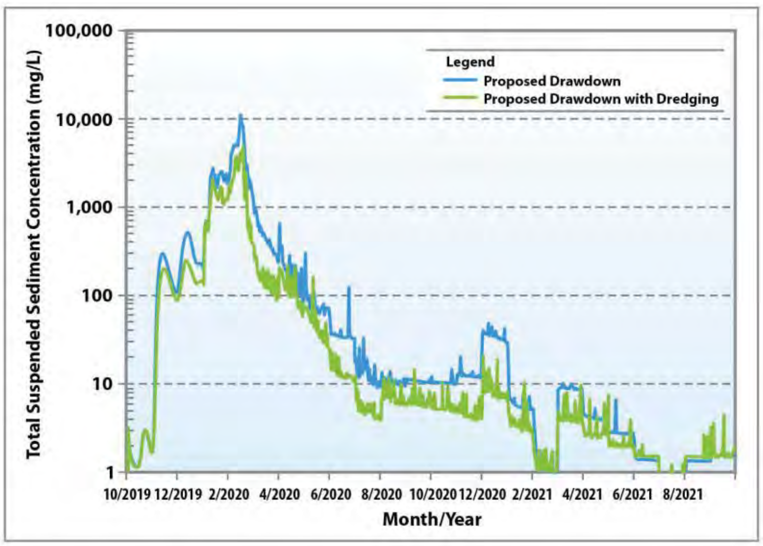
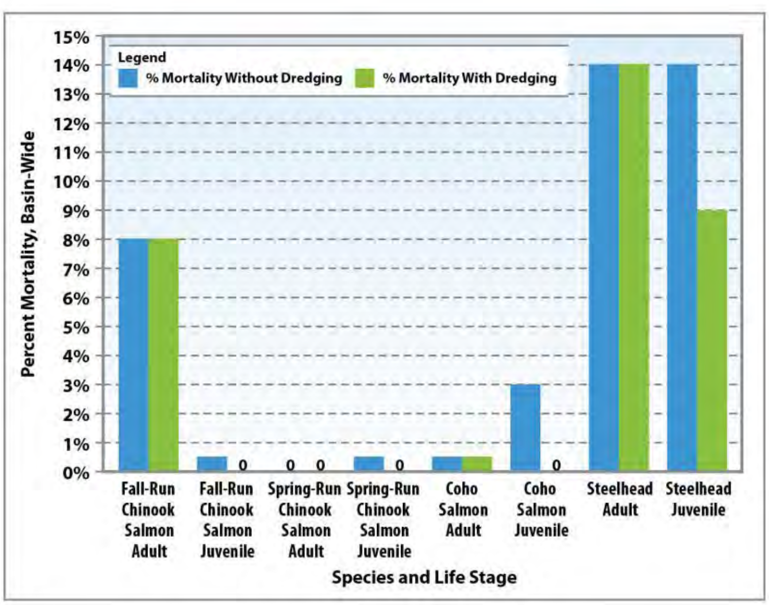


Figure 4.1-44: Comparison of estimated fish mortality impacts with and without sediment dredging under the most likely to occur scenario.



Source: Stillwater Sciences 2011a

With hydraulic dredging, the amount of sediment eroded downstream would be reduced by 2.8 million cubic yards, thereby decreasing SSC downstream. Figure 4.1-43 shows the effect of dam removal on TSS concentrations below Iron Gate Dam for a median flow year, with and without reservoir dredging (Stillwater Sciences 2011a). Peak TSS concentrations decrease significantly with dredging, estimated at about 11,000 mg/L without dredging decreasing to about 5,000 mg/L with dredging. Both scenarios, however, produce TSS concentrations that would be high enough, and of long duration (January through March 15) during reservoir drawdown, to be lethal or highly stressful to fish in the Klamath River, particularly immediately downstream of Iron Gate Dam. Figure 4.1-44 compares the basin-wide percent mortality of adult and juvenile Chinook salmon, coho salmon, and steelhead for a median flow year with and without dredging (Stillwater Sciences 2011a). Reductions in basin-wide fish mortality associated with reduced SSC from dredging would be relatively small, remaining unchanged at 8 percent for fall-run adult Chinook, decreasing from 3 percent to negligible for juvenile coho salmon, remaining unchanged for adult steelhead at 14 percent, and decreasing from 14 percent to 9 percent for juvenile steelhead. Mortality of the other life stages of Chinook and coho salmon shown in Figure 4.1-44 are less than one percent and would not be influenced by sediment dredging. As noted earlier, the percent basin-wide mortalities are generally low for both scenarios because most life stages of fish are not present in the mainstem Klamath River in peak numbers during the proposed time of reservoir drawdown (see Figure 4.1-41) (Stillwater Sciences 2011a).

An Opinion of Probable Construction Cost (OPCC) (CDM 2011d) for the dredging operation described above would be about $97 million in 2011 dollars. Escalating this figure to 2020 dollars (3 percent compounded annually), the cost estimate would be about $127 million at the time of dredging. The OPCC estimates did not include design engineering, construction oversight, legal fees, land acquisition fees, and site restoration (e.g. re-vegetation), that typically cost an additional 30 percent, which result in an estimated cost of $165 million (in 2020 dollars) for reservoir dredging.

Based on a number of factors, including the relatively small reductions in mortality of fish, the land disturbance that would occur for sediment containment structures, the potential disturbance of cultural resources, and the high cost of the dredging operation, dredging reservoir bottom sediments prior to dam removal was deemed infeasible (Lynch 2011). In lieu of dredging, mitigation measures (e.g. trapping and relocating potentially affected fish during dam removal) were identified to minimize effects to aquatic species from sediment release associated with dam removal and to be significantly more cost effective.

4.1.3.5 Mitigation Actions

It is anticipated that the short-term effects of dam removal (low dissolved oxygen and high SSC) would result in mortality of some salmonids downstream of the Hydroelectric Reach. Other species, including lamprey and freshwater mussels, would be affected directly as well. The primary approach for reducing impacts on salmonids is drawing down the reservoirs at a time when adult and juvenile life stages are in tributaries or the ocean. Additional actions to help mitigate impacts of dam removal on aquatic resources are described below and in Section 4.2, *Detailed Plan for Dam Removal and Estimated Costs.*

Deleterious short-term effects of dam removal on mainstem spawning could be reduced by capturing migrating adult fish (Chinook salmon, coho salmon, steelhead, or Pacific lamprey) in the mainstem Klamath River during the fall preceding dam removal (2019) and relocating them to suitable habitat. Capture of adult fish could be accomplished with the use of an Alaskan-style weir and box trap, similar to that currently used at the Willow Creek, Trinity River site. Fish could be released either in tributaries downstream of Iron Gate Dam (e.g., Scott River), or in tributaries upstream of Iron Gate Dam if that were consistent with post-dam removal management goals. Effects on adults could also be reduced by increasing river flows during fall 2019, prior to dam removal. It has been observed that increased flows in the fall stimulate the migration of post-spawned green sturgeon out of the Klamath River (Benson et al. 2007). Additionally, increased fall flows might increase the rate and proportion of fall-run Chinook salmon, steelhead, and coho salmon spawning in tributaries rather than the mainstem Klamath River; this might reduce the proportion of the population that would be exposed to elevated SSC in the mainstem during their migration period (Stillwater Sciences 2009).

Figure 4.1-45: Fish rescue locations to mitigate for potential impacts from sediment release with dam removal.

Figure 4.1-46: Fish rescue operations would include out-migrant traps such as these two operating in the Shasta River.

The protection of outmigrating juvenile salmon is particularly important to off-set the likelihood of direct mortality of a portion of juvenile Chinook salmon, coho salmon, and steelhead present during dam removal activities. To this end, rescue of outmigrating juveniles before they enter the mainstem Klamath River during the spring following drawdown could be conducted at key tributaries known to have a high abundance of juvenile salmonids and located within the area of highest predicted SSC (see Figure 4.1-45). Rescued fish would be transported downstream, released in locations possessing suitable water quality, and allowed to continue their downstream migration to the ocean. Traps are currently in operation at some of these locations (see Figure 4.1-46); these traps would be operated more aggressively (e.g., weir panels to direct fish to traps) to capture a higher percentage (greater than 50 percent) of outmigrating fish.

Deleterious short-term effects on outmigrating hatchery coho salmon and steelhead trout yearling releases could be reduced by adjustments to hatchery management. Hatchery managers could adjust or delay the release of these yearlings during spring 2020. Although it would be out of phase with natural life history timing, if yearlings were released later (e.g., mid-May), impacts associated with high SSC earlier in the spring could be reduced.

While there is some uncertainty, lamprey may experience some mortality in the short-term as a result of dam removal. Mitigation for short-term lamprey mortality could involve salvage of larval lamprey from preferred habitat areas, where impacts are predicted to be highest, and relocation to suitable habitats (with current low occurrences of lamprey) in tributaries upstream of J.C. Boyle Reservoir.

It is anticipated that short-term effects of dam removal would result in mostly sublethal, and in some cases lethal impacts on Lost River and shortnose suckers in Klamath Hydroelectric Project reservoirs. Adult Lost River and shortnose suckers in the reservoirs downstream of Keno Dam could be captured and relocated to Upper Klamath Lake; the percentage that could be relocated in this fashion prior to dam removal is uncertain.

Freshwater mussels in the Klamath Hydroelectric Reach and in the Lower Klamath River, downstream of Iron Gate Dam, would likely be adversely affected by elevated SSC and bedload movement during the latter part of reservoir drawdown. Freshwater mussels cannot move to avoid these impacts. Mitigation for this effect would involve relocation of freshwater mussels to tributary streams or the mainstem river upstream of the Klamath Hydroelectric Reach, followed by relocation to their approximate location or to other suitable habitat in the river after dam removal was completed.

4.1.4 Summary of Effects on Fish and Associated Uncertainties

Anadromous fish and several resident native fish populations in the Klamath Basin have declined markedly from historical levels, primarily as a result of blocked access to their historical habitat, overfishing, degraded freshwater and marine habitat, disease, water quality (including temperature), and altered hydrology. During the Secretarial Determination process, the TMT used a variety of analytical tools, both qualitative and quantitative, including a series of four expert fish panels, to assess the expected effects of dam removal with KBRA implementation on salmonid (salmon, steelhead, and trout) and other fish populations. In general, the TMT concluded that dam removal and KBRA implementation would improve fish populations primarily by increasing access to historical habitat, restoring mainstem and tributary habitat, and by improving key biological and physical factors that heavily influence fish populations (e.g. flow conditions, sediment and bedload transport, water quality, fish disease, toxic algal blooms, and water temperature). Table 4.1-12 summarizes many of these key factors, as well as the TMT's level of certainty and uncertainty for each in its response to dam removal and implementation of the KBRA.

In the short-term, reservoir drawdown associated with dam removal would result in the release of high SSC. Although short in duration, this suspended sediment release is expected to result in some lethal and sublethal effects on a proportion of fish populations, in particular, steelhead trout in the mainstem Klamath River downstream of Iron Gate Dam (see Figure 4.1-42). However, the timing of drawdown (early January) was selected to coincide with periods of naturally high SSC in the Klamath River, to which aquatic species have adapted by avoiding or tolerating. 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 greatest SSC (January through March), with several species primarily located in tributaries, further downstream where concentrations would be diluted by accretion of flows, or in the Pacific Ocean. In spite of some short-term mortalities associated with suspended sediment releases, salmon, steelhead trout and other native anadromous species are anticipated to increase in abundance and viability in the long-term.

Table 4.1-12: Certainty of ecological conditions affecting future salmonid (salmon, steelhead and trout) populations with dam removal and KBRA implementation

Current and Future Ecological Conditions Affecting Basin Fisheries with Dams Remaining	Anticipated Change in Ecological Function Expected with Dam Removal and KBRA	Predicted Certainty of Response or Action with Dam Removal and KBRA	Discussion
Dams block access to over 420 miles of potential salmonid habitat upstream of Iron Gate Dam.	Over 420 miles of habitat would be available to anadromous salmonids including access to cold water refugia in the upper basin and improved habitat quality from KBRA restoration actions.	Moderate to High	Quantitative modeling and multiple studies demonstrate with high certainty that additional usable stream habitat and important cold water refugia would become available; the amount of habitat used by individual species would differ. The amount of habitat used by fish could vary based on the success of KBRA implementation, representing moderate uncertainty on miles of new habitat used.
Dams diminish bedload sediment transport and gravel recruitment in the Hydroelectric Reach and downstream of Iron Gate Dam.	Reservoir removal and variable flows would improve bedload transport and gravel recruitment downstream of Iron Gate Dam.	High	Quantitative modeling and multiple studies indicate dam removal would improve stream-bed mobility and gravel transport, creating better salmonid spawning and rearing areas, and decreasing juvenile salmon disease.
Fish habitat is degraded at various locations within the Klamath Basin. Improvements in future habitat quality are uncertain, but competition for natural resources will likely place increasingly greater stress on Klamath fisheries. Tribal water rights being adjudicated in Oregon may result in greater allocation of water to support fisheries but the outcome remains uncertain.	KBRA Fisheries Program, based on the principles of adaptive management, would improve fish habitat in key areas of the basin and distribute water to support fisheries in Upper Klamath Lake and the Klamath River.	Moderate	Multiple studies demonstrate that restoring fish habitat improves fisheries; habitat restoration is a priority of the KBRA. However, specific restoration actions are not identified and some rely on private land owner cooperation to implement. Ideal flows and timing needed to enhance fish populations following dam removal are uncertain but represent an adaptive management opportunity for potentially controlling juvenile salmon disease and preventing adult die offs.
Iron Gate Hatchery provides Chinook, coho, and steelhead recruits adding to fisheries abundance. The continued operation of this conservation hatchery is certain.	Iron Gate Hatchery will likely not be used to augment Chinook, coho, or steelhead trout populations after 2028 when PacifiCorp funding for the hatchery would end.	Low to Moderate	The exact response of the ecosystem by 2028 is not certain, being dependent upon several highly variable factors (e.g. weather, flow, and ocean conditions). It is possible that an analysis of KBRA fish monitoring data may indicate the need for an extension of this hatchery's operation beyond 2028 for one or more species.
Iron Gate Hatchery dilutes natural spawning populations reducing diversity of Chinook, coho, and steelhead.	Fish diversity would increase without augmentation from the Iron Gate Hatchery and because salmonids would spawn, rear, and return to a wider geographic area.	Moderate to High	Multiple studies demonstrate hatcheries reduce the diversity of natural fish. The Trinity River Hatchery would continue production adding to a system-wide diversity reduction. There is high certainty that expanding the geographic range of fish habitat will increase their diversity.
High incidence of juvenile salmon disease below Iron Gate Dam from current flow conditions, limited bed mobility, diminished sediment transport, polychaete food supply from reservoirs, and limited salmon carcass dispersal will likely continue in some years.	Reduced juvenile salmon disease would likely occur with dam removal through a combination of increased flow variability, increased bed mobility and suspended sediment transport, and dispersal of salmon carcasses.	Moderate to High	Disease in the infectious zones below Iron Gate Dam would decrease by disrupting the life cycle requirements of the protozoan parasites through increased flow variability, bed mobility and suspended sediment transport, and dispersal of salmon carcasses. While it is possible that the current infectious nidus (reach with the highest infectivity) may move upstream where salmon spawning congregations occur, and there is associated uncertainty, the likelihood of this happening is remote.

Table 4.1-12: (Continued) Certainty of ecological conditions affecting future salmonid (salmon, steelhead and trout) populations with dam removal and KBRA implementation

Current and Future Ecological Conditions Affecting Basin Fisheries with Dams In without KBRA	Anticipated Change in Ecological Function Expected with Dam Removal and KBRA	Predicted Certainty of Response or Action with Dam Removal and KBRA	Discussion
Copco 1 and Iron Gate reservoirs support the growth of toxin producing phytoplankton blooms.	Toxin producing phytoplankton blooms in Copco 1 and Iron Gate reservoirs would be eliminated.	High	Multiple literature studies indicate that reservoir removal would eliminate the production of algal toxins.
Copco 1 and Iron Gate Dam reservoirs create unfavorable water temperatures for salmonids; warmer in late summer/fall and cooler in the spring.	Seasonal water temperature lags and dampened diel water temperature fluctuations caused by the large reservoirs would be eliminated, returning the river to a more natural condition for fish.	High	Multiple temperature modeling studies demonstrate an improvement in seasonal and daily water temperatures with dam removal.
Reservoir operations create low dissolved-oxygen concentrations just below Iron Gate Dam that are unfavorable for salmonids.	Reservoir generated low dissolved-oxygen problems just below Iron Gate Dam would be eliminated by dam removal.	High	Multiple studies and quantitative modeling demonstrate an improvement in dissolved oxygen concentrations with dam removal.
Upper basin water quality is seasonally poor in Upper Klamath Lake and Keno Impoundment.	KBRA restoration plans may improve water quality in the upper basin, benefiting resident and migrating salmonids.	Moderate	TMDL and KBRA restoration actions would improve water quality in Upper Klamath Lake and the Keno Impoundment. However, the degree of improvements and their timing are uncertain because restoration plans are yet to be worked out.
J.C. Boyle, Copco 1, and Iron Gate reservoirs store both fine and coarse sediment.	There is a high degree of certainty that suspended sediment released during dam removal would produce short-term lethal conditions for some salmon and steelhead. Steelhead adults and juveniles would have the highest 1-year basin-wide mortalities (about 14 percent in a median flow year). Salmon mortalities would be less than 10 percent. Impacts to other aquatic species, including fresh water mussels and Pacific lamprey, are uncertain.	High	Quantitative modeling was used to estimate impacts to adult and juvenile Chinook, coho, and steelhead. Variable flow conditions at the time of dam removal were modeled to assess the possible range of lethal conditions. A dry year would produce worst-case mortalities. Mitigation measures have been identified to reduce fisheries impacts, and could reduce actual mortalities predicted by the model.
Climate change will likely produce warmer water temperatures and earlier spring runoff. Changes in precipitation amounts may be small, but there is uncertainty in this analysis. The magnitude of future ecosystem response is uncertain but warmer water temperature would likely increase stress on fish.	There is a high degree of certainty that climate change would produce warmer water temperatures (excluding groundwater influenced areas) and earlier spring runoff. Changes in precipitation amounts may be small, but there is uncertainty in this analysis. The magnitude of future ecosystem response to climate change is uncertain but warmer water temperature would likely increase stress on fish. There is high certainty that dam removal would provide access to large cold-water refuge areas (springs and tributaries in the Hydroelectric Reach and the upper basin), reducing climate change impacts on migrating salmonids.	Low to High	Stream temperature modeling was used to predict effects of climate change on water temperatures and runoff, using output from a range of global circulation models (climate models). These climate models predict that future precipitation amounts could be less than or greater than current conditions, depending on the climate model. Cold water refuge areas from large natural springs and tributaries are well documented.
Hydroelectric peaking diminishes resident trout and benthic macroinvertebrate habitat in the Hydroelectric Reach.	Hydroelectric peaking would be eliminated.	High	Multiple studies demonstrate adverse impacts to habitat and native fish populations associated with peaking operations.
Turbine entrainment in the Hydroelectric Reach causes mortality to resident fish, including trout.	Turbine entrainment would be eliminated.	High	Multiple studies demonstrate fish mortality associated with turbine entrainment.

It is extremely difficult to predict with certainty the long-term effects of the dams remain scenario on native fish populations. Although fish populations have declined markedly, it is difficult to know with certainty whether these declines have stabilized, whether further declines are likely, or whether improvements are possible owing to ongoing restoration actions. Ongoing actions include addressing water-quality concerns under the Clean Water Act (nine separate TMDLs), providing Klamath River flows and Upper Klamath Lake water elevations that are protective of three ESA listed fish (two recent ESA biological opinions), and restoring fish habitat basin-wide. Moreover, it is equally difficult to predict whether climate change over the study period (2012 through 2061) would offset any gains made by these restoration actions or whether climate change impacts on water temperatures and flows in the Klamath Basin would cause further declines in fish populations. Consequently, because of the large uncertainties, and because of the numerous offsetting factors that complicate an analysis, the TMT assumed for the purpose of this analysis that the current status of fish populations in the Klamath Basin would continue into the future if dams remain and KBRA was not implemented.

In contrast to dams remain, the short-term and long-term effects (both positive and negative) of dam removal and implementation of KBRA are expected to be relatively large for some fish populations, and the long-term effects are expected to advance salmonid fisheries. Summaries of the potential effects of dam removal and KBRA implementation on selected fish populations, and the associated levels of uncertainty, are provided below.

Figure 4.1-47: Returning Chinook salmon kegged at the mouth of Scott River in late September 2009 due to low tributary flow. Improved late summer/fall flows with dam removal and implementation of the KBRA would improve conditions for returning fall-run Chinook salmon.

Chinook Salmon - There is a high degree of certainty, based on available science (and the lack of contrary conclusions), that in the long-term Klamath dam removal would expand usable habitat for Chinook Salmon and would significantly increase their abundance as compared to leaving dams in place (Oosterhout, 2005; Huntington 2006; FERC 2007; Hetrick et al. 2009; Goodman et al. 2011; Hamilton et al. 2011; Hendrix 2011; and Lindley and Davis 2011). Researchers, however, differ on the likely range of this response based on differing assumptions about the amount and quality of useable habitat above Keno Dam the abundance and productivity of spring-run Chinook salmon, how effectively KBRA would be implemented, and the likely trajectory of Chinook salmon if dams were left in place. For example, Goodman et al. (2011) cautioned that KBRA needed to be effectively implemented to reduce or eliminate a number of the environmental factors limiting Chinook salmon production. Although cautious in tone, this panel also clearly stated that dam removal and implementation of KBRA appeared to be a major step forward for Chinook salmon, that substantial increases were possible, and that there was a high degree of certainty that leaving the dams in place would lead to further declines.

Hendrix (2011) provides the most recent, comprehensive quantitative analysis of likely Chinook salmon response to dam removal and implementation of KBRA. Modeling results from 50 years (2012 through 2061) indicate, with a high level of certainty (greater than 97 percent), that dam removal and KBRA implementation would increase median Chinook adult production and harvest (Hendrix 2012). Annual median increases in production, however, varied considerably among years. For the period 2033 through 2061, corresponding to the period after dam removal and after the effects of Iron Gate Hatchery releases, annual median production ranged from 50 to 189 percent increases, with an overall median increase of 81 percent. Fisheries would also increase in this period, with median increases of 55 percent for tribal harvest, 46 percent for ocean commercial and sport fisheries, and 9 percent for the river sport fishery. Harvest would vary from year to year, but would always be greater with dam removal and KBRA than if dams remain. This model does not incorporate adjustments to minimum escapement levels to account for additional habitat area opened after dam removal or any possible improvements in juvenile salmon disease, so results likely underestimate actual increases in Chinook salmon production.

Short-term (1 to 2 years) impacts of sediment release following dam removal appear to be relatively small for Chinook salmon, largely owing to the planned winter drawdown of the reservoirs when Chinook adults and juveniles are largely absent from the main stem river. The certainty of this conclusion was increased by evaluating a range of possible hydrologic conditions (dry and median flow years) during reservoir drawdown; the worst-case scenario (dry year) produced lethal conditions for less than 10 percent of adults and less than one percent for juveniles (Stillwater Sciences 2011a).

Coho Salmon - There is a high degree of certainty, based on available science, and the lack of contrary conclusions, that coho salmon will benefit from dam removal and implementation of KBRA by restoring fish access to approximately 76 additional miles of historical habitat (main stem river and tributaries) above Iron Gate Dam (NRC 2004; FERC 2007; Dunne et al. 2011; and Hamilton et al. 2011). The early response following dam removal is likely to be small (Dunne et al. 2011), but that recolonization of the reach between Keno Dam and Iron Gate Dam would likely lead to an increase in their abundance, spatial distribution, productivity and life-history diversity, all of which improve viability of future populations. There are uncertainties associated with the magnitude of increases, with the level of responses possible if KBRA is effectively implemented to improve habitat and/or the level of juvenile coho disease benefits below Iron Gate Dam under dam removal and implementation of KBRA. Smaller increases are more likely absent these conditions. There is a high degree of certainty that KBRA and dam removal would help reduce the risk of coho salmon becoming extinct in the future. Full recovery of coho salmon populations over the next 50 years will depend on the effectiveness of habitat restoration and water conservation measures implemented through KBRA or other restoration programs in the basin.

Short-term (1 to 2 years) impacts of sediment release following dam removal appear to be relatively small for coho salmon, again owing to the planned winter drawdown of the reservoirs when coho salmon adults and juveniles are largely absent from the main stem river. Again, the certainty of this conclusion was increased by evaluating a range of possible hydrologic conditions (dry and median flow years) during reservoir drawdown; the worst-case scenario (dry year) produced lethal conditions for less than one percent of adults and less than 10 percent for juveniles (Stillwater Sciences 2011a).

Steelhead - There is a high degree of certainty, based on available science, that dam removal and implementation of KBRA would benefit steelhead trout by recolonizing historical habitat upstream of Iron Gate Dam (Fortune et al. 1966; Chapman 1981; Huntington 2006; FERC 2007; Dunne et al. 2011; Hetrick et al. 2009; and Hamilton et al. 2011). There is no contrary information in the literature. There are uncertainties, however, associated with the magnitude of the likely increases. Dunne et al. (2011) was optimistic that dam removal coupled with an effective implementation of KBRA would increase their abundance and distribution compared to current conditions. However, the degree of success would center on how well KBRA was implemented, to what degree poor summer and fall water quality conditions affected their migration, the outcome of their interactions with resident trout, and the impact of hatcheries. The likelihood of success increases based on the fact that steelhead are genetically resistant to *C. shasta* that causes disease in juvenile salmon, that similar species (resident redband/rainbow trout) are doing well in habitat upstream of Iron Gate Dam, that steelhead are relatively tolerant of warmer water temperatures, and their life-history strategy (do not spawn and die) increases their opportunity of utilizing more than 420 miles of historical habitat if dams were removed (Hetrick et al. 2009; Hamilton et al. 2011; Huntington 2006).

There is a high degree of certainty that short-term (1 to 2 years) lethal impacts of sediment release following dam removal would be larger for steelhead trout than for salmon because a planned winter release of sediment overlaps with the presence of adult and juvenile steelhead in the mainstem river. Losses of adult and juvenile steelhead could be 28 and 19 percent, respectively, under a worst-case condition (dry year); losses of adult steelhead would likely be smaller (about 14 percent) if dam removal occurred in a median flow year (Stillwater Sciences 2011a).

Redband/Rainbow Trout – Available literature indicates, with a moderate amount of certainty, that dam removal would substantially increase high-quality, contiguous redband and rainbow trout habitat below Keno Dam and through the Hydroelectric Reach, increasing their abundance (Hamilton et al. 2011; Buchanan et al. 2011). Trout are currently abundant in parts of this reach, and would do better in the absence of entrainment into turbines and in reaches currently subjected to hydroelectric peaking flows. Existing redband trout and colonizing anadromous steelhead are expected to co-exist, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food.

Resident trout above Keno Dam may also increase in abundance because of KBRA restoration actions, including improvements in water quality, water quantity, and the riparian corridor. The magnitude of this response has a significant amount of uncertainty because details of KBRA have not been defined. Past restoration efforts above Upper Klamath Lake have demonstrated benefits to resident trout and if these types of action are repeated and expanded under KBRA they would be expected to increase resident trout habitat and abundance.

Pacific Lamprey - The response of Pacific lamprey to dam removal and implementation of KBRA is inherently uncertain largely because these species are not well studied, their habitat requirements and historical distribution are not well known, and their life cycle is complicated. Close et al. (2011) examined the available lamprey information and concluded that relatively small increases in production were possible for Pacific lamprey (1 to 10 percent). The process of recolonization upstream of Iron Gate Dam could take decades, but this timeframe is uncertain. In addition, sediment release associated with dam removal would result in an unknown effect on various lamprey life stages. Close et al. (2011) did conclude with certainty that lamprey population levels may either remain at current levels or continue to decline if dams were left in place.

Lost River and Shortnose Suckers – Dam removal would have little appreciable effect on Federally listed suckers. However, implementation of KBRA, including greater in-stream flows above Upper Klamath Lake, improvements in near-shore water quality in Upper Klamath Lake, and restoration of degraded riparian corridors, may improve conditions for these endangered species (Buchanan et al. 2011). But the magnitude of beneficial effects on sucker abundance has a high degree of uncertainty partly because of the current lack of specificity of KBRA restoration actions and partly because factors contributing to their endangered status, which are not fully understood, may not be specifically addressed by KBRA restoration actions. The expert panel covering suckers (Buchanan et al. 2011) concluded that dam removal and implementation of KBRA "provides greater promise [than leaving dams in place] for preventing extinction of these species and for increasing overall population abundance and productivity." This statement captures the most likely outcome of dam removal and KBRA implementation for endangered suckers while expressing uncertainty regarding this outcome.

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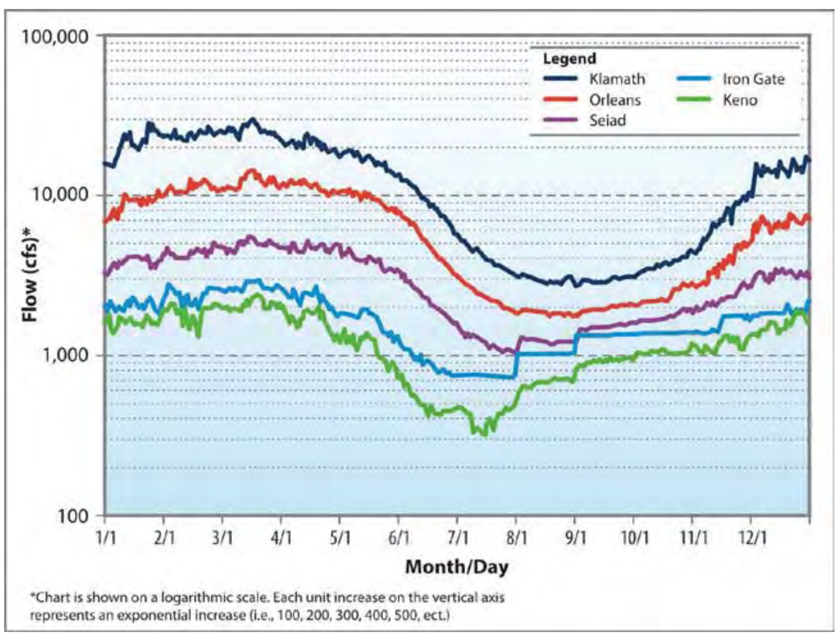
4.2 DAM REMOVAL DETAILED PLAN AND ESTIMATED COST

Removal of the Four Facilities required development of a detailed deconstruction plan, titled *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2012e). This plan, which is the foundation for much of the material summarized in this section, largely integrates requirements in the KHSA for hydroelectric operations through 2019; considers the full range of flow conditions that could be encountered during dam removal; considers the unique features of each dam and each reservoir (see Table 4.2-1); and, includes drawdown rates that minimize bank slumping in reservoirs as well as the need to minimize impacts on the ecosystem.

In particular, the plan for reservoir drawdown and facilities removal was designed to minimize impacts on fish species and to protect threatened coho salmon. These goals resulted in a plan to drawdown the three larger reservoirs at a rate of 1 to 3 feet per day in the winter of a single year (2020). The *Detailed Plan for Dam Removal* ensures that the majority of reservoir sediments are transported downstream from January through March 15 when coho salmon as well as several other native species are not present in large numbers in the mainstem river (see Life Cycle part of Figure 4.1-41). Drawdown in January and February was also selected because of likely high flows that would initially erode the fine-grained sediments in the reservoirs and continued high flows basin wide through the month of April to carry those sediments to the ocean (see Figure 4.2-1).

Timing of removal of the Four Facilities (e.g., dams, powerhouses, and penstocks) differs depending on the "dam type" (see Table 4.2-1), such as concrete versus earthfill embankment, and whether a feature to be removed is in the flood plain. Features in a floodplain, or features that could be compromised by a high-flow event, would be removed in the summer of 2020. Table 4.2-1 provides the basic information for each of the Four Facilities built during the 40-year period of their construction.

Figure 4.2-1: Chart of the median daily 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 2012e

Table 4.2-1: General information of Four Facilities on the Klamath River

	J.C. Boyle	Copco 1	Copco 2	Iron Gate
Year Operational	1958	1922	1925	1962
Location (river mile)	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	Overflow Spillway with Control Gates	Overflow Spillway with Control Gates	Uncontrolled Overflow Spillway
Maximum Power Capacity (Megawatts)	98	20	27	18

Source: FERC 2007, Reclamation 2012e

Figure 4.2-2: Photos of J.C. Boyle Dam and Reservoir with specific components labeled. With full facilities removal, all visible components would be removed. With partial facilities removal, certain components (e.g., steel conveyance pipe) would be retained.

Image from Klamath Riverkeeper

Image from Klamath Riverkeeper

Reclamation (2012e) analyzed and provided estimated costs for two dam removal scenarios: (1) full facilities removal, and (2) partial facilities removal. Full facilities removal is described as the removal of all features of the dam facilities with the exception of buried features. Partial facilities removal is defined as the removal of the main dam structure to allow a free-flowing river and full volitional fish passage, while some related facilities and/or abutments would be retained. It is assumed that all retained structures would be either sealed or fenced for safety reasons and would require long-term maintenance.

4.2.1 Dam Removal Engineering and Construction

4.2.1.1 J. C. Boyle Dam

The J.C. Boyle Development, the most upstream PacifiCorp-owned hydroelectric facility, includes the dam, reservoir, gated spillway, diversion culvert, water conveyance system, power generation facilities and powerhouse (see Figures 4.2-2 and 4.2-3). The hydropower facility is used

Figure 4.2-3: Map of the J.C. Boyle Dam and Associated Facilities.

to produce peaking power (i.e., it generates power when demands are highest). Under the proposed plan, power generation would cease at J.C. Boyle on January 1, 2020. At that time, the Dam Removal Entity (DRE) (see sidebar) would begin to draw the reservoir down and remove the spillway gates, spillway bridge, and the concrete intake structure. This initial removal work would be completed before March 15, 2020, when spring runoff historically starts and sustained high flows would be present in the river.

A concrete box culvert with two 9.5 by 10-foot bays is located beneath the center and right spillway gates 30 feet below the spillway crest. This feature was used for diversion during construction of the dam, and has been sealed with concrete bulkheads at the upstream end. Following reservoir drawdown to the lowest possible level using the existing release facilities, one of the two bulkheads would be removed under reservoir head (by blasting if necessary) for additional drawdown, followed by removal of the second bulkhead. Removal of

Dam Removal Entity (DRE)

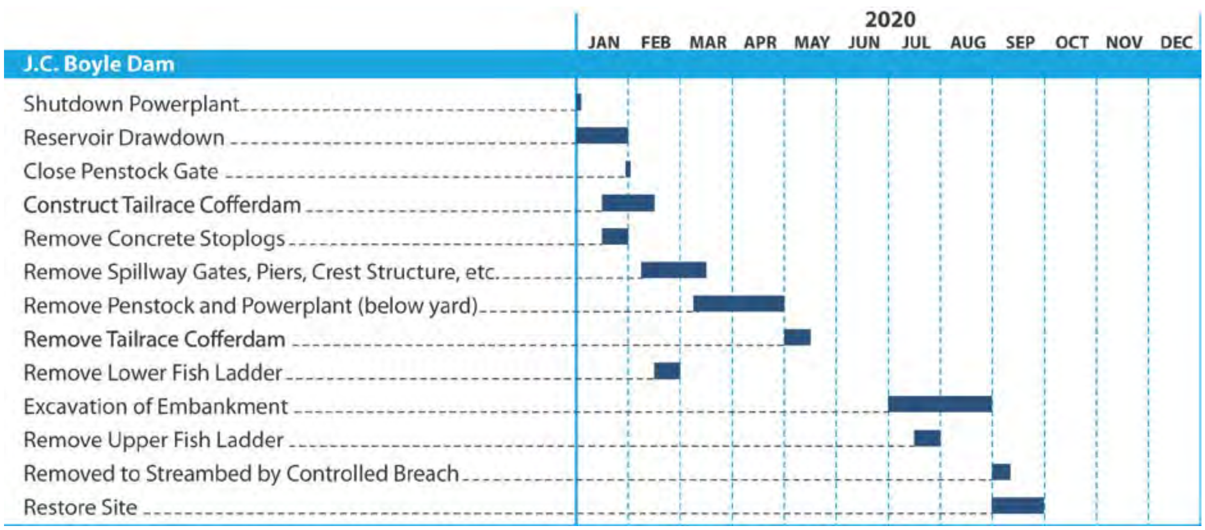
The DRE is the entity with primary responsibility for carrying out the dam removal and other components of the KHSA. The DRE would be identified by the Secretary of the Interior.

these bulkheads would facilitate necessary reservoir drawdown to allow for the final controlled breach of the dam.

Concurrent with dam removal, a cofferdam would be constructed to isolate and remove the powerhouse downstream. Features such as penstocks, switchyards, and other associated buildings could be removed during high flows because they are primarily out of the floodplain. The remaining portion of the dam, primarily the embankment dam, would be removed during the low flow period of the year, July through August (Figure 4.2-4), working from the top of the dam downward. The lowest portion of the dam embankment would be allowed to overtop and breach in a controlled fashion in early September 2020. The DRE would use the concrete and earth materials generated from the deconstruction first to fill the original borrow pits near the right abutment of the dam and then the downstream scour hole below the forebay spillway. The DRE would haul mechanical and electrical waste to a waste processing site near Klamath Falls, Oregon (Reclamation 2012e).

Figure 4.2-4 describes the major timelines associated with the deconstruction of J.C. Boyle Dam and associated Facilities.

Figure 4.2-4: JC Boyle Removal Timeline



Partial Removal

With partial facilities removal, portions of the facilities and ancillary structures associated with J.C. Boyle Dam would be left in place (see Figure 4.2-5). Table 4.2-2 below provides the list of facilities that would either be retained or removed as part of partial facilities removal. The primary features remaining include the powerhouse, canal intake structure, steel pipeline, and multiple buildings at the site (Reclamation 2012e).

Table 4.2-2: Partial Removal of J.C. Boyle Dam

Feature	Action
Embankment Dam, Cutoff Wall	Remove
Spillway Gates and Crest Structure	Remove
Fish Ladder	Remove
Steel Pipeline and Supports	Retain
Canal Intake (Screen) Structure	Retain
Left Concrete Gravity Section	Retain
Power Canal (Flume)	Remove Walls
Shotcrete Slope Protection	Retain
Forebay Spillway Control Structure	Remove
Tunnel Inlet Portal Structure	Remove
Surge Tank	Remove
Penstocks, Supports, Anchors	Remove
Tunnel Portals	Concrete Plug
Powerhouse Gantry Crane	Remove
Powerhouse Substructure/Slab	Retain
Powerhouse Hazardous Materials (Transformers, batteries, insulations, petroleum products)	Remove
Tailrace Flume Walls	Retain
Tailrace Channel Area	Partial Backfill
Canal Spillway Scour Area	Partial Backfill
69-kV Transmission Line, 0.24 miles	Remove
Switchyard	Remove
Warehouse, Support Buildings	Remove Some

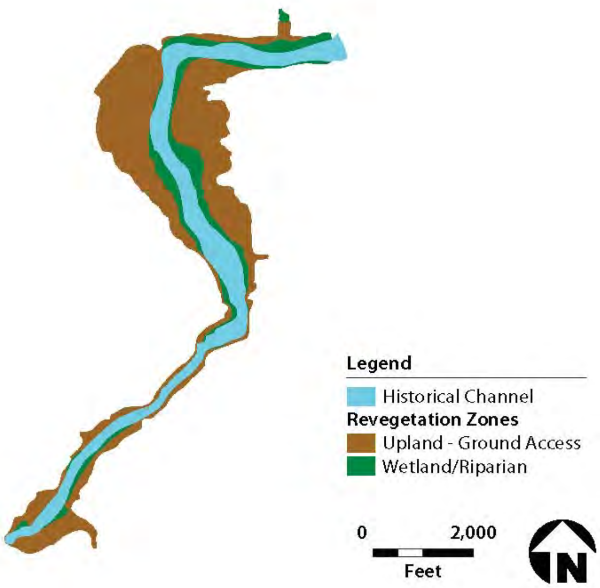
Figure 4.2-5: Partial removal of the J.C. Boyle Facility would provide a free flowing river and allow full volitional fish passage. However, certain structures would be retained.

Challenges Associated with the Restoration of the Reservoir Basins

The challenges for restoration of the three reservoirs include the following (Reclamation 2012e):

- The need to use a mixture of barges, trucks, and aerial applicators for hydroseeding.
- Exact dates and methods for re vegetation are subject to weather conditions and flow forecasts.
- Difficult terrain, slopes, and stability for ground equipment.
- Weed control.

Figure 4.2-6: Potential locations for revegetation in J.C. Boyle Reservoir. Revegetation efforts would be focused as shown below.



Source: Reclamation 2011g

Post Reservoir Management at J.C. Boyle

With dam removal, and the associated drawdown of the reservoir, there would be significant erosion of the reservoir sediment. The DRE would begin revegetation efforts with the goal of establishing sustainable riparian, wetland, and upland habitats on the newly exposed reservoir sediment. Reclamation (2011g) performed a study and provided a detailed plan on the reservoir restoration activities.

To limit the impacts of erosion, various methods of hydroseeding (including application from ground, barge, and aerial-based equipment) would be employed by the DRE. Seed mixes would include specific applications for native grasses, riparian plantings, and wetland vegetation. Locations for hydroseeding would vary for each of the reservoirs.

In J.C. Boyle Reservoir, the majority of the reservoir sediment has accumulated near the dam, and is expected to be flushed downstream at the time of initial drawdowns. It is also expected that sediment would be eroded from the steep slopes of the reservoir bottom. Potential locations for revegetation in J.C. Boyle Reservoir are shown in Figure 4.2-6. Estimated costs are presented in Table 4.2-4 and Table 4.2-5 (Reclamation 2011g).

Recreational Facilities Removal at J.C. Boyle

With either full or partial facilities removal, the DRE would remove or modify two of the recreational facilities adjacent to the existing reservoir. Modification of these facilities is necessary as they are adjacent to the reservoir, which would no longer be present following dam removal (see Table 4.2-3).

Table 4.2-3: Existing Recreational Facilities Adjacent to J.C. Boyle Reservoir

Recreational Site	Estimated Use (2001/2002)[1]	Existing Facilities	Facilities After Dam Removal[2]
Pioneer Park (East & West Units)	16,700	Two day-use areas with picnic tables, fire rings, and portable toilets	All Facilities would be removed.
Topsy Campground	5,600	Campground, day-use area, boat launch	Removal of the boat launch, floating dock, and fishing pier. The remainder will be retained for public use.

Source: Reclamation 2012e
[1] In "recreational days".
[2] Sites where facilities would be removed would be regraded, seeded, and planted.

Mitigation Actions

Several mitigation actions have been identified to lessen the potential impacts of the dam removal process throughout the Klamath Basin. As described in Sections 4.2.1.2, 4.2.1.3, and 4.2.1.4 below, many of the following mitigation measures would be applicable to all of the dams and reservoirs. 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 not discussed in this report. Additional mitigation actions would likely increase the estimated cost for dam removal.

Fish Relocation

As described in Section 4.1.3.5, *Effects on Fisheries from Dam Removal, Mitigation Actions*, aquatic species would be captured and relocated in order to reduce mortality. Aquatic species that would be relocated include juvenile outmigrating salmonids, suckers, and Pacific lamprey. Relocation of sucker would be applicable to J.C. Boyle. In addition, all methods used for fish capture and relocation would comply with appropriate state and Federal regulations.

Culturally and Historically Significant Sites

Since potential effects on all historic properties cannot be fully determined prior to approval of dam removal, DOI, through consultation under NEPA and the National Historic Preservation Act (NHPA) Section 106, proposes measures that the designated federal officials must follow as specific details are evaluated through future decisions prior to implementation of dam removal. Over 100 prehistoric, ethnographic, and historic sites are known to be in the area most likely to be impacted by dam removal. Additional sites may be present but have not been identified due to a lack of cultural resources survey coverage, inundation by reservoirs, or lack of visibility due to sedimentation or other factors. Consultations would continue under NHPA Section 106 with other federal agencies, the Advisory Council on Historic Preservation, Oregon and California State Historic Preservation Officers, Tribal Historic Preservation Officers, Indian Tribes, and other consulting parties, to develop a Programmatic Agreement (PA) to establish a process for continued compliance with Section 106 of the NHPA. Prior to the approval of any activities that may directly or indirectly adversely affect historic properties, planning and actions as may be needed to avoid, minimize or mitigate adverse effects would be developed and implemented as stipulated in the PA. Stipulations in the PA would include some or all of the following measures as appropriate to the specifics of dam removal:

- Identify plans to assist in management, consultation, and compliance, such as a Cultural Resources Management Plan, for overall management of known, to be identified, and inadvertently discovered resources; a Plan of Action for management, treatment, identification, and disposition of human remains; a Monitoring Plan for monitoring conditions and impacts to known and unknown resources; Historic Property Treatment Plans for protection, avoidance, and recovery of data from historic properties; and a Heritage Education plan for public education regarding cultural resources along the Klamath River.

- Develop avoidance, minimization, and mitigation measures for the removal of the dams and other dam-related facilities listed or eligible for the National Register of Historic Places, including an update of the Klamath Hydroelectric Historic District; documentation, including Historic American Building Surveys, Historic American Engineering Records, and Historic American Landscapes Surveys, of the district for the National Park Service's Heritage Documentation Program; and meeting the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (36 CFR Part 68) as applicable for any remaining facilities.

- Provide a process to identify and evaluate other known and unknown cultural resources for eligibility for listing on the National Register and develop measures to avoid, minimize, or mitigate adverse effects to historic properties.

- Outline an approach for identifying and evaluating Traditional Cultural Properties and cultural landscapes for eligibility for listing on the National Register of Historic Places, and for seeking ways to avoid, minimize, or mitigate adverse effects to such resources.

- Develop plans and consult under Section 106 of the NHPA, Native American Graves Protection and Repatriation Act (NAGPRA), and other federal and state laws, as applicable, to add stipulations and appendices to cover exposure, management, disposition, and treatment of human remains.

Development of New or Modification of Existing Recreational Facilities

The DRE, in consultation with state and federal agencies, would produce a plan to update existing and develop new recreational facilities and river access points to replace the facilities that would be removed with dam removal. Modifications would include the development of new river access points; upgrades and expansions to existing campgrounds and facilities; and, the redesign and reconstruction of removed facilities.

At least one year before starting dam removal, the dam removal entity (DRE) would prepare a plan to develop new recreational facilities and river access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. The purpose of the plan would be to mitigate for recreational facilities that would be removed during dam removal. These activities would be coordinated with stakeholders during the planning and design process.

Fencing

The DRE would install a fence to reduce the impacts on newly exposed Parcel B lands in the Klamath Basin (defined in the Section 4.4.7, *Real Estate*) and for the protection of the revegetation and restoration efforts in the reservoirs. In addition, the installation of fences around Parcel B lands would protect both the property and the water quality in the river from free ranging cattle. Fences would be installed on Parcel B lands that border private properties. Existing fence lines would be used as much as possible and it is assumed that these would not be replaced. During the development of the Definite Plan, final fencing requirements would be identified.

Culvert Relocation

Culverts are used to transport flows from some small Klamath River tributaries under roads and into the reservoirs. With dam removal, reservoirs would be drained and these tributary channels would return to their pre-dam elevations, potentially impacting the existing road crossings. Detailed culvert information was provided to the TMT by Siskiyou County. Using this information it was determined that reservoir drawdown would affect multiple culverts adjacent to the reservoirs. To prevent scour damage and headcutting, these culverts would either be moved upstream prior to dam removal or a new road would be graded down to the elevation of the pre-dam channel immediately after reservoir drawdown. For J.C. Boyle, culverts located along Topsy Grade Road (Figure 4.2-3) would need to be modified.

Wetland Replacement

Due to the reservoir drawdown, there would be a permanent loss of approximately 245 acres of wetland habitat surrounding the Four Facilities. If a Section 404 Permit under the Clean Water Act (CWA) is required, a mitigation plan would also be required for the loss of wetlands. The DOI analysis assumes that dam removal activities would be authorized under a U.S. Army Corps of Engineer's Nationwide Permit because the objective of the project is the restoration of the basin. Under a U.S. Army Corps of Engineer's Nationwide Permit, mitigation activities would be designed to protect or replace habitats affected by construction activities. A remote sensing analysis performed by the DOI determined that 20 or less acres would be directly affected by dam deconstruction activities. During the development of the Definite Plan, an assessment of needed wetland mitigation measures and locations would occur.

Bat Habitat Replacement

Removal of the structures associated with the Four Facilities, and associated construction activities, would displace resident bats. Mitigation actions for the displacement would include conducting bat surveys prior to construction activities to determine bat use patterns. Replacement habitats (roosts) would be provided near each dam site. Under partial removal, mitigation for displaced resident bats may not be required.

Estimated Costs

Cost estimates for all the facilities presented in this section were prepared for feasibility-level design, and therefore have inherent levels of uncertainties. The following costs for facilities removal are based on detailed engineering drawings provided by PacifiCorp and site visits by members of the Engineering Sub-team. (See sidebar for *Understanding the Estimated Costs*.) Price levels used for the estimates are based on quarterly data, specifically July 2010 dollars.[1]

Understanding the Estimated Costs

Costs estimates were completed using engineering design principles for the removal of each of the four dams and associated mitigation actions. The following are definitions of specific terms used in the costs estimates:

- Most Probable Cost Estimate: A compilation of pay items, quantities, and unit prices representing the Designer's and Cost Estimator's best or most likely opinion and assessment of the scope of work and cost for the project.
- Life Cycle Cost Estimating: Is an analysis to determine the long-term cost of ownership over a defined period of time. The life cycle cost estimate includes any initial capital cost investment, operational costs, maintenance costs, and any periodic replacement costs. All costs as presented in a life cycle cost estimate are computed and represented as present value totals based on a specific discount rate. The base assumption for dam removal is that, with full removal, all facilities would be removed; therefore, there would be no requirement for long term operation and maintenance. With partial removal, remaining facilities would require maintenance over the analysis period, assumed to be 50 years.

[1] It is anticipated that there will be an update to the estimates to use October 2011 dollars. When complete, updated costs will be found on www.klamathrestoration.gov.

Associated with the estimated costs are some degrees of both cost risk and uncertainty. Uncertainties include the volumetric estimates for features to be removed or demolished, production rates for demolition activities, unanticipated weather conditions, future unit prices, and future economic conditions. Due to these uncertainties, cost risk models were developed to determine their potential impacts to the project costs.

Cost risks were evaluated using a Monte Carlo simulation process, which approximates the probability of certain outcomes through multiple iterations using random variables. All cost variables were assigned probability distributions and used in the Monte Carlo simulation to determine a range of possible outcomes and the probabilities with which they would occur. In addition to the Monte Carlo simulation, the greatest cost risks are represented by the assumptions for the cost escalation and contingencies.

Estimated costs are presented for full facilities and partial facilities removal of J.C. Boyle Dam (see Tables 4.2-4 and 4.2-5). These tables present the most probable costs for the physical removal of J.C. Boyle Dam, the restoration of the reservoir, the removal of adjacent recreational facilities, and the mobilization of equipment and contingencies associated with the action. The cost estimate for partial facilities removal includes the life cycle cost (see sidebar on previous page) associated with maintenance of facilities that are not removed.

Table 4.2-4: Estimated Costs for the Full Removal of J.C. Boyle Dam (2020 Dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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			$17,769,070
Reservoir Restoration			$2,738,500
Recreational Facilities Removal			$89,480
Mobilization and Contingencies[4]			$9,958,175
Escalation to January 2020			$7,444,775
Subtotal (Field Costs)	**$30,900,000**	**$63,900,000**	**$38,000,000**
Engineering (20%)[5]			$7,600,000
Mitigation (35%)[6]			$13,400,000
Total Construction Cost	**$47,400,000**	**$98,300,000**	**$59,000,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

3 The most probable costs were used in the Economics analysis (See Section 4.4.1).

4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table 4.2-5: Estimated Costs for the Partial Removal of J.C. Boyle Dam (2020 Dollars)[1]

	Forecast Range[2]		
	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)**	**Most Probable[3]**
Dam Facilities Removal			$10,824,805
Reservoir Restoration			$2,738,500
Recreational Facilities Removal			$89,480
Mobilization and Contingencies[4]			$6,417,935
Escalation to January 2020			$4,929,280
Subtotal (Field Costs)	**$19,900,000**	**$45,100,000**	**$25,000,000**
Engineering (20%)[5]			$7,600,000
Mitigation (45%)[6]			$13,400,000
Total Construction Cost	**$31,800,000**	**$76,400,000**	**$41,000,000**
Total Life Cycle Cost[7]	**$4,900,000**	**$14,700,000**	**$6,800,000**

Source: Reclamation 2012e.

[1] An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

[2] The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

[3] The most probable costs were used in the Economics analysis (See Section 4.4.1).

[4] Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

[5] Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

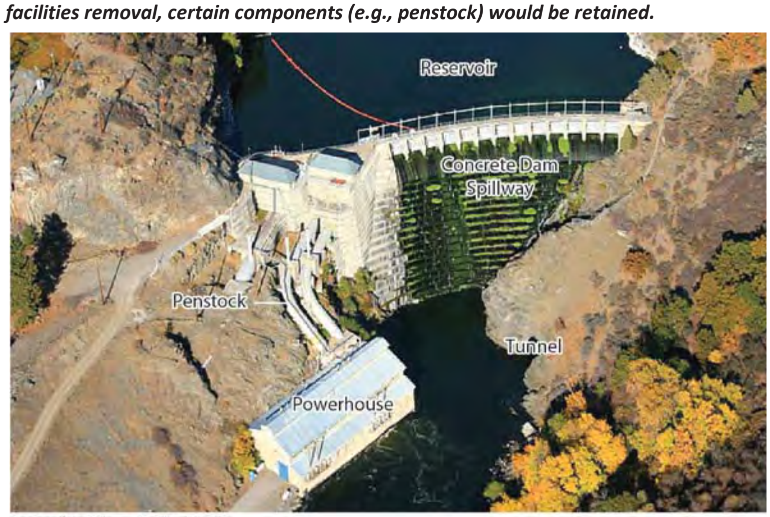
[6] Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

[7] Life cycle costs are the long-term cost of ownership over a defined period of time (50 years). See "Understanding the Estimated Costs" Side Bar.

4.2.1.2 Copco 1 Dam

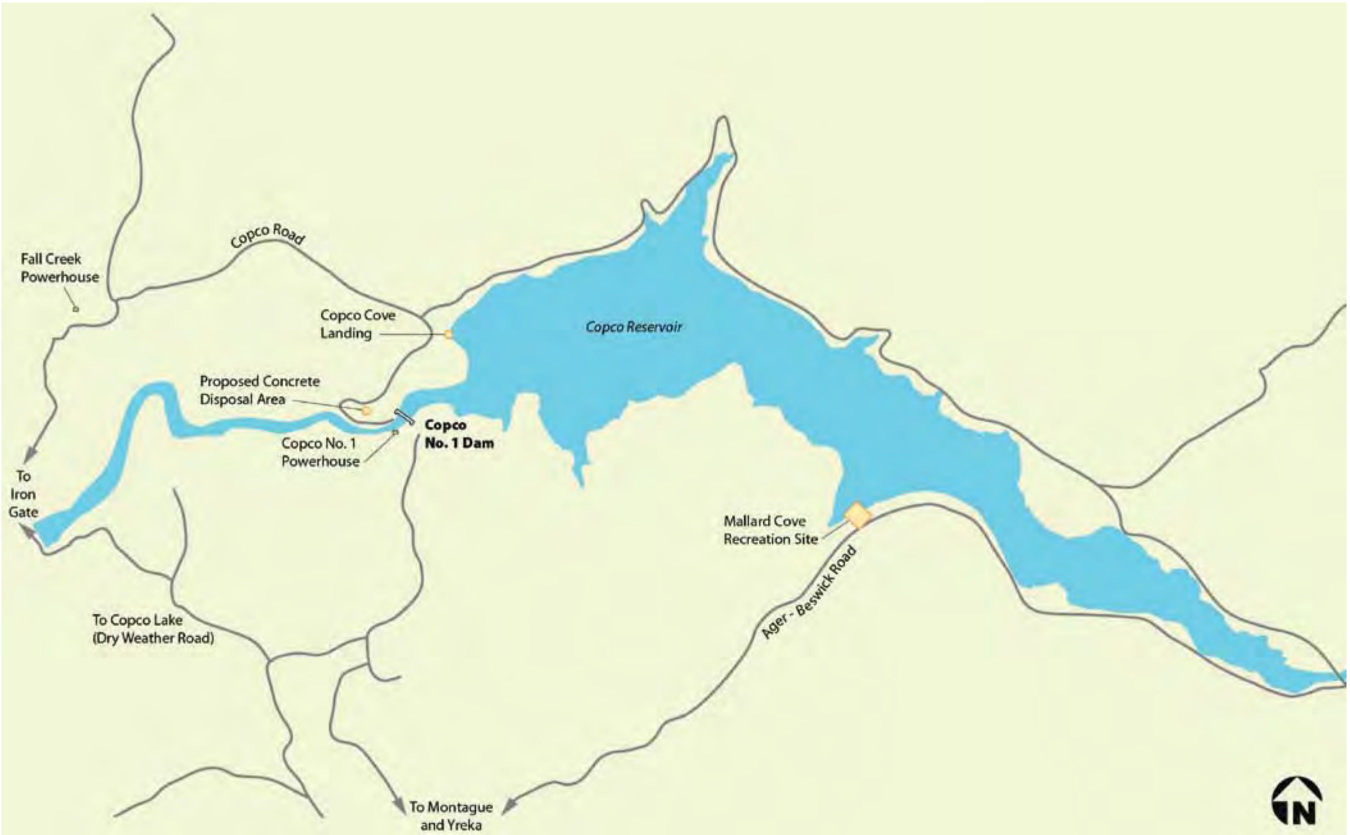
Full facilities removal would include removal of the concrete dam, concrete water intake structure, concrete gate houses, penstock pipes and supports, powerhouse, power generation support facilities, switchyard, and unused transmission lines (see Figures 4.2-7 and 4.2-8). Reservoir drawdown would begin in November 2019, and power generation would cease prior to the January 1, 2020 start date under the KHSA.

Figure 4.2-7: Photo of Copco 1 Dam and Reservoir with specific components labeled. With full facilities removal, all visible components would be removed. With partial facilities removal, certain components (e.g., penstock) would be retained.



Images from Klamath Riverkeeper

Figure 4.2-8: Map of the Copco 1 Dam and Associated Facilities.



Challenges Associated with the Removal of Copco 1 Dam

There are several potential challenges for the removal of Copco 1 Dam (Reclamation 2012e):

- Potential for high flows in the Klamath River
- Deconstruction difficulty due to large boulders and steel rails embedded in the concrete
- Confined work area with one-way construction traffic and difficult access for concrete removal
- Modification of gated diversion tunnel for controlled releases during drawdown
- Breach of concrete dam during the months of January 1 and March 15

Reservoir drawdown would be initiated with flow over the gated spillway and further drawdown by modifying the existing diversion tunnel. This 16- by 18-foot diversion tunnel was excavated through the left abutment for streamflow diversion during construction of the dam, but was later sealed by the construction of a concrete plug approximately 200 feet upstream from the downstream tunnel portal. A gated concrete intake structure was provided upstream of the dam for flow regulation of diversion releases during construction. The diversion plan is to mobilize a barge-mounted crane to remove sediment from the diversion tunnel intake using a clamshell or suction dredge to allow removal of the three existing 72-inch flap gates on the upstream face of diversion intake structure under balanced head and no flow conditions, using hard hat divers (117 foot depth). Then three new 6- by 6-foot slide gates with hydraulic operators and remote controls would be installed at the upstream face of the diversion structure by divers. The concrete plug would be removed in the dry from the downstream end of the tunnel. If further investigations reveal potential problems with this diversion plan, additional notching of the concrete dam could be performed to meet the reservoir drawdown requirements without the benefit of the tunnel, but at the risk of extending the concrete demolition period beyond the target window of January 1 to March 15, 2020. During the development of the Definite Plan, additional information would be collected to ensure that this important diversion feature could be rehabilitated and reduce the risk of adverse impacts.

The initial drawdown in November 2019 is not expected to release a significant amount of sediment and would allow initial deconstruction work to begin. Once in the dry, and no longer needed for flow control, the spillway gates, bridge deck and piers would be removed from the top of the dam using a barge-mounted crane.

Reservoir drawdown would resume in January 2020 through the diversion tunnel. Removal of the concrete dam would begin by removing horizontal lifts of concrete in approximately 8-foot-high layers. As the diversion tunnel flow capacity decreased, further reservoir drawdown would be accomplished by removing rectangular notches in the dam to allow the reservoir to fully drain. The notches would be at least 10 feet wide and a minimum of 16 feet deep. The notches would continue to the bottom of the dam as necessary for reservoir drawdown and concrete dam removal. The powerhouse would be removed during summer low flows after the dam was removed.

It is expected that the DRE would bury the concrete debris within an on-site disposal area near the right abutment. The DRE would separate the reinforcing steel from the concrete and haul it to a local recycling facility in Weed, California. The DRE would haul mechanical and electrical equipment to Yreka, California for transfer to a salvage company or disposal outside the project boundaries (Reclamation 2012e).

Figure 4.2-9 describes the timeline associated with the deconstruction of J.C. Boyle Dam and associated facilities.

Figure 4.2-9: Copco 1 Removal Timeline

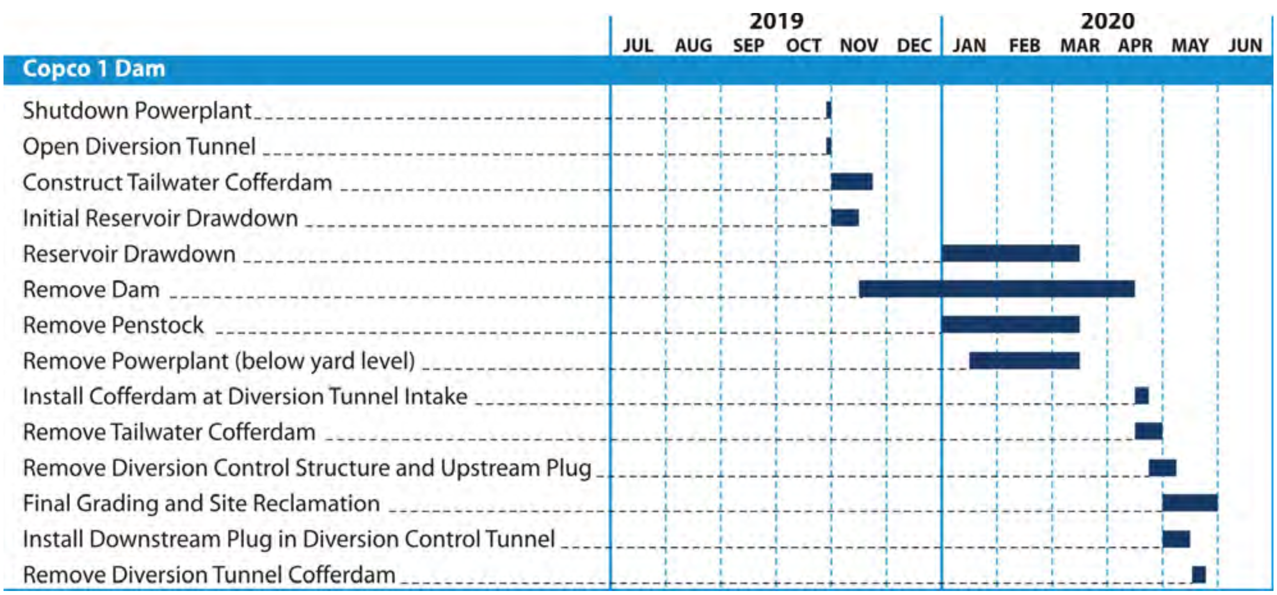


Figure 4.2-10: Partial removal of Copco 1 facilities would provide a free flowing river and allow full volitional fish passage. However, certain structures would be retained.

Partial Removal

Partial facilities removal would include preservation of portions of the facilities associated with Copco 1 Dam (see Figure 4.2-10). This would primarily entail leaving the powerhouse, penstocks, and powerhouse intake structure in place. Table 4.2-6 provides the list of facilities that would either be retained or removed as part of partial facilities removal.

Table 4.2-6: Partial Removal of Copco 1 Dam

Feature	Action
Concrete Dam	Remove to 5 feet below channel
Spillway Gates, Deck, Piers	Remove
Penstocks	Retain
Powerhouse Intake Structure	Retain
Gate House on Right Abutment	Retain
Diversion Control Structure	Retain
Tunnel Portals	Close Gates Concrete Plug
Powerhouse	Retain
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
Two 69-kV Transmission Lines, 0.7 mile	Remove
Switchyard	Remove
Warehouse and Residence	Remove

Source: Reclamation 2012e

Post Reservoir Management at Copco 1

In Copco 1 Reservoir, the majority of the erosion would occur in the main channel of the reservoir where the thickness of the sediment would be the greatest. This erosion is expected to occur during the first few months of 2020. As described above for reservoir management at J.C. Boyle Dam, hydroseeding would minimize the erosion. Hydroseeding at Copco 1 Reservoir would begin immediately following reservoir drawdown, in the spring of 2020, with reseeding during the fall of that year (Reclamation 2011g).

Recreational Facilities Removal at Copco 1

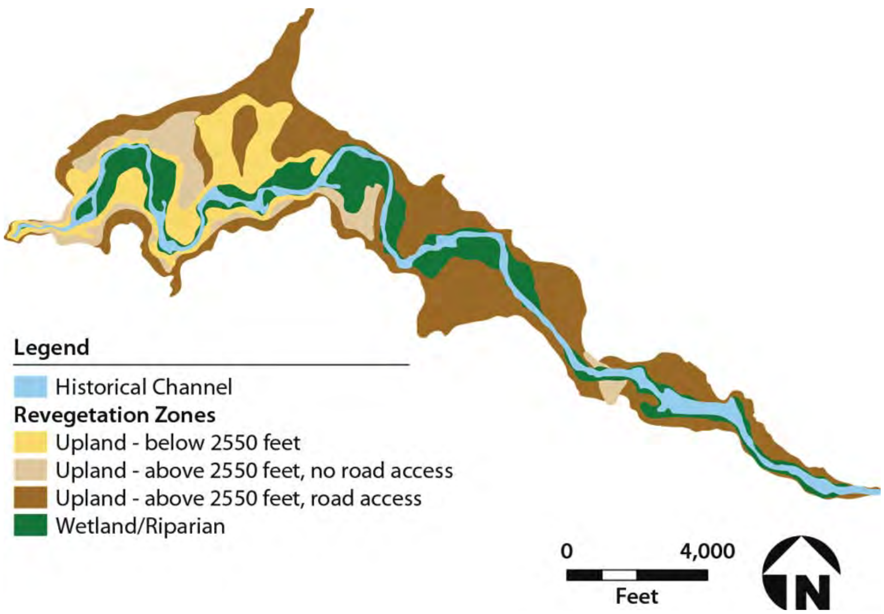
With either full or partial facilities removal, the DRE would remove recreational facilities adjacent to the existing reservoir (see Table 4.2-7). Removal of these facilities is warranted because they would no longer be near a large water body.

Table 4.2-7: Existing Recreational Facilities Adjacent to Copco 1 Reservoir

Recreational Site	Estimated Use (2001/2002)[1]	Existing Facilities	Facilities After Dam Removal[2]
Mallard Cove	7,600	Day-use picnic area and boat launch	All facilities would be removed.
Copco Cove	1,250	Picnic area and boat launch	All facilities would be removed.

Source: Reclamation 2012e
[1] In "recreational days".
[2] Sites where facilities would be removed would be regraded, seeded, and planted.

Figure 4.2-11: Potential locations for revegetation in Copco 1 Reservoir. Revegetation efforts would be focused as shown below.



Mitigation Actions

Several mitigation actions have been identified to lessen the potential impacts of the dam removal process. As described for J.C. Boyle Dam above, the following mitigation actions would also be required at Copco 1:

- Relocate Suckers
- Culvert Relocation (Two culverts, located along Copco Road at Beaver Creek and Raymond Gulch)
- Protect Culturally and Historically Significant Sites
- Install Fencing
- Install Bat Roosts to Replace Lost Habitat

In addition to these mitigation actions, the following additional action would be applicable to the removal of Copco 1 Dam.

Groundwater Wells

With the removal of the reservoirs, localized groundwater levels around the dams would decrease and would affect existing domestic or irrigation wells. This mitigation action would deepen wells and restore their production rates to pre-dam removal conditions. Data on all wells within 2.5 miles of the reservoirs at the Four Facilities were collected and analyzed for potential impacts. Reclamation identified approximately 15 wells that were most likely to be affected. Prior to dam removal, a preconstruction survey of sufficient detail and duration would be conducted to measure water levels and pumping rates in existing domestic and irrigation wells to clearly define potentially impacted wells.

Estimated Costs

Estimated costs are presented for full facilities removal (see Table 4.2-8) and partial facilities removal (see Table 4.2-9) of Copco 1 Dam. The estimated cost tables present the most probable costs for the physical removal of Copco 1 Dam, the restoration of the reservoir, the removal of adjacent recreational facilities, and the mobilization of equipment and contingencies associated with the action. The cost estimate for partial facilities removal includes the life cycle cost associated with maintenance of the remaining facilities.

Table 4.2-8: Estimated Costs for the Full Removal of Copco 1 Dam (2020 Dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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			26,710,485
Reservoir Restoration			9,658,000
Recreational Facilities Removal			187,100
Mobilization and Contingencies[4]			18,236,105
Escalation to January 2020			13,208,310
Subtotal (Field Costs)	**60,100,000**	**106,400,000**	**68,000,000**
Engineering (20%)[5]			13,500,000
Mitigation (35%)[6]			23,500,000
Total Construction Cost	**89,400,000**	**169,700,000**	**105,000,000**

Source: Reclamation 2012e.

[1] An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

[2] The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

[3] The most probable costs were used in the Economics analysis (See Section 4.4.1).

[4] Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

[5] Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

[6] Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table 4.2-9: Estimated Costs for the Partial Removal of Copco 1 Dam (2020 Dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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			15,770,000
Reservoir Restoration			9,658,000
Recreational Facilities Removal			187,100
Mobilization and Contingencies[4]			13,128,356
Escalation to January 2020			9,256,544
Subtotal (Field Costs)	**40,800,000**	**75,200,000**	**48,000,000**
Engineering (20%)[5]			9,500,000
Mitigation (45%)[6]			21,500,000
Total Construction Cost	**64,700,000**	**136,700,000**	**79,000,000**
Total Life Cycle Cost[7]	**1,300,000**	**3,900,000**	**1,750,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

3 The most probable costs were used in the Economics analysis (See Section 4.4.1).

4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

7 Life cycle costs are the long-term cost of ownership over a defined period of time (50 years). See "Understanding the Estimated Costs" Side Bar.

Figure 4.2-12: Photo of Copco 2 Dam and Reservoir with specific components labeled. With full facilities removal, all visible components would be removed. With partial facilities removal, certain components (e.g., penstock) would be retained.

Images from Klamath Riverkeeper

4.2.1.3 Copco 2 Dam

With full facilities removal, the DRE would remove the dam, gated spillway, embankment, water intake structure, pipelines, penstock, powerhouse, power generation equipment, and unused transmission lines (see Figures 4.2-12 and 4.2-13). The switchyard would be retained to meet power supply requirements unrelated to dam removal.

The Detailed Plan provides PacifiCorp with the ability to continue power generation through May 1, 2020. This longer period of power generation (beyond December 2020 as prescribed in KHSA) could be used to offset the loss of power generation at Copco 1 due to its early drawdown.

The DRE would start by removing the spillway gates and the spillway bridge using cranes and excavators. A cofferdam would then be constructed to isolate the left portion of the dam. The river would be routed through the right two spillway bays as the left two spillway bays would be removed using mechanical methods. After removing the left portion, the river would be diverted through the vacated structure and the right portion of the dam would be removed using similar mechanical methods. The remaining reinforced concrete walls and water intake structure on the side of the river would be removed after the dam is removed. The DRE would bury concrete rubble on the right abutment within an on-site disposal area. The DRE would handle and dispose of reinforcing steel, concrete, and mechanical equipment in the same manner as for the removal of the Copco 1 facilities.

The powerhouse downstream would be removed, along with the penstocks and power generation equipment. A cofferdam would be installed to isolate the powerhouse and the cofferdam would be incorporated into the final river bank restoration.

Challenges Associated with the Removal of Copco 2 Dam

There are potential challenges for the removal of Copco 2 Dam including (Reclamation 2012e):

- Significant improvements to steep and narrow access road needed for construction equipment
- Potential for high flows in the Klamath River

Figure 4.2-13: Map of the Copco 2 Dam and Associated Facilities.

Figure 2-14: Copco 2 Removal Timeline

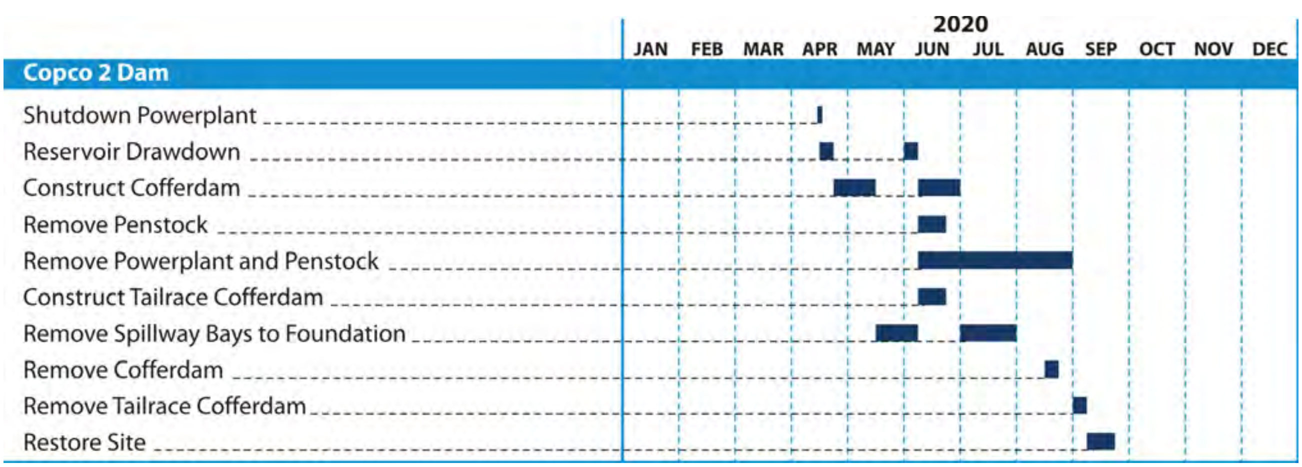


Figure 4.2-15: Partial removal of Copco 2 facility would provide a free flowing river and allow full volitional fish passage. However, certain structures would be retained.

Partial Removal

With partial facilities removal, the DRE would not remove all the facilities associated with Copco 2 Dam. Table 4.2-10 below provides the list of facilities that would either be retained or removed as part of partial facilities removal; the primary features to remain would be the powerhouse and penstock pipes.

Table 4.2-10: Partial Removal of Copco 2 Dam

Feature	Action
Spillway Gates, Structure	Remove
Power Penstock, Intake Structure	Retain
Tunnel Portals	Concrete Plug; Close Gate
Embankment Section	Retain
Wood-stave Penstock	Remove
Concrete Pipe Cradles	Retain
Steel Penstock, Supports, Anchors	Retain
Powerhouse	Retain
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
69-kV Transmission Line	Remove
Switchyard	Retain
Tailrace Channel	Backfill

Source: Reclamation 2012e

Post Reservoir Management at Copco 2

Copco 2 Reservoir is a small impoundment that holds approximately 73 acre-feet of water. It has been assumed that revegetation of this particular reservoir site would not be needed.

Recreational Facilities Removal at Copco 2

No recreational facilities exist at the Copco 2 Development.

Mitigation Actions

Mitigation actions have been identified to lessen the potential impacts of the dam removal process. The following mitigation actions, described previously for J.C. Boyle Dam, would be required:

- Install Bat Roosts to Replace Lost Habitat
- Protect Culturally and Historically Significant Sites
- Install Fencing

Estimated Costs

Estimated costs are presented for full facilities removal (see Table 4.2-11) and partial facilities removal (see Table 4.2-12). These tables present the most probable costs for the physical removal of Copco 2 Dam, the restoration of the reservoir, the removal of adjacent recreational facilities, and the mobilization of equipment and contingencies associated with the action. The cost estimate for partial facilities removal includes the life cycle cost associated with maintenance of the remaining facilities.

Table 4.2-11: Estimated Costs for the Full Removal of Copco 2 Dam (2020 Dollars)[1]

	Forecast Range[2]		
	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)**	**Most Probable[3]**
Dam Facilities Removal			8,436,910
Reservoir Restoration			0
Recreational Facilities Removal			0
Mobilization and Contingencies[4]			4,017,054
Escalation to January 2020			3,046,036
Subtotal (Field Costs)	**13,500,000**	**27,700,000**	**15,500,000**
Engineering (20%)[5]			3,100,000
Mitigation (35%)[6]			5,400,000
Total Construction Cost	**19,600,000**	**46,600,000**	**24,000,000**

Source: Reclamation 2012e.

[1] An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

[2] The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

[3] The most probable costs were used in the Economics analysis (See Section 4.4.1).

[4] Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

[5] Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

[6] Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table 4.2-12: Estimated Costs for the Partial Removal of Copco 2 Dam (2020 Dollars)[1]

	Forecast Range[2]		
	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)**	**Most Probable[3]**
Dam Facilities Removal			3,872,090
Reservoir Restoration			0
Recreational Facilities Removal			0
Mobilization and Contingencies[4]			1,929,171
Escalation to January 2020			1,398,739
Subtotal (Field Costs)	**6,100,000**	**10,300,000**	**7,200,000**
Engineering (20%)[5]			1,500,000
Mitigation (45%)[6]			3,300,000
Total Construction Cost	**9,700,000**	**18,100,000**	**12,000,000**
Total Life Cycle Cost[7]	**2,800,000**	**8,200,000**	**3,800,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

3 The most probable costs were used in the Economics analysis (See Section 4.4.1).

4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

7 Life cycle costs are the long-term cost of ownership over a defined period of time (50 years). See "Understanding the Estimated Costs" Side Bar.

Figure 4.2-16: Photo of Iron Gate Dam and reservoir with specific components labeled. With full facilities removal, all visible components would be removed. With partial facilities removal, certain components (e.g., penstock) would be retained.

Image from Klamath Riverkeeper

4.2.1.4 Iron Gate Dam

With full facilities removal, the DRE would remove the earthen dam, diversion tunnel gate structure, concrete water intake structure, powerhouse generation facility, penstock and its concrete supports, unused transmission lines, and the switchyard (see Figure 4.2-16). The DRE would bury the concrete spillway to restore the pre-dam appearance of the right abutment.

In the year prior to the beginning of drawdown, the DRE would need to modify the diversion tunnel to increase the release capacity. The diversion tunnel used during construction of the dam was driven through bedrock in the right abutment and terminates in a reinforced concrete outlet structure near the downstream toe of the dam. The diversion tunnel intake is a reinforced concrete structure equipped with four 10- by 33-foot trashracks (assumed to be still in place) and is located approximately 480 feet upstream from the dam near the upstream toe. Control of the flow in the tunnel is provided by a two-piece concrete slide gate located in a gate shaft approximately 112 feet upstream of the dam. The lower diversion gate is currently welded in place. The diversion plan requires the upstream concrete gates to be closed for removal of the downstream stoplog structure and miscellaneous metalwork from the tunnel. The existing blind flange would then be securely bolted to the reinforced concrete ring downstream of the concrete gates to retain full reservoir head (design loading condition). Next, the one concrete gate would be raised slowly to fill the portion of the downstream tunnel between the concrete gates and an existing blind flange, with necessary venting and drainage provided. Using a barge-mounted crane, the concrete gates would be removed with hard hat divers and a new 16.5- by 18-foot roller gate with remote controls would be

Figure 4.2-17: Map of the Iron Gate Dam and Associated Facilities.

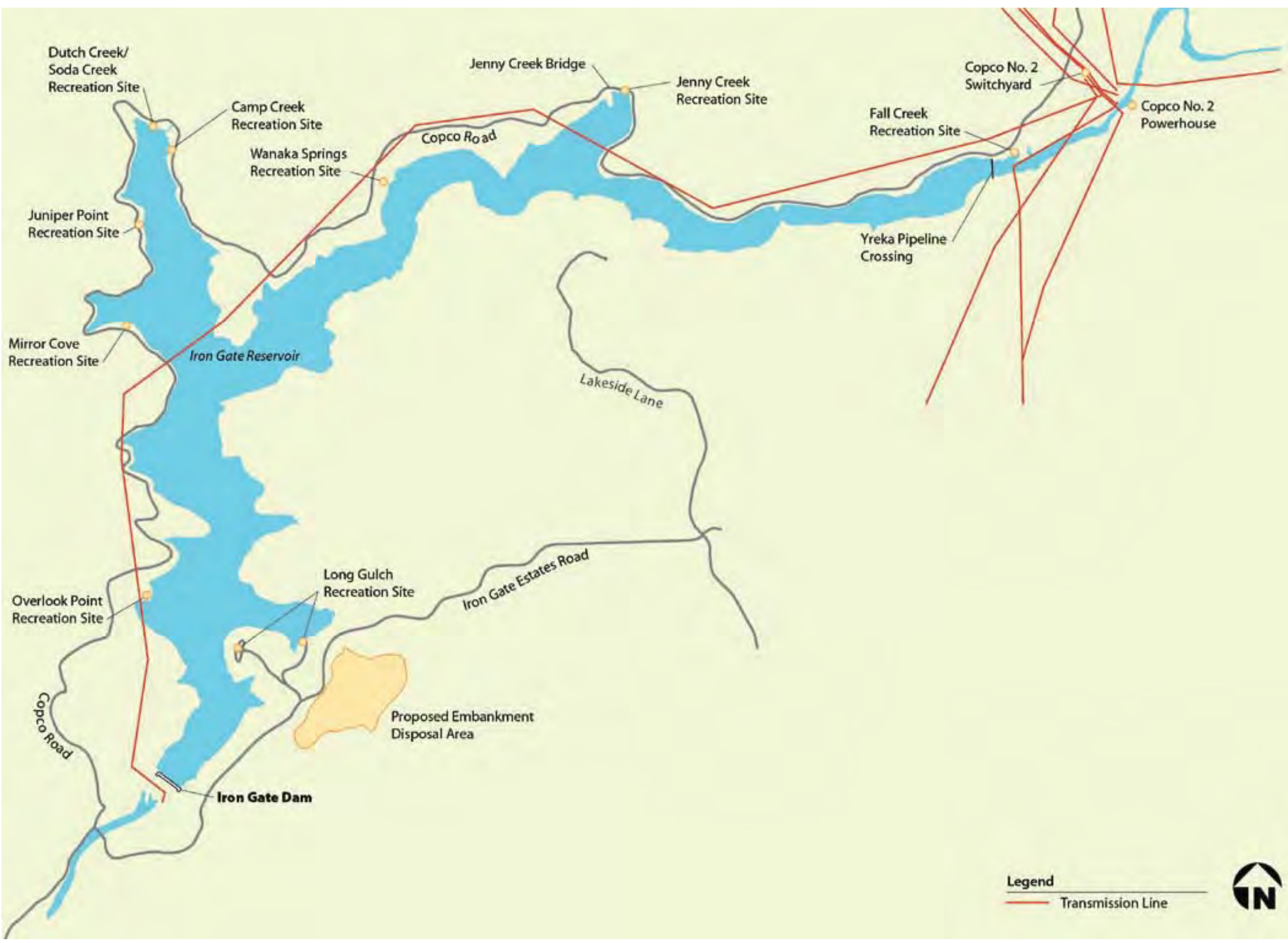
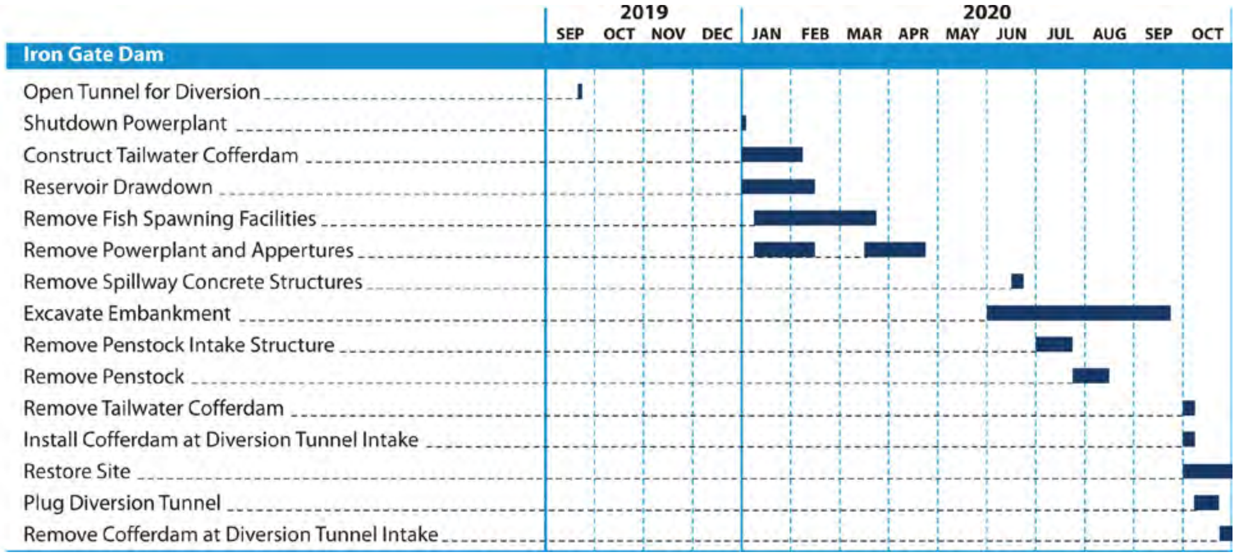


Figure 4.2-18: Iron Gate Dam Removal Timeline



installed in the existing slots in the gate shaft (with a 150-foot design head). With the new roller gate closed, the downstream tunnel would be drained using the existing air vent and drain valve provided at the blind flange and the blind flange and reinforced concrete ring would be removed. The diversion tunnel would be the only means of reservoir drawdown for the embankment and must be completed successfully for removal of the dam, although the details for installation of the new gate would be re-evaluated during preparation of a Definite Plan if dam removal moved forward. Development of the full capacity of the diversion tunnel would facilitate necessary reservoir drawdown to below elevation 2183 for the final controlled breach of the dam in September 2020.

Power generation would cease and reservoir drawdown would begin in January 2020. The DRE would draw down the reservoir by releasing water through the diversion tunnel. Dam removal would include removal of the fish handling facilities at the base of the dam, but the Iron Gate Fish Hatchery would remain in place, as per the KHSA. PacifiCorp would need to identify an alternate water source for the fish hatchery in order for it to remain operational; the exisitng water supply pipe from the penstock intake structure to the fish hatchery would be removed during dam removal. PacifiCorp would fund hatchery operations for eight years after the decommissioning of Iron Gate Dam.

Challenges Associated with the Removal of Iron Gate Dam

There are several potential challenges for the removal of Iron Gate Dam including (Reclamation 2012e):

- Potential for high flows in the Klamath River
- Large volume of embankment material to be excavated and high production rate required
- Modification of gated diversion tunnel for controlled releases during drawdown
- Improvements to the access bridge, which crosses the Klamath River, to handle construction equipment and haul loads

Excavation of the embankment would take several months, occurring from June 2020 into the month of September 2020 (Figure 4.2-18). After the spring runoff, the DRE would begin excavation of the embankment, working from the top of the dam downwards. The DRE would remove the riprap during embankment excavation. The DRE would then remove reinforced concrete from remaining structures (including intake structures, fish handling facilities, and the powerhouse) using mechanical methods if possible or drilling and blasting if necessary. The lowest portion of the dam embankment would be allowed to overtop and breach in a controlled fashion in September 2020.

The DRE would use earth and concrete debris to fill an original borrow site, less than 1 mile upstream from Iron Gate Dam. Excess debris, including reinforcing steel and mechanical and electrical equipment, would be disposed of in an approved local waste processing site (Reclamation 2012e).

Partial Removal

Table 4.2-13 provides the list of facilities that would either be retained or removed as part of partial facilities removal; the powerhouse would be the main feature remaining (see Figure 4.2-19).

Figure 4.2-19: Partial removal of Iron Gate facility would provide a free flowing river and allow full volitional fish passage. However, certain structures would be retained or retained and buried.

Reservoir Management for Iron Gate Reservoir

The reservoir sediment in Iron Gate Reservoir is relatively thin, with the only thicknesses greater than 5 feet found at the delta formed by Jenny Creek. Vegetation would need to be restored in a much narrower corridor than at either J.C. Boyle or Copco 1 reservoirs (see Figure 4.2-20) (Reclamation 2011g).

Figure 4.2-20: Potential locations for revegetation in Iron Gate Reservoir. Revegetation efforts would be focused as shown below.

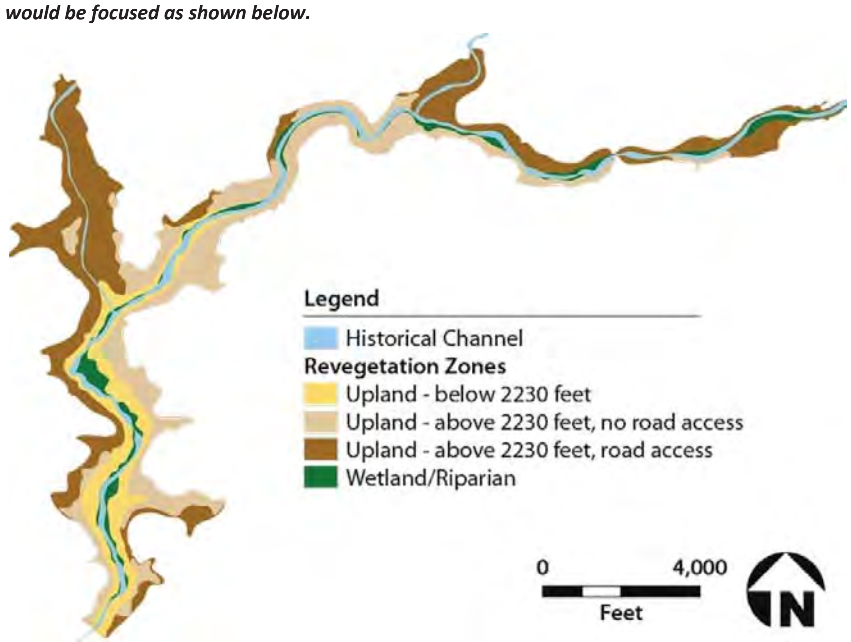


Table 4.2-13: Partial Removal of Iron Gate Dam

Feature	Action
Embankment Dam, Cutoff Walls	Remove
Penstock Intake Structure	Remove
Penstock	Remove
Water Supply Pipes	Remove
Spillway Structure	Retain, Bury
Powerhouse	Retain, Bury
Powerhouse Hazardous Materials (Transformers, Batteries, Insulation)	Remove
Powerhouse Tailrace Area	Backfill
Fish Facilities on Dam	Remove
Fish Hatchery	Retain
Switchyard	Remove
69-kV Transmission Line	Remove
Diversion Tunnel Intake Structure	Remove
Diversion Tunnel Portals	Concrete Plug
Diversion Tunnel Control Gate	Remove

Source: Reclamation 2012e

Post Recreational Facilities Removal at Iron Gate

For either full or partial facilities removal, the DRE would remove or modify a number of recreational facilities adjacent to the existing reservoir. Modification or removal of these facilities would be necessary because they are currently adjacent to the reservoir, which would no longer be present following dam removal (see Table 4.2-14).

Table 4.2-14: Existing Recreational Facilities Adjacent to Iron Gate Reservoir

Recreational Site	Estimated Use (2001/2002)[1]	Existing Facilities	Facilities After Dam Removal[2]
Fall Creek	4,150	Day-use picnic area and boat launch	The site would remain as is.
Jenny Creek	3,700	Day-use picnic area and campground	The site would remain as is.
Wanaka Springs	4,150	Day-use area, campground, boat launch	All facilities would be removed.
Camp Creek	15,250	Day-use area, campground, boat launch	All facilities would be removed.
Juniper Point	4,700	Primitive campground and boat dock	All facilities would be removed.
Mirror Cove	11,140	Campground and boat launch	All facilities would be removed.
Overlook Point	1,900	Day-use area	All facilities would be removed.
Long Gulch	5,200	Picnic area and boat launch	All facilities would be removed.
Iron Gate Fish Hatchery Public Use Area	2,200	Day-use area and boat launch	The site would remain as is.

Source: Reclamation 2012e

1 In "recreational days".

2 Sites where facilities would be removed would be regraded, seeded, and planted.

Mitigation Actions

Several mitigation actions have been identified to lessen the potential impacts of the dam removal process. As described for the removal of other dams and reservoirs earlier, the following mitigation actions would be required:

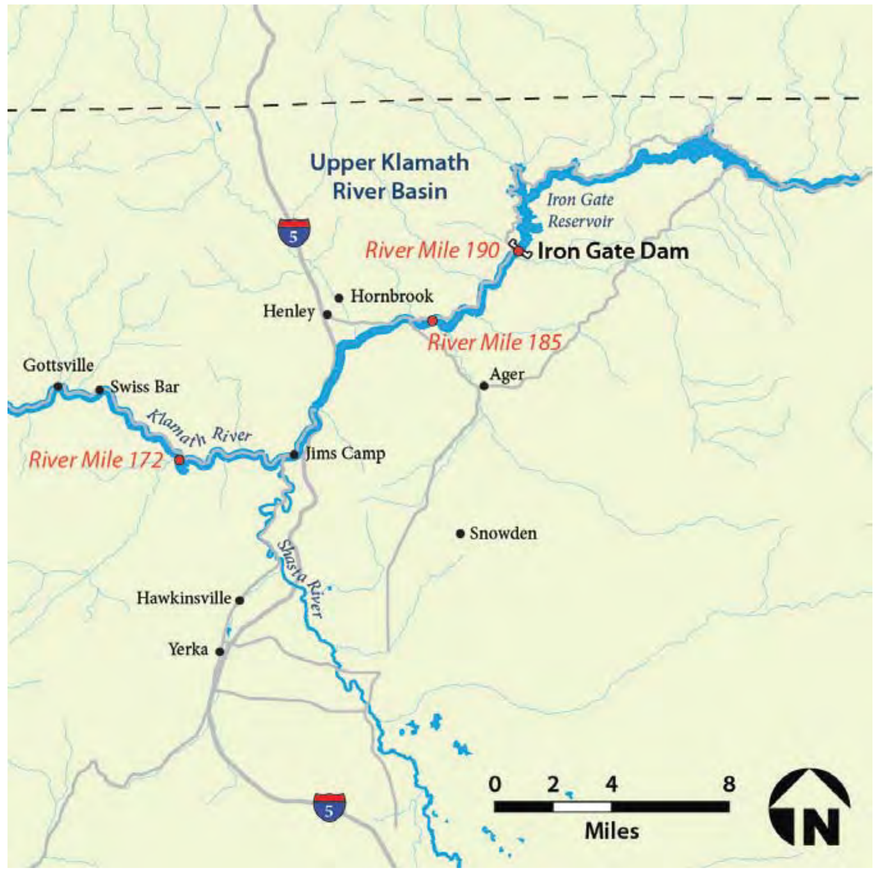
- Relocate fish
- Protect culturally and historically significant sites
- Install fencing
- Deepen groundwater wells
- Develop new or modify existing recreational facilities
- Install bat roosts to replace lost habitat

In addition to these mitigation actions, the following additional measures would be applicable for the removal of Iron Gate Dam.

Freshwater Mussel Relocation

Freshwater mussels in the Klamath Hydroelectric Reach and in the lower Klamath River, downstream of Iron Gate Dam, are likely to be adversely affected by prolonged elevated suspended sediment concentrations and bedload movement during the later part of reservoir drawdown and subsequent dam removal. Freshwater mussels cannot move to avoid these impacts, and some species are very long lived and may not reproduce successfully (or at all) each year. An action to mitigate this effect would be to relocate freshwater mussels prior to reservoir drawdown. As described in Section 4.1.3.5, *Mitigation Actions*, freshwater mussels could be relocated to tributary streams or upstream of the Hydroelectric Reach and then moved back to their approximate location of origin, or to another suitable habitat in the river, after dam removal has been completed.

Figure 4.2-21: The 100-year floodplain could change between RM 190 and 172 due to dam removal, with no discernable effects below RM 172.

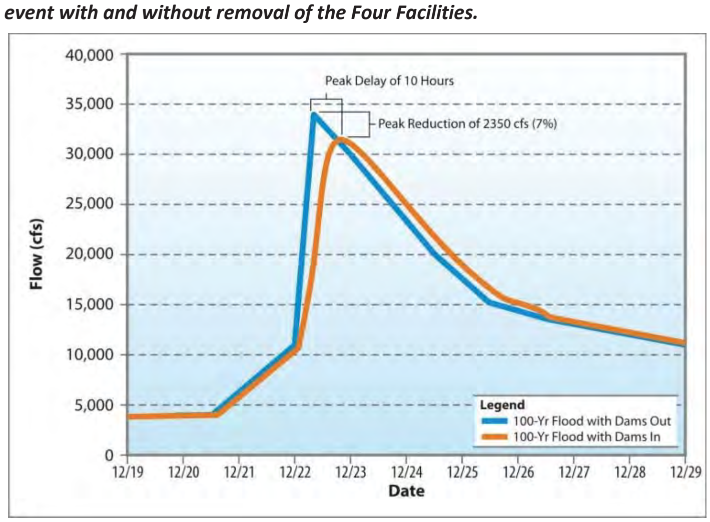


Expansion of the 100-Year Floodplain

Hydrologic modeling of changes shows that removal of the Four Facilities could alter the 100-year floodplain inundation area downstream of Iron Gate Dam between RM 190 and 172 (from Iron Gate Dam to Humbug Creek). Figure 4.2-21 shows the RM locations where the flood crest elevation would change (Reclamation 2012g).

Modeling of flood flows downstream of Iron Gate Dam shows that the Four Facilities provide a slight attenuation of peak flood flows. Current estimates are that the discharge rate of the 100-year peak flood immediately downstream of Iron Gate would increase by up to 7 percent following dam removal (Reclamation 2012g) and flood peaks would occur about 10 hours earlier. This increased discharge rate would result in approximately 1.5 feet higher flood elevations on average from Iron Gate Dam (RM 190) to Willow Creek (RM 185). Figure 4.2-22 shows the difference in the hydrograph peak and timing during a 100-year flood event downstream of Iron Gate Dam. Reclamation (2011b) conservatively assumed that this change in the peak flood discharge would be the same from RM 190 to 172 (Humbug Creek). The impact of dam removal on flood peak elevations would decrease

Figure 4.2-22: Hydrographs immediately below Iron Gate Dam for a 100-year flood event with and without removal of the Four Facilities.



Source: Reclamation 2012g

with distance downstream of Iron Gate Dam, and Reclamation (2012g) estimated that there would be no significant effect on flood elevations downstream of RM 172 because of attenuation effects in the channel and tributary peak flows would not coincide with the peak flow below Iron Gate.

Figure 4.2-23: Close up of one or two structures potentially affected by the change in the 100-year floodplain – comparison of dams in and dams out floodplain. (NOT A REGULATORY FLOOD PLAIN, this is just a comparison)

Changes in flood peak elevations and changes to the floodplain could affect properties and structures along the river downstream of Iron Gate Dam during a flood event. The Klamath Basin is subject to flooding and the Federal Emergency Management Agency (FEMA) has developed flood insurance risk maps that Siskiyou County has recognized in regulations concerning development along the river.

An estimate of the number of residences and structures potentially affected from Iron Gate Dam downstream to Humbug Creek was provided by Reclamation (2012g). This estimate was based on photo interpretation and field visits. Structures in the Klamath Basin were categorized according to whether they are within the existing 100-year floodplain or would be in the 100-year floodplain after dam removal. The structures were further classified as either residences or garages (including buildings such as equipment sheds and horse barns). With the Four Facilities in place, approximately two dozen residences and two dozen garages are located in the existing 100-year floodplain between RM 190 and RM 172. Given the current plans for removal of the Four Facilities, less than six additional structures (including residences and garages) are projected to be within the modeled 100-year flood plain. Figure 4.2-23 illustrates the modeled change in the floodplain at representative structures at RMs 188 and 190. Any new information developed to assess likely impacts to the flood plain and nearby habitable structures would be shared with the appropriate authorities and the public. In addition, the DRE would work with willing landowners to develop and implement a plan to address any increased flood threat caused by dam removal for permanent, legally established, permitted, habitable structures prior to dam removal. Such a plan could include measures to move, modify, or elevate structures where feasible.

By undertaking the following additional mitigation actions, the DRE could minimize other effects from changes in the 100-year floodplain, flood crest elevations, timing of flood peaks, and downstream transport of sediment.

Flood Warning System

When a large flood event is predicted, the National Weather Service provides river stage forecasts for the Klamath River for the USGS gages at Seiad Valley, Orleans, and Klamath, CA. The National Weather Service does not publish a forecast for river stage at the Iron Gate Gage, but does work with PacifiCorp to issue flood warnings to Siskiyou County. The DRE would work with the National

Weather Service, River Forecast Center to update its hydrologic model of the Klamath River to incorporate hydraulic changes following dam removal so that changes to the timing and magnitude of flood peaks would be included in the forecasts. As currently occurs, flood forecasts and flood warnings would be publicly posted by the River Forecast Center for use by federal, state, county, tribal, and local agencies, as well as the public, so timely decisions regarding evacuation or emergency response could be made.

Prior to dam removal, the DRE would inform FEMA of a planned major hydraulic change to the Klamath River that could affect the 100-year flood plain. The DRE would ensure that recent hydrologic/hydraulic modeling, and updates to the land elevation mapping, would be provided to FEMA so that it can update its 100-year flood plain maps downstream of Iron Gate Dam (as needed), so flood risks (real-time and long-term) can be evaluated and responded to by agencies, the private sector, and the public.

Bridge and Culvert Relocation

The Jenny Creek Bridge, located along Copco Road at Iron Gate Reservoir, was constructed in 2008. With dam removal and the associated reservoir drawdown, the abutments for Jenny Creek Bridge could be damaged by the new channel. These abutments are built on material deposited since the construction of Iron Gate Dam. After dam removal, the channel would incise through the deposits and potentially undermine the abutments of the bridge. Therefore, the bridge would be relocated upstream at a location of a temporary crossing used for its construction. Design loads and flood levels would be determined during final design (preparation of a Definite Plan). In addition to the Jenny Creek Bridge, the culvert crossing along Copco Road at Fall Creek, which would be affected by dam removal and reservoir drawdown, would be modified to prevent scour damage and headcutting.

Downstream Water Intake Protection

During removal of the Four Facilities, the sediment built up within the reservoirs would be released downstream. Following removal of the Four Facilities, the DRE would investigate intake and pump sites for adverse effects caused by the removal of the dams and the release of reservoir sediment. If necessary, the DRE would complete modifications to the intakes, such as excavation of aggraded sediment, or provide temporary water replacement to reduce these effects. It is estimated that the number of potentially affected intakes would be 7 to 18 (Reclamation 2012e).

Estimated Costs

Estimated costs are presented for full facilities removal (see Table 4.2-15) and partial facilities removal (see Table 4.2-16). These tables present the most probable costs for the physical removal of Iron Gate Dam, the restoration of the reservoir, the removal/restoration of adjacent recreational facilities, and the mobilization of equipment and contingencies associated with the action. The cost estimate for partial facilities removal includes the life cycle cost associated with maintenance of facilities left behind.

Table 4.2-15: Estimated Costs for the Full Removal of Iron Gate Dam (2020 Dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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			23,702,529
Reservoir Restoration			9,331,500
Recreational Facilities Removal			520,725
Mobilization and Contingencies[4]			17,320,559
Escalation to January 2020			12,124,687
Subtotal (Field Costs)	**51,100,000**	**97,600,000**	**63,000,000**
Engineering (20%)[5]			12,700,000
Mitigation (35%)[6]			22,300,000
Total Construction Cost	**78,100,000**	**169,000,000**	**98,000,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.
2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.
3 The most probable costs were used in the Economics analysis (See Section 4.4.1).
4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.
5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.
6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table 4.2-16: Estimated Costs for the Partial Removal of Iron Gate Dam (2020 Dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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			21,629,277
Reservoir Restoration			9,331,500
Recreational Facilities Removal			520,725
Mobilization and Contingencies[4]			16,158,423
Escalation to January 2020			11,360,075
Subtotal (Field Costs)	**47,800,000**	**94,000,000**	**59,000,000**
Engineering (20%)[5]			11,700,000
Mitigation (45%)[6]			26,300,000
Total Construction Cost	**75,400,000**	**162,900,000**	**97,000,000**
Total Life Cycle Cost[7]	**0**	**0**	**0**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.
2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.
3 The most probable costs were used in the Economics analysis (See Section 4.4.1).
4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.
5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.
6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.
7 Life cycle costs are the long-term cost of ownership over a defined period of time (50 years). See "Understanding the Estimated Costs" Side Bar.

City of Yreka Water Supply Pipeline

Currently, the City of Yreka's water supply pipeline passes under the upstream end of the Iron Gate Reservoir and would become exposed to high-velocity river flows if Iron Gate Dam was removed. Under the KHSA, the DRE would be responsible for modifications to the pipeline to allow continued water supply service to the City of Yreka. Details regarding pipeline modifications can be found in Reclamation 2012e.

Reconstructing the 24-inch pipeline further underground would likely require digging in bedrock, which may prove impractical or cost prohibitive. Therefore, for the purposes of estimating costs for replacing the pipeline river crossing in this cost analysis, it is assumed the DRE would construct a new, elevated pipeline and steel pipeline bridge to support the pipe above the river. This replacement pipe crossing would be constructed prior to dam removal or reservoir drawdown. The prefabricated steel pipe bridge would be wide enough to accommodate the pipeline and walkway on the deck. The pipeline bridge would span approximately 300 feet, supported by concrete piers. The new pipeline would be connected to the existing buried pipeline at each end of the bridge, and would be aligned parallel to the existing pipeline. To avoid a disruption to the city's water supply, the permissible outage period would be limited by the available storage tank capacity. If there is an Affirmative Secretarial Determination, and dam removal proceeds, the City of Yreka and the DRE would consult on a final design, which may or may not include an elevated steel pipeline bridge.

In addition to pipeline modifications, the existing fish screens for the two water supply intakes on Fall Creek would need modifications to meet the current regulatory agency screen criteria for anadromous fish. For both intakes, the DRE would replace the existing flat panel fish screens with a cylindrical tee screen.

Table 4.2-17 provides the estimated costs for the necessary modifications to the Yreka water supply pipeline and the Fall Creek fish screens. The pipeline designs prepared for the feasibility-level study are at an appraisal-level and included design and construction contingency allowances of 15 and 25 percent, respectively, rather than 10 and 20 percent assumed for all other estimates.

Table 4.2-17: Estimated Costs for the Modification of the Yreka Pipeline (2020 Dollars)[1]

	Forecast Range[2]		
	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)**	**Most Probable[3]**
Dam A Intake Screen			208,860
Dam B Intake Screen			212,950
Pipeline River Crossing			1,344,100
Mobilization and Contingencies[4]			1,196,500
Escalation to January 2020			637,590
Subtotal (Field Costs)	**2,000,000**	**5,600,000**	**3,600,000**
Engineering (20%)[5]			700,000
Mitigation (35%)[6]			1,300,000
Total Construction Cost	**3,500,000**	**9,500,000**	**5,600,000**

Source: Reclamation 2012e.

[1] An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

[2] The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

[3] The most probable costs were used in the Economics analysis (See Section 4.4.1).

[4] Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

[5] Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

[6] Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

4.2.2 Summary of Costs

Table 4.2-18 presents a summary of the total costs presented in this section for full facilities removal. Table 4.2-19 presents the summary of total costs for partial facilities removal.

What Happens if Costs Exceed the Cost Cap?

The upper end forecasted cost (less than the one percent probability) for full facilities removal is estimated to be $493,100,000. This upper end cost exceeds the state cost cap of $450,000,000. The KHSA has specific provisions to identify and mitigate a potential state cost cap exceedence through a meet and confer process of the KHSA parties (KHSA Section 8.7.2). The meet and confer process could modify the final design for dam deconstruction or identify alternate funding sources to reduce the possibility of exceeding the state cost cap. Development of the Definite Plan (as defined in KHSA Section 7.2.A) under an Affirmative Secretarial Determination would more accurately determine the cost of facilities removal and would provide an early indication if a meet and confer action prior to dam deconstruction was likely.

Table 4.2-18: Summary of Costs for Full Removal of the Four Facilities (2020 dollars)[1]

	Forecast Range[2]		
	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)**	**Most Probable[3]**
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[4]			50,728,393
Escalation to January 2020			36,461,398
Subtotal (Field Costs)	**157,600,000**	**301,200,000**	**188,100,000**
Engineering (20%)[5]			37,600,000
Mitigation (35%)[6]			65,900,000
Total Construction Cost	**238,000,000**	**493,100,000**	**291,600,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

3 The most probable costs were used in the Economics analysis (See Section 4.4.1).

4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

Table 4.2-19: Summary of Costs for Partial Removal of the Four Facilities (2020 dollars)[1]

	Forecast Range[2]		Most Probable[3]
	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[4]			38,830,385
Escalation to January 2020			27,582,228
Subtotal (Field Costs)	**116,600,000**	**230,200,000**	**142,800,000**
Engineering (20%)[5]			28,400,000
Mitigation (45%)[6]			63,400,000
Total Construction Cost	**185,100,000**	**403,600,000**	**234,600,000**
Total Life Cycle Cost[7]	**9,000,000**	**26,800,000**	**12,350,000**

Source: Reclamation 2012e.

1 An allowance for escalation for a period of 10 years, from the July 2010 price level to July 2020, was included in the cost estimates. The Most Probable cost estimates used an escalation rate of 3 percent per year, compounded annually, over 10 years. The 3 percent annual escalation rate used to measure the effects of inflation for future construction costs from July 2010 through July 2020 was based on Reclamation's Construction Cost Trends, OMB Circular No. A-94, other published historical data, and professional judgment.

2 The Minimum and Maximum ranges were determined using a Monte Carlo-based Simulation Process. See "Understanding the Estimated Costs" Side Bar.

3 The most probable costs were used in the Economics analysis (See Section 4.4.1).

4 Mobilization and Contingencies includes the mobilization of construction equipment to the dam site, design contingencies and construction contingencies.

5 Engineering costs include design data, engineering designs, permitting, procurement, construction management, and closeout activities.

6 Mitigation includes environmental mitigation, monitoring, and cultural resources preservation.

7 Life cycle costs are the long-term cost of ownership over a defined period of time (50 years). See "Understanding the Estimated Costs" Side Bar.

4.3 RISKS AND UNCERTAINTIES OF DAM REMOVAL

The removal of large dams involves inherent risks and uncertainties. Through development of the Detailed Plan (Reclamation 2012e) and other studies, the TMT identified four primary areas that the Dam Removal Entity (DRE) should focus upon when developing and executing a Definite Plan (as defined in Section 7.2 of the KHSA) for Klamath dam removal if there is an Affirmative Secretarial Determination. A Definite Plan would build upon the Detailed Plan, providing refinements and additional details regarding facilities removal tasks, cost estimates, scheduling, construction management, mitigation planning, and information necessary for obtaining permits and other authorizations needed for dam removal. A Definite Plan would also focus on reducing uncertainties and minimizing risks. Many dam removal uncertainties and risks have been described elsewhere in this Overview Report; the ones below warrant some additional focus and evaluation if a Definite Plan for dam removal is prepared:

- Effects to aquatic species and fisheries from extended downstream sediment transport;
- Cost exceedence potential for a Federal DRE;
- Minimizing potential for short-term flooding; and,
- Effects to cultural and historic resources in the project area.

The following sections describe and analyze these issues in more detail and identify measures or plans to reduce risk and uncertainty.

4.3.1 Effects to Aquatic Species and Fisheries from Extended Downstream Sediment Transport

As described in detail in Section 4.1.3, *Effects of Sediment Release on Fish following Dam Removal*, dam removal and reservoir drawdown would result in short-term effects from increased suspended sediment concentration (SSC) and short-term decreases in dissolved oxygen in the mainstem of the Klamath River. Model results indicate that high SSC would occur downstream of Iron Gate Dam for 2 to 3 months following the beginning of reservoir drawdown. As shown in Figure 4.1-42, reservoir drawdown and associated levels of SSC are likely to result in varying levels of mortality for salmonid species, including fall and spring-run Chinook, coho, and steelhead.

While the modeled effects of sediment release are previously described (see Section 4.1.3.2, *Water Quality Effects from Suspended Sediment*), there is risk from an extended schedule for reservoir drawdown resulting from engineering and/or technical difficulties during dam removal. In addition to the general effects of SSC on salmonids and other aquatic species, the length of exposure time to high SSC plays a critical role in the severity of the effects (see sidebar for a listing of *Sediment Effects of Salmonids*). The current plan for removing the Four Facilities calls for reservoir drawdown beginning January 1, 2020. Drawdown would occur in a controlled manner and the majority of the erodible

Sediment Effects on Salmonids

The most commonly observed effects of suspended sediments on salmonids include the following (Newcombe and Jensen 1996):

1. Avoidance of turbid waters in homing adult anadromous salmonids
2. Avoidance or alarm reactions by juvenile salmonids
3. Displacement of juvenile salmonids
4. Reduced feeding and growth
5. Physiological stress and respiratory impairment
6. Damage to gills
7. Reduced tolerance to disease and toxicants
8. Reduced survival
9. Direct mortality

sediment would be released in the winter of 2020. This approach would limit the major fisheries impacts to the winter and early spring months of 2020.

In the event that reservoir drawdown cannot be accomplished in this timeframe, continued high levels of SSC in the mainstem of the Klamath River would produce similar impacts during the extended drawdown period and would negatively affect fish into the summer or fall, or into consecutive years, potentially affecting multiple year classes. For example, extending reservoir drawdown across two years could result in the release of 50 percent of the total volume of erodible sediment in two consecutive years, roughly doubling the predicted mortality of fall-run Chinook salmon spawning in the mainstem Klamath River. Even if lower concentrations of sediment were released over multiple years at sublethal levels, the cumulative long-term effects on a population of successive cohorts are uncertain but are expected to be detrimental. Under existing conditions, salmon smolts outmigrating from Klamath River tributaries downstream of Iron Gate Dam have high mortality (35 to 70 percent) (Beeman et al. 2007, 2008), which, in conjunction with sublethal physiological stress and reduced growth from released sediments, could result in even higher cumulative mortality. In addition, sublethal impacts associated with elevated SSC, such as major physiological stress and reduced or no growth (Newcombe and Jensen 1996), could result in smaller smolt size of outmigrants, which could reduce marine survival (Bilton et al. 1982, Bilton 1984).

Reductions in fish populations as a result of an extended draw-down period could result in corresponding reductions to recreational, commercial, and tribal fisheries, as well as impacts on the regional economy and the cultural practices of Indian tribes.

Due to the uncertainty regarding the length of time over which high SSC would occur if a technical or engineering problem arose during dam removal, the exact effects on aquatic resources and on basin fisheries is not known. To reduce this uncertainty and possible risk, the Definite Plan for dam removal should place an emphasis on provisions, planning, and extensive preparation for reservoir drawdown to ensure drawdown occurs in the first 2 months of 2020 to avoid high SSC beyond March 15, 2020. A particular focus for the Definite Plan should be ensuring that all old diversion structures and tunnels could be successfully reopened on January 1, 2020 in order to begin prompt drawdown of J.C. Boyle, Copco 1, and Iron Gate reservoirs. Aquatic species relocation mitigation measures (described in Section 4.1.3.5) could be expanded or lengthened to remove fish from effects of high SSC if they extend beyond March 15, 2020.

4.3.2 Cost Exceedence to a Federal DRE

The large and complex construction activities associated with dam removal have the potential to include unexpected changes or unforeseen events, which could result in project costs that are greater than originally estimated. Project challenges could impede the dam removal process or extend the project timeline, and could result in accrual of additional project costs. Project challenges could include high flows in the Klamath River during dam removal, severe or prolonged cold temperatures and icy conditions, difficulty in reopening the existing diversion tunnels and structures for reservoir drawdown, presence of special status species, or uncovering culturally significant sites.

If an agency of the Federal government is the DRE, the KHSA states that the Federal Government has no responsibility to pay for any of the facilities' removal costs, even in the event of cost overruns (KHSA, Section 4.10). The KHSA states that if the DRE determines that costs are likely to exceed the state cost cap, the DRE shall suspend facilities removal (KHSA, Section 7.2.2). The DRE would resume removal at such time that the parties, through a defined "meet and confer process" (KHSA, Section 8.7.2), have modified the final design or identified alternate funding. Risk to a Federal DRE would occur if, during facilities removal, the DRE anticipated exceeding the state cost cap but was unable to stop a portion of facilities removal due to safety concerns. For example, Iron Gate Dam must be completely removed in the dry summer months once removal activity commences and could not be delayed through a winter season and risk overtopping. If the cost cap was expected to be exceeded during the course of this action, the "meet and confer process" might not occur quickly enough to prevent a federal DRE from exposure to cost risk.

To reduce this potential risk, the DRE construction management team would utilize construction cost forecasting during facilities removal to determine early on in the project process whether a "meet and confer" action would be required. Further, construction activities could be prioritized with non-essential activities delayed while critical path, safety-related activities were completed prior to or during a "meet and confer" action by the KHSA parties.

4.3.3 Short-term Flooding

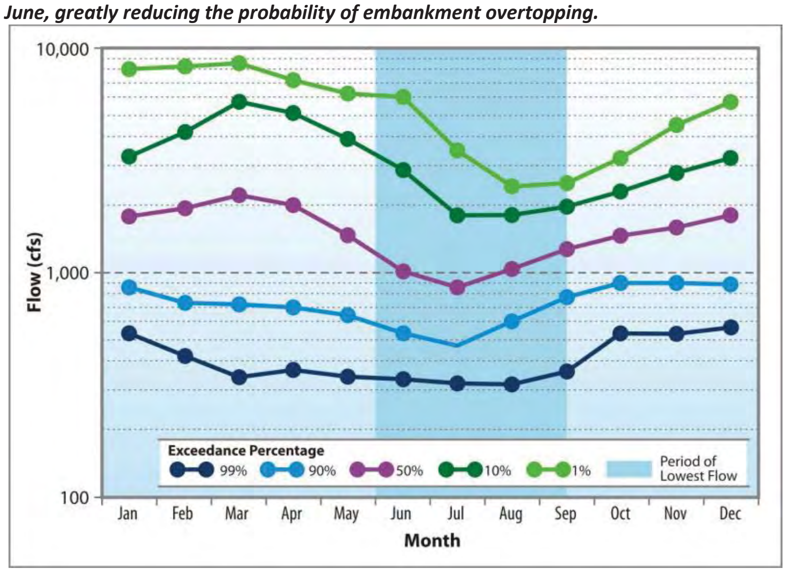
Dams are manmade structures and do exhibit some small risks of catastrophic failure that could result in flooding downstream during facilities removal. According to the Association of State Dam Safety Officials (2011), dams can fail from overtopping or due to the structural failure of dam materials. It is important to note that the Four Facilities also have a small risk of failure if left in place. The discussion below does not suggest that the risk of catastrophic failure during dam removal would be greater or less than leaving the dams in place through the period of analysis (2012 through 2061). Rather, this discussion is to disclose the remote possibility of catastrophic failure during dam removal and the approaches recommended in the *Detailed Plan for Dam Removal - Klamath River Dams* (Reclamation 2012e) to minimize those risks. Moreover, this discussion is to emphasize the importance of building on these approaches in the DRE's Definite Plan and exploring opportunities to evaluate and reduce this remote risk even further.

There is a remote risk that the earthen embankment structures at J.C. Boyle and Iron Gate dams could fail during reservoir drawdown and dam removal. The prescribed reservoir drawdown rates, and the timing for removing these embankment dams during the low-flow season, are intended to minimize flood risks from catastrophic dam failure due to overtopping or slope failure. There are two different time periods during reservoir drawdown and dam removal where short-term dam failure could result in flood risks:

1. **Initial reservoir drawdown.** Flood risks stem from an overly rapid drawdown rate, resulting in embankment instability. Instability occurs as the soil strength of the embankment decreases from rapidly increasing pore pressure during drawdown, which creates failure or slumping of the exposed dam face. Reclamation (2012e) describes the controlled releases that would commence at the beginning of January 2020 in order to drain the reservoirs safely. The drawdown rate for J.C. Boyle Reservoir would be about 1 foot per day and the drawdown rate for Iron Gate Reservoir would be about 3 feet per day (subject to confirmation by a more detailed slope stability analysis conducted for the Definite Plan).

2. **Dam excavation**. As the embankment is removed, reservoir storage is decreased. Flood risks during this period stem from the possibility of flows from a large flood event exceeding the available water bypass capacity and overtopping the lowered dam embankment, or at the point during excavation when the embankment is removed below the level of the spillway, thus making the spillway unavailable during this period of time.

Figure 4.3-1: The timing of J.C. Boyle and Iron Gate dam excavation and removal has been designed to occur when river flow is at its lowest point beginning in June, greatly reducing the probability of embankment overtopping.



Source: Reclamation 2012e

To address this risk, the Detailed Plan (Reclamation 2012e) does not begin any excavation of the embankment section at Iron Gate Dam until June 1, 2020, and would require excavation to be complete by September 15, 2020. The drawdown plans do not begin any excavation of the embankment section at J.C. Boyle Dam until after July 1, 2020 and would require completion in September 2020. The timing of dam excavation and removal has been designed to occur when river inflow is at its lowest point (see Figure 4.3-1). During this period, outlet structures for the reservoirs would have sufficient capacity to bypass river flows. The 100-year frequency flood hydrograph for July was routed through the reservoirs and available outlets and spillways. At J.C. Boyle Dam, an upstream cofferdam would be provided for flood protection for flows through the excavated left abutment up to about 3,500 cfs. At Iron Gate Dam, a minimum flood release capacity of about 7,700 cfs would be maintained in June, 7,000 cfs would be maintained in July, and 3,000 cfs would be maintained in August and September, before final breach of an upstream cofferdam. Each of these capacities would be able to accommodate a flood event having a minimum return period of 100 years for that time of year, based on historical streamflow records. The risk stems from the unlikely possibility of an unprecedented high flow event—an event significantly greater than historical streamflow conditions—that overtops the embankment.

4.3.4 Cultural and Historic Resources

Ethnographic information and cultural resources research completed for the study area identified traditional cultural properties, significant prehistoric and historic sites, historic hydroelectric facilities, and other culturally sensitive sites along and near the Klamath River and around the reservoirs (compiled and summarized in Cardno Entrix 2012). These sites include villages at traditional salmon fishing sites, habitation sites associated with secondary resource procurement areas, ceremonial sites, a “riverscape,” burial sites, historic ranching and homestead sites, and the Klamath Hydroelectric Historic District (including the Four Facilities). Based on ethnographic studies and the location and density of known sites, there is a high probability of existing submerged and other culturally sensitive sites, particularly villages with burials, within the area of disturbance if the Four Facilities were removed.

Dam removal and reservoir drawdown could affect forty-six sites reported to be submerged in reservoirs, and other sites that may be submerged in the reservoirs, and any human remains that may be associated with these sites. Culturally sensitive sites, artifacts or human remains could be exposed when the reservoirs are drained owing to (1) the river cutting a new channel, (2) decades of wind action along the shore of reservoirs that caused localized scour, or (3) slumping of banks as the reservoirs are drawn down. Once exposed, these sites would need to be documented, avoided or mitigated, and protected from vandalism, looting, and natural destructive forces. Indian or pioneer burial sites affected by reservoir removal would be subject to any state and local burial laws, federal laws on federal and tribal lands, and possibly historic preservation laws.

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 human remains, traditional cultural properties or other culturally sensitive resources could affect the timeline and cost of dam removal. The Definite Plan should include detailed contingency planning and extensive preparations for the possibility of encountering any of these cultural and historic resources before or during dam removal.

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4.4 ANALYSIS OF INFORMATION TO INFORM A DECISION ON WHETHER DAM REMOVAL AND KBRA ARE IN THE PUBLIC INTEREST

This section provides a summary of analyses, for multiple topic areas, to help inform a Secretarial Determination on whether or not dam removal and implementation of KBRA is in the public interest. This section does not draw an overarching conclusion regarding a public interest determination; that conclusion will be made by the Secretary of the Interior after considering and weighing multiple factors, values, and perspectives important to the public. The factors, values, and perspectives summarized in this section include: national and regional economic development, Indian tribal trust resources and perspectives, historic cultural resources, effects on PacifiCorp's customers (electricity ratepayers), Wild and Scenic River values, recreation, real estate values, National Wildlife Refuges, transport of chemicals downstream and health effects, algal toxins and health effects, greenhouse gases, and views of individuals and households from local, regional, and national perspectives.

4.4.1 Economic Analysis

The economic analysis conducted to evaluate the effects of dams out with KBRA (and partial facilities removal with KBRA) relative to dams in without implementation of the KBRA followed the framework of the National Economic Development (NED) and Regional Economic Development (RED) accounts as defined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983)*. The summary of the economic analysis presented in this section is described in more detail in the *Economics and Tribal Summary Technical Report* (Reclamation 2012b) and *Benefit-Cost and RED Technical Report* (Reclamation 2012a). Table 3-1 lists the economic analyses conducted for the Secretarial Determination. The analysis of tribal fisheries and related effects provided here is expanded more broadly in Section 4.4.2, *Tribal*, to include all tribal trust resources. In this section, as in other sections of the report, the terms "facilities removal" and "dam removal" refer to the dams out with KBRA scenario described in Section 1.1, *Purpose and Scope of this Report*.

The Federal objective is to contribute to national economic development consistent with protecting the nation's environment. The NED account measures the beneficial and adverse monetary effects (i.e., economic benefits and costs) of the dams out scenario (which can also be assumed to include partial facilities removal) in terms of changes in the net economic value of the national output of goods and services. For businesses, net economic value pertains to the monetary gain they receive when the minimum price at which they are willing to provide a good or service is less than the price actually received. For consumers, net economic value pertains to the monetary gain they receive when the price of obtaining a good or service is less than the maximum amount they are willing to pay for it. Net economic value is applicable not only to market goods but also to non-market goods such as recreation and non-use values that may be held by the public. A benefit cost analysis (BCA) is a formal process in which monetary measures of the benefits of a proposed project are compared to its costs. The results of a BCA are presented in term of net benefits (i.e., subtracting total costs from total benefits) and a benefit-cost ratio (i.e., total benefits divided by total costs). If all benefits and costs can be monetized and benefits exceed costs (resulting in positive net benefits or a benefit-cost ratio greater than one), the project is considered economically justified.

The RED account evaluates changes in economic activity in the affected region that could result from the dams out scenario (which also includes a separate evaluation for partial facilities removal). The affected region reflects the geographic area where these changes are largely expected to occur. In general, a regional economic impact analysis measures how the expenditures resulting from a policy, program or event cycle through the economy of the affected region and affect regional employment, labor income, and output. The RED analysis includes the initial or direct impact on the primary affected industries as well as the secondary impacts, which include changes in demand for inputs from industries supplying goods and services to the directly affected industries and changes in household spending from income earned by those employed in the affected industries. The secondary impacts are often referred to as “multiplier effects.” The RED’s measurement of changes in economic activity and employment that occur locally or regionally when a project is implemented does not account for the extent to which these changes are offset through transfers of this economic activity and employment to or from regions of the nation outside of the affected region.

The primary differences between the NED and RED pertain to the geographic scope of the analysis and the economic measures being evaluated. The NED analysis evaluates changes in net economic value (i.e., benefits minus costs) experienced by businesses and consumers directly affected by the dams out scenario, regardless of where they live in the U.S. The RED analysis evaluates how changes in economic expenditures cycle through the affected local/regional economy in terms of direct and secondary effects on employment, labor income, and output in that region. The RED discussion below (Section 4.4.1.2, *Regional Economic Development*) identifies the local regions used in the RED analysis. NED and RED analyses are useful for informing comparisons of policy alternatives but are not necessarily definitive, as other factors may also influence the decisions made by policy makers.

4.4.1.1 National Economic Development

For the NED BCA, the benefits of dam removal are compared to the conditions that would occur if the dams were left in place. Thus, under a dams in scenario, the analysis assumes annual licenses would continue to be issued to the dam owner, PacifiCorp, as has occurred since expiration of the FERC license in 2006. The period of analysis was 50 years, beginning in year 2012 with the scheduled Secretarial Determination, and continuing through 2061. Before comparisons were made between costs and benefits, they were corrected for inflation to the same dollar year. Furthermore, since the benefits and costs were estimated to occur at different times across the 2012-2061 period of analysis, they were discounted to the same year in order to have a consistent basis for comparison. Thus, all benefits and costs were estimated in 2012 dollars and discounted back to the year 2012 using the 2011 Federal water resources planning rate of 4.125 percent.[1]

NED Benefit Estimation Methods

The economic valuation methods used to estimate the NED benefits of a dams out scenario included revealed preference (RP), stated preference (SP), and benefits transfer (BT). RP methods rely on individuals' observed behavior to infer values of environmental resources, while SP methods rely on individuals' statements about their intended behavior or expression of value under future environmental resource conditions. Absent the ability to collect primary data for the estimation of a site specific RP or SP valuation study, economic values can be estimated using BT. BT involves the transfer of data or analyses from existing studies from their original settings to other similar settings. RP methods are only able to capture NED benefits associated with use values under environmental resource conditions that have been experienced. By contrast, SP methods are able to capture NED benefits associated with both use and nonuse values and can be used to value environmental resource conditions that have not been experienced. However, SP must rely on surveys to elicit the preferences of the public in a hypothetical context (the hypothetical context is a common concern with SP methods). The use of BT is limited by the degree to which existing studies conducted in other contexts reflect the economic values associated with the site being analyzed. In general, it can be particularly difficult to develop an appropriate estimate of nonuse values via BT. It was necessary to apply a combination of these methods in order to measure the broad scope of potential benefits and costs resulting from a dams out scenario. Further details about the particular economic valuation method applied for the various economic analyses conducted as part of the overall NED BCA can be found in the technical reports referenced in each NED benefit category sub-section.

Uncertainty

Uncertainty is almost always present when evaluating the net economic benefits of projects or activities that extend into the future. Virtually all of the economic values estimated in the NED analysis are contingent on the results of studies conducted by other technical Sub-teams for the Secretarial Determination. These include construction and mitigation cost estimates and hydrology projections provided by the Engineering/Geomorphology/Construction Sub-team, water quality projections provided by the Water Quality Sub-team, fish population modeling and projections provided by the Biological Sub-team, and real estate, recreational and tribal information provided by the Real Estate, Recreation and Tribal/Cultural Sub-teams. The results provided here reflect the uncertainties in these other studies, as well as uncertainties associated with conditions such as weather, prices, and population growth. Major sources of uncertainty in the NED analysis include the following:

- **Hydrology:** Future hydrology would be expected to affect agricultural activities, hydropower production, fisheries, and recreation. In general, additional surface water supplies would increase the benefits to most

[1] Change in Discount Rate for Water Resources Planning. 75 FR 82066 (29 December 2010).

affected resources. However, the timing of the additional supplies would also be a factor.

- **Crop prices and agricultural production input costs:** Crop prices and input costs would affect the agricultural benefits in the Klamath Basin. In general, when input costs increase, all else being equal, agricultural benefits would decrease. The effects of crop price changes would depend on the direction and magnitude of the changes. Higher crop prices, all else equal, would be expected to increase net agricultural revenues.

- **Hydropower:** The hydropower analysis is sensitive to hydrology, future electricity prices and the timing of future capital investments necessary to replace aging equipment at the hydropower plants. New equipment is expected to result in some improvements in efficiency. Lengthy periods of greater than average hydrologic conditions would result in higher foregone hydropower benefits. The higher future electricity prices are, the larger the foregone hydropower values would be. The sooner in time the aging hydropower equipment at these four plants is replaced, the earlier capital costs are incurred, the gains in hydropower generation efficiency are realized and the larger the foregone hydropower benefits.

- **Fisheries:** Natural variability in biological and environmental parameters and uncertainty regarding future harvest management policies would affect commercial, recreational and tribal fishery benefits. The magnitude of these changes is difficult to predict.

- **Capital and mitigation costs:** Costs are subject to changes in supply and prices of labor, materials, and equipment. Shifts in the timing of when costs are incurred would also change the present value of the costs. All else equal, shifting capital costs closer to the present would increase the present value of these costs; shifting costs further into the future would decrease present values.

- **KBRA:** The timing, nature, extent, and success of the KBRA measures implemented could affect both costs and benefits, including use and nonuse values. Shifting KBRA costs closer to the present would increase the present value of these costs; shifting costs further into the future would decrease present values.

- **Recreation:** Changes in population and visitation projections could affect recreation. For instance, flow conditions under a dams out scenario are expected to allow some continuation of whitewater boating trips but the extent of such activity is uncertain. Future effects of blue-green algae at Copco 1 and Iron Gate reservoirs on recreational visitation under a dams in scenario are uncertain.

- **Nonuse value**: The soundness of nonuse value surveys is highly dependent on how well the survey is designed to address potential concerns such as hypothetical bias. The accuracy of nonuse value estimates cannot be verified directly; modeling exercises and statistical tests are used to evaluate the consistency and validity of the values elicited in such surveys.

Survey results are contingent on the specific scenarios or attributes being valued, which are themselves subject to uncertainty.

Uncertainty regarding outcomes is typically addressed by calculating expected values in a manner that incorporates variability. Uncertainty can also be recognized explicitly by using sensitivity analysis to measure how the results are affected by a change in an input or assumption, holding all else constant. In general, the individual economic analyses conducted as part of the overall BCA address uncertainty in this manner. Further details can be found in the individual technical reports referenced in each sub-section discussing the categories of benefits analyzed.

Benefits Analyses

A range of potentially affected benefits associated with dam removal and KBRA activities was identified for this study. Benefits were analyzed for the following categories:

- Commercial fishing
- In-river sport fishing
- Ocean sport fishing
- Irrigated agriculture
- Refuge recreation
- Nonuse values
- Tribal effects
- Hydropower
- Reservoir recreation
- Whitewater recreation

The evaluation of hydropower, reservoir recreation, and whitewater recreation resulted in foregone benefits, implying that benefits for those categories in the dams out scenario are less than the dams in scenario. Although tribal effects are sometimes included in the “Other Social Effects” account (as defined in the Principles and Guidelines framework), they are included in this report in this section, *Benefits Analyses,* to facilitate comparison with other benefits and costs.

Commercial Fishing

The information presented in this section is based on the *Economics and Tribal Summary Report* (Reclamation 2012b) and the *Commercial Fishing Economics Technical Report* (NOAA Fisheries Service 2012a). The particular salmon stocks influenced by the presence of or removal of the Four Facilities are the Southern Oregon Northern California Coastal (SONCC) coho salmon Evolutionarily Significant Unit (ESU) and Klamath River fall- and spring-run Chinook salmon. Reclamation (2012b) and NOAA Fisheries Service (2012a) discuss in detail the methods and models used to evaluate commercial fishing benefits. All economic effects described below for the troll fishery under a dams out scenario would similarly apply to partial facilities removal.

SONCC Coho Salmon

The SONCC coho ESU includes 28 coho populations ranging from the Elk and Rogue rivers in southern Oregon to the Eel River in northern California, and includes the coho populations in the Klamath Basin (Williams et al. 2008). The SONCC coho ESU is listed as "threatened" under the ESA. Coho salmon retention has been prohibited in the troll fishery south of Cape Falcon, OR since 1993 to meet consultation standards for SONCC coho and three other coho ESUs listed under the ESA. This prohibition is expected to continue into the future under a dams in scenario.

According to the Coho/Steelhead Expert Panel, a dams out scenario is expected to improve habitat conditions that are relevant to the viability of Klamath River coho populations and advance recovery of the SONCC coho ESU (Dunne et al. 2011). However, because the dams out scenario does not include coho restoration outside the Klamath Basin, this option alone would not create conditions that would warrant de-listing of this ESU throughout its range. Thus, under a dams out scenario, coho retention would likely continue to be prohibited in the California and Oregon troll fisheries south of Cape Falcon.

Klamath Chinook Salmon

Klamath Chinook salmon consist of fall and spring-run populations, neither of which is listed under the ESA. Although fall-run Chinook salmon (which includes a sizeable hatchery component) experiences wide temporal fluctuations in abundance, it consistently accounts for a much larger share of ocean troll harvest than spring-run Chinook salmon, which is at low levels of abundance (though not ESA-listed). This stock composition is likely to persist in the future if the dams are left in place. A modest harvestable surplus of spring-run Chinook salmon may become available if the Four Facilities are removed (Goodman et al. 2011, Hamilton et al. 2011, Lindley and Davis 2011). However, assuming that the current troll season structure is retained (due to ESA consultation standards for other stocks and other constraints), troll harvest of spring-run Chinook salmon may be limited, as a large portion of the spring-run Chinook salmon would have returned to the river by the time the troll season opens.

Due to the biological effects of habitat restoration and expansion (and accompanying fishery regulations), troll harvest of combined fall- and spring-run Klamath Chinook salmon is expected to increase by an annual average 43 percent during 2012-2061 under a dams out scenario (Hendrix 2011). Table 4.4.1-1 shows average annual net revenue associated with total Chinook salmon harvest (all stocks) attributable to Klamath Chinook salmon availability in the seven affected ocean management areas (NOAA Fisheries Service 2012a). The average annual increase in net revenue (for all areas combined) under dams out relative to a dams in scenario is $7.296 million. Over the period of analysis, this is equivalent to $134.5 million in discounted present value terms.

Table 4.4.1-1: Annual and Total Discounted Net Economic Value of the Chinook Troll Fishery (all stocks) Under Dams In and Dam Removal, by Management Area (Million $, 2012 dollars)

Management Area	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Northern OR	0.112	0.160	0.048
Central OR	5.567	7.948	2.381
KMZ –OR	0.217	0.310	0.093
KMZ-CA	0.267	0.381	0.114
Fort Bragg	3.417	4.879	1.462
San Francisco	7.419	10.593	3.174
Monterey	0.058	0.083	0.025
Total Annual Value	17.057	24.353	7.296
Total Discounted Value (2012-2061)	***375.3***		***134.5***

Note:
KMZ = Klamath Management Zone

Annual harvest is projected to be higher in 70 percent of years if the Four Facilities are removed than if they remain in place. In 2006, unusually low Klamath fall-run Chinook salmon abundance triggered major regulatory restrictions and adverse economic conditions for all Chinook fisheries (including the troll fishery). Such population conditions are projected to occur in 66 percent fewer years under a dams out scenario.

In-River Sport Fishing

The information in this section is taken from Reclamation 2012a and the *In-River Sport Fishing Economics Technical Report* (NOAA Fisheries Service 2012c). In-river recreational fisheries potentially affected under a dams out scenario include existing fisheries for salmon, steelhead and redband trout, and the recreational sucker fishery, which has been closed since 1987. The particular salmon stocks influenced by the dams in and dams out scenarios are the SONCC coho salmon ESU and Klamath fall- and spring-run Chinook salmon. All economic effects described below for the in-river recreational fisheries under full removal of the Four Facilities would similarly apply to partial removal of the Four Facilities.

Salmon Fishery

As with the commercial fishery, the expected impacts of a dams out scenario on the in-river fishery are expected to differ between the SONCC coho ESU and the Klamath Chinook salmon.

As explained in the Commercial Fishing section above, because the SONCC coho ESU is listed as “threatened” under the ESA, coho retention is also prohibited in the Klamath River recreational fishery. Since dam removal would not lead to SONCC coho restoration throughout its range, these prohibitions are expected to continue in the future under a dams out or dams in scenario.

Unlike the SONCC coho ESU, in-river recreational fishing for Klamath Chinook salmon is allowed. If the dams remain, the annual average net economic value of the in-river recreational Klamath Chinook salmon fishery is estimated to be $1.648 million. The discounted present value of the in-river sport fishery during 2012-2061 under a dams in scenario equates to $36.4 million.

Due to the biological effects of habitat restoration and expansion (and accompanying fishery regulations), in-river recreational harvest of Klamath Chinook salmon is expected to increase by an annual average of 8 percent during 2012-2061 with dam removal (Hendrix 2011). The resulting average annual net economic value would be $1.774 million, an increase of $126,000 per year. The increase in the discounted present value of the in-river sport fishery during 2012-2061 associated with a dams out scenario equates to $1.75 million.

Annual harvest is projected to be higher in 70 percent of years under a dams out scenario compared to a dams in scenario. As noted above, population conditions leading to major regulatory restrictions and adverse economic conditions for all Chinook fisheries (including the in-river recreational fishery) are projected to occur in 66 percent fewer years under a dams out scenario.

A modest harvestable surplus of Klamath spring-run Chinook salmon may become available if the dams are removed (Goodman et al. 2011, Hamilton et al. 2011, Lindley and Davis 2011). Such a surplus is more likely to be advantageous to in-river fisheries than it is to ocean troll and recreational fisheries, because the season structure of ocean fisheries is constrained by ESA consultation standards for other stocks and other factors; thus, a large portion of Klamath spring-run Chinook salmon would have returned to the river by the respective opening dates of the ocean fisheries. To the extent that Klamath spring-run Chinook salmon numbers become sufficient to allow in-river recreational harvest, economic benefits can be expected for that fishery, as Klamath spring-run Chinook salmon are highly desirable for their fat content and have the potential to temporally expand recreational harvest opportunities beyond the current Klamath fall-run Chinook salmon season.

Steelhead Fishery

The Coho/Steelhead Expert Panel considered it unlikely that the steelhead's status would change if the dams are left in place (Dunne et al. 2011). Thus, the steelhead fishery with the dams remaining in place is characterized in terms of existing conditions. The total annual economic value of the fishery is estimated to be $1.426 million – based on a net value per angler day derived from various steelhead valuation studies in the economics literature. The discounted present value of the fishery with the dams remaining in place equates to $31.2 million.

An important component of the Klamath River steelhead fishery is the half-pounder fishery. Half pounders are immature steelhead (less than 16 inches) that migrate to the river while immature, then return to the ocean before again migrating to the river as adults. Half pounders are unique to northern California and southern Oregon. Data on the half-pounder fishery are sparse; California's requirement that steelhead anglers submit a "report card" to the State documenting their steelhead catch applies only to steelhead that are larger than 16 inches. This analysis does not cover the half-pounder fishery and, thus, underestimates steelhead fishing activity and value with the dams remaining in place.

Over the longer term, the Expert Panel concluded that removal of the Four Facilities would likely lead to increases in the abundance and spatial distribution of steelhead, including successful colonization of the Upper Klamath Basin (Dunne et al. 2011). These conclusions are contingent on conditions such as effective implementation of the KBRA and successful fish passage through Keno Reservoir and Upper Klamath Lake. The Biological Sub-team noted that access to Upper Klamath Basin habitat provided by removal of the Four Facilities would be more favorable to steelhead than other anadromous species, due to steelhead's ability to navigate steep gradients and spawn in small streams and their resistance to the disease *C. Shasta* (Hamilton et al. 2011).

It is not possible to make quantitative economic inferences for the steelhead fishery, as the Expert Panel and Biological Sub-team were able to draw only qualitative conclusions regarding effects of a dams out scenario on the steelhead population. However, removal of the Four Facilities appears to provide notable potential to enhance the net economic value of the steelhead fishery from its current discounted present value of $31.2 million with the dams remaining in place.

Redband Trout Fishery

The Resident Fish Expert Panel expected the distribution and abundance of redband/rainbow trout to remain stable with the dams remaining in place (Buchanan et al. 2011). Thus, current fishery conditions provide a reasonable representation of fishing activity if the dams remain in place.

The redband trout fishery is a renowned trophy fishery. The tributary streams upstream of Upper Klamath Lake "offer some of the best fly fishing in the United States;" however, due to the lack of upstream fishery data from Oregon or any other source, quantitative estimates of effort and harvest for that area are not available. The fishery downstream of Keno Dam is largely limited to the Keno Reach (Keno Dam to J.C. Boyle Reservoir), where redband trout also reach trophy size. Fishing activity downstream of J.C. Boyle Dam is likely modest, as hydropower operations make fishing conditions (fishable flows) in that area during daylight hours unpredictable.

The Resident Fish Expert Panel predicted marked improvement in the redband trout fishery under a dams out scenario. The Expert Panel predicted an expansion in the distribution and abundance of large-sized trout in upper Klamath River and the lower Williamson and Wood rivers. The qualitative nature of their evaluation and the lack of data on fishing activity in the tributaries make it infeasible to quantify the economic effects of such improvement. The Expert Panel concluded that short-term adverse impacts from removal of the Four Facilities would be outweighed by increases in the size and abundance of resident trout in the 43 miles between J.C. Boyle Reservoir and Iron Gate Dam and a potential seven-fold increase in the fishery. Lack of data on fishing effort downstream of Keno Dam makes it infeasible to draw quantitative inferences for that area (Buchanan et al. 2011). Even given the lack of quantitative information, it is considered likely that removal of the Four Facilities would represent a major change from current conditions and a considerable increase in the value of the redband trout fishery.

Sucker Fishery

Lost River and shortnose suckers are listed as "endangered" under the ESA. The recreational sucker fishery has been closed since 1987 and the prospects of a future fishery are unlikely under a dams in scenario. As noted by the Resident Fish Expert Panel, "With declining populations under the current conditions, there are no opportunities for tribal or recreational harvest" (Buchanan et al. 2011).

The prospects for restoration of the recreational sucker fishery appear quite limited under a dam removal scenario. As noted by the Resident Fish Expert Panel, "Harvest other than ceremonial tribal harvest should only occur after a sustained population growth can be shown over a period of decades" (Buchanan et al. 2011). Given the susceptibility of long-lived species like suckers to over-harvest, if and when the suckers are de-listed, population monitoring will be needed for an extended period thereafter before considering whether to re-open the recreational fishery.

Ocean Sport Fishing

This section is from *Economics and Tribal Summary Technical Report* (Reclamation 2012b) and the *Ocean Sport Fishing Economics Technical Report* (NOAA Fisheries Service 2012f). As for commercial fishing, benefits of ocean sport fishing are evaluated separately for each of the seven management areas. All economic effects described below for the ocean recreational fishery under full removal of the Four Facilities would similarly apply to partial removal of the Four Facilities.

Coho salmon retention has been prohibited in California's recreational fishery since 1996 to meet the consultation standard for ESA-listed Central California Coast coho salmon (listed in 1996); this prohibition also meets the consultation standard for SONCC coho salmon (listed in 1997). In 1998, a mark-selective recreational coho salmon fishery was established in Oregon with a marked coho salmon quota and season limits to ensure that the fishery does not exceed maximum allowable exploitation rates for three ESA-listed coho salmon ESUs, including SONCC coho salmon. These California and Oregon regulations are expected to continue in the future if the dams remain.

The SONCC coho ESU includes coho populations both inside and outside the Klamath Basin (Williams et al. 2008). Dam removal and implementation of the KBRA are expected to improve habitat conditions that are relevant to the viability of Klamath River coho populations and advance recovery of the SONCC coho ESU (Dunne et al. 2011). However, since a dams out scenario does not include coho restoration outside the Klamath Basin, this option alone would not create conditions that would warrant de-listing of the SONCC coho ESU throughout its range. Thus, the prohibition on coho retention in California and the mark-selective coho regulations in Oregon would likely continue under a dams out scenario.

Due to the biological effects of habitat restoration and expansion (and accompanying fishery regulations), the recreational harvest of Klamath Chinook salmon is expected to increase by an average annual 43 percent during 2012-2061 under a dams out scenario. Table 4.4.1-2 summarizes annual net economic value associated with total Chinook salmon harvest (all stocks) attributable to Klamath Chinook salmon availability with dams out and dams in. The average annual increase in net economic value (for all areas combined) for dams out relative to dams in is $2.744 million. Over the period of analysis, this is equivalent to $50.5 million in discounted present value terms.

Table 4.4.1-2: Annual and Total Discounted Net Economic Value of the Ocean Recreational Chinook Fishery (all stocks) Under Dams In and Dam Removal, by Management Area (2012 dollars, million $)

Management Area	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Northern OR	0.088	0.125	0.037
Central OR	0.144	0.206	0.062
KMZ-OR	2.142	3.058	0.916
KMZ-CA	3.683	5.258	1.575
Fort Bragg	0.237	0.338	0.101
San Francisco	0.090	0.128	0.038
Monterey	0.033	0.047	0.014
Total Annual Value	6.415	9.159	2.744
Total Discounted Value (2012-2061)	***141.2***	***191.7***	***50.5***

Annual harvest is projected to be higher in 70 percent of years if the facilities are removed than if they remain in place. As noted above, population conditions leading to major regulatory restrictions and adverse economic conditions for all Chinook fisheries (including the ocean recreational fishery) are projected to occur in 66 percent fewer years under a dams out scenario.

Fall-run Chinook salmon (consisting largely of hatchery fish) is currently a much larger component of ocean recreational harvest than spring-run Chinook salmon, which is at low levels of abundance. This stock composition is likely to persist in the future if the dams remain. A modest harvestable surplus of spring-run Chinook salmon may become available with dam removal. However, assuming that the current ocean recreational season structure is retained (due to ESA consultation standards for other stocks and other factors), ocean recreational harvest of spring-run Chinook salmon may be limited, as a large portion of the spring-run Chinook salmon would have returned to the river by the time the season opens.

Irrigated Agriculture

This section is from Reclamation (2012b) and the *Irrigated Agriculture Economics Technical Report* (Reclamation 2012d). These reports discuss in detail methods used to evaluate economic benefits and results. Table 4.4.1-3 shows the economic benefits relating to agriculture under dams in and dams out scenarios. Agricultural benefits under the dams out scenario relate to elements of the

KBRA, primarily Reclamation's Klamath Project hydrology. The KBRA provides larger amounts of water for irrigated agriculture in drought years, relative to what is anticipated under the baseline. The agricultural benefits are directly related to reducing the economic losses that might occur absent the water sharing agreement in the KBRA. Economic benefits related to agriculture for partial removal of the Four Facilities would have the same economic benefits as full removal of the Four Facilities.

Table 4.4.1-3: Total Discounted Economic Value of Irrigated Agriculture Under Dams In and Dam Removal (2012 dollars, million $)

	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Total Discounted Value (2012-2061)	1,578.9	1,608.8	29.89

Source: Reclamation 2012b

Refuge Recreation

This section is from *Economics and Tribal Summary Technical Report* (Reclamation 2012b) and the *Refuge Recreation Economics Technical Report* (Reclamation 2011f). These reports discuss methods to evaluate effects and results in detail.

It is assumed that with the dams in scenario, during the hunting season, an estimated 7,740 hunting trips are taken in response to the relative abundance of birds. The annual economic benefit associated with waterfowl hunting activities during a normal water year is estimated to range between $351,720 and $485,708. The midpoint of this range, or $418,714, is used as the annual waterfowl hunting benefit under the dams in scenario.

With the dams out scenario, the economic benefit associated with waterfowl hunting activities during a normal water year is estimated to range between $516,867 and $713,769 annually. As compared to the dams in scenario, this represents a difference of $165,147 to $228,061 per year in additional economic benefit associated with waterfowl hunting. The midpoint of this range, or $196,604, was used as the change in annual waterfowl hunting benefit within the overall BCA. Table 4.4.1-4 summarizes the discounted present value of the annual waterfowl hunting benefits from 2012 to 2061 with the dams in, dams out and the difference between the two. The change in economic benefits for refuge recreation under partial removal of the Four Facilities would be the same as full removal of the Four Facilities.

Table 4.4.1-4: Total Discounted Net Economic Value of Refuge Recreation Under Dams in and Dam Removal (2012 dollars, million $)

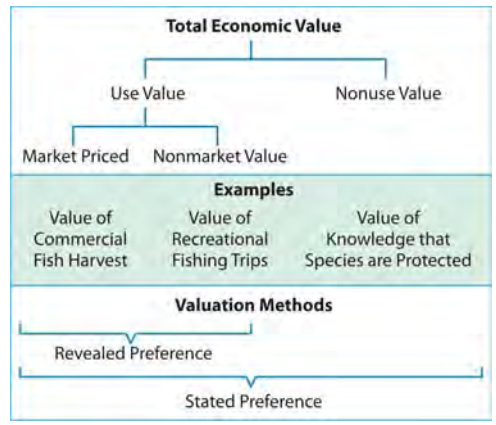
	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Total Discounted Value (2012-2061)	9.2	13.5	4.3

Source: Reclamation 2012b

Nonuse Values

The total economic value that an individual derives from a natural resource, such as a river basin, can be conceptually divided into use and nonuse values (see Figure 4.4.1-1). Therefore, in the context of economic analysis, the value of an environmental service or resource is equal to the sum of use and nonuse values. Use values can arise from the exchange and consumption of market goods and services, such as commercially harvested fish. Important use values can also be derived from nonmarket activities, such as recreational use activities. Economic methods used to estimate use values include revealed preference (RP) methods, whereby use values are inferred from individuals' observed behavior, and stated preference (SP) methods, whereby use values are inferred from individuals' statements regarding their intended behavior under future conditions. Up to this point, the discussion of the NED BCA has focused on use values.

Figure 4.4.1-1: Total Economic Value: Typology and Valuation Methods



Source: Adapted from Bateman et al. (2003).

Nonuse values capture individuals' preferences for public goods or resources that are not derived directly from their use. As such, nonuse values can accrue to members of the public who value Klamath Basin improvements regardless of whether they ever consume Klamath River fish, visit the Klamath Basin, or otherwise use the resources from the Klamath Basin. Factors that give rise to nonuse values could include the following:

- Desire to preserve the functioning of specific ecosystems
- Desire to preserve the natural ecosystem to maintain the option for future use
- Feeling of environmental responsibility or altruism towards plants and animals

Evidence of nonuse values can be found in the trade-offs people make to protect or enhance environmental resources that they do not use. In some cases, they are motivated to provide opportunities for their children or more generally for others in society to use or enjoy such resources in the future. They may feel such resources contribute to their conception of the nation's natural heritage. What is important from the perspective of economic analysis is that they are willing to give up resources (money) to achieve the environmental improvements.

To fully capture the benefits that would accrue to society from restoration of the Klamath Basin resulting from removal of the Four Facilities, an estimate of nonuse values is needed. Because nonuse values, by definition, cannot be revealed from observed behavior, estimation of nonuse values requires the use of SP methods. Although there has been debate about SP methods, particularly as applied to estimation of nonuse values, SP methods have been used in various settings to help inform decision making.[2]

SP methods rely on responses to carefully designed and worded surveys to elicit the preferences of the public. In keeping with this protocol, the DOI, in conjunction with Research Triangle Institute (RTI) International, designed, pre-tested, pilot tested, and implemented a SP survey in order to account for the nonuse benefits that would accrue to society from fish habitat and river ecosystem improvements in the Klamath Basin. The survey was designed to measure the total economic value (i.e., nonuse values as well as use values) that households in the United States place on the changes in Klamath Basin conditions expected to occur under dam removal. Details of the survey and results are contained in RTI International, December 2011, *Klamath River Basin Restoration Nonuse Value Survey Final Report* (RTI International 2011).

This survey was the first to date to use SP methods to estimate the total economic value associated with dam removal and other restoration measures on the Klamath River. The design of the survey instrument was done iteratively and subject to several formal and informal peer reviews prior to implementation. Best practices in survey design methods were followed and input from a diverse set of experts and interested parties was solicited. The beginning of Section 4.4.1.1, *National Economic Development,* discussed the various methods used to estimate NED benefits and some of their limitations. With regard to the Klamath SP survey, a number of steps were taken to mitigate hypothetical bias, a common concern with SP methods.[3]

Overall, the purpose of implementing the Klamath SP survey was to provide an estimate of total economic value, which includes nonuse and use values, by determining how much households would be willing to pay (WTP) for specific scenarios for ecosystem restoration within the Klamath Basin. To accomplish this, a conjoint or discrete choice experiment format was chosen for the SP survey. The conjoint format allows one to estimate the value of alternative plans, where the plans are constructed from a set of attributes. Based on pretesting and expert review, three “fixed” attributes and four “varying” attributes were selected to describe Action and No Action plans for the SP choice questions. The levels of the fixed attributes were different for the Action and No Action plans, but they did not vary across the Action plans presented to respondents. The fixed attributes comprise the three main elements of the KHSA and KBRA: dam removal, the water-sharing agreement, and fish restoration

[2] Examples include the National Park Service’s (NPS) evaluation of snowmobile regulations for the Greater Yellowstone Area, the Bureau of Reclamation’s and NPS’s assessment of the effects of the re-regulation of Glen Canyon Dam on resources of the Grand Canyon, and natural resource damage assessments conducted for oil spills or hazardous substance releases.

[3] Efforts made to mitigate possible sources of hypothetical bias included using a binary choice referendum (choice-based format); a short script warning respondents to be aware of hypothetical bias; reminders about the respondents’ budget constraints; and text emphasizing the importance of the respondents’ answers to policy makers. In addition, after each SP question, respondents were asked how certain they were of their response.

projects. The purpose of these three attributes is to remind respondents to consider all the elements of the agreements when making their choice.

The four varying attributes of the survey pertained to changes in the abundance of wild Chinook salmon and steelhead trout, changes in the extinction risk for coho salmon, changes in the extinction risk for the shortnose and Lost River suckers, and the cost to the household per year for a 20-year period starting in 2012. The levels of the varying fish related attributes were selected to encompass the range of most likely outcomes from implementation of the KHSA and KBRA, and were based on expert judgment, existing empirical studies, and the state of the science at the time the survey was developed.

The survey was a nationwide survey, and was mailed to a random sample of U.S. households. To capture potential differences among respondents based on proximity to the Klamath River, the overall target population sampled was divided into three geographic strata: the 12-county area around the Klamath River[4], the rest of Oregon and California, and the rest of the United States. Table 4.4.1-5 below shows the survey response rate for each stratum. The Klamath SP survey response rates were slightly higher than what was projected at the survey development and approval stages. As such, more than a sufficient number of responses were received to allow for statistically valid estimates to be computed.

Table 4.4.1-5: Klamath Survey Response Rates

Strata	Total Number of Surveys Mailed (less undeliverables)	Number of Paper Survey Responses	Number of Web Survey Responses	Total Responses	Response Rate[1]
12-County Klamath Area[2]	2,496	985	42	1,027	41.1%
Rest of CA & OR (Excluding the 12-County Klamath Area)	3,932	1,105	76	1,181	30.0%
Rest of the U.S. (Excluding CA & OR)	3,849	1,100	64	1,164	30.2%
Total	10,277	3,190	182	3,372	32.8%

[1] Response rate = total surveys completed/(total surveys mailed – undeliverable surveys).
[2] 12-County Klamath Area is defined as: Lake, Klamath, Douglas, Jackson, and Josephine counties in southern Oregon and Modoc, Siskiyou, Del Norte, Humboldt, Trinity, Shasta, and Tehama counties in northern California.

In addition to collecting responses to questions designed to measure economic values, the survey also included questions related to demographics, attitudes, and opinions. The sample was designed to be representative of households, not individuals. Therefore, similarities or differences between the individual-level characteristics reported by survey respondents relative to other sources such as the Census do not imply that the sample is either representative or not representative at the household level.

The 12-County Klamath Area sample had the highest percentage of households in the lower income brackets; 56.4 percent of Klamath area respondents reported household incomes below $50,000 per year compared to 40.4 percent

[4] The 12-County Klamath Area around the Klamath River is defined as Lake, Klamath, Douglas, Jackson, and Josephine counties in southern Oregon and Modoc, Siskiyou, Del Norte, Humboldt, Trinity, Shasta, and Tehama counties in northern California.

for the rest of Oregon and California sample and 47.5 percent for the rest of the United States sample. The relative differences in reported household income levels between the three strata are consistent with census data for these areas.

The rate of home ownership reported by respondents was highest for the rest of the United States sample (roughly 75 percent), but closely followed by the 12-County Klamath Area sample at about 74 percent. Homeownership in the rest of Oregon and California sample was approximately 66 percent. Homeownership rates in the overall survey sample are relatively high (74 percent) compared to U.S. statistics (67 percent in 2010).

Results

The survey contained a number of questions about the use of Klamath Basin resources, the economy, the environment, and the respondent's attitudes and opinions about restoration of the Klamath Basin. As stated previously, the sample was designed to be representative of households, not individuals. Therefore, similarities or differences between the individual-level characteristics reported by survey respondents relative to other sources such as the Census do not imply that the sample is either representative or not representative at the household level.

Respondents were asked how they use their local rivers. More than 50 percent of respondents in each of the regions indicated they used local rivers for at least one form of recreation, while less than 15 percent reported no use of local rivers. Table 4.4.1-6 contains the distribution of responses regarding river use.

Table 4.4.1-6: Survey Results Regarding Respondents' Use of Their Local Rivers

Use	12-County Klamath Area	Rest of CA & OR (Excluding the 12-County Klamath Area)	Rest of the US (Excluding CA & OR)
Recreational boating or rafting	57.9%	49.7%	61.5%
Transportation	2.3%	4.5%	9.6%
Swimming	48.8%	40.11%	42.0%
Near-shore recreation (such as hiking, picnicking, or bird watching)	59.4%	56.4%	52.4%
Recreational fishing	63.6%	44.0%	56.1%
Commercial fishing	2.2%	3.8%	4.3%
Irrigating farmland	15.4%	13.3%	11.9%
Drinking water	23.0%	29.3%	27.4%
Spiritual or ceremonial purposes	10.5%	5.2%	4.6%
My electric power comes from a hydroelectric-power dam	38.5%	18.6%	15.2%
Other	4.3%	4.3%	3.6%
None of the above	6.2%	14.0%	13.0%

Respondents were also asked their opinions regarding the importance of using rivers for different purposes. Overall, respondents either agreed or strongly agreed that rivers were important:

- As a source of electric power – 48 percent
- To provide places for recreation – 73 percent

- To provide healthy habitat for fish – 92 percent
- As a source of water for irrigation – 68 percent
- To provide Indian tribes with traditional fishing areas – 59 percent
- To support commercial fishing – 32 percent

Several survey questions focused specifically on respondents opinions regarding fish species in the Klamath Basin. A large majority of respondents in each of the regions surveyed were concerned or very concerned about declines or the risk of extinction to Klamath Basin fish species. Table 4.4.1-7 describes the distribution of responses pertaining to concern for the fish species highlighted in the survey. The highest levels of concern were for the high risk of extinction for coho salmon. The opinions of 12-County Klamath Area respondents were divided; although a sizeable percentage strongly agreed that the fish populations warranted concern, the percentages disagreeing and strongly disagreeing were higher in the 12-County Klamath Area than in the other two areas.

Table 4.4.1-7: Survey Results Regarding Respondents' Concern for Species in Klamath Basin

	I am concerned about declines in the number of Chinook salmon and steelhead trout that return to the Klamath River each year.				
(p = 0.0000)[1]	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**	**No Opinion**
12-County Klamath Area	40.9%	32.9%	12.5%	5.4%	8.4%
Rest of CA & OR (Excluding the 12-County Klamath Area)	42.6%	39.9%	5.4%	2.2%	9.9%
Rest of the U.S. (Excluding CA & OR)	35.1%	43.7%	4.9%	1.3%	15.1%
	I am concerned about the shortnose and Lost River suckers that are at very high risk of extinction.				
(p = 0.0000)[1]	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**	**No Opinion**
12-County Klamath Area	23.8%	26.6%	17.2%	16.8%	15.6%
Rest of CA & OR (Excluding the 12-County Klamath Area)	35.9%	38.4%	8.5%	3.4%	13.8%
Rest of the U.S. (Excluding CA & OR)	30.1%	43.8%	8.1%	2.7%	15.3%
	I am concerned about the Klamath coho salmon that are at high risk of extinction.				
(p = 0.0000)[1]	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**	**No Opinion**
12-County Klamath Area	44.1%	31.5%	12.1%	5.6%	6.8%
Rest of CA & OR (Excluding the 12-County Klamath Area)	49.5%	35.7%	5.7%	1.5%	7.5%
Rest of the U.S. (Excluding CA & OR)	40.4%	40.8%	5.4%	1.5%	11.9%

[1] Pearson Design-based chi-squared test of association across strata (< .05 indicates strong likelihood of strata-level statistical association).

Table 4.4.1-8 presents survey responses on opinions about Klamath Basin dam removal plans. A larger percent (56 percent) of respondents in the rest of the U.S. agreed or strongly agreed that Oregon and California residents should pay more, compared to 40 percent in the Oregon and California stratum, and 24 percent in the 12-County Klamath Area stratum.

Just as a majority of respondents expressed concern about the welfare of Klamath Basin resources, a majority also expressed the view that the Federal government should be involved in restoring the Klamath Basin. About 52 percent of the respondents from the 12-County Klamath Area agreed or strongly agreed that the Federal government should be involved in restoring the Klamath Basin; this compares to 67 percent in the rest of California and Oregon and 60 percent in the rest of the U.S. For both sets of responses displayed in the table, the differences in the distribution of responses across the three geographic areas were statistically significant.

Table 4.4.1-8: Respondents' Opinions Regarding Klamath River Basin Dam Removal Plans

	Do you agree or disagree that Oregon and California residents should, on average, pay more than residents of other states for Klamath Basin restoration?					
(p = 0.0000)[1]	**Strongly Agree**	**Agree**	**See Both Sides**	**Disagree**	**Strongly Disagree**	**No Opinion**
12-County Klamath Area	6.0%	18.3%	29.4%	18.0%	24.3%	4.1%
Rest of CA & OR (Excluding the 12-County Klamath Area)	9.2%	30.7%	26.7%	16.4%	11.4%	5.6%
Rest of the U.S. (Excluding CA & OR)	25.4%	30.6%	29.0%	6.2%	1.9%	7.0%
	Do you agree or disagree that the Federal government should be involved in restoring the Klamath Basin?					
(p = 0.0000)[1]	**Strongly Agree**	**Agree**	**See Both Sides**	**Disagree**	**Strongly Disagree**	**No Opinion**
12-County Klamath Area	26.2%	25.4%	17.8%	11.4%	15.7%	3.5%
Rest of CA & OR (Excluding the 12-County Klamath Area)	33.0%	33.9%	16.4%	6.8%	5.7%	4.2%
Rest of the U.S. (Excluding CA & OR)	23.4%	36.2%	19.3%	8.5%	6.8%	5.8%

[1] Pearson Design-based chi-squared test of association across strata (< .05 indicates strong likelihood of strata-level statistical association).

Beyond general Federal government involvement in restoration, the survey asked respondents to vote on whether they would support an Action plan for restoration of Klamath Basin resources or would instead support No Action. The No Action plan scenario provided in the survey was the same for all respondents. Multiple Action plan scenarios were developed. All Action plans contained the three main elements of the KHSA and KBRA: dam removal, the water-sharing agreement, and fish restoration projects. Attributes of the Action plan scenarios that varied included the cost of the plan to the household, the percent increase in Chinook salmon and steelhead trout abundance, and the extinction risk for the shortnose and Lost River suckers and the coho salmon. Each respondent was randomly assigned one of the Action plan scenarios.

Table 4.4.1-9 shows the percent of respondents who voted for the Action and No Action plans by geographic stratum and in total. The table reports the total voting for any Action plan scenario, independent of the attribute levels. Roughly 55 percent, 71 percent, and 66 percent of the respondents from the 12-County Klamath Area sample, rest of Oregon and California sample, and the rest of the U.S. sample, respectively, voted in favor of an Action plan scenario.

Table 4.4.1-9: Vote on Action Plan Scenarios, by Sample Area

Vote on Action Plan (p = 0.000)[1]	12-County Klamath Area	Rest CA & OR (Excluding the 12-County Klamath Area)	Rest of the US (Excluding CA & OR)
Voted for No Action	45.3% (680)	28.7% (491)	33.7% (575)
Voted for Action plan	54.7% (820)	71.3% (1,220)	66.3% (1,130)
Total	1,500	1,711	1,705

[1] Pearson Design-based chi-squared test of association across strata (< .05 indicates strong likelihood of strata-level statistical association).

A majority of respondents in each region supported an Action plan over No Action to restore the Klamath Basin. As expected, the percent of respondents voting for an Action plan decreased as the household cost of the plan increased. However, even at the highest cost, 55.3 percent of the respondents for all geographic areas combined still voted in favor of an Action plan (see Table 4.4.1-10).

Table 4.4.1-10: Vote by Annual Cost of Plan to Household

	$12	$48	$90	$168
Voted for Action plan	72.9%	65.9%	65.9%	55.3%

After the respondents voted for either an Action or No Action plan, the survey presented them with a series of statements related to their choices between the Action and No Action plans. Fewer than 30 percent of respondents in any region either agreed or strongly agreed with the statement that their answers would have been different if the economy were better (see Table 4.4.1-11). Significantly fewer than half of the respondents in each region agreed or strongly agreed with a statement that they should not have to contribute to the restoration of the Klamath Basin. When asked about the statement that removing the dams from the Klamath River is a bad idea, approximately 42 percent of respondents in the 12-County Klamath Area sample agreed or strongly agree compared to roughly 20 percent each for the rest of Oregon and California and rest of the United States samples. Around 40 percent of respondents in the 12-County Klamath Area agreed or strongly agreed with the statement that they are concerned the plan would hurt the economy of the Klamath Basin, while 25 percent and 22 percent of respondents in the rest of Oregon and California and rest of the United States samples, respectively, agree or strongly agreed with this statement. In terms of the amount of information provided to make a choice, at least 67 percent of respondents in each sample agree or strongly agreed that the survey provided enough information to make a choice between the Action versus No Action plan options.

Table 4.4.1-11: Extent of Respondents' Agreement with Statements Regarding the Survey and the Choices Provided in the Survey

	My choices would have been different if the economy in my area were better				
(p = 0.001)[1]	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
12-County Klamath Area	8.9%	16.0%	28.0%	29.1%	18.0%
Rest of CA & OR (Excluding the 12-County Klamath Area)	8.9%	19.7%	27.8%	29.0%	14.6%
Rest of the U.S. (Excluding CA & OR)	10.1%	19.4%	31.8%	27.5%	11.3%
	I do not think I should have to contribute to the restoration of the Klamath Basin				
(p = 0.000)[1]	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
12-County Klamath Area	15.9%	17.9%	27.5%	29.2%	9.5%
Rest of CA & OR (Excluding the 12-County Klamath Area)	7.4%	16.4%	29.5%	35.5%	11.1%
Rest of the U.S. (Excluding CA & OR)	11.9%	22.3%	33.2%	25.9%	6.8%
	Removing the dams from the Klamath River is a bad idea				
(p = 0.000)[1]	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
12-County Klamath Area	22.5%	19.4%	20.1%	22.0%	16.1%
Rest of CA & OR (Excluding the 12-County Klamath Area)	5.8%	13.8%	30.7%	34.3%	15.4%
Rest of the U.S. (Excluding CA & OR)	6.5%	13.9%	35.7%	31.6%	12.3%
	I am concerned that the plans would hurt the economy in the Klamath Basin				
(p = 0.000)[1]	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
12-County Klamath Area	14.1%	25.9%	32.3%	21.4%	6.3%
Rest of CA & OR (Excluding the 12-County Klamath Area)	2.8%	22.3%	44.0%	25.4%	5.6%
Rest of the U.S. (Excluding CA & OR)	3.5%	18.4%	43.0%	30.1%	5.0%
	The survey provided me with enough information to make a choice between the options shown				
(p = 0.066)	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
12-County Klamath Area	18.0%	52.4%	17.5%	9.6%	2.5%
Rest of CA & OR (Excluding the 12-County Klamath Area)	15.4%	51.4%	21.8%	8.7%	2.6%
Rest of the U.S. (Excluding CA & OR)	14.9%	56.1%	18.5%	8.7%	1.8%

[1] Pearson Design-based chi-squared test of association across strata (< .05 indicates strong likelihood of strata-level statistical association).

Table 4.4.1-12 contains two sets of estimates of economic value expressed as household willingness to pay (WTP). The first set of values reflects the average household WTP to have a "minimal" Action plan implemented. This Action plan is defined as a 30 percent increase in Chinook salmon and steelhead trout returning to the river each year, sucker extinction rates declining from very high to high, and coho extinction rates declining from high to moderate, along with the three common elements associated with all Action plans: dam removal, the water-sharing agreement, and fish restoration projects. This Action plan was compared to the No Action plan (no increase in fish returning to the river, very high extinction rate for the suckers and a high extinction rate for the coho salmon, along with no dam removal, no water-sharing agreement, and no fish restoration projects).

The second set of values reflects the average household WTP associated solely with reducing the extinction risk of coho salmon from high to moderate. Generally speaking, it was not possible, given the survey design, to divide household WTP for the minimal Action plan into separate use and nonuse components or to determine how much each component of the minimal Action plan contributes to household WTP for the entire Action plan. However, the survey design did allow estimation of WTP for improvements in coho extinction risk separately from other components of the Action plan.[5] These values are presented to provide additional context by isolating household WTP for one component of the minimal Action plan that would be associated purely with nonuse value. Although the extinction risk for coho salmon would improve, such improvement would not lead to delisting. This indicates there would be very little possibility of any use values (e.g., recreational fishing) associated with this species in the foreseeable future under the minimal Action plan. As such, this value can be viewed as a conservative estimate of nonuse value because it does not also include any nonuse values associated with the other components of the minimal Action plan.

Table 4.4.1-12: Average Household Annual WTP Values with 95% Confidence Interval[1] ($)

Plan	12-County Klamath Area	Rest CA & OR (Excluding the 12-County Klamath Area)	Rest of the US (Excluding CA & OR)
Annual WTP per household for 20 years for "minimal" Action plan relative to No Action plan[2]	$121.85 ($79.09 - $164.61)	$213.03 ($160.9 - $265.15)	$213.43 ($155.7 - $271.16)
PV over 20 years of annual Household WTP for "minimal" Action plan relative to No Action plan	$1,637.76 ($1,063.06 - $2,212.54)	$2,863.30 ($2,162.68 - $3,563.92)	$2,868.72 ($2,092.78 - $3,644.70)
Annual WTP per household for 20 years for reduced extinction risk for coho salmon from high to moderate	$37.75 ($8.93 - $66.58)	$49.10 ($15.1 - $83.09)	$38.39 ($0.12 - $76.66)
PV over 20 years of annual household WTP for reduced extinction risk for coho salmon from high to moderate	$507.44 ($120.03 - $894.91)	$659.91 ($202.96 – 1,116.82)	$515.98 ($1.61 - $1,030.40)

WTP: Willingness to Pay
PV: Present Value
[1] The table presents results for a "restricted sample" that was created by dropping respondents who strongly agreed that the Klamath Basin should be restored no matter what it cost. These respondents may not have been assessing the trade-off between the Action plan and the No Action plan. The standard errors and confidence intervals for these value estimates were estimated using the Krinsky and Robb (1986) simulation method.
[2] The Action plan attributes include a 30 percent increase in Chinook salmon and steelhead trout returning to the river each year, high extinction rates for the suckers, and moderate extinction rates for the coho salmon. The No Action plan attributes are no increase in number of fish returning to the river, very high extinction rate for the suckers, and a high extinction rate for the coho salmon.

The estimated average per household annual WTP value associated with the minimal Action plan for the 12-County Klamath Area is about $122 per year, compared to about $213 and $214, respectively, for the rest of Oregon and California and the rest of the United States samples. The WTP values in the 12-County Klamath Area are lower than the other two geographic areas, reflecting the larger percentage of respondents in that stratum who voted for the No Action plan.

[5] The survey design also allowed estimation of WTP separately for improvements in extinction risk for suckers; however, the parameter estimates associated with this aspect of the minimal Action plan were generally not statistically significant in the empirical models.

The household WTP values estimated from the survey are comparable to other similar studies, although the values are on the high end of the studies.[6] However, the WTP values need to be interpreted with a clear understanding of the scope of the benefits described in the survey. Each of the Action plans involved removing the dams, establishing water sharing agreements, and improving fish habitat. While the survey varied the size of the improvements to the three fish species in different versions of the Action plans, it is important to note that the plans included impacts beyond just improvements for the fish. The survey described significant problems during droughts in the early 2000's and also described how most of the parties reached an agreement in 2010. As such, the values estimated from this survey reflect a large scope of potential benefits, thus making it difficult to directly compare these results to other surveys that focused more narrowly on improvements for individual fish species or water quality.

Table 4.4.1-13 presents the aggregated discounted present value (PV) WTP estimates. These estimates were derived by applying the PV WTP per household values from Table 4.4.1-12 to the relevant household population in each geographic stratum after accounting for nonrespondents, "yea saying", and non-English speaking households.[7] The total discounted PV of WTP across the three strata is $84.271 billion. The 12-County Klamath Area WTP comprises $217 million of the total; the rest of Oregon and California comprises $9.071 billion, and the rest of the U.S. comprises $74.983 billion. It should be noted that the aggregate WTP estimates in the left hand column of Table 4.4.1-13 represent total economic value, in that they include nonuse values as well as use values.

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[6] RTI International, Final Report, *Klamath River Basin Restoration Nonuse Value Survey*, November 18, 2011 contains a discussion of other studies. No studies to date have used SP methods to estimate total household values (including nonuse values) for the environmental benefits expected to result from the Klamath agreements; however, a limited number of studies have used these methods to investigate values for related programs in other parts of the U.S. Although a number of other economic valuation studies have addressed dam removal activities in the U.S., most of them have applied RP methods and focused on use-related values. The values estimated in other previous studies are not directly comparable to this study because the context of other studies is different, the extent of the market is different, and different time periods were considered. The one study that is most directly comparable to this Klamath study is the Loomis (1996) analysis of dam removal and salmon restoration on the Elwha River in Washington. The scope of the project and affected area are smaller than the Klamath dam removal; however, the Elwha study also estimates annual household WTP for three separate strata. It estimates average values ranging from $87 per year for the local population to $107 for the rest of the state and $100 for the rest of the country (converted to 2010 dollars). The other studies, which examine a wide variety of dam removal and/or river ecosystem restoration projects, produce annual estimates that range from less than $20 to almost $600 per year.

[7] To account for potential effects of survey nonrespondents, a conservative approach was taken that aggregated household WTP over a portion of households equal to the proportion of the sample that returned the survey, based on the response rate for each geographic sample, and also accounting for respondents who skipped the SP choice questions and those who were dropped when adjusting for potential "yea saying". "Yea saying" respondents were identified as those who strongly agreed that the Klamath Basin should be restored no matter what it cost. These respondents may not have been assessing the trade-off between the Action plan and the No Action plan. The calculation of aggregate WTP also excludes non-English speaking households because the survey was in English and non-English speaking households may not have completed the survey.

Table 4.4.1-13: Aggregate Present Value of Household WTP Over 20 Years, with 95% Confidence Interval, ($ billions)

	Present Value of Household Annual WTP for "Minimal" Action Plan Relative to No Action, Aggregated over Households, for 20 years ($ billions)	Present Value of Household Annual WTP for Reducing the Extinction Risk for Coho Salmon from High to Moderate, Aggregated over Households, for 20 years ($ billions)
12-County Klamath Area	$0.217 ($0.141–$0.293)	$0.067 ($0.016–$0.119)
Rest of CA & OR (Excluding the 12-County Klamath Area)	$9.071 ($6.851–$11.290)	$2.091 ($0.643–$3.538)
Rest of the U.S. (Excluding CA & OR)	$74.983 ($54.701–$95.265)	$13.487 ($0.042–$26.933)
Total	$84.271 ($61.694–$106.850)	$15.645 ($0.701–$30.589)

The aggregate discounted PV WTP estimates presented in Table 4.4.1-13 indicate that respondents support and see significant value in the restoration of Klamath Basin resources, even for resources not supporting any of the many direct use activities within the Klamath Basin.

A conservative estimate of nonuse value is given by the values in the right hand column of Table 4.4.1-13 that represents the present value of aggregate household WTP for solely reducing the extinction risk for coho salmon from high to moderate. For all three strata combined, the total discounted PV of WTP is $15.6 billion. The 12-County Klamath Area WTP comprises $67 million of the total; the rest of Oregon and California comprises $2.091 billion, and the rest of the U.S. comprises $13.487 billion. It should be noted that these aggregate WTP estimates represent a conservative estimate of nonuse values in that they do not also include any nonuse values associated with the other components of the minimal Action plan.

Cost Analyses

This section summarizes analyses contained in *Economics and Tribal Summary Technical Report* (Reclamation 2012b).

Project Costs:

Project costs include KBRA restoration costs, facility removal costs, site mitigation costs, and operations, maintenance, and replacement (OM&R) costs.

KBRA Restoration

Annual KBRA costs from 2012 through 2026 were obtained from the KBRA (February 18, 2010), Appendix C-2 Revised, Budget of Implementation of Agreement. Because these costs were presented in 2007 dollars, they were escalated to 2012 dollars using the gross domestic product implicit price deflator to be consistent with the other costs and benefits included in this report.

Table 4.4.1-14 summarizes KBRA costs by year. It is assumed that KBRA cost components incurred under the dams in scenario would be covered by agency base funding. The full and partial facilities removal options include KBRA costs that are in addition to base funds assumed for the dams in scenario. Partial facilities removal would have the same costs as full facilities removal for KBRA implementation.

Table 4.4.1-14: Agency Base Funding and KBRA Program Costs (Million $, 2012 dollars)

Year	Base Funding Total Costs	KBRA Program Total Costs	KBRA Program Costs Incremental to Base Funding
2012	15.862	25.2	9.4
2013	15.410	66.1	50.7
2014	15.396	65.1	49.7
2015	19.003	62.0	43.0
2016	20.195	66.7	46.5
2017	20.101	66.7	46.6
2018	20.447	84.1	63.6
2019	20.573	113.1	92.5
2020	20.773	101.6	80.8
2021	16.439	46.9	30.5
2022	14.853	37.0	22.1
2023	14.853	34.2	19.4
2024	14.853	32.6	17.8
2025	14.853	30.6	15.7
2026	14.853	28.5	13.6
Total	**258.466**	**860.4**	**601.9**
Discounted	**199.101**		**474.1**

Source: Reclamation 2012b

Four Facilities Removal and Site Mitigation

Four Facilities removal costs, which would occur during the single year, deconstruction period for each facility removal option (year 2020), include field costs related to construction contracts and noncontract costs related to engineering design, permitting, and construction management. Four Facility removal costs include removal of J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams and replacement of the Yreka water supply line.

Tables 4.4.1-15 and 4.4.1-16 show facilities removal and total mitigation costs for full and partial facilities removal, respectively. Cost estimates for facility removal, which would occur in year 2020, totaled $178.4 million (2012 dollars). For use in the NED BCA, the full facilities removal cost estimate ($178.4 million) was discounted to year 2012, resulting in an estimate of $129.1 million. Cost estimates for partial facilities removal totaled $135.4 million (2012 dollars). For use in the NED BCA, the partial removal cost estimate ($135.4 million) was discounted to year 2012, resulting in an estimate of $98.0 million.

Site mitigation costs represent the costs to mitigate effects on environmental and cultural resources. Estimated mitigation costs for both full and partial facilities removal are expected to occur during an eight-year period (2018–2025). The eight-year stream of mitigation costs for full facilities removal was discounted to year 2012, resulting in an estimate of $37.7 million. For partial facilities removal, the eight-year stream of mitigation costs was discounted to year 2012, resulting in an estimate of $36.6 million. These discounted values were used in the NED BCA calculation.

Table 4.4.1-15: Full Facilities Removal and Total Site Mitigation Costs for Full Facilities Removal (2012 dollars)[1]

Cost Element	J.C. Boyle ($M)	Copco 1 ($M)	Copco 2 ($M)	Iron Gate ($M)	Yreka Water Supply ($M)	Total ($M)
Facility removal	36.0	65.0	15.0	59.0	3.4	178.4
Mitigation	10.5	18.9	4.3	17.2	1.0	51.9
Facility removal and mitigation	46.5	83.9	19.3	76.2	4.4	230.3
Facility removal and mitigation (2020 $)	59.0	105.0	24.0	98.0	5.6	291.6

Source: Reclamation 2012b
[1] Except where indicated.

Table 4.4.1-16: Partial Facilities Removal and Total Site Mitigation Costs for Partial Facilities Removal (2012 dollars)[1]

Cost Element	J.C. Boyle ($M)	Copco 1 ($M)	Copco 2 ($M)	Iron Gate ($M)	Yreka Water Supply ($M)	Total ($M)
Facility removal	24.0	46.0	7.0	55.0	3.4	135.4
Mitigation	9.0	17.1	2.6	20.7	1.0	50.4
Facility removal and mitigation	33.0	63.1	9.6	75.7	4.4	185.8
Facility removal and mitigation (2020 $)	41.0	79.0	12.0	97.0	5.6	234.6

Source: Reclamation 2012b
[1] Except where indicated.

Operation, Maintenance, and Replacement

The OM&R costs would occur every year under the dams in scenario. These costs were estimated to average $9.34 million and range from a high of $31.98 million to a low of $4.37 million. The discounted stream of annual OM&R costs across the 2012–2061 period equates to $219.4 million. Because certain OM&R costs would no longer be incurred under the proposed facilities removal options, the eliminated OM&R costs would reflect a cost savings. The average annual OM&R cost savings during 2021-2061 associated with both dam removal options was estimated at $8.64 million (discounted value equals $188.9 million). Under the partial facility removal option, an additional cost associated with maintaining the facilities left in place would be required. The stream of remaining facility maintenance costs during 2021–2061 discounts to $6.5 million. Combining the discounted cost savings ($188.9 million) with the additional discounted maintenance costs ($6.5 million) results in an estimated discounted cost savings of $182.4 million for the partial facilities removal option.

Table 4.4.1-17 summarizes OM&R cost saving for full and partial facilities removal relative to the dams in scenario.

Table 4.4.1-17: Average Annual and Total Discounted Value OM&R Costs (Million $, 2012 dollars)

	Dams In Costs	Full Facilities Removal Cost Savings Relative to Dams In	Cost Savings Relative to Dams In	Partial Facilities Additional Cost for Remaining Facilities	Net OM&R Cost Savings
Average Annual	9.34	-8.64	-8.64	not available	not available
Discounted Value	219.4	-188.9	-188.9	6.5	-182.4

Source: Reclamation 2012b

Foregone Benefits:

Several benefit categories (hydropower, reservoir recreation, and whitewater recreation) result in foregone benefits because dam removal would provide fewer benefits than the dams in scenario. These foregone benefit categories are presented as project costs.

Hydropower

This section is from *Economics and Tribal Summary Technical Report* (Reclamation 2012b) and the *Hydropower Benefits Technical Report* (Reclamation 2012c). These reports discuss methods to evaluate effects and results in detail.

The four Klamath hydropower plants generate an average of 895,846.9 megawatt hours (MWh) of electricity annually. Dependable capacity, a measure of the maximum generation capability available on a reliable basis, was estimated to be 55.9 megawatts (MW) in summer and 66.6 MW in winter, using the 90 percent exceedence method. The output from these four plants was estimated to have a mean discounted present value of $1,609.3 million (2012 dollars) over the 50-year analysis period (Reclamation 2012c).

Under the dams out scenario, the four Klamath hydropower plants were expected to operate normally during 2012–2019 (8 years). The analysis assumed that production of electrical energy and capacity at the four hydropower plants was expected to be zero from January 1, 2020 through the end of 2061 (42 years). With dam removal, the estimated mean discounted present value of hydropower economic benefits was approximately $289.2 million (2012 dollars), over the 50-year analysis period. Relative to the dams remaining in place, this represents a mean reduction in economic benefits of $1,320.1 million (2012 dollars)—a loss of approximately 82 percent. Partial facilities removal would have the same effects as full facilities removal (see Table 4.4.1-18).

Table 4.4.1-18: Total Discounted Value of Forgone Hydropower Economic Benefits of Dams In Relative to Dam Removal (Million $, 2012 Dollars)

	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Total Discounted Value	1,609.3	289.2	-1,320.1

Source: Reclamation 2012b

Whitewater Boating

This section is from Reclamation 2012b and the *Whitewater Boating Recreation Economics Technical Report* (DOI 2012b). These reports provide further explanation regarding how the economic effects on whitewater boating were evaluated and provide additional detail on the overall results.

Whitewater boating occurs on the upper Klamath River, defined as Link Dam to Iron Gate Dam, and on the lower Klamath River, defined as Iron Gate Dam to the Pacific Ocean. Whitewater boating on the upper Klamath River, which primarily occurs on the Hell's Corner Reach, is dependent upon releases made from the J.C. Boyle Dam; therefore, the loss of the J.C. Boyle Dam could decrease the potential for whitewater boating.

Under the dams in scenario, whitewater boating activity would not be affected. Under the dams out scenario, whitewater boating activity on the upper Klamath River would be affected beginning in 2020 due to the dependence on water releases from the J.C. Boyle Dam to provide sufficient and predictable flows, primarily for whitewater boating along the Hell's Corner Reach. Analysis of predicted hydrology modeling shows that the average number of days with acceptable flows for primarily commercial whitewater boating on the Hell's Corner Reach would decline by 47.3 percent during the five month period from May through September (months when the majority of whitewater boating activity occurs annually) and decline by 29.5, 36.4, and 88.2 percent in June, July and August, respectively, relative to the dams in scenario. In terms of private whitewater boating use on the Hell's Corner Reach, the predicted hydrology modeling shows that the average number days with acceptable flows are estimated to decline by 35.6 percent during the five month period from May through September and decline by 16.1, 49.4, and 57.8 percent in June, July and August, respectively, relative to the dam in scenario. The combination of the decline in the number of days with acceptable flows, particularly during the three months when most of the use is observed (June, July, and August), and the lack of consistency and predictability of days with acceptable flows could make it more challenging for outfitters to continue offering trips for this reach of the upper Klamath River in the future, and to a lesser extent also make it more challenging for private users to engage in whitewater boating activities. Therefore, it is assumed whitewater boating activity on the upper Klamath River would be negatively affected by facilities removal. Analysis of the predicted hydrology for the Klamath River under the dams in and dams out scenarios shows the average number of days with acceptable flows for whitewater boating on the lower Klamath River would not change in any measurable way.

Therefore, it is assumed that the level of whitewater boating on the lower Klamath River would not be affected.

Whitewater boating use for the entire Klamath River projected for the period of analysis (2012–2061) is estimated to be 868,211 to 1,012,362 user-days. The total discounted present value of whitewater boating on the Klamath River is estimated to range from $29.8 to $35.6 million under the dams in scenario, with a midpoint estimate of $32.7 million. The total discounted present value of the loss in economic value associated with whitewater boating recreation under dams out, measured as a change from dams in, is estimated to be $5.3 to $6.8 million, with an associated loss of 99,674 to 127,659 user days. The midpoint estimate of $6.0 million for the total discounted present value loss in economic value for whitewater boating was used in the NED BCA. Partial facilities removal would have the same effects as full facilities removal (see Table 4.4.1-19).

Table 4.4.1-19: Total Discounted Value of Forgone Whitewater Boating Benefits of Dams Removal Relative to Dams In (Million $, 2012 dollars)

	Dams In	Dam Removal	Difference between Dam Removal and Dams In
Total Discounted Value	32.7	26.7	-6.0

Source: Reclamation 2012b

Reservoir Recreation

This section is from *Economics and Tribal Summary Technical Report* (Reclamation 2012b) and the *Reservoir Recreation Economics Technical Report* (Reclamation 2012f). These reports discuss methods to evaluate effects and results in detail. Changes in recreation visitation at each reservoir for the dams out compared to dams in scenarios were adjusted to account for possible site substitution. Visitors from outside the market area were assumed not to substitute. Conversely, only a small portion of within-market-area visitors was assumed not to substitute. The non-substituting portion was based on visitors who identified each reservoir as their favorite site.

Total visitation in year 2002 (year of the PacifiCorp recreation survey) (FERC 2007) at the three reservoirs (J.C. Boyle, Copco 1, and Iron Gate) was estimated in the PacifiCorp recreation report at 95,470 recreation days. Projections based on PacifiCorp's annual activity-specific growth rates results in an estimated 112,900 days in 2020 and 167,500 days in 2061 across the three reservoirs (no recreation occurs in Copco 2 Reservoir). Aggregating visitation across all three reservoirs for 2020–2061 totals over 5.8 million recreation days. With the dams in scenario, the total discounted reservoir recreation economic value for the three reservoirs is estimated to be $99.5 million.

A significant blue-green algae problem exists at Copco 1 and Iron Gate reservoirs (but not J.C. Boyle Reservoir), sufficient to warrant health advisories related to water ingestion or contact. These advisories suggest avoiding use of water for cooking and washing as well as avoiding the consumption of fish. While these advisories have been in place for several years, no data exist as to their impact on recreation visitation. Should these algae problems continue across the 50-year period of analysis for this study, a significant percentage of visitations at Copco 1 and Iron Gate reservoirs may be lost. This could significantly reduce the baseline level of recreation visitation and value with the dams remaining in place. However, the algae problem is unlikely to expand into J.C. Boyle Reservoir due to the manner in which water flushes through the reservoir. At this point, the impact of the blue-green algae problem on visitation is unknown, so attempting to provide algae adjusted visitation estimates is speculative.

Under the dam removal scenario, the reservoirs would be lost. As a result, pursuing facilities removal would imply a loss in reservoir recreation visitation and value as compared to the dams remaining in place.

Adjusting for site substitution, whereby a significant portion of potentially lost Copco 1, Iron Gate, and J.C. Boyle reservoir recreation visitations would substitute to other lakes and reservoirs in the area (for further discussion on substitution see *Reservoir Recreation Economics Technical Report* [Reclamation 2012f]), total reservoir recreation losses for the dam removal scenario, measured as a change from the dams remaining in place, were estimated at 2.03 million recreation days and $35.4 million in discounted economic value. Partial facilities removal would have the same effects as full facilities removal.

Tribal Fisheries and Related Effects

This section focuses on changes in tribal fishing opportunities and how they affect tribal members' standard of living, cultural and social practices, and ability to carry out resource stewardship responsibilities. The analysis focuses on five of the six Federally recognized tribes in the Klamath Basin (Klamath Tribes, Karuk Tribe, Yurok Tribe, Resighini Rancheria, Hoopa Valley Tribe). Based on information available at the time of this analysis, the sixth tribe, the Quartz Valley Indian Community, was not expected to be directly affected by the dams out scenario. Information in this section is from the *Economics and Tribal Summary Technical Report* (Reclamation 2012b), *Hoopa Valley Tribe Fishery Socioeconomics Technical Report* (NOAA Fisheries Service 2012b), *Karuk Tribe Fishery Socioeconomics Technical Report* (NOAA Fisheries Service 2012d), *Klamath Tribes Fishery Socioeconomics Technical Report* (NOAA Fisheries Service 2012e), *Resighini Rancheria Fishery Socioeconomics Technical Report* (NOAA Fisheries Service 2012g), and *Yurok Tribe Fishery Socioeconomics Technical Report* (NOAA Fisheries Service 2012h).

For the tribes of the Klamath Basin, fish are integral to a worldview that emphasizes interconnectedness, balance, and mutual respect as guiding principles. The diversity, abundance, distribution, run timing and health of fish are important indicators of how well such balance is being maintained. The seasonal round of harvest provides sustained access to food that is synchronous with the cycles of nature. Fish are honored in rituals such as the First Salmon Ceremony and (for the Klamath Tribes) the Return of the C'waam, which traditionally precede the commencement of fishing for spring Chinook and suckers respectively. Fishing itself is a social and cultural activity – an opportunity to meet with family and friends; to engage in traditional fishing practices; to strengthen community bonds, demonstrate respect and promote food security by sharing fish with elders and others who are unable to fish; and to transmit these traditions to the next generation. Trade and barter occur both within and between tribes as a means of increasing access to fish and other valued goods, and cementing social relationships.

While fish has been central to the daily life and culture of the tribes, access to fish has declined due to reductions in abundance and distribution and loss of access to traditional fishing sites. These changes have affected the tribes' dietary habits and well-being, as well as their cultural, ritualistic and social lives. Despite these challenges, the tribes have been persistent in ensuring continuation of practices and values that have been a part of their worldview for many centuries.

Sedimentation and water quality changes associated with dam removal may have adverse short-term effects on fish stocks that inhabit areas downstream of the dams. Over the longer term, dam removal and successful implementation of the KBRA are expected to increase tribal harvest opportunities on the Klamath River. These actions, however, are not expected to affect the productivity of Hupa fisheries (which depend on Trinity River stocks).

Effects of dam removal on Klamath Basin stocks (excluding the Trinity River) can be summarized as follows:

- Steelhead is expected to increase in abundance and extend its distribution to areas currently under the reservoirs and upstream to Keno Dam; expansion upstream of Keno Dam is possible but not certain (Dunn et al. 2011).
- Redband trout is expected to increase in abundance and distribution in Upper Klamath Lake and its tributaries and also downstream of Keno Dam (Buchanan et al. 2011).
- Pacific lamprey harvest potential downstream of Keno Dam is expected to increase from one to ten percent over the long term due to habitat improvement and recolonization of the reach between Iron Gate Dam and Keno Dam. Harvest potential upstream of Keno Dam is possible but more uncertain (Close et al. 2010).
- Sucker populations in the Upper Klamath Basin are expected to increase over the long term, although anything more than tribal ceremonial harvest would be unlikely until a sustained upward trend in the population is observed (Buchanan et al. 2011).
- The SONCC coho ESU is listed as "threatened" under the ESA. This ESU is comprised of coho populations both inside and outside the Klamath Basin (Williams et al. 2008). Dam removal is expected to lead to an increase in the viability of Klamath River coho populations and advance the recovery of the ESU (Dunne et al. 2011). However, since dam removal does not include coho restoration outside the Klamath Basin, it alone would not create

conditions that would warrant de-listing of the SONCC coho ESU throughout its range.

- Tribal harvest of spring- and fall-run Chinook salmon on the Klamath River is expected to increase by 50 percent (Hendrix 2011) on an average annual basis (from 31,127 fish to 46,682 fish) during 2012–61 with facilities removal. This projection is subject to considerable uncertainty due to natural biological and environmental variability and other factors. Despite this uncertainty, tribal harvest is projected to be higher in 74 percent of years with facilities removal, as compared with no facilities removal. In 2006, unusually low Klamath fall-run Chinook salmon abundance triggered major regulatory restrictions for all Chinook salmon fisheries (including tribal fisheries). Such conditions are projected to occur in 80 percent fewer years under facilities removal.

- Fall-run Chinook salmon (which has a sizable hatchery component) currently comprises a much larger share of tribal harvest than spring-run Chinook salmon, which is at low levels of abundance. This stock composition is likely to persist in the future under the dams in scenario. A modest harvestable surplus of spring Chinook may become available under dams out (Goodman et al. 2011, Hamilton et al. 2011, Lindley and Davis 2011). This harvest opportunity would be beneficial to tribal fisheries, as spring-run Chinook salmon are highly desirable for their fat content and have the potential to temporally expand tribal harvest opportunities beyond the current season.

Table 4.4.1-20 summarizes species-specific effects on tribal fisheries by geographic area, as follows: upper basin (Klamath Tribes), middle and lower basin excluding the Trinity River (Karuk Tribe, Yurok Tribe, Resighini Rancheria), and Trinity River (Hoopa Valley Tribe). Positive effects of any given species on the fisheries of any given tribe are relative to that tribe's recent harvest opportunities and are not necessarily equal among tribes.

Table 4.4.1-20: Effects of Dam Removal and KBRA on Tribal Harvest Opportunities, by Geographic Area

Species	Dams In	Difference between Dam Removal and Dams In
Upper Klamath Basin (Klamath Tribes):		
• Chinook salmon	No access to spring- or fall-run Chinook salmon	Return of salmon to upper basin would be first time in almost a century. Interim fishing site downstream of Iron Gate Dam would provide first Chinook salmon harvest opportunity in almost a century
• Coho	ESA-listed, no access	Improved viability of Klamath Basin coho but no change in listing status
• Sucker (mullet)	ESA listed, ceremonial only, no subsistence use since 1986	Continued ceremonial use, potential long-term subsistence use
• Redband trout	Some subsistence	Increase in abundance and distribution, greater subsistence opportunity
• Steelhead	No access	Re-introduction to upper basin
Mainstem Klamath River - Middle and Lower Klamath Basin (Karuk Tribe, Yurok Tribe, Resighini Rancheria):		
• Chinook salmon	Very low abundance of spring-run Chinook salmon, moderate abundance of fall-run Chinook salmon	Potential adverse short-term effect due to sedimentation associated with dam removal Approximate 50 percent increase in spring- and fall-run Chinook salmon after dam removal Spring-run Chinook salmon particularly valued for high fat content and potential to extend salmon season
• Coho	ESA-listed	Improved viability of Klamath Basin coho but no change in listing status
• Steelhead	Stable/declining abundance	Potential adverse short-term effect due to sedimentation associated with dam removal Increased abundance and distribution after dam removal
• Pacific lamprey	Very low abundance	One to ten percent increase in harvest potential
• Sturgeon	Very low abundance	Limited documentation of potential effects
• Eulachon	ESA-listed	Limited documentation of potential effects
Trinity River (Hoopa Valley Tribe):		
• Chinook salmon	Very low abundance of spring-run Chinook salmon, moderate abundance of fall-run Chinook salmon	Potential for modest adverse short-term effect due to sedimentation associated with dam removal No change in productivity of Trinity River salmon Potential reduction in incidence of fish kills downstream of confluence with Trinity
• Coho	ESA-listed	Improved viability of Klamath Basin coho but no change in listing status
• Steelhead	Stable/declining abundance	Potential for modest adverse short-term effect due to sedimentation associated with dam removal No change in productivity of Trinity River steelhead Potential reduction in incidence of fish kills downstream of confluence with Trinity
• Pacific lamprey	Very low abundance	Little, if any long-term change
• Sturgeon	Very low abundance	No change
• Eulachon	ESA-listed	No change

Table 4.4.1-21 describes how changes in subsistence harvest opportunities (as described in Table 4.4.1-20) and KBRA funding would affect tribal members' standard of living, cultural and social practices, and ability to carry out stewardship responsibilities. As indicated earlier, the return of even modest numbers of spring-run Chinook salmon under the dams out scenario would provide opportunity for revival of the First Salmon Ceremony; improvement in the status of sucker populations would enhance the significance of the First C'waam Ceremony for the Klamath Tribes. Effects of dam removal on these and other ceremonial and cultural practices are discussed more expansively in the context of all aquatic resources in Section 4.4.2, *Tribal*.

Table 4.4.1-21: Effects of Dam Removal and KBRA on Standard of Living and Engagement in Resource Stewardship, by Tribe

Indicator	Dams In	Difference between Dam Removal and Dams In
Klamath Tribes:		
Standard of living	Employment provided by Klamath Tribes' Natural Resources Department supports standard of living	Increased employment and income opportunities associated with funding for fisheries and conservation management, economic development study and Mazama Forest Project (KBRA Sections 32.2, 33.1, 33.2, 34)
	Subsistence fishery for redband trout provides modest contribution to standard of living	Increased subsistence fishing opportunities would expand opportunities for trade and barter and enhance food security for tribal members (particularly important for elders)
Engagement in resource stewardship, monitoring and management	Active engagement in data collection, research, and management pertaining to aquatic resources, wildlife, and habitat	Engagement would be expanded and supported by new funding for fisheries and conservation management (KBRA section 32.2)
Land base/ fishing access sites	Limited Tribal land ownership	Mazama Forest Project (KBRA Section 33.2) would increase access to traditional lands and expand opportunities to exercise fishing rights and engage in traditional cultural practices
Karuk Tribe:		
Standard of living	Employment provided by Karuk Tribe's Natural Resources Department	Increased employment and income opportunities associated with funding for fisheries and conservation management and economic development study (KBRA Sections 32.2, 33.1, 33.2)
	Existing subsistence fisheries contribute modestly to standard of living	Increased subsistence fishing opportunities would expand opportunities for trade and barter and enhance food security for tribal members (particularly important for elders)
Engagement in resource stewardship, monitoring and management	Active engagement in data collection, research and management pertaining to fish and wildlife, water quality, and habitat	Engagement would be expanded and supported by new funding for fisheries and conservation management (KBRA section 32.2)

Table 4.4.1-21: Effects of Dam Removal and KBRA on Standard of Living and Engagement in Resource Stewardship, by Tribe

Indicator	Dams In	Difference between Dam Removal and Dams In
Yurok Tribe:		
Standard of living	Employment provided by Yurok Tribal Fisheries Program and participation of tribal members in commercial and guide fisheries	Increased employment and income opportunities associated with funding for fisheries and conservation management and economic development study (KBRA Sections 32.2, 33.1, 33.2) Increased harvest opportunities would provide additional employment and income for commercial and guide fisheries
	Existing subsistence fishery contributes modestly to standard of living	Increased subsistence fishing opportunities would expand opportunities for trade and barter and enhance food security for tribal members (particularly important for elders)
Engagement in resource stewardship, monitoring and management	Active engagement in data collection, research and management pertaining to fish, wildlife, habitat and fisheries	Engagement would be expanded and supported by new funding for fisheries and conservation management (KBRA section 32.2)
Resighini Rancheria:		
Standard of living	Resighini Rancheria's campground contributes modestly to standard of living	Increase in fishing opportunities may modestly increase campground usage
Engagement in resource stewardship, monitoring and management	Active engagement in stewardship of fish, wildlife, habitat and fisheries	Engagement not affected – not KBRA funding recipient
Hoopa Valley Tribe:		
Standard of living	Employment provided by Hoopa Valley Tribal Fisheries Program and participation of tribal members in commercial fishery Existing subsistence fishery contributes modestly to standard of living	Little if any change in Trinity River fishing opportunities
Engagement in resource stewardship, monitoring and management	Active engagement in data collection, research and management pertaining to fish, wildlife, habitat and fisheries	Engagement not affected – not KBRA funding recipient

Benefit-Cost Analysis

The purpose of a NED BCA is to compare a proposed project's benefits to its costs. Total costs are subtracted from the total benefits to obtain net benefits. If the net benefits of a project alternative are positive, then the alternative could be considered economically justified. When multiple mutually exclusive plans are being considered, the alternative with the greatest positive net benefit would be preferred from strictly an economic perspective. Quantified project benefits and costs can also be displayed using a benefit-cost ratio (BCR) where total project benefits are divided by total project costs. A BCR greater than one is analogous to a positive net benefit in terms of economic justification.

However, if all project benefits are not quantified, it may not be possible to determine if an alternative has net benefits or if the BCR exceeds one.

This section provides estimates of those components of benefits and costs that could be readily quantified and monetized. However, it was not possible to quantitatively analyze some important benefit and cost categories.

The economic benefits associated with in-river steelhead fishing, redband trout fishing, and refuge wildlife viewing could not be quantified because sufficient data was not available to quantify these benefits. However, given that dam removal is anticipated to positively affect these activities, the net economic benefits associated with these activities are expected to be positive.

Tribal benefits are also not amenable to quantification, but for reasons other than data availability. Economic values are typically estimated using models that relate individual choice to well-defined goods and services which consumers consider in terms of price, the availability of substitutes, and their ability to pay (income). From a tribal perspective, however, resources such as fish are inseparable from other components of the ecosystem, provide individual values that are indistinguishable from communal values, are viewed as unique and not amenable to substitution at any price, and generate 'demand' that is not related to income. Therefore, models that are typically used to estimate economic values are not applicable to many tribal benefits.

For instance, from a tribal perspective, the sustainability of fisheries is indicative not only of harvest opportunity; it is emblematic of the extent to which the world is 'in balance'. Fisheries are also important for maintaining cultural and social cohesion. Thus subsistence fishing provides not only food but also the opportunity to practice and demonstrate to the younger generation important aspects of tribal culture – including fishing methods, resource stewardship, and the obligation to provide food for the elderly. Tribal ceremonies demonstrate the integral role of fish to tribal identity and honor not only the fish but also the ecosystem of which they are a part.

Even tribal commercial fishing, which provides economic benefits, is more than a commercial enterprise; during the fishing season, tribal members who live on and off the reservation gather in fish camps along the river and renew their social ties. Overall, dam removal would restore, over time, fisheries that have important cultural significance for tribes in the Klamath Basin. However, given the limited ability of standard economic methodologies to capture the expansive and integral value of fish to tribal members, it was not considered appropriate to monetize tribal resource effects. The economic costs associated with ancillary hydropower services, real estate values, and regional powerplant emissions and air quality could not be quantified because sufficient data were not available to quantify costs in these categories. However, given the negative effects dam removal is anticipated to have on these activities, the net economic benefits associated with these activities are generally expected to be negative.

Reservoir real estate values are expected to decline in the short-term due to adverse landscape changes associated with dam removal. This loss in value may be partially offset over the long-term as barren landscape becomes revegetated open space. However some of this loss may be permanent as a shift from reservoir view to no view or from reservoir frontage to river view may make a parcel less desirable. Riverine water quality improvements are likely to have little effect on reservoir parcels, which are generally not expected to become riverfront properties after dam removal. Available data are insufficient to quantify such short- and long-term effects. Riverine parcels in areas downstream of Iron Gate Dam that experience detectable improvements in water quality and/or fish availability may experience positive changes in value. However, available data are insufficient to quantify such effects or to determine whether gains in riverine real estate values would be sufficient to offset the losses in reservoir values (Real Estate Sub-team 2012).

Table 4.1-22 describes all of the quantified and unquantified benefits and costs discussed above. Benefits and costs are characterized in terms of the change associated with dams out (partial and full facilities removal) relative to dams in. To allow direct comparison of quantified benefits and costs, all such quantified effects are estimated in 2012 dollars and discounted back to year 2012. As indicated above, benefits and costs that are not quantified include tribal cultural values which are not amenable to quantification using standard economic methods; ancillary hydropower values; real estate values; refuge wildlife viewing values; and in river steelhead and redband trout recreation values. These unquantified benefits and costs are discussed in qualitative terms in Table 4.1-22.

Included in Table 4.4.1-22 are the nonuse values discussed previously, shown separately for individuals in the 12-County Klamath Area, the rest of Oregon and California, and the rest of United States. The estimated nonuse WTP values are substantial. The WTP values are comparable to other similar studies, although the values are on the high end of the studies. To put the household annual WTP values in context, the $122 per year value in the 12-County Klamath Area represents about $10 per month and a total of about $2,440 over 20 years. These WTP values as expressed by respondents to the Klamath survey are an indication of support for action to restore Klamath Basin resources. This public interest in restoring Klamath Basin resources was also reflected in the strong expressions of concern for the restoration of coho salmon (above 75 percent) and in the 54 percent of respondents who stated they favored action to restore the Klamath Basin.

The NED BCA indicates that the net economic benefits of removing the four Klamath Hydroelectric Project dams and implementing the activities identified in the KBRA are strongly positive. This implies that full facilities removal and partial facilities removal are justified from an economic perspective. The implication that both dam removal options are justified from an economic perspective is made in recognition that there are categories of economic benefits (in-river steelhead fishing, redband trout fishing, refuge wildlife viewing and tribal fishing and cultural values) and costs (relicensing costs, ancillary hydropower services, real estate values, and regional powerplant emissions and air quality) that could not be quantified.

Table 4.4.1-22: Estimated benefit-cost comparison of proposed scenarios (discounted present values, Million $, 2012 dollars)

	Full Facilities Removal	Partial Facilities Removal
	($M, 2012 dollars, incremental changes from the dams in scenario)	
Total Quantified Benefits[1]:		
Low Estimate	15,866.0	15,866.0
Calculated as the sum of total *nonuse* value for the three regions (as derived from the nonuse valuation survey) and all other quantified benefits provided in this table.		
High Estimate	84,435.4	84,435.4
Calculated as the sum of total *economic* value for the three regions (as derived from the nonuse valuation survey) and irrigated agriculture and commercial fishing benefits. Total economic value includes use and nonuse values held by the public – including recreational use value. Thus the individual estimates for ocean sport fishing, in-river salmon sport fishing, and refuge waterfowl hunting provided in this table are excluded from calculation of the High Estimate to avoid double counting.		
Irrigated agriculture	29.9	29.9
Commercial fishing	134.5	134.5
Ocean sport fishing	50.5	50.5
In-river salmon sport fishing	1.8	1.8
Refuge waterfowl hunting	4.3	4.3
Nonuse values[2]		
12-County Klamath Area		
Total nonuse value	67.0	67.0
Total economic value	217.0	217.0
Rest of OR/CA		
Total nonuse value	2,091.0	2,091.0
Total economic value	9,071.0	9,071.0
Rest of the U.S.		
Total nonuse value	13,487.0	13,487.0
Total economic value	74,983.0	74,983.0
Unquantified Benefits:		
Tribal commercial fisheries	Insufficient data available to quantify these benefits. However, dam removal is anticipated to positively affect tribal commercial fisheries dependent resources.	
Tribal cultural values (including ceremonial and subsistence uses)	Applying a traditional economic framework to monetize tribal cultural values was not considered to be appropriate. However, dam removal is anticipated to positively affect tribal cultural values.	
In-river steelhead and redband trout sport fishing	Insufficient data available to quantify these benefits. Given that dam removal is anticipated to positively affect these in-river fisheries, the net economic benefits would also be positive.	
Refuge wildlife viewing	Insufficient data available to quantify these benefits. Given that dam removal is anticipated to positively affect refuge recreation, the net economic benefits associated with refuge wildlife viewing would also be positive.	

Table 4.4.1-22: Estimated benefit-cost comparison of proposed scenarios (discounted present values, Million $, 2012 dollars)

	Full Facilities Removal	Partial Facilities Removal
	($M, 2012 dollars, incremental changes from the dams in scenario)	
Total Quantified Costs:		
High Estimate	1,813.5	1,787.8
Calculated as sum of all quantified costs provided in this table.		
Low Estimate	1,772.1	1,746.4
Calculated as the sum of all quantified costs provided in this table except foregone reservoir and whitewater recreation benefits. This Low Cost Estimate is intended to be compared with the High Benefit Estimate. Because the High Benefit Estimate implicitly includes recreational use value, the individual estimates for forgone reservoir and whitewater recreation benefits provided in this table are excluded from calculation of the Low Cost Estimate to avoid double counting when the Low Cost Estimate and High Benefit Estimate are compared.		
KBRA restoration	474.1	474.1
Facilities removal	129.1	98.0
Site mitigation	37.7	36.6
OM&R (cost savings)	-188.9	-182.4
Forgone hydropower benefits	1,320.1	1,320.1
Forgone reservoir recreation benefits	35.4	35.4
Forgone whitewater recreation benefits	6.0	6.0

Table 4.4.1-22: Estimated benefit-cost comparison of proposed scenarios (discounted present values, Million $, 2012 dollars)

	Full Facilities Removal	Partial Facilities Removal
	($M, 2012 dollars, incremental changes from the dams in scenario)	
Unquantified Costs:		
Real estate values	Insufficient data available to quantify losses in reservoir real estate values and gains in riverine real estate values. Including real estate values in the benefit-cost comparisons would likely result in some double counting because changes in real estate values would likely also be reflected in the economic benefits associated with recreation activities (that is, potential increases in riverine property values would be reflected in recreational fishery economic gains; declines in reservoir property values would also be reflected in reservoir recreation economic losses).	
Hydropower ancillary services (ancillary services support the transmission of electricity from its generation site to the customer; may include load regulation, spinning reserve, non-spinning reserve, replacement reserve and voltage support)	Explicit consideration of ancillary services is outside the scope of this analysis. If these plants produce any ancillary services, their consideration could be expected to increase the foregone economic benefits reported here.	
Regional powerplant emissions	The analysis does not fully consider the effect, if any, of changing hydropower production levels on system-wide powerplant emissions or regional air quality.	
Net Economic Benefits[3]		
Low Estimate (Low Benefit Estimate minus High Cost Estimate)	14,052.5	14,078.2
High Estimate (High Benefit Estimate minus Low Cost Estimate)	82,663.3	82,689.0
Benefit-Cost Ratio[4]		
Low Estimate (Low Benefit Estimate divided by High Cost Estimate)	8.7 to 1	8.9 to 1
High Estimate (High Benefit Estimate divided by Low Cost Estimate)	47.6 to 1	48.3 to 1

[1] The Klamath nonuse valuation survey provided an estimate of total economic value, which included both use and nonuse values. The low and high estimates of total quantified benefits provided in this table reflect two different methods of characterizing the nonuse component of total value. The low estimate from the nonuse valuation survey (identified as "Total *nonuse* value" in the table) is based on the average household WTP associated solely with reducing the extinction risk of coho salmon from high to moderate, as estimated using survey data. The high estimate (identified as "Total *economic* value" in the table) is based on the survey estimate of total economic value, but excludes the separate estimates of recreation use values presented in the benefits cells of this table to avoid double counting. Although the extinction risk for coho salmon would improve under the action plans, those plans do not indicate a prospect for delisting of coho. This indicates there would be very little possibility of any use values (e.g., recreational fishing) associated with this species in the foreseeable future under the action plans. As such, this value can be viewed as a conservative estimate of nonuse value because it does not also include any nonuse values associated with reduction in extinction risks for suckers or other components of the minimal Action plan.

[2] The Klamath nonuse valuation survey provided an estimate of total economic value which includes both use and nonuse value. The nonuse value presented represents the average household WTP, aggregated for each stratum, associated solely with reducing the extinction risk of the coho salmon from high to moderate. The estimates of total economic value should not be added to the estimates of use values presented in this table to avoid double counting.

[3] Low and high estimates of net economic benefits are presented because the Klamath nonuse valuation survey provided an estimate of total economic value which included both use and nonuse values. The low estimate reflects the average household WTP associated solely with reducing the extinction risk of the coho salmon from high to moderate. The high estimate is based on the survey estimate of total economic value, but excludes the separate estimates of recreation use values presented in both the benefits and costs cells of this table to avoid double counting.

[4] The net benefits and benefit-cost ratio reflect only those benefits and costs that could be quantified. Nonquantifiable benefits and costs should also be considered in weighing the merits of the plans.

Figure 4.4.1-2: Economic Regions for Regional Economic Benefits in the Klamath Basin

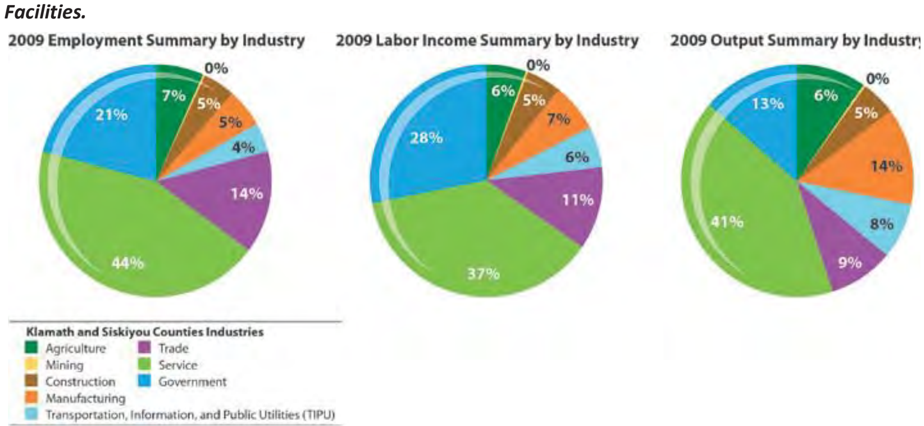
4.4.1.2 Regional Economic Development

The RED account measures the effect of leaving the dams in place and facilities removal on the region's local economy. This analysis describes potential regional economic impacts associated with implementation of facilities removal.

The economic regions vary somewhat, depending on the affected activity, but generally include Del Norte, Humboldt, Modoc, and Siskiyou counties in California and Curry, Klamath, and Jackson counties in Oregon (see Figure 4.4.1-2). The Four Facilities are in Siskiyou and Klamath counties. The remaining counties have local economies linked to the Klamath River through fishing, recreation/tourism, or agriculture industries. Commercial fishing effects can be more far-reaching than the Klamath Basin and include Mendocino, Sonoma, Marin, San Francisco, and San Mateo counties in California and Lane, Douglas, and Coos counties in Oregon (not included in Figure 4.4.1-2).

In general, the counties in the area of analysis are in rural areas of the states and have resource- and environmental amenity-based economies (e.g., timber, agriculture, fishing, recreation). Like many rural areas, the counties have lower population densities, lower incomes, less economic output and fewer employment opportunities than counties with larger urban centers in California and Oregon. Services and government entities are typically the largest employers in the counties. Figure 4.4.1-3 shows employment, labor income, and output by industry in a combined regional economy for Siskiyou and Klamath counties. Various economic regions were developed for the economic analysis, based on the geographic location where the direct economic activity would likely occur. In general, the industry make up is similar to Siskiyou and Klamath counties, shown in the pie chart.

Figure 4.4.1-3: 2009 Regional economy for Siskiyou and Klamath counties, the location of the Four Facilities.



The modeling package used to assess the regional economic impacts from the expenditures associated with leaving the dams in place and facilities removal was IMPLAN (IMpact analysis for PLANning) Version 3 with 2009 county data sets.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. IMPLAN measures the initial impact to the economy but does not consider long-term adjustments as labor and capital move into alternative uses. This approach is used to compare the scenarios. Realistically, the structure of the economy will adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between the dams out and dams in scenarios and cannot be used to predict or forecast future employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a 1-dollar change in final demand.

Regional economic total effects are presented in terms of employment, labor income, or output. IMPLAN defines these parameters as follows:

- **Employment** – Number of jobs; a job can be full-time or part-time. Jobs can be short-term or long-term depending on the economic impact.
- **Labor Income** - All forms of employment income; including employee compensation (wages and benefits) and proprietor income.
- **Output -** Value of industry production; in IMPLAN these are annual production estimates for the year of the data set.

IMPLAN is used to estimate regional economic impacts of facilities removal, and changes to commercial fishing, reservoir recreation, ocean and in-river sport fishing, and white water boating as a result of dam removal. The analysis also uses IMPLAN to estimate regional economic impacts of the KBRA, including effects to irrigated agriculture, refuge recreation, and implementation of fisheries, water resources, regulatory assurances, tribal and county programs.

Facilities Removal

Facilities removal has three components: dam decommissioning, annual operation and maintenance, and mitigation activities associated with dam removal. These components would affect economic output, employment, and labor income in Klamath and Siskiyou counties.

IMPLAN

Impact Analysis for Planning, or IMPLAN, is an economic input output modeling system that estimates the effects of economic changes in a defined area of analysis.

The total effects are the total changes to the original economy as the result of a project, or Direct effects + Indirect effects + Induced effects Total Effects.

Direct effects – Initial economic activities (jobs and income) generated by a project. Direct effects are the inputs into IMPLAN.

Indirect Effects – Changes in production, employment, and income occurring in other industries that provide inputs (such as supplies) to the project.

Induced Effects Changes in household spending in the local economy from direct and indirect effects of a project (e.g., people employed by a project spending their newly earned income in their local community).

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data.

IMPLAN measures the initial impact but does not consider long term adjustments as labor and capital move into alternative uses. The structure of an economy will adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between scenarios; it cannot be used to predict or forecast future employment, labor, or output (sales).

This analysis uses 2009 IMPLAN data for the counties in the area of analysis, compiled from various sources including U.S. Bureau of Economic Analysis, U.S. Bureau of Labor, and U.S. Census Bureau.

Effects from dam decommissioning expenditures would occur for one year in 2020. In 2012 dollars, the costs for full facilities removal would be $178.4 million. Not all dollars would be spent within the region. Approximately $114.3 million of $178.4 million (2012 dollars) would be spent in Klamath and Siskiyou counties. Partial facilities removal is estimated to cost $135.4 million (2012 dollars) (Reclamation 2012a). Expenditures associated with partial facilities removal spent within the region were estimated to be $84.68 million (2012 dollars) (Reclamation 2012a). These expenditures are part of the output impacts of dam decommissioning as shown is Table 4.4.1-1.

As described in the NED analysis, dam removal would reduce annual operation and maintenance (O&M) costs for the Klamath Hydroelectric Project. As a result, there would be a decrease in expenditures in the region with facilities removal relative to leaving the dams in place.

Mitigation spending could increase economic output, employment, and labor income in the regional economy. The regional impacts associated with mitigation would be spread over the 2018 to 2025 period and would vary year by year, proportionate to actual expenditures. Not all mitigation dollars would be spent within the region. Klamath County has highway, street, and bridge construction companies that provide asphalt and asphalt products for road construction. Siskiyou and Klamath counties also have county road crews. Much of the roadwork could be done by local workers and businesses. Local workers could also provide much of the replanting and habitat restoration required for mitigation.

Table 4.4.1-23 shows regional economic impacts of in-region spending for full and partial facilities removal relative to leaving the dams in place. Only in-region expenditures would generate positive regional economic effects. Most economic effects would be in the sector where the direct impact occurs. For dam deconstruction expenditures, this analysis assumes direct effects would mostly occur in the construction sector. Employment created in this sector would be full and part time jobs and would include contractors and subcontractors directly engaged in construction operations (such as equipment operators, drillers, carpenters, electricians, mechanics, apprentices, skilled and unskilled laborers, truck drivers, on-site record keepers and security guards), and any of their related office or administrative staff. After construction and mitigation activities are complete, output, employment, and labor incomes within the region would generally return to levels prior to construction.

Table 4.4.1-23: Regional Economic Impacts from Dam Decommissioning Expenditures with Facilities Removal Relative to Dams In (2012 dollars)

		Total Impact[4]		
		Dams In	Full Facilities Removal Relative to Dams In	Partial Facilities Removal Relative to Dams In
Dam Decommissioning	Employment (Jobs)[1]	None	1,423	1,138
	Labor Income ($ millions)[2]	None	59.70	48.11
	Output ($ millions)[3]	None	163.32	131.84
Operation and Maintenance	Employment[1] (Jobs)	49	-49	-47.4
	Labor Income[2] ($ millions)	2.05	-2.05	-1.98
	Output[3] ($ millions)	5	-5	-5
Mitigation	Employment[1] (Jobs)	none	217	Same as Full Removal
	Labor Income[2] ($ millions)	none	10.01	Same as Full Removal
	Output[3] ($ millions)	none	30.86	Same as Full Removal

Source: Reclamation 2012a

[1] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production

[4] Total Impact = Direct + Indirect + Induced Impacts

Commercial Fishing

The five management areas where the commercial fishery is most likely to experience economic impacts are depicted in Figure 4.4.1-4. Figure 4.4.1-5 presents average ocean commercial fishing harvest data from 1981 through 2010, with yearly data for the 2001–2010 period. Removal of the Four Facilities with KBRA would restore a more natural Klamath River flow regime and improve and expand spawning and rearing habitat for salmon on the Klamath River, which would benefit salmon populations. Commercial fishing landings would increase because of increased salmon abundance, which would increase fishing revenues. Table 4.4.1-24 shows how revenue would be affected by dams out relative to dams in for each management area. Partial facilities removal would have the same total impact as full facilities removal.

Figure 4.4.1-4: Commercial fishery management areas included in the analysis

Table 4.4.1-24: Annual Ex-Vessel Revenue for Most Impacted Management Areas with Dams Out Relative to the Dams In (2012 Dollars)

Management Area	Dams In - Revenue	Dam Removal - Revenue	Dam Removal - Change in Revenue Relative to Dams In
Central Oregon	6,847,058	9,775,879	2,928,821
KMZ OR	266,894	381,058	114,164
KMZ CA	328,574	469,121	140,547
Fort Bragg	4,202,992	6,000,817	1,797,825
San Francisco	9,125,553	13,028,998	3,903,445

Source: Reclamation 2012a

Note: KMZ = Klamath Management Zone.

Figure 4.4.1-5: Recent ocean commercial fishing in the area of analysis.

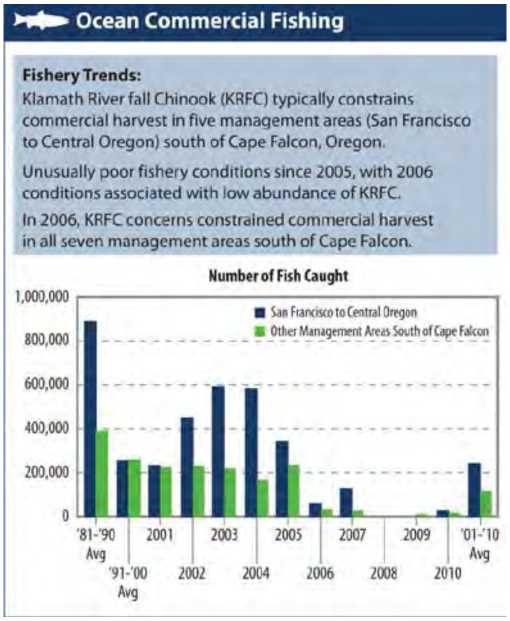


Table 4.4.1-25 summarizes annual regional economic impacts to ocean commercial fishing under the dams in scenario and the change in these impacts that would occur under dams out. Most employment, labor income, and output effects would occur in the natural resources sector (which includes the fishery sector) of the regional economy. Employment created in this sector could be full time or part time and include various types of services, such as fishing, provision of fuel, bait, and ice, and other supporting jobs. Partial facilities removal would have the same total impact on employment, labor income, and output as full facilities removal.

Table 4.4.1-25: Annual Regional Economic Impacts from Commercial Fishing with Dam Removal Relative to Dams In (2012 Dollars)

		Total Impact	
		Dams In	Dam Removal - Incremental Impacts Relative to Dams In
Central Oregon	Employment (Jobs)	319	136
	Labor Income ($ millions)	4.15	1.74
	Output ($ millions)	9.55	4.07
KMZ Oregon	Employment (Jobs)	26	12
	Labor Income ($ millions)	0.15	0.06
	Output ($ millions)	0.33	0.13
KMZ California	Employment (Jobs)	44	19
	Labor Income ($ millions)	0.19	0.07
	Output ($ millions)	0.45	0.19
Fort Bragg	Employment (Jobs)	162	69
	Labor Income ($ millions)	2.45	1.05
	Output ($ millions)	5.62	2.41
San Francisco	Employment (Jobs)	510	218
	Labor Income ($ millions)	6.1	2.56
	Output ($ millions)	15.52	6.6

Source: Reclamation 2012a

Note: KMZ = Klamath Management Zone.

Reservoir Recreation

The economic region used in the reservoir recreation regional economic impact analysis is based on the location of the affected reservoirs. Recreation activity occurs at J.C. Boyle, Copco 1, and Iron Gate reservoirs, Copco 2 Reservoir does not generate recreation activity. Therefore, the reservoir recreation regional analysis focuses exclusively on J.C. Boyle Reservoir, which is in Klamath County, Oregon, and Copco 1 and Iron Gate reservoirs, which are in Siskiyou County.

Figure 4.4.1-6: Reservoir based recreation occurs in the region.

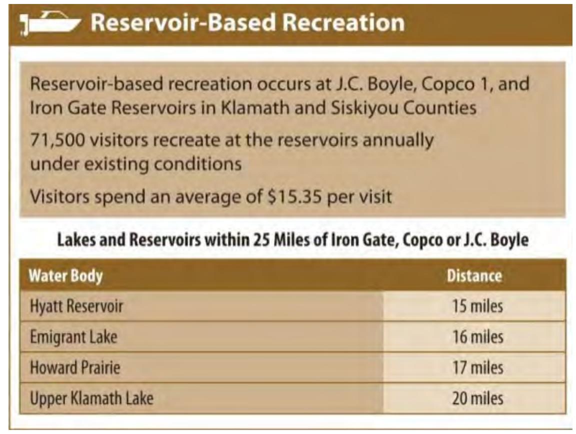


Figure 4.4.1-6 describes recent reservoir-based recreational activity and expenditures per visitor day, and the distances to other lakes and reservoirs in the region that could be utilized following removal of J.C. Boyle, Copco 1 and Iron Gate reservoirs. An average annual reduction of 40,901 visits (Reclamation 2012f) would occur if the reservoirs were removed. This would result in a reduction in average annual expenditures of $627,838. Table 4.4.1-26 compares annual regional economic impacts with the dams remaining in place and the decrease in such impacts that would occur under facilities removal. Most employment, labor income, and output effects would occur in the services sector. Employment affected in this sector could be full time or part time. Partial facilities removal would have the same total impact on employment, labor income, and output as full facilities removal.

Table 4.4.1-26: Annual Regional Economic Impacts from Reservoir Recreation with Dam Removal Relative to the Dams In (2012 dollars)

	Total Impact[4]	
	Dams In	**Dam Removal Relative to Dams In**
Employment[1] (Jobs)	7	-4
Labor Income[2] ($ millions)	0.22	-0.13
Output[3] ($ millions)	0.54	-0.31

Source: Reclamation 2012a

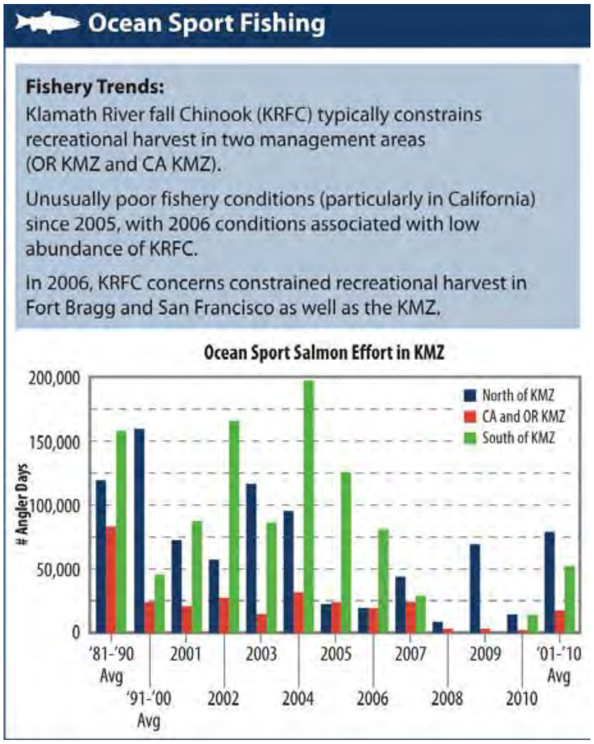
[1] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production

[4] Total Impact = Direct + Indirect + Induced Impacts

Figure 4.4.1-7: Ocean sport fishing contributes to the regional economy.



Ocean Sport Fishing

The area of analysis for ocean sport fishing includes KMZ California (Humboldt and Del Norte counties) and KMZ Oregon (Curry County) because Klamath River salmon availability is the constraining stock for this area. Figure 4.4.1-7 describes recent ocean sport fishing activity and expenditures per angler day.

Table 4.4.1-27 summarizes annual regional economic impacts of ocean sport fishing in the KMZ under the dams in scenario and the change in such impacts that would occur under dams out. Partial facilities removal would have the same total impact on employment, labor income and output as full facilities removal. Most employment, labor income, and output effects associated with ocean sport fishing would occur in the services sector. Employment created in this sector could be full time or part time.

Table 4.4.1-27: Annual Regional Economic Impacts from Ocean Sport Salmon Fishing with Dam Removal Relative to the Dams In (2012 dollars)

	Total Impact[4]			
	Dams In		Dam Removal Relative to Dams In	
	KMZ - California	KMZ - Oregon	KMZ – California	KMZ - Oregon
Employment[1] (Jobs)	13	3	5.5	1.2
Labor Income[2] ($ millions)	0.42	0.08	0.18	0.02
Output[3] ($ millions)	1.12	0.21	0.48	0.09

Source: Reclamation 2012a

[1] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production

[4] Total Impact = Direct + Indirect + Induced Impacts

In-River Sport Fishing

The economic region used in the regional economic impact analysis for in-river recreational fisheries includes Del Norte, Humboldt and Siskiyou counties in California and Klamath County in Oregon. Annual in-river salmon angler trips from 2001 through 2010 are presented in Figure 4.4.1-8. Annual salmon fishing effort on the Klamath River is estimated at 26,578 angler days with facilities removal. The portion of this effort attributable to nonresident anglers is 17,036 angler days. Expenditures in the region by nonresident anglers are estimated at $1.789 million (2012 dollars). The annual increase in nonresident expenditures with facilities removal relative to the dams remaining in place would be $127,000. Table 4.4.1-28 summarizes annual regional economic activity with the dams in place and the increase in such activity that would be supported by facilities removal (Reclamation 2012a, NOAA Fisheries Service 2012c). Most employment, labor income, and output effects associated with in-river sport fishing would occur in the services sector. Employment created in this sector could be full time or part time.

Some information on recent steelhead and redband trout fishing activity is available (see Figure 4.4.1-8). Facility removal would result in increased abundance of these two species; however, the economic impacts of these changes could not be quantified. It is likely that these changes would generate additional expenditures, jobs, labor income, and output in the regional economy. Partial facilities removal would have the same total impact on employment, labor income and output as full facilities removal.

Figure 4.4.1-8: In-river sport fishing angler days and expenditures.

In-River Sport Fishing

Salmon anglers from outside region spend $105 per angler per day (*NOAA Fisheries Services 2004)*

An average of 17,155 angler trips for steelhead occurred on Klamath River from 2003-2008

About 15,200 angler trips for redband trout occurred in Upper Klamath Lake and Agency Lake from March - September 2009

Estimated Number of Recreational Salmon Angler Days and Chinook Harvest on the Klamath River, 2001-2010

Year	Number of Angler Days	Chinook Harvest (fish)
2001	28,251	2,904
2002	24,993	4,942
2003	23,259	10,986
2004	24,751	10,420
2005	17,789	7,911
2006	12,141	5,756
2007	19,597	1,941
2008	15,249	5,259
2009	20,755	5,232
2010	16,219	5,599
01-05 Average	**23,809**	**7,403**
06-10 Average	**16,792**	**5,425**

Table 4.4.1-28: Annual Regional Economic Impacts from In-River Sport Salmon Fishing with Dam Removal Relative to Dams In (2012 dollars)

	Total Impact[4]	
	Dams In	**Dam Removal Relative to Dams In**
Employment[1] (Jobs)	34	3
Labor Income[2] ($ millions)	0.93	0.07
Output[3] ($ millions)	2.01	0.15

Source: Reclamation 2012a

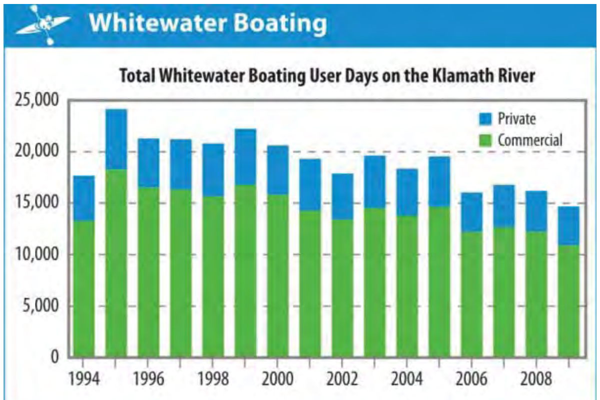
[1] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production

[4] Total Impact = Direct + Indirect + Induced Impacts

Figure 4.4.1-9: Whitewater boating user days and expenditures.



River	Boating Class	Factors Affecting Use	Total Expenditures Per Person Per Day
Klamath River (above CA/OR state line)	III-IV+	Hells corner has one of the few Class V rapids, created by releases from J.C. Boyle. Loss of boaters will result in loss of expenditures to the region.	Private = $176 Commercial = $333
Klamath River (downstream of Iron Gate Dam)	II-V	Most skill levels, easy access, 186 miles support multi-day floats, shoreline camping, scenery, many outfitters, commercial use	Private = $176 Commercial = $333

Whitewater Boating

The regional economic impact analysis region for whitewater boating is Klamath and Jackson counties in Oregon and Humboldt and Siskiyou counties in California. Figure 4.4.1-9 presents a historical record of annual whitewater boating user-days from 1994 through 2009 and estimates of expenditures per user-day. Facilities removal would result in loss of whitewater boating activity on the upper Klamath River (primarily the Hell's Corner Reach). Hell's Corner Reach is located below J.C. Boyle Dam. Daily "peaking" releases from this dam create predictable class V rapids during the daytime hours; class V rapids are rare in the area. Removal of J.C. Boyle Dam would eliminate "peaking" in this reach, making Hell's Corner less desirable for whitewater boating. Annual losses would begin in 2020 with the removal of J.C. Boyle Dam. The difference in average annual user-days between facilities removal and the dams remaining in place was estimated at 2,706. The difference in average annual lost expenditures between facilities removal and the dams remaining in place was estimated as $701,170 (DOI 2012b). Table 4.4.1-29 summarizes annual regional economic impacts with dams in place and the decrease in such impacts that would occur with facilities removal. Most employment, labor income, and output effects associated with whitewater boating would occur in the services sector. Employment created in this sector could be full time or part time. Partial facilities removal would have the same total impact on employment, labor income, and output as full facilities removal.

Table 4.4.1-29: Annual Regional Economic Impacts from Whitewater Boating with Dam Removal Relative to Dams In (2012 dollars)

	Total Impact[4]	
	Dams In	Dam Removal Relative to Dams In
Employment[1] (Jobs)	56	-14
Labor Income[2] ($ millions)	$1.56	-0.43
Output[3] ($ millions)	$4.31	-0.89

Source: Reclamation 2012a

[1] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production

[4] Total Impact = Direct + Indirect + Induced Impacts

KBRA

Implementation of the KBRA would result in substantial spending in the Klamath Basin over a 15-year period. Effects are analyzed for two economic regions, a 4-county region of Klamath, Siskiyou, Humboldt, and Del Norte counties, and a 3-county region of Klamath, Siskiyou, and Modoc counties. The KBRA identifies up to 112 projects that include restoration, reintroduction, and monitoring projects, water resource programs, regulatory programs, and funding to local counties and Indian tribes. This analysis estimates the regional economic impacts of implementing the KBRA. The KBRA would be implemented under full facilities removal and partial facilities removal; therefore, the KBRA impacts would be the same for both. Some actions were analyzed in the 3-county region and some in the 4-county region depending on where the action would occur.

Fisheries Program

The KBRA includes fishery restoration, reintroduction and monitoring actions in the upper and lower basin. Actions would be implemented in the 4-county region. Restoration activities would involve some degree of construction including floodplain rehabilitation, large woody debris placement/replacement, fish passage correction, cattle exclusion fencing, and riparian vegetation planting. It is likely that much of the construction could be done by local construction workers from the region. The KBRA also calls for construction of new fish facilities, which may require more out-of-region contractors. KBRA actions would provide new jobs and increase labor income within the region during the implementation period. Table 4.4.1-30 summarizes regional economic effects from implementation of the Fishery Program actions under the KBRA. These effects are incremental to base funding that would be expended without the KBRA. Effects are based on funding levels identified by Federal agencies in a revised Table C-2 of the KBRA. Effects would occur over the KBRA implementation period (2012–2026) and would vary year by year, proportionate to actual expenditures. Some actions would be completed in less than 15 years.

Table 4.4.1-30: Regional Economic Impacts of KBRA Fishery Program Actions Relative to Base Funding Over a 15-year period (2012 dollars)

KBRA Table C-2 Line #	KBRA Action	15 Year KBRA In-Region Spending (1,000 dollars)	Total Impact of KBRA Funding (not including base funding)[1]		
			Employment (Jobs)[2]	Labor Income (1,000 dollars)[3]	Output (1,000 dollars)[4]
1	Coordination and Oversight	$117	3	$90	$142
2	Planning & Implementation--Phase I and II Restoration Plans	$1,211	20	$918	$1,456
3	Williamson River aquatic habitat restoration	$890	12	$568	$1,258
4	Sprague River aquatic habitat restoration	$41,994	546	$26,206	$60,228
5	Wood River Valley aquatic habitat restoration	$10,777	136	$6,476	$15,892
6	Williamson Sprague Wood Screening Diversion	$2,232	28	$1,334	$3,306
7	Williamson & Sprague USFS uplands	$4,886	64	$3,049	$7,007
8	Upper Klamath Lake aquatic habitat restoration	$10,785	134	$6,365	$16,105
9	Screening of UKL pumps	$425	6	$255	$632
10	UKL watershed USFS uplands	$1,641	23	$1,024	$2,354
11	Keno Impoundment water quality studies & remediation actions	$29,647	366	$17,443	$44,360
12	Keno Impoundment wetlands restoration	$1,008	13	$594	$1,508
13	Keno to Iron Gate upland private & BLM	$0	0	$0	$0
14	Keno to Iron Gate upland USFS	$713	10	$440	$1,036
15	Keno to Iron Gate mainstem restoration	$951	13	$620	$1,321
16	Keno to Iron Gate tributaries - diversions & riparian	$1,141	16	$744	$1,585
17	Shasta River aquatic habitat restoration	$0	0	$0	$0
18	Shasta River USFS uplands	$0	0	$0	$0
19	Scott River aquatic habitat restoration	$0	0	$0	$0
20	Scott River USFS uplands	$460	6	$284	$668
21	Scott River private uplands	$0	0	$0	$0
22	Mid Klamath River & tributaries aquatic habitat restoration	$0	0	$0	$0
23	Mid Klamath tributaries USFS upland	$4,574	59	$2,815	$6,631
24	Mid Klamath tributaries private upland	$1,887	25	$1,162	$2,736
25	Lower Klamath River & tributaries aquatic habitat restoration	$0	0	$0	$0
26	Lower Klamath private uplands	$25,428	326	$15,641	$36,863
27	Salmon River aquatic habitat restoration	$1,959	26	$1,206	$2,840
28	Salmon River USFS upland	$2,701	35	$1,662	$3,916
29	Reintroduction Plan	$1,631	26	$1,236	$1,960
30	Collection Facility	$6,014	78	$3,700	$8,719
31	Production Facility	$6,113	79	$3,762	$8,865
32	Acclimation Facility	$4,709	61	$2,898	$6,827
33	Transport	$826	13	$627	$994
34	Monitoring and Evaluation – Oregon	$29,828	461	$22,601	$35,828
35	Monitoring and Evaluation – California	$2,995	47	$2,270	$3,599
36	New Hatchery	$5,546	72	$3,412	$8,041
37	Adult Salmonids	$9,952	154	$7,542	$11,954
38	Juvenile Salmonids	$14,630	227	$11,086	$17,573
39	Genetics Otololith	$0	0	$0	$0
40	Hatchery Tagging	$0	0	$0	$0
41	Disease	$5,214	82	$3,952	$6,264
42	Green Sturgeon	$0	0	$0	$0
43	Lamprey	$1,837	29	$1,393	$2,208
44	Geomorphology	$1,608	26	$1,219	$1,933
45	Habitat Monitoring	$2,641	42	$2,002	$3,173
46	Water Quality	$86	2	$65	$110
47	UKL bloom dynamics	$0	0	$0	$0
48	UKL water quality/phytoplankton/zooplankton	$4,143	68	$3,153	$5,324
49	UKL internal load/bloom dynamics	$1,244	21	$947	$1,599

Table 4.4.1-30: Regional Economic Impacts of KBRA Fishery Program Actions Relative to Base Funding Over a 15-year period (2012 dollars)

KBRA Table C-2 Line #	KBRA Action	15 Year KBRA In-Region Spending (1,000 dollars)	Total Impact of KBRA Funding (not including base funding)[1]		
			Employment (Jobs)[2]	Labor Income (1,000 dollars)[3]	Output (1,000 dollars)[4]
50	UKL external nutrient loading	$3,881	64	$2,952	$4,985
51	UKL analysis of long-term data sets	$652	11	$497	$838
52	UKL listed suckers	$4,331	71	$3,294	$5,564
53	Tributaries water quality/nutrients/sediment	$4,718	77	$3,589	$6,061
54	Tributaries geomorphology/riparian vegetation	$3,637	60	$2,767	$4,672
55	Tributaries physical habitat	$3,241	53	$2,466	$4,164
56	Tributaries listed suckers	$4,777	77	$3,634	$6,136
57	Keno Impoundment water quality/algae/nutrients	$6,048	99	$4,601	$7,770
58	Keno Impoundment to Tributaries: Meteorology (weather stations)	$3,044	50	$2,316	$3,911
59	Remote Sensing acquisition and analysis	--	No in-region spending, no regional economic effects		

Source: CDM 2011b
IMPLAN results presented in 2012 dollars
UKL: Upper Klamath Lake
USFS: United States Forest Service
BLM: Bureau of Land Management
[1] Total Impact = Direct + Indirect + Induced Impacts
[2] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Water Resource Program

The KBRA includes water resource actions to improve water supply reliability in Reclamation's Klamath Project. Actions include monitoring, analysis, restoration, and construction. Actions affecting agriculture or refuges would occur in the 3-county region, while restoration-related water resources actions would occur in the 4-county region. It is likely that much of the construction could be done by local construction workers from the region. State and local government workers in the region would likely implement many actions, including monitoring, analysis, and administration. KBRA actions would provide new jobs and increase labor income within the region during the implementation period. Table 4.4.1-31 summarizes regional economic effects from implementation of the Water Resources Program actions under the KBRA relative to the KBRA not being implemented. Some actions could change Reclamation's Klamath Project hydrology and have direct effects on irrigated agriculture or refuge recreation; these programs are evaluated separately following this section.

Table 4.4.1-31: Regional Economic Impacts of KBRA Water Resource Program Actions Relative to Base Funding over a 15-year period (2012 dollars)

KBRA Table C-2 Line #	KBRA Action	15 Year KBRA In Region Spending	Total Impact[1] of KBRA Funding (not including base funding)		
			Employment (Jobs)[2]	Labor Income (1,000 dollars)[3]	Output (1,000 dollars)[4]
60	Keno Dam fish passage	--	No in-region spending, no regional economic effects		
61	Data Analysis and evaluation	$168	3	$126	$197
62	Development of predictive techniques	$391	7	$298	$471
63	Klamath Basin Wildlife Refuges: O&M North and P Canals	--	No funding identified in Revised C2		
64	Klamath Basin Wildlife Refuges: Walking Wetland Construction	$2,500	40	$1,955	$3,799
65	Klamath Basin Wildlife Refuges: Big Pond Dike Construction	--	No funding identified in Revised C2		
66	On Project water plan	--	Evaluated in Irrigated Agriculture Technical Report		
67	Groundwater Technical Investigation	--	No in-region spending, no regional economic effects		
68	Costs Associated with Remedy for Adverse Impact	--	No funding identified in Revised C2		
69	D Pumping Plant	--	Transfer of funds, no regional economic effects		
70	Water Use Retirement Plan	--	Evaluated in Irrigated Agriculture Technical Report		
71	Off Project Plan and Program: Use of 30,000 ac ft upstream of Upper Klamath Lake	--	Evaluated in Irrigated Agriculture Technical Report		
72	Interim Power Sustainability	--	Evaluated in Irrigated Agriculture Technical Report		
73	Federal Power	--	Transfer of funds, no regional economic effects		
74	Energy Efficiency and Renewable Resources	$4,402	54	$2,278	$6,211
75	Renewable Power Program Financial and Engineering Plan	--	No in-region spending, no regional economic effects		
76	UKL Wetlands Restoration: Agency/Barnes	$2,717	34	$1,576	$4,108
77	UKL Wetlands Restoration: Wood River	$2,717	34	$1,576	$4,108
78	Drought Plan Development	--	No funding identified in Revised C2		
79	Drought Plan Restoration Agreement Fund	--	Evaluated in Irrigated Agriculture Technical Report		
80	Emergency Response Plan	--	No funding identified in Revised C2		
81	Emergency Response Fund	--	No funding identified in Revised C2		
82	Technical Assessment of Climate Change	--	No in-region spending, no regional economic effects		
83	Off-Project Reliance Program	--	Evaluated in Irrigated Agriculture Technical Report		
84	Real Time Water Management	--	No funding identified in Revised C2		
85	Real Time Water Management: Water Flow Monitoring and Gauges	$3,239	51	$2,455	$3,892
86	Snowpack Gauges	--	No funding identified in Revised C2		
87	Adaptive Management: Science and Analysis	$1,087	17	$824	$1,307
88	Real Time Management: Calibration and improvements to KLAMSIM or other modeling and predictions	$109	3	$84	$131
89	Interim Flow and Lake Level Program	--	Evaluated in Irrigated Agriculture Technical Report		

Source: CDM 2011b
IMPLAN results presented in 2012 dollars
UKL: Upper Klamath Lake
[1] Total Impact = Direct + Indirect + Induced Impacts
[2] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Regional economic effects are calculated only on the planned KBRA spending that is in addition to base funding that would likely be spent by Federal agencies without KBRA implementation. Effects are based on funding levels identified by Federal agencies in a revised Table C-2 of the KBRA. Effects would occur over the KBRA implementation period (2012-2026) and would vary year by year, proportionate to actual expenditures. Some actions would be completed in less than 15 years.

Irrigated Agriculture:

Gross Farm Revenue

Figure 4.4.1-10 presents irrigated agriculture acreage by crop and average gross revenue 2005 through 2009. Changes in Reclamation's Klamath Project hydrology could affect gross farm revenue and the regional economy. Table 4.4.1-31 identifies the KBRA actions evaluated for irrigated agriculture impacts. The economic region used to model agricultural impacts includes Klamath, Siskiyou, and Modoc counties.

Figure 4.4.1-10: Irrigated Agriculture Acreage and Revenue in the Area of Analysis

Irrigated Agriculture

Reclamation's Klamath Project delivers irrigation water to about 200,000 farmland acres and 35,000 wetland acres in Siskiyou, Modoc, and Klamath Counties

Average gross revenue from 2005 to 2009 was about $148.6 million

Crop Acreage Summary for Irrigated Agriculture

Crop	2005	2006	2007	2008	2009	Average
Small Grains	10,962	13,952	14,083	16,216	11,943	13,431
Wheat	35,401	28,126	25,761	30,318	35,211	30,964
Alfalfa	77,104	81,587	82,933	79,561	77,654	79,768
Irrigated Pasture	40,046	42,973	43,544	44,846	44,564	43,197
Potatoes	11,427	15,869	11,861	12,126	12,789	12,815
Other[1]	6,655	7,577	8,041	7,440	7,917	7,527
Fallow	11,711	5,949	7,746	6,500	4,962	7,374
Total	**193,306**	**196,033**	**193,979**	**197,007**	**195,040**	**195,076**

[1] *Other mainly includes onions, peppermint, horseradish and strawberries*

Model results indicated that gross farm revenue would be equal in all years with facilities removal relative to the dams remaining in place, except for five modeled drought years (2027, 2043, 2045, 2051, and 2059). The drought years were estimated using the indexed sequential hydrology modeling using the 1961 hydrologic conditions, explained in the *Irrigated Agriculture Economics Technical Report For the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon* (Reclamation 2012g). For the five modeled drought years 2027, 2043, 2045, 2051, and 2059, the gross farm revenue increased with facilities removal relative to the dams remaining in place. Table 4.4.1-32 shows gross farm revenue with facilities removal. For all modeled drought years, regional employment, labor income and output would be higher than if the dams remained in place, shown in Table 4.4.1-33. These increases are possible under KBRA because of programs including the on-project program, drought plan, and the water certainty.

Table 4.4.1-32: Gross Farm Revenue by IMPLAN Crop Sectors Between the Dams In and Dam Removal for Drought Years (1,000 dollars)

	Grains		Vegetables		Other (Hay & Pasture)		Total	
Modeled Drought Years	**Full Facilities /Partial Facilities Removal**	**Increase when compared to Dams In**	**Full Facilities/ Partial Facilities Removal**	**Increase when compared to Dams In**	**Full Facilities/ Partial Facilities Removal**	**Increase when compared to Dams In**	**Full Facilities/ Partial Facilities Removal**	**Increase when compared to Dams In**
2027	21,857	2,667	60,993	319	65,688	7,301	148,537	10,287
2043	21,664	17,145	60,966	5,000	64,439	36,798	147,069	58,944
2045	21,857	10,394	60,993	2,432	65,688	18,438	148,537	31,263
2052	21,857	4,779	60,993	866	65,688	9,872	148,537	15,517
2059	21,857	1,556	60,993	203	65,688	5,231	148,537	6,990

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors as cited in Reclamation 2012g.

Table 4.4.1-33: Regional Economic Impacts from Gross Farm Revenue between Dams In and Dams Out with KBRA for Drought Years (2012 dollars)

	Total Impact[1]					
	Employment[2]		Labor income[3]		Output[4]	
Modeled Drought Years	Additional Jobs Compared to Dams In (Jobs)	% Change from Dams In	Additional Income Compared to Dams In ($ millions)	% Change from Dams In	Additional Output Compared to Dams In ($ millions)	% Change from Dams In
2027	112	8.2	2.3	5.2	13.0	7.3
2043	695	90.6	11.2	33.8	84.0	71.4
2045	397	36.9	7.3	18.1	41.0	26.0
2052	187	14.5	3.6	8.1	20.0	11.4
2059	70	5.0	1.6	3.5	9.0	4.8

Source: Reclamation 2012d

[1] Total Impact = Direct + Indirect + Induced Impacts

[2] Employment is measured in number of jobs.

[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[4] Output represents the dollar value of industry production.

On Farm Pumping Costs

Increases in on-farm pumping costs could affect household income and reduce employment, labor income, and output in the regional economy. Regional employment, labor income, and output with facilities removal are equal to the employment, labor income, and output with dams remaining in place in all non-drought years. The regional economic effects of changes in on-farm pumping would be the same in all drought years because it is assumed that irrigators would use groundwater supplies to supplement irrigation.

Irrigators may be pumping more groundwater with dam removal in dry years than with the dams in and therefore would be paying more for electricity with dam removal, even with a decrease in electricity rates assumed for both partial and full facilities removal (Reclamation 2012b). The average annual cost of pumping groundwater would be $178,000 per year.

Because farmers would be paying more for electricity to pump groundwater with dam removal, household income would reduce by the additional money spent to pump groundwater. A reduced household income due to increased pumping costs would have a relatively small negative impact on the regional economy. Regional economic effects would be a loss of one job, a decrease of about $41,000 in labor income, and a decrease of about $121,000 in output.

Water Acquisitions

KBRA programs include several water acquisition programs that involve the voluntary sale of a water right or short-term voluntary water leasing. The regional impacts of these actions are measured by the impacts associated with the reduction in irrigated agricultural production from the water right transfer or lease, and by the impact of the water transfer compensation or lease payment to growers. These payments often compensate, to some degree, for the impacts from reduced irrigated crop production. The net RED impact is the sum of these two impacts.

Permanent Voluntary Water Rights Sales

The water acquisition programs, including the Water Use Retirement Program (WURP) and the Off-Project Reliance programs in the KBRA, could result in a negative regional effect. The WURP would be implemented to generate on an average annual basis an additional 30,000 acre-feet of inflow to Upper Klamath Lake. The KBRA states that the WURP would provide for increased stream flow and inflow into Upper Klamath Lake through actions that could include the voluntary transfer of water rights or water uses. The KBRA states "acquisition of water rights or uses to achieve the WURP purpose will be compensated, as applicable, through market mechanisms based upon values mutually agreed to by purchaser and seller, as informed by appraisals." Water right transfers proposed as part of WURP could affect the regional economy. The land once irrigated with the surface water right would be converted to either dryland production or would be fallowed. If all or part of the land was converted to dryland and/or was fallowed, the losses to the economy would be the gross revenue produced on this land.

The second aspect of WURP that could affect the regional economy is that only growers would be compensated, no compensation would be paid to those in the regional economy who do not own the water right yet are affected by the grower's activities. Farm workers, agribusiness firms such as fertilizer and chemical dealers and wholesale and agricultural service providers are examples of those who would not receive compensation but would be affected by the water right sale.

The lands currently being irrigated by the water rights proposed to be acquired under the WURP are off-Project in the Sprague River sub-basin; the Sycan River; the Williamson River sub-basin; and the Wood River sub-basin. This land is mostly used to grow irrigated pasture to support local livestock operations.

The combined impact of the lost irrigated pasture production and the associated livestock forward linkage from the 30,000 acre-foot water right sale proposed under the WURP is a loss of 34 jobs, $0.86 million in labor income, and 5.85 million in output. However, a portion of these effects would be offset from household induced effects resulting from household wages that are spent as a result of the compensation made to the water right holder.

Short-Term Water Leasing

Other programs in the KBRA, like the Off-Project Reliance Program and the Interim Flow and Lake Level Program, suggest the use of water lease programs in drought years. Water lease programs are short-term programs that may have negative effects on the regional economy during water short years. The programs allow farmers to sell or lease their water for fisheries programs on a short-term basis when sufficient water is unavailable for fish. The regional economy would be affected by the loss in gross farm revenue generated on the land idled by farmers who voluntarily lease water. Household induced effects would offset some of these regional effects when farmers spend a portion of the compensation in the local area. Because the KBRA does not specify what crops would be idled, is not possible to use IMPLAN to measure these effects.

Refuge Recreation

The economic region used in the refuge recreation regional economic impact analysis is based on the locations of the Lower Klamath Lake and Tule Lake National Wildlife Refuges. These two refuges sit along the border of Oregon and California in Siskiyou and Klamath counties. While a small portion of Tule Lake Refuge also lies within Modoc County, California, expenditures are most likely to take place either in Klamath Falls (Klamath County) or Tule Lake (Siskiyou County).

Changes in water supply for the two National Wildlife Refuges could affect refuge recreational visitation and expenditures and associated employment, labor income, and output in the regional economy. While the effect of the KBRA on wildlife viewing could not be determined, there would be an additional estimated 3,634 hunting trips (Reclamation 2011f). The addition of these trips would result in an increase of $287,099 in direct expenditures within the regional economy. Regional impacts would be an increase of 5 jobs, $0.12 million in labor income, and $0.27 million in output.

Regulatory Assurances

The KBRA includes regulatory assurance actions that generally include conservation and habitat planning and construction for the Reclamation's Klamath Project fish screens. Regulatory assurances actions correspond to line items #90-93 in the Revised Appendix C-2. These actions would provide new jobs and increase labor income within the region during the implementation period (2012–2026) and would vary year by year, proportionate to actual expenditures. The Reclamation's Klamath Project fish screens' action would be complete in 4 years and the Federal General Conservation Plans/Habitat Conservation Plans would be implemented over 8 years. These actions would result in a total of $10.2 million in direct expenditures within the local economies. Regional impacts would be an increase of 146 jobs, $7 million in labor income, and $17.4 million in output.

The KBRA also identified actions to develop laws for California and Oregon. The states would be responsible for implementing these actions. These actions would provide some local employment to state government staff in the region. Much of the work would occur by state workers outside of the region, which would not affect the regional economy.

County Programs

The Klamath County Economic Development Plan would include a study and implementation of projects for economic development associated with fisheries restoration and reintroduction, tourism and recreational development, agricultural development, alternative energy development, and The Klamath Tribes economic development (KBRA 27.3.1). Appendix C-2 of the KBRA indicates $3.2 million of funding for the plan in 2016. The Klamath County Development Plan also calls for Klamath County to be compensated for the loss of property tax revenues from reduced agricultural land values in Reclamation's Klamath Project due to a reduction of water deliveries and reduced agricultural land values in the areas upstream of Upper Klamath Lake due to the willing (compensated) surrender of significant water rights. Implementation of these actions would support long-term economic growth in Klamath County, by funding county programs, providing jobs, attracting visitors, attracting new businesses to establish in the area, supporting the agricultural economy, and supporting economic growth of tribes.

Funds from the California Water Bond Legislation could be used by Siskiyou County to improve economic conditions in the county and to support future economic growth. The economic downturn that began in 2008 has adversely affected Siskiyou County. Siskiyou County's 2009 and 2010 unemployment rates are the highest in the county since the early 1990s, and unemployment and poverty rates are consistently well above state averages. California legislation passed in 2009 proposes a bond measure to fund an economic development plan for Siskiyou County and for hydroelectric facilities removal. The bond measure, if passed, would also fund other mitigation measures to reduce the potential effect of dam removal. If approved, bond funds would be used for economic development in Siskiyou County and mitigations ($250 million; one mitigation includes protection of City of Yreka water supply). Humboldt and Del Norte counties are not included in the economic development fund. Remaining bond measure funds may be used for fisheries restoration projects in Siskiyou, Humboldt and Del Norte counties, including removal or improvement of bridges, culverts, diversions, or other obstructions to fish passage.

It cannot be determined at this time how Siskiyou County would distribute funds from the California Water Bond Legislation. However, the bond funds could assist Siskiyou County in addressing unemployment, poverty, bankruptcy, and social problems, and continuing funding for other county programs. Spending would likely increase employment opportunities and labor incomes in the county, which would result in a long-term, positive economic effect.

Some funds from the California Water Bond Legislation may be left over for fishery restoration projects in Siskiyou, Humboldt and Del Norte counties. Implementation of these projects would result in economic effects similar to those described for the Fisheries Restoration Program. Fishery restoration projects implemented by the California Water Bond Legislation would result in a long-term and positive economic effect.

Tribal Program

Tribal Programs correspond to line items #100-110 in the Revised Appendix C-2 (CDM 2011b). Construction and monitoring activities associated with Tribal Program actions would increase jobs, labor income, and output for The Klamath Tribes, Karuk Tribe, and Yurok Tribe. Federal agencies have identified funding for fisheries and conservation management actions to be implemented by tribes with dam removal. Effects would occur in Klamath, Siskiyou, Humboldt and Del Norte counties where tribes are located and would be spread over the 2012–2026 period. Spending on local actions would affect employment, labor income, and output in the regional economy. Most actions would be implemented by tribal staff and would positively affect the economic conditions of the tribes. A portion of the funding would result in positive effects in the construction sector and professional and technical services sector. These actions would result in a total of $25 million in direct expenditures within the local economies. Regional impacts would be an increase of 378 jobs, $17.9 million in labor income, and $30.3 million in output.

Summary of Regional Economic Impact Results

Tables 4.4.1-34 and 4.4.1-35 summarize the estimated regional economic impacts estimated using IMPLAN as described above. The information in this table is described in Reclamation 2012b and CDM 2011b.

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.1	**Dam Decommissioning** **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	None	Short-term impacts during the 1-year decommissioning. Approximately 1,400 jobs, $60 million in labor income, and $163 million in output estimated to stem from in-region decommissioning expenditures.	Short-term impacts during the 1-year decommissioning. Approximately 1,100 jobs, $48 million in labor income, and $132 million in output estimated to stem from in-region decommissioning expenditures.
2.2	**Operation and Maintenance** **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	Regional economic impacts stemming from existing in-region O&M expenditures were estimated to generate approximately 49 jobs and labor income and output of $2 million and $5 million, respectively.	No long-term annual O&M expenditures; therefore, the regional economy would lose the 49 jobs, $2 million of labor income, and $5 million output associated with the in-region O&M expenditures for dams in.	Based on in region O&M expenditures, approximately 47 jobs, $2 million in labor income, and $5 million in output would be lost to the regional economy compared to having dams remain.
2.3	**Mitigation** **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	None	These would be temporary short-term impacts and vary year by year during 2018–2025 proportionate to actual in-region expenditures. A total of approximately 220 jobs, $10 million in labor income, and $31 million in output during the years 2018–2025 were estimated to stem from the total in region mitigation expenditures.	Same as for the full facilities removal.

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.4	**Irrigated Agriculture** **Economic Region:** Klamath County OR Siskiyou and Modoc counties CA **Regional Economy:** Employment (Jobs): 52,141 Labor Income: $2,083 million Output: $5,497 million	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. Estimated regional economic impacts stemming from irrigated agriculture for the years in the hydrologic model that correspond with the drought years of 1975, 1992, 1994, 2001, and 2008:	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. Estimated regional economic impacts stemming from the change in irrigated agriculture for the years in the hydrologic model that correspond with the drought years of 1975, 1992, 1994, 2001, and 2008 – dams in versus full facilities removal:	Same as for the full facilities removal.
		2027 — Jobs 1,361 Labor Income $45 million Output $184 million	2027 — Jobs 112 Labor Income $2 million Output $13 million	
		2043 — Jobs 766 Labor Income $33 million Output $118 million	2043 — Jobs 695 Labor Income $11 million Output $84 million	
		2045 — Jobs 1,076 Labor Income $40 million Output $156 million	2045 — Jobs 397 Labor Income $7 million Output $41 million	
		2051 — Jobs 1,286 Labor Income $44 million Output $177 million	2051 — Jobs 187 Labor Income $4 million Output $20 million	
		2059 — Jobs 1,403 Labor Income $46 million Output $188 million	2059 — Jobs 70 Labor Income $2 million Output $9 million	

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.5	**Commercial Fishing** **Economic Regions and Regional Economies:** • **San Francisco Management Area** (San Mateo, San Francisco, Marin and Sonoma counties CA) Employment (Jobs): 3,060,366 Labor Income: $204,685 million Output: $599,164 million	Estimated regional economic impacts stemming from ocean commercial fishing: • **San Francisco Management Area** Jobs: 510 Labor Income: $6.10 million Output: $15.52 million	Estimated regional economic impacts stemming from the change in ocean commercial fishing between dams in versus full facilities removal. • **San Francisco Management Area** Jobs: 218 Labor Income: $2.56 million Output: $6.6 million	Same as for the full facilities removal.
	• **Fort Bragg Management Area** (Mendocino County CA) Employment (Jobs): 40,117 Labor Income: $1,731 million Output: $4,814 million	• **Fort Bragg Management Area** Jobs: 162 Labor Income: $2.45 million Output: $5.62 million	• **Fort Bragg Management Area** Jobs: 69 Labor Income: $1.05 million Output: $2.41 million	
	• **KMZ-CA** (Humboldt and Del Norte counties CA) Employment (Jobs): 71,633 Labor Income: $2,983 million Output: $7,360 million	• **KMZ-CA** Jobs: 44 Labor Income: $0.19 million Output: $0.45 million	• **KMZ-CA** Jobs: 19 Labor Income: $0.07 million Output: $0.19 million	
	• **KMZ-OR** (Curry County OR) Employment (Jobs): 8,656 Labor Income: $311 million Output: $859 million	• **KMZ-OR** Jobs: 26 Labor Income: $0.15 million Output: $0.33 million	• **KMZ-OR** Jobs: 11 Labor Income: $0.06 million Output: $0.13 million	
	• **Central Oregon Management Area** (Coos, Douglas and Lane counties OR) Employment (Jobs): 258,047 Labor Income: $10,170 million Output: $27,815 million	• **Central Oregon Management Area** Jobs: 319 Labor Income: $4.15 million Output: $9.55 million	• **Central Oregon Management Area** Jobs: 136 Labor Income: $1.74 million Output: $4.07 million	

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.6	**In-River Sport Fishing** **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	**Recreational Salmon Fishery** Regional economic impacts stemming from in river salmon fishing trip expenditures were estimated to create approximately 34 jobs and stimulate about $0.93 million of labor income and $2.01 million of output.	**Recreational Salmon Fishery** Regional economic impacts stemming from the change in river salmon fishing trip expenditures were estimated to create approximately three more jobs and stimulate increases of about $0.07 million of labor income and $0.15 million of output compared to dams in.	**Recreational Salmon Fishery** Same as for the full facilities removal.
		Recreational Steelhead Fishery Regional economic impacts stemming from in-river steelhead fishing trip expenditures were estimated to create approximately 20 jobs and stimulate about $0.62 million of labor income and $1.31 million of output.	**Recreational Steelhead Fishery** The Coho/Steelhead Expert Panel Report and previous studies were generally positive regarding the potential for increased distribution and abundance of steelhead. However, insufficient data precluded estimation of potential regional economic impacts associated with changes in steelhead fishing trip expenditures compared to dams in.	**Recreational Steelhead Fishery** Same as for the full facilities removal.
		Recreational Redband Trout Fishery A popular guide fishery occurs on the lower Williamson River. Given demand for guide trips is generally higher among non-resident than resident anglers, the proportion of trips by non-resident anglers is likely higher; however, data are lacking to verify this or quantify regional economic impacts associated with in-region guide fishing expenditures.	**Recreational Redband Trout Fishery** The Resident Fish Expert Panel concluded that dam removal would result in increased abundance and distribution of redband trout in Upper Klamath Lake and its tributaries and a potential seven-fold increase in the trophy fishery in the Keno Reach. However, the potential regional economic impacts of this notable increase could not be quantified with available data.	**Recreational Redband Trout Fishery** Same as for the full facilities removal.

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.7	**Ocean Sport Fishing** **Economic Regions and Regional Economies:** • **KMZ-OR – Curry County OR** Employment (Jobs): 8,656 Labor Income: $311 million Output: $859 million	• **KMZ-OR – Curry County OR** An estimated three jobs, $0.08 million of labor income, and $0.21 million in output were estimated to stem from in-region ocean sport salmon fishing related expenditures	• **KMZ-OR – Curry County OR** Regional economic impacts stemming from the change in in-region ocean sport salmon fishing trip expenditures were estimated to be increases of approximately one job, $0.02 million in labor income, and $0.09 million in output compared to dams In.	Same as for the full facilities removal.
	• **KMZ-CA – Humboldt and Del Norte counties CA** Employment (Jobs): 71,633 Labor Income: $2,983 million Output: $7,360 million	• **KMZ-CA – Humboldt and Del Norte counties CA** Approximately 13 jobs, $0.42 million of labor income, and $1.12 million of output were estimated to stem from in-region ocean sport salmon fishing related expenditures.	• **KMZ-CA – Humboldt and Del Norte counties CA** Regional economic impacts stemming from the change in in-region ocean sport salmon fishing trip expenditures between the dams in and full facilities removal were estimated to be approximately five more jobs, $0.18 million of labor income, and $0.48 million of output.	Same as for the full facilities removal.
2.8	**Refuge Recreation** **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	Approximately 11 jobs stem from refuge hunting related expenditures and stimulate about $0.26 million of labor income and $0.62 million of output	The change in refuge hunting expenditures between the dams in and full facilities removal was estimated to create 5 more jobs, increase labor income by $0.12 million, and output by $0.27 million compared to dams in.	Same as for the full facilities removal.
2.9	**Reservoir Recreation** **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	Approximately seven jobs stem from reservoir recreation related expenditures. Reservoir recreation related expenditures stimulate about $0.22 million of labor income and $0.54 million of output.	Four jobs would be lost with the change in reservoir recreation related expenditures between dams in and full facilities removal. Labor income and output would decline by $0.13 million and $0.31 million respectively compared to dams in.	Same as for the full facilities removal.

Table 4.4.1-34: Regional Economic Development Impact Analysis Summary Table[1]

	Category	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal (Incremental changes from Dams In) (2012 dollars)
2.10	**Whitewater Recreation** **Economic Region:** Klamath and Jackson counties OR Humboldt and Siskiyou counties CA **Regional Economy:** Employment (Jobs): 224,667 Labor Income:$8,682 million Output: $23,330 million	Jobs stemming from whitewater recreation expenditures made inside the region account for almost 56 jobs. Labor income and output produced by the in region whitewater expenditures account for $1.56 million and $4.31 million respectively.	Jobs stemming from whitewater recreation expenditures made inside the region would decline by 14 compared to dams in; labor income and output would decline by $0.43 million and $0.89 million respectively.	Same as for the full facilities removal.

[1] Impacts are presented as average annual values unless otherwise stated.

Table 4.4.1-35: KBRA Program Regional Economic Development Impact Analysis Summary Table[1]

KBRA Program	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal of Four Dams (Incremental changes from Dams In) (2012 dollars)
Fisheries Program **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	Fishery restoration, reintroduction and monitoring expenditures support 2,015 jobs, $95 million in labor income and $203 million in output.	Increase of approximately 3,917 jobs (average annual of 261), $186.8 million in labor income and $380 million in output.	Same as for the full facilities removal.
Water Resources Program **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million **Economic Region (related to Klamath Project):** Klamath County OR Modoc and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 52,140 Labor Income: $2,082 million Output: $5,498 million	No ongoing activities under the water resources program.	Water resources program expenditures supports 243 jobs (average annual of 16), $11.2 million in labor income and $24.2 million in output. See for Irrigated Agriculture and Refuge Recreation in Table 4.1-13 for effects of KBRA actions.	Same as for the full facilities removal.
Regulatory Assurances: **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	No ongoing activities.	Implementation of regulatory assurances would support 146 jobs (average annual of 10), $7 million in labor income and $14.4 million in output.	Same as for the full facilities removal.

Table 4.4.1-35: KBRA Program Regional Economic Development Impact Analysis Summary Table[1]

KBRA Program	Dams In	Full Facilities Removal (Incremental changes from Dams In) (2012 dollars)	Partial Facilities Removal of Four Dams (Incremental changes from Dams In) (2012 dollars)
County Program: **Siskiyou County CA** Employment (Jobs): 17,679 Labor Income: $755 million Output: $2,107 million **Klamath County OR** Employment (Jobs): 30,525 Labor Income: $1,174 million Output: $3,032 million	No ongoing activities.	$20 million of funding for Siskiyou County would increase jobs, labor income and output. $3.2 million of funding for Klamath County would increase jobs, labor income and output.	Same as for the full facilities removal.
Tribal Program: **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	Karuk Tribal Program expenditures support 237 jobs, $10.5 million in labor income and $16.3 million in output. Klamath Tribal Program expenditures support 174 jobs, $8.7 million in labor income and $14.3 million in output. Yurok Tribal Program expenditures support 208 jobs, $10 million in labor income and $17.8 million in output.	Karuk Tribal Program results in an increase of approximately 122 jobs (annual average of 8), $5.2 million in labor income and $8.3 million in output. Klamath Tribal Program results in an Increase of approximately 120 jobs (annual average of 8), $5.8 million in labor income and $9.6 million in output. Yurok Tribal Program results in an Increase of approximately 144 jobs (annual average of 10), $6.8 million in labor income and $12.1 million in output.	Same as for the full facilities removal.

[1] Economics values reported as total impacts over 15 years. These would be temporary short-term impacts and vary year by year during 2012–2026 proportionate to actual in-region expenditures.

4.4.2 Tribal

This section describes the historic and existing effects of the Four Facilities, as well as potential effects from their proposed removal, on the Indian trust resources, traditional cultural practices, and the physical, emotional, and economic health of the Indian tribes in the Klamath Basin. This section relies primarily on four source documents:

1) *Current Effects on Indian Trust Resources and Cultural Values* (DOI 2012a).

2) *Potential Effects of Implementing the KHSA and KBRA on Trust Resources and Cultural Values* (DOI 2011b).

3) *Economics and Tribal Summary Technical Report for the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon* (Reclamation 2012b).

4) *Klamath Secretarial Determination Cultural Resources Report* (Cardno Entrix 2012).

The U.S. Court of Appeals for the 9th Circuit recognized the importance of fish to area tribes when it concluded that fish were "not much less necessary to the existence of the Indians than the atmosphere they breathed."

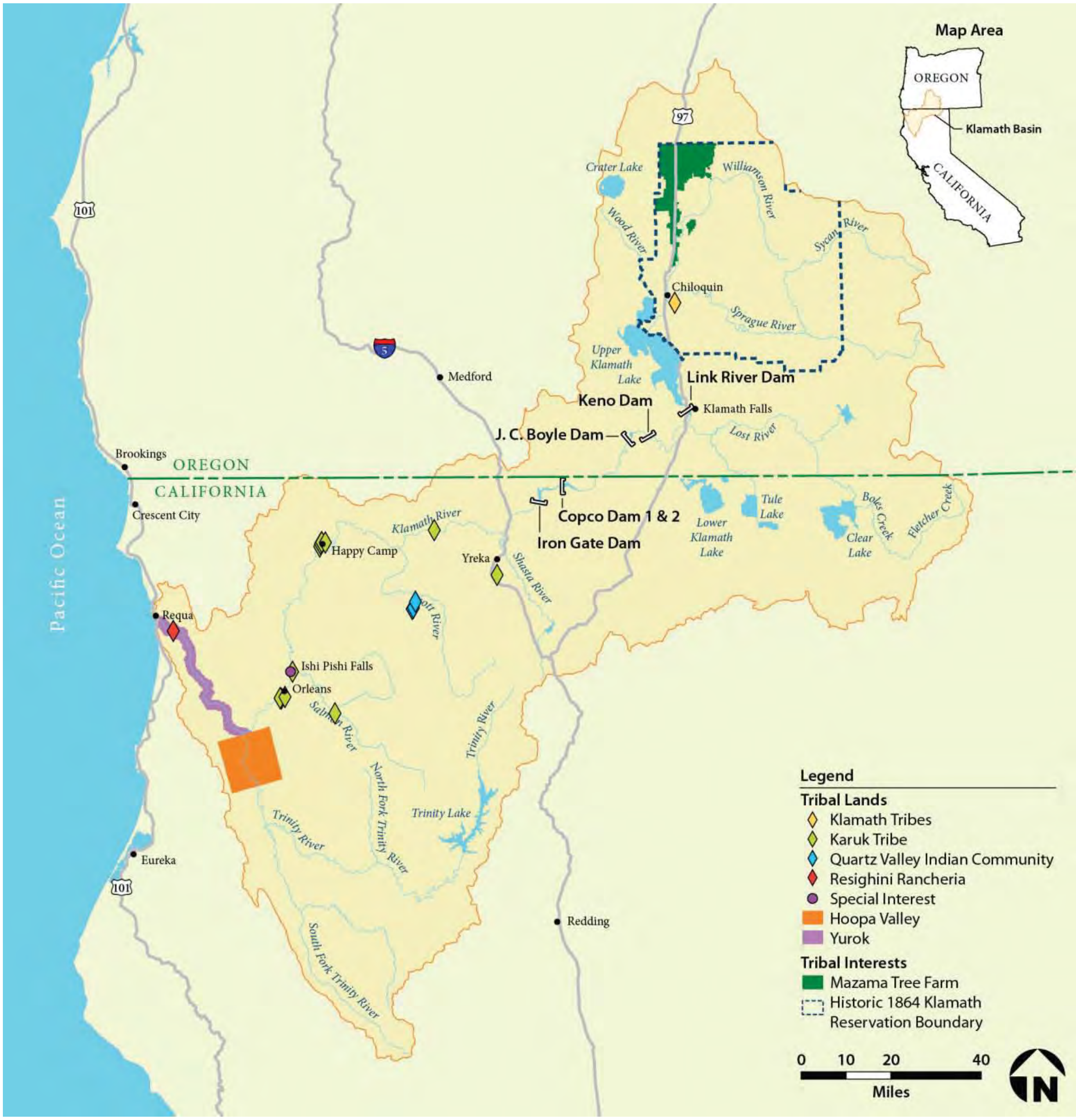
(Blake v. Arnett, supra, at 909 1981)

4.4.2.1 Background

Indian tribes of the northwest coast of California and extending inland through the Klamath Basin are considered to have a "Salmon Culture," characterized by salmon runs and the presence of indigenous people who developed elaborate ways of life and a fish based economy intricately tied to the historical runs of salmon and other fisheries. Klamath Basin tribes have social, cultural, and economic ties to each other due in large part to their shared reliance on the resources, particularly salmon, associated with the Klamath River and its tributaries. This reliance extends beyond subsistence and commerce to the cultural and social fabric of their societies, as evidenced by their traditional ceremonial and spiritual practices that focus on the Klamath River, its fish and wildlife. Salmon far exceeds other resources in its importance to the diet and culture of the Klamath Basin tribes (Swezey and Heizer 1977; Warburton and Endert 1966).

At the time of contact with Euro-Americans in the early 19th century, seven Indian cultures had established aboriginal territories within the Klamath River drainage. The ancestral territory of the Yurok (Yurok Tribe and Resighini Rancheria) included the lowest reach of the river, its mouth, and stretches of the Pacific Coast north and south of the estuary. The Hupa (Hoopa Valley Tribe) were primarily on the Trinity River, a main tributary of the Klamath River. The Karuk (Karuk Tribe and Quartz Valley Indian Community) were most closely associated with the middle reaches of the Klamath River. The Shasta (not federally recognized as a tribe) occupied areas along the Klamath River east of Karuk territory to the location of the California and Oregon border. The Modoc and Klamath, and the Yahooskin Band of Snake Indians (The Klamath Tribes), lived in the upper reaches of the drainage. Figure 4.4.2-1 identifies the current location of the six federally recognized tribal governments within the basin.

4.4.2-1: Map of Current Tribal Reservation Locations, Other Features, and Reserve Areas
(Disclaimer: Tribal reservation and lands are close approximations for general reference purposes only.)



4.4.2.2 Tribal Trust Resources, Rights and Other Resources Traditionally Used by Tribes

There are six federally recognized tribal governments in the study area that are affected by the Secretarial Determination Process: Yurok Tribe, Resighini Rancheria, Hoopa Valley Tribe, Karuk Tribe, Quartz Valley Indian Community of the Quartz Valley Reservation, and The Klamath Tribes.

Based upon treaties, statutes, executive orders, and other regulations, the Federal government has a responsibility to ensure that trust resources and other associated rights are properly managed for the benefit of each federally recognized tribe or individual Indian trust landowner. The Federal government has additional responsibilities as presented in multiple Federal laws and related regulations such as the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et seq.), the CWA (33 U.S.C. §1251 et seq.), National Historic Preservation Act (NHPA) (16 U.S.C. § 470 et seq.), American Indian Religious Freedom Act (42 U.S.C § 1996), Executive Order No. 13007: Indian Sacred Sites, and Executive Order No. 12898 which addresses environmental justice. The Federal government also has an obligation to consult with tribal governments concerning its actions following direction in several executive orders.

Indian trust resources consist of certain real property, natural resources, and related rights held in trust by the Federal government for the benefit of one or more federally recognized Indian tribes or individual Indians. Trust resources attributed to tribes are called “tribal” trust resources, and trust resources attributed to individual Indians (usually called “allottees”) are called “individual” trust resources. Some tribes have the right to use resources that are transitory or migratory in nature and that move beyond the reach of Federal or tribal management (e.g., fish and water).

The nature and scope of tribal rights in the Klamath Basin are defined by treaties, statutes, executive orders, and other laws specific to the individual Indian tribes in the basin, resulting in unique tribal rights to trust resources for each tribe. In the case of the Klamath Basin tribes, the Federal government has the responsibility to safeguard the fishery to ensure that tribes with fishing rights are able to practice those rights. Water quantity and quality are essential for the success of a safeguarded fishery, and in providing for the maintenance of any federally recognized water rights identified for the tribes in the basin. Tribal spiritual beliefs and traditional practices are inseparable from the river and surrounding homeland environments. Although the language spoken and traditional practices sometimes vary among the tribes, all of them derived their cultures, commerce, and subsistence primarily from the river and its aquatic and terrestrial resources (salmon based economy including a barter system related to those resources).

Fish, water, and other natural resources are incorporated into the traditional cultural practices of the tribes in the Klamath Basin. These traditional cultural practices (e.g., ceremonies to insure abundant fish populations and use of water for ceremonial bathing) are intertwined with the resources and are viewed as essential to the survival of the tribes and to the continuation of the natural

Indian Trust Resources

Indian trust resources are property or legal interests that the United States has a legal obligation to manage for the benefit of one or more federally recognized Indian tribes or individual Indians. Indian trust resources can include, but are not limited to, water rights, fishing rights, land, and minerals.

An Indian trust resource has three components:

1. The trustee (the United States)
2. The beneficiary (federally recognized Indian tribes and individual Indians)
3. The trust resource or right

By definition, Indian trust resources cannot be sold, leased, or otherwise encumbered without approval of the United States. The characterization and application of the United States trust relationship have been defined by case law that interprets Congressional acts, executive orders, and historic treaty provisions.

Figure 4.4.2-2: Historical tribal photo of dip net fishing on the Klamath River. (Photo Courtesy of the Karuk Tribe.)

resources. Consequently, degradation of fish, water, and other natural resources is viewed as affecting the spiritual, physical, and mental health of the Indians tribes of the Klamath Basin and has an adverse impact on the tribes' fish based economy and barter system.

Other Resources Traditionally Used by Tribes

Tribes of the Klamath Basin also use resources related to cultural values associated with a tribal way of life (lifeway materials) that may not meet the definition of a trust resource, and may or may not be entitled to legal protection under statute, regulation, or other law or regulation. These resources are referred to as other resources traditionally used by tribes. Each of the six federally recognized tribes in the Klamath Basin has their own set of traditionally used resources that they consider important to the formation and maintenance of their culture that are not considered trust resources by the Federal government.

Cultural Values

Although the tribes of the Klamath Basin share many cultural values, their histories and practices are not necessarily the same. Cultural values related to a tribal way of life centered on rivers and lakes are composed of myriad styles, practices, resources, and items transmitted and evolving through time. Together, these elements define the identities of the six federally recognized Klamath Basin tribes. Cultural values can be described as the unique manner in which tribal people access, take, prepare, administer, and otherwise use their territory, including natural resources, in unique tribal ways. Degradation of these natural resources may lead to a corresponding degradation of those cultures including practices associated with the mental, spiritual, and physical health of the Indian tribes in the Klamath Basin. Cultural values are linked to trust resources, rights, and other resources traditionally used by tribes.

For the tribes of the Klamath Basin, fish are integral to a world view that emphasizes interconnectedness to nature, balance, and mutual respect as guiding principles. The diversity, abundance, distribution, run timing, and health of fish are important indicators of how well such interconnectedness, balance, and mutual respect are being maintained. The seasonal harvests provided sustained access to food that is synchronous with the cycles of nature. Fish are honored in cultural and religious traditions such as the First Salmon Ceremony and the Return of the *C'waam* Ceremony, which traditionally precede the commencement of fishing for spring-run Chinook salmon and suckers, respectively. Fishing itself is a social, economic, survival, and cultural activity; an opportunity to gather food, trade goods (barter), meet with family and friends; to engage in traditional fishing practices; to strengthen community bonds, demonstrate respect and promote food security by sharing fish with elders and others who are unable to fish; and to transmit those traditions to the next generation.

The Klamath Basin tribes have identified culturally sensitive areas that are related to their traditional cultural practices along, and in the vicinity of, the Klamath River. These areas are an integral part of their culture and traditional life ways. The relation of these tribes to the river and access to the river's resources are significant to their culture. A disruption of this relationship, whether due to a reduction in the fishery or a decline in the health of the river and/or access to culturally important sites, affects the ability of Klamath Basin tribes to maintain their economy, traditional practices, and culture. Improving the Klamath River ecosystem by removing obstacles to fish returning to the river would provide opportunities for the Klamath Basin tribes to engage in traditional cultural practices and improve their economic well-being.

Research completed for the Karuk Tribe showed that by 2003 the Karuk diet contained only 1.1 percent the amount of salmon consumed in "pre-contact" times, and the Karuk identified several health issues associated with no or limited access to certain food resources (Norgaard 2004). Other Indian tribes in the area have had similar experiences and health concerns and believe that their high rates of diabetes, heart disease, and related conditions are related to a restricted or lack of access to traditional food resources, primarily salmon, and other aquatic species.

Tribal Importance of Salmon and Other Aquatic Species

The health of the Klamath Basin tribes is directly tied to the health and abundance of the fish, which is, in turn, tied to the health of the rivers. Numerous observers over many decades have noted that salmon far exceed other resources in importance to cultural and religious practices, tribal diets, and barter economies. The abundance of salmon has always been an important measure of tribal well being. Even feasting is not simply an exercise in eating, but has deep-rooted connections to the vitality of the Earth and carries a traditional connotation of community health. The Klamath River fisheries have remained an essential part of the region's tribal economies.

Declining fish stocks have diminished or eliminated the ability of the Klamath Basin tribes to have a salmon based economy and barter system. Additionally, declining fish stocks have reduced the tribes' ability to engage in their fish based ceremonies and other traditional cultural practices. Klamath Basin tribes have subsisted on the salmon and other fish and resources in the Klamath River for centuries. Table 4.4.2-1 summarizes the cultural, ceremonial, and social conditions associated with subsistence fishing under current conditions, and, the projected changes with removal of the Four Facilities and implementation of KBRA.

Table 4.4.2-1: Effects of the Current Conditions and Projected Changes with KHSA and KBRA Implementation Common to all Tribes

	Current Conditions	Projected Changes with KHSA and KBRA Implementation
	Cultural, Socioeconomic, and Health Effects	
Ceremonial Uses	Altered cultural ceremonies (i.e., World Renewal Ceremony, Brush Dance), ceremonial bathing and ceremonial drinking from the Klamath River.	Improved toxic algae conditions would enable tribes to practice their religious ceremonies in the proper ways without the fear of health problems.
Fishing/Fish Consumption	Contact with the water, and consumption of aquatic resources is a health concern because of toxic algae.	Contact with the water and consumption of aquatic resources would reduce health concerns.
Cultural Uses of Vegetation	Reduced availability of vegetation and loss of riparian habitat has made gathering and processing basketry materials more difficult, and water quality health concerns have limited consumption of riverine plants for food and as medicine.	Improved water quality and natural river conditions could increase the availability of edible and medicinal plants and other vegetation used for cultural purposes.

Source: DOI 2012a, 2011b

Water Quality - Health of the River

The Klamath River dams have caused water quality degredation that, in addition to contributing to reduced fish populations, have had cultural and health impacts on Indian tribes. For example, the Karuk World Renewal Ceremony is completed when the medicine man reaches the Klamath River at the end of his long journey and drinks water from the river. Similarly, bathing in the river is an important part of Klamath Basin tribes' ceremonies such as the Brush Dance Ceremony, funeral rituals, and purification rites. Currently, some of these traditional practices do not occur because toxic algae blooms have led to health warnings along the river.

Because of the health warnings posted by the state of California that advise limiting or avoiding consumption of fish from the Klamath River, ingesting aquatic species has become an important health concern. Traditionally, tribes collected fresh water mussels from the rivers of the Klamath Basin. As mussels are filter feeders, they are also affected by water quality and other river conditions.

Other water quality concerns revolve around gathering plants for consumption (including medicinal uses), basketry, barter (trade goods), and other cultural uses. Members of the Klamath Basin tribes collect willow, wild grape, and cottonwood in the riparian zone along the Klamath River and use these materials to make baskets. Traditional collection of these basketry materials can involve wading in the Klamath River and washing and cleaning the materials in the river. After cleaning with river water, most basketry material are then processed using the mouth as a tool. The use of many plants for traditional practices and production of cultural items may pose a health risk. Table 4.4.2-2 summarizes current conditions such as water quality and related effects to the Klamath Basin tribes and beneficial changes associated with dam removal and implementation of the KBRA.

Figure 4.4.2-3: Sampling an algal bloom in Copco 1 Reservoir. The state of California regularly posts public health warnings for these algal blooms due to the presence of the algal toxin microcystin. (Photo Courtesy of the Karuk Tribe.)

Traditional Diet and Health Conditions

With the loss of naturally occurring resources, especially fish, Indian tribal members often have had no choice but to supplement their diets with government-provided subsidies and store-bought food. Studies have found that supplementing or replacing the traditional diets of Indian people is often detrimental to their health, contributing to obesity and related diabetes in Indian populations today (DOI 2011b). U.S. Department of Agriculture food banks, in particular, provide highly processed staples that contain significant amounts of sodium, sugar, and fat. One study in California found that the foods provided by the food programs varied considerably from traditional foods in their nutritional quality, and healthier foods such as fresh fruits, vegetables, and meats were either completely lacking or in short supply (Dillinger et al. 1999). In the past 100 years, poor nutrition is believed to have contributed to diabetes, obesity, and hypertension. Cardiovascular disease is now the leading cause of non-accidental death for Indian tribal members.

Table 4.4.2-2: Effects of the Current Conditions and Projected Changes with KHSA and KBRA Implementation Common to all Tribes

	Current Conditions	Projected Changes with KHSA and KBRA Implementation
	Water Resources	
Hydrology	Unnatural hydrology, hydropower peaking pulses , homogenized flows , increased fish mortality and decreased riparian vegetation	More natural hydrology, no hydropower peaking pulses, natural flushing flows would benefit aquatic species and riparian vegetation
Water Quality	Altered water temperature regime, high nutrients, low dissolved oxygen, high pH	More natural temperature regime and generally improved water quality would benefit aquatic life
Toxic Blue Green Algae	Reservoirs cause proliferation of toxic algae	Free flowing river segments would deter conditions that lead to toxic algal blooms and reduce human health risks
Habitat	Loss of habitat, less suitable water temperature regime, reduced bedload transfer, increased potential for fish disease/parasites	Additional habitat, and of higher quality, would increase abundance of fish and may also decrease the incidence of fish diseases and parasites
Aesthetics	Diminished aesthetics adversely affect opportunities for traditional and ceremonial uses	Improvements in water quality would improve aesthetics and opportunities for ceremonies, funerals, and similar religious observances that require a healthy river
	Aquatic Resources	
Traditional Lifestyle	Extirpation or reduced population abundance of salmon and subsistence fisheries contributes to lost opportunities for transmitting traditional knowledge to successive generations, including the important practice of giving fish to elders. The result has been a weakened sense of tribal identity and a contributing factor to incidences of social dysfunction among Indian populations.	Greater fisheries abundance would bolster opportunities for transmitting traditional knowledge to successive generations, including the important practice of giving fish to elders. Results would include a strengthened sense of tribal identity that could contribute to improving social cohesion and function among Indian populations.
Cultural and Religious Practices	Extirpation or greatly reduced abundance of salmon, sucker, mussel, and other culturally important fisheries has negated, truncated, or diminished some of the intrinsic components of religious ceremonies. Tribal identity has been adversely affected.	Improved abundance would facilitate the ability of the tribes to reinstate and continue to practice ceremonies in their historic, complete forms at the appropriate times of the year. Tribal identity would be improved.
Standard of Living	Reduced abundance of fish and other aquatic species has contributed to less food security for the Indian populations. Cost to purchase salmon in amounts comparable to traditional diets is estimated at over $4,000 per tribal member per year (2005 dollars).	Increased abundance would contribute to greater food security for the Indian population, which could reduce poverty rates.
Health	Reduction in traditional fisheries diet, especially salmon, has been identified as a potential contributing factor to high diabetes, heart disease, and obesity rates (and associated complications) in the Indian populations.	Greater opportunity for healthy food consumption associated with increased subsistence fishing opportunities could improve overall health conditions.

Source: DOI 2012a, 2011b

Importance of Tribal Water Rights

In 1908, the U.S. Supreme Court issued its decision in *Winters v. United States*, 207 U.S. 564 (1908). In that decision, the Court found that the agreement creating the Fort Belknap Reservation impliedly reserved water necessary to irrigate its lands and to provide water for other purposes. Under the *Winters Doctrine*, as it has become known, water rights necessary to meet the purposes of Federal reservations, including Indian reservations and Indian allotments held in trust, have been reserved pursuant to Federal law.

Winters rights – or Federal reserved water rights – have a priority date no later than the date of the treaty, statute, or executive order that established the Federal reservation. *See Arizona v. California*, 373 U.S. 546 (1963). Certain Federal Indian reserved water rights, such as those addressed in the *Adair* litigation (*United States v. Adair*, 723 F.2d 1394 (9th Cir. 1984)) with respect to the Klamath Reservation, may have an aboriginal or "time immemorial" priority. Also pursuant to the *Adair* litigation, if the reservation is established with a purpose beyond agriculture, such as fishing, water is reserved to sustain that use. Federal courts have jurisdiction to adjudicate Indian water rights, which depend on the analysis of treaties, statutes, and executive orders. See *1-19 Cohen's Handbook of Federal Indian Law § 19.05.* The amount of water actually diverted for beneficial use is not the measurement used to quantify Indian water rights. Instead, courts look to the purposes that those water rights are intended to fulfill. *Id*. Unlike state-based water rights in the West, *Winters* rights cannot be lost for non-use under state law concepts such as abandonment or forfeiture.

As a general matter, Federal Indian reserved water rights may attach to a variety of water sources, such as rivers, lakes, and springs, "which arise on, border, traverse, underlie, or are encompassed within Indian reservations." Cohen's Handbook of Federal Indian Law 585 (1982 ed.); *see also* Cohen's Handbook of Federal Indian Law 1176-77 (2005 ed.). The award in *Arizona v. California*, 376 U.S. 340, 344 (1964) recognized, without discussion, that Federal Indian reserved water rights may attach to waters outside of an Indian reservation as necessary to support irrigation on the reservation (Canby Jr. 2009). Also, according to a decision pre-dating *Winters, United States v. Winans*, 198 U.S. 371 (1905), a tribe's treaty fishing rights may not be limited to waters on the reservation. In that case, treaty fishing rights survived subsequent private acquisition of lands bordering the Columbia River. In the on-going Klamath River adjudication in the State of Oregon, the United States and the Klamath Tribes filed claims to support the fishing rights reserved to the Klamath Tribes in their 1864 Treaty, both in areas within the former Klamath Reservation as well as in areas outside the former Reservation.

To date, only the Federal Indian reserved water rights of The Klamath Tribes, both as part of the *Adair* litigation and now as part of the on-going Klamath River Adjudication in Oregon, have been the subject of a water rights adjudication within the Klamath Basin. No claims were filed by or on behalf of the California tribes as part of the Oregon adjudication, and no adjudication in California has addressed the nature and extent of the *Winters* rights of the California tribes. In other contexts, DOI has opined generally in support of

Winters rights to support the reserved fishing rights of the Hoopa Valley and Yurok Tribes, and the DOI has also recently implemented a new instream flow regime in the Trinity River based on these rights as well as related statutory directives.

Potential Effects of Dam Removal and KBRA on Tribal Water Rights

KBRA Section 15.3 and related provisions provide certain assurances related to Reclamation's Klamath Project operations in Oregon and directly tie into claims filed as part of the Oregon adjudication. As noted above and as referenced in these KBRA sections, the only tribal water rights being litigated there involve claims filed by the United States and The Klamath Tribes, not to any other Indian tribe in the Klamath Basin. Under the KBRA, these claims--to Upper Klamath Lake (Case 286 in the Oregon adjudication) and to the Klamath River from the Lake to the Oregon border (Case 282)--will be subordinated in relation to the Reclamation's Klamath Project as specified in the KBRA. In particular, Section 15.3.9 (the KBRA "no-call" provision) affects the ability of the United States or other parties to alter Reclamation's Klamath Project's water budget in the future if the Secretary were to make an Affirmative Secretarial Determination regarding dam removal, the KBRA were implemented, dams were removed, and certain KBRA conditions were met.

As important (and controversial) as this Section of the KBRA has been in relation to tribal water rights, it is also important to emphasize what this Section does not do. First, no provision of the KBRA waives or releases water, fishing, or any other rights in California held by the United States or any Indian tribe, something reaffirmed by KBRA Section 15.3.2.A. Second, nothing in that section or any other part of the KBRA determines any tribal rights in California. Third, the KBRA does not affect the ability of the California tribes or others to challenge or limit other users in Oregon as may be appropriate. Fourth, nothing in the KBRA or otherwise affects the ability of California tribes to continue exercising whatever rights they have, in the interim or otherwise and with or without an adjudication or negotiated settlement to define their rights with specificity. Fifth, nothing in the KBRA affects the ability of the United States or any other tribe to develop and assert water rights claims in California in the context of a state adjudication or other action. Sixth, the DOI has also committed to identify other potential mitigation tools, including additional releases from Trinity Reservoir, as necessary to protect Trinity River-based fishery resources as well (KBRA Section 2.2.12).

Finally, whether or not the KBRA becomes law and gets implemented, the United States will not have unfettered discretion to alter Reclamation's Klamath Project operations in the future. Even in the absence of the KBRA, the Oregon adjudication will ultimately determine both claims related to Reclamation's Klamath Project operations as well as claims filed by the United States and The Klamath Tribes for Upper Klamath Lake and the Klamath River in Oregon. Thus, Reclamation's Klamath Project diversions and associated Klamath River flows from Oregon will be defined either through an adjudicated decree or through a negotiated settlement and not by determinations of the DOI and its agencies.

4.4.2.3 Tribal History, Historical and Current Effects of Dams, and Effects of Dam Removal

The Klamath Tribes

The Klamath Tribes are federally recognized and are composed of three historically separate tribes: the Klamath Tribe, the Modoc Tribe, and the Yahooskin Band of Snake Indians. The current membership is about 3,700. The Tribes current land base is approximately 600 acres.

For millennia, these tribes occupied the entire Upper Klamath Basin and adjacent interior drainages to the east, living in close association with the marshes and riverine resources of this area. The Yahooskin people principally occupied lands east of the Klamath Basin, but often participated with Klamath and Modoc in multi-tribal resource harvests, including salmon and steelhead harvests, on the Sprague River and other Klamath River tributaries. Archaeological evidence and tribal oral tradition suggest an unusually long period of occupation within the Upper Klamath Basin, far predating the eruption of Mount Mazama (now Crater Lake) some 7,700 years ago. (DOI 2012a, Deur 2004; Gatschet 1890; Spier 1930)

By the 1820s, Euro-American fur trappers working for the Hudson's Bay and North West Companies began making forays into southwestern Oregon and northern California, initiating the first direct cross-cultural contacts with the Klamath, Modoc, and Yahooskin. Despite the violence between the Euro-Americans and Indians that occurred in the Pacific Northwest and northern California from the 1840s through the 1860s, The Klamath Tribes remained relatively buffered from Euro-American occupation, and their affluence and influence with other tribes arguably grew throughout the region into the mid-19th century. (DOI 2012a; Gatschet 1890; Spier 1930)

Still, American influence was expanding, and the United States government was eager to negotiate with the tribes to open the majority of their lands for settlement and to contain the strategic threats of these relatively large and powerful tribes. This led to a treaty council near modern-day Fort Klamath, where the Klamath, Modoc, and Yahooskin Band of Snake Indians signed The Klamath Tribes Treaty of 1864 on October 14 (16 Stat. 707) which ceded tribal lands to the United States. These ceded lands included much of south-central Oregon as well as portions of north-central California. Based on the language of the treaty, from that point on the three signatory populations—Klamath, Modoc, and Yahookskin—were together called The Klamath Tribes.

Reserved from the Tribes' land cessions was roughly 2.2 million acres of their ancestral lands—the Klamath Indian Reservation. This was the largest reservation in the state of Oregon and was created from the lands of the Klamath Tribe. In this treaty, The Klamath Tribes reserved the rights to hunt, fish, and gather plants in perpetuity. A number of Modocs resisted relocation to the newly formed Klamath Reservation and soon chose to return to their homeland under the guidance of Modoc chief Kintpuash, called by the non-Indians Captain Jack. U.S. authorities sought to return them to the reservation.

Conflicts quickly escalated, culminating in the Modoc War of 1872–1873. Finally, after a long standoff in the lava beds of northern California, the Modoc were captured, their leaders hanged, and some portion of the combatants sent to Oklahoma. Today, a relatively small population of Modoc still live in Oklahoma as part of the federally recognized Modoc Tribe of Oklahoma while the majority of the Modoc descendants are enrolled with The Klamath Tribes (DOI 2012a).

In its first decades, the Klamath Reservation was resurveyed multiple times, and Federal agents disposed of portions of the reservation lands incrementally under a variety of authorities (some legitimate and some demonstrably fraudulent). For 20 years, The Klamath Tribes lived on their reservation under the terms of the 1864 treaty. In 1887, Congress passed the General Allotment Act, which fundamentally changed the nature of land ownership on the Klamath Reservation. Under the allotment system, approximately 25 percent of the original Klamath Reservation passed from tribal to individual Indian ownership. Over time, many of these individual allotments passed into the hands of non-Indians. (http://users.sisqtel.net/armstrng/Indupper_klamath.htm)

The U.S. Government wanted to build a military road across the reservation and granted a private land company a checkerboard of Reservation land sections for this purpose. Later it was decided not to build the road and an act of Congress dated June 21, 1906, authorized the Secretary of the Interior to exchange unallotted lands in the reservation for the lands earlier conveyed. On August 22, 1906, an agreement between the Secretary of the Interior and the land company re-conveyed the checkerboard acres to the United States, and in return the government conveyed 87,000 acres of unallotted lands to the company. The Klamath Tribes claimed the transfer was made without fair compensation. The Federal courts stated that the obligation of the United States to make good on the Tribes' loss was a moral one, because the government's dealings with Indian tribes are not subject to judicial review (United States v. Klamath and Modoc Tribes, 304 U.S. 119, 58 S.Ct. 799, 82 L.Ed. 1219 (1938)). (Ibid.) By the early 20th century, the reservation had been reduced to about 1.1 million acres, or roughly half the size specified in the treaty. The arrival of the railroad in 1911 finally allowed for the rapid integration of the Klamath Reservation into the larger national economy, bringing a rapid increase in timber harvesting and cattle ranching on the Reservation. A growing number of tribal members moved to the railroad and mill town of Chiloquin from elsewhere on the Reservation, and the Tribe entered a period of prosperity that set it apart from most other Indian tribes of the region. In spite of rigorous Federal efforts to encourage The Klamath Tribes to participate in modern economic activities, most Indian families continued to utilize a mixed economy. Primarily, they engaged in wage labor while seasonally continuing to harvest fish, game, and plant materials, both on- and off-Reservation. Often hidden from the view of Indian agents, traditional ceremonial activities continued to be practiced among certain families of The Klamath Tribes. In this context, by most oral accounts, the completion of the Copco Dam in 1917 and the resulting loss of anadromous fish had disastrous effects on The Klamath Tribes' ability to continue to participate in the mixed economy. Coinciding events, for example, the influenza pandemic of

1918–1921, brought disproportionately high mortality to the Reservation community, which a number of tribal members attribute to the concurrent and abrupt dietary shift away from anadromous fish to the then recently introduced high carbohydrate foods. (Deur 2004; DOI 2012a)

By the mid-20th century, intensified Federal efforts at cultural assimilation served to compound the social and economic changes previously introduced to The Klamath Tribes by Reservation life. In 1954, as part of a nationwide effort to assimilate Indian tribes into the cultural and economic mainstream, the Federal government, passed the Klamath Termination Act (25 USC §564, et seq.) The Klamath Tribes was one of the federally recognized tribes chosen for "termination." The Klamath Tribes were chosen in part because of their self-sufficiency, enabled by the timber, grazing, and other values on their Reservation lands. Ironically, termination involved taking from the Klamath Tribes the very lands that enabled their self-sufficiency.

Under this Act, tribal members could give up their interest in tribal property for a cash payment, which a large majority of the tribe chose to do, while others chose not to accept this condition. Those "withdrawing" received a per capita payment for their interest in the Reservation. In order to meet the cash obligation for those who accepted the payment, the United States divided the Reservation into large timber tracts, intending to sell them to private timber companies. However, for various reasons, only one such tract was actually sold, and the government found it impossible to dispose of the others. In 1961, the United States purchased much of the former Klamath Reservation. After paying those who gave up their interest, the remaining balance of Reservation land was placed in a private trust with the U.S. National Bank, Portland, Oregon for the 474 "remaining" tribal members who had not accepted payment. The "remaining" members then voted in 1969 to dissolve this trust and receive a per capita distribution from the sale of their 135,000 acres. In 1973, to complete implementation of the Klamath Termination Act, the United States condemned most of the tribal land held in trust. Payments from the condemnation proceeding and sale of the remaining trust land went to "remaining" Indians still enrolled in the tribe. They received an initial payment in 1974 and a second payment in 1980. This final distribution of assets essentially extinguished the original Klamath Reservation as a source of tribal property.

Even though The Klamath Tribes currently hold very little of its former Reservation, the United States still holds title to much of the former Reservation lands. In 1958 the Government purchased approximately 15,000 acres of the Klamath Marsh, in the heart of the former Reservation, to establish a migratory bird refuge under the jurisdiction of the United States Fish and Wildlife Service. In 1961 and again in 1973, the Federal government purchased large forested portions of the former Klamath Reservation. This forest land became part of the Winema National Forest under the jurisdiction of the United States Forest Service. By these two purchases, the Government became the owner of approximately 70% of the former Reservation lands. The balance of the Reservation is now in private, Indian and non-Indian, ownership either through allotment or sale of Reservation lands at the time of termination.

Klamath Tribes Adjudication

The Klamath Tribes retain a right to in stream water quantities in areas above the Klamath Hydroelectric Project in Oregon at levels that are sufficient to support fishing and other harvest rights on former Reservation lands, as affirmed in the 9th Circuit Court of Appeals' decision in United States v. Adair, 723 F.2d 1394. The magnitude of this water right is being adjudicated by the State of Oregon and an initial ruling is expected by December 2012. If there is a Negative Secretarial Determination, the United States Government, the Klamath Project Water Users (as defined in the KBRA), and The Klamath Tribes have a year to conclude a new agreement that would maintain the water rights forbearance arrangements under the KBRA. If those talks are unsuccessful, The Klamath Tribes would have the option under the KBRA to exercise their water rights, which could have a large implication on water deliveries in the upper basin depending on the outcome of the adjudication.

Termination ended The Klamath Tribes' status as a federally recognized tribe, dissolved the federally nexus to their tribal government, and nullified some Federal fiduciary responsibilities to the tribal community. It did not, however, dissolve the Tribes' own government and social organization nor, did it convert Indians into non-Indians. The social, economic, and cultural implications of termination were both significant and complex and are generally viewed as dire by members of The Klamath Tribes. Reservation employment and benefits disappeared, and access to traditional lands and resources were quickly denied by the new "owners". Control over irrigation water supporting tribal farms diminished and agency infrastructure was privatized and fell into non-Indian control (http://users.sisqtel.net/armstrng/Indupper_klamath.htm). Once a model of economic self-sufficiency, many former members of The Klamath Tribes were now impoverished.

Despite termination, The Klamath Tribes retained their identity and their members continued to advocate for tribal rights. In the 1970s, tribal members obtained judicial recognition which reaffirmed their continuing legal right to hunt, fish, trap, and gather on the lands of the 1954 Klamath Reservation (Kimball v. Callahan, 493 F.2d 564 (9th Cir. 1974)), as well as the right to sufficient water to support the exercise of those rights (United States v. Adair, 723 F.2d 1394 (9th Cir. 1984)).

Less than a decade after implementation of the termination policy, the United States reversed course and began a process of reinstating tribal governments that were previously terminated. At the same time, witnessing the corrosive impacts of this social experiment on The Klamath Tribes, certain individuals and families began to organize with the aim of restoring tribal status. On August 26, 1986, they were successful: The Klamath Tribes officially regained Federal recognition under the Klamath Restoration Act (25 USC §566, et seq.). Ownership of their former Reservation, however, was not restored, and tribal efforts to regain a land base have continued without interruption since that time. The Klamath Tribes are now acquiring lands in the former Reservation whenever and wherever they can and placing them in Federal trust.

Today, The Klamath Tribes are experiencing a cultural and economic revival, as poverty levels decline and tribal members take a growing interest in preserving their cultural traditions, including traditional subsistence practices and related ceremonies (Deur 2011a; DOI 2012a). They employ hundreds of people in an elaborate tribal government that provides a wide array of services to the membership and maintain active natural and cultural resources departments.

Figure 4.4.2-4: Klamath Tribal Elder, Betty Blackwolf, prays for the c'waam at the Annual Return of the c'waam Ceremony on the banks of the Sprague River. Creator- (G'mokumpk) told the Native people to honor the c'waam after the first snow of each year and that if the fish are healthy, the people and the land will be healthy.

Unemployment in The Klamath Tribes

The unemployment rate for The Klamath Tribes was 21% in 2005 for Indians in the BIA service area, or Klamath County (BIA 2005). Based on 2000 Census data that appears to be unchanged through 2009, between 30 and 40% of the Indian population in Chiloquin, surrounding areas, and Klamath County (the BIA service area) was in poverty, a rate two to three times higher than the general population in the same areas. Unemployment was about 22% for the Indian population in Chiloquin; this was three times higher than the total population percentage in Klamath County and roughly five times higher than the State of Oregon (Reclamation 2011e).

Figure 4.4.2-5: Fire and blessings at Klamath Tribes return of the c'waam Ceremony. Once an important part of the Klamath Tribes' diet, the c'waam (Lost River sucker) fishery was closed in 1986 due to severe population declines and was listed as endangered under the ESA in 1988.

Figure 4.4.2-6: The Klamath Tribes taking part in a traditional Powwow. Improved fish abundance with dam removal would strengthen ceremonial practice improving tribal identity.

Historical and Current Effects of Dams on The Klamath Tribes

The construction of Copco 1 Dam, completed in 1917, blocked anadromous fish runs into the upper Klamath Basin and disrupted The Klamath Tribes' access to anadromous fish. Other major fisheries available to The Klamath Tribes are resident salmonids ("trout") and catostomids (suckers). The catostomid fishery consisted primarily of *c'waam* (Lost River sucker) and *koptu* (shortnose sucker). The Klamath Tribes closed their fishery in 1986 to protect it in the face of severe population declines and these two species of suckers have been listed as endangered under the ESA since 1988.

The Klamath Tribes retain a right to in stream water quantities in off-Reservation locations at levels that are sufficient to support fishing and other harvest rights on former Reservation lands, as affirmed in the 9th Circuit Court of Appeals' decision in *United States v. Adair*, 723 F.2d 1394. The magnitude of this water right is currently being adjudicated by the State of Oregon and a ruling is expected by December 2012. A number of ritual traditions of The Klamath Tribes depend on access to clean water from natural sources for the ritual purification of people, places, and objects, and in rituals associated with drought abatement and other environmentally restorative activities. Although tribal members sometimes acquire water for these purposes from the Klamath River canyon area, this water is currently viewed as being inappropriate for ritual uses because of its temperature, growth of algae, and other issues of water quality.

In 1907, prior to dam construction, elders of The Klamath Tribes and non-Indian settlers in the area state that salmon were present upstream from Klamath Lake as far as the Sprague and Williamson rivers. Anthropologist Leslie Spier also reports that salmon "ascend all the rivers leading from Klamath Lake...going as far up Sprague River as Yainax, but are stopped by the falls below the outlet of Klamath marsh." This historical report is corroborated by more recent studies (Hamilton *et al*., 2005; Butler *et al.,* 2010). Salmon and steelhead have not been present in the area upstream of the Klamath River dams in approximately 90 years.

Salmon, steelhead, suckers, lampreys, redband trout, and fresh water clams and mussels, continue to be symbolically and culturally important to members of The Klamath Tribes. Tribal members continue to use traditional salmon and steelhead fishing stations downstream of the Klamath Hydroelectric Reach for subsistence purposes, ceremonial activities, historical memorialization, and a place to instruct children on tribal history and culture. Resources that were once harvested secondarily to the salmon and steelhead harvest have now become the focus of subsistence activity at these stations, and tribal members still use certain historical campsites at these stations during subsistence, social, and ceremonial activities. In addition to ritual activities "to bring back the salmon," The Klamath Tribes' tribal government continues to explore legal and administrative options to achieve the same goal of fish return.

Potential Effects of Dam Removal on The Klamath Tribes

As described above, hydrology and water quality throughout the Klamath River are important for supporting aquatic ecosystems and the fishery as well as the many cultural activities of The Klamath Tribes. These cultural activities include conducting traditional bathing ceremonies, participating in tribal fishing rights, and valuing the aesthetic qualities of the river.

Currently, algae are a major problem associated with the use of the Klamath River by The Klamath Tribes. Algae degrade water for recreational and ceremonial uses, and can produce toxins hazardous to fish, clams, mussels, and humans. Removal of the dams and reservoirs along the Klamath River and implementation of the KBRA would provide for a fishing site downstream of Iron Gate Dam for The Klamath Tribes; restoration of sucker and fish passage to Upper Klamath Lake; improvements in water quality; and would allow The Klamath Tribes to fish, conduct traditional bathing ceremonies, and enjoy the aesthetic qualities of the river. Implementation of the KBRA would also provide funding to The Klamath Tribes for restoration projects, purchase of the privately owned Mazama Tree Farm property, and could create jobs for tribal members.

Chinook salmon, coho salmon, steelhead, suckers, and Pacific lamprey have been the main historic food sources for The Klamath Tribes. The removal of dams on the Klamath River and implementation of the KBRA would likely increase these fish populations over time, which would benefit The Klamath Tribes by facilitating the continuation of traditional ceremonies and practices and providing the opportunity to improve their standard of living through more stable subsistence fisheries. The Klamath Tribes assert that an increase in fish could improve the health of tribal members by increasing salmon in their diets; providing employment; reducing social problems; and, improving tribal unity by reducing the number of tribal members leaving the Reservation.

Unemployment in the Karuk Tribe

According to a 2005 BIA Labor Force Report, unemployment for the Karuk area Indian population was 63%. Census 2000 data for the Karuk Reservation showed an unemployment rate that was about two to three times that of the general population in Siskiyou County with greater disparities for Indian area populations. The Karuk Reservation had the lowest per capita income of all surrounding areas, at half or less than that of other areas, particularly for the Indian population. More than half the population was in poverty in 2000, and the 2009 estimate has increased to about 60% and previous Tribal surveys have placed it as high as 80%. The Census 2009 estimates for Reservation unemployment indicate rates that could have increased to about three to five times higher than surrounding area general population rates (Reclamation 2011d).

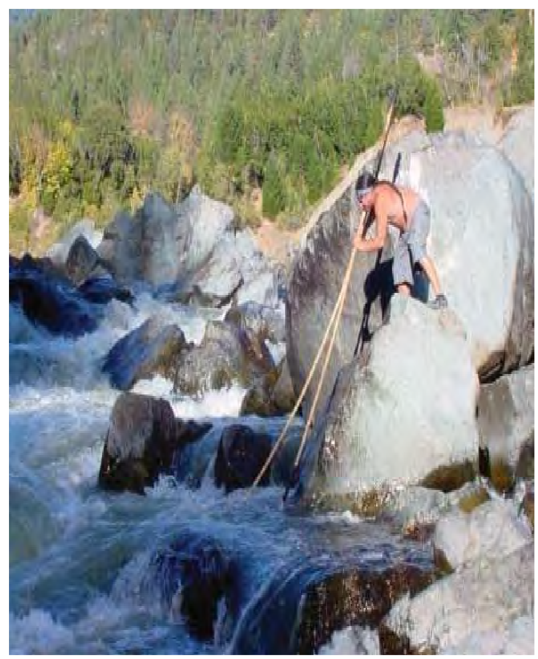
Karuk Tribe

The Karuk began efforts in 1978 to receive Federal government recognition. In November 1978, the Bureau of Indian Affairs Central Office (BIA) staff conducted a field trip to Northern California. The BIA determined that the aboriginal sub entities of the tribe consisted of three communities located in Happy Camp, Orleans, and Siskiyou (Yreka). See 13 IBIA 76, 78; 1985 WL 69127 (I.B.I.A.). The Assistant Secretary for Indian Affairs, in a memorandum entitled "Revitalization of the Government-to-Government Relationship Between the Karok (sic) Tribe of California and the Federal Government," notified the local offices of the Bureau of Indian Affairs on January 15, 1979, that:

> Based on the findings collected . . ., the continued existence of the Karoks as a federally recognized tribe of Indians has been substantiated. In light of this finding, I am directing that the government-to-government relationship, with attendant Bureau services within available resources, be re-established.

The Karuk Tribe has been federally recognized since 1979 (DOI 2012a). The Tribe's ancestral territory was about 1.4 million acres along the middle section of the Klamath River. The Karuk do not have a legally designated reservation but

Figure 4.4.2-7: Members of the Karuk Tribes still use traditional dip net fishing at Ishi Pishi Falls on the Klamath River. (Photo Courtesy of the Karuk Tribe)



the Tribe owns about 851 acres of small, widely scattered parcels in trust status along the middle section of the Klamath River, downstream of Iron Gate Dam. In the 2000 U.S. Census, tribal membership was 2,702 (Ibid). Today, the Karuk are one of the largest tribes in California, with approximately 4,800 members. The Karuk maintain a downriver office in Orleans, Humboldt County; a middle office in Happy Camp, Siskiyou County; and an upriver office in Yreka, Siskiyou County.

The Tribe acquired land in trust in 1979 via Gift Deed from the State of California to the United States for land located in Happy Camp, California. In 1987, the Tribe also acquired several parcels of land now held in trust in Happy Camp, California. Additionally, the Tribe acquired a parcel of land located in Yreka, Siskiyou County that was then accepted in trust by the United States for the benefit of the Tribe on April 26, 1989. In addition to the properties detailed above, the Tribe, throughout the 1990s and 2000s, acquired numerous other parcels of land in Siskiyou and Humboldt Counties, that are now held in trust and in 1997 the Tribe acquired land that is contiguous to the Tribe's 1989 Trust Land.

Origins of the Federal government's relationship with the Karuk Tribe are found in the negotiation of 1851 treaties between the United States and the various tribes of California. Unlike The Klamath Tribes, Congress never formally ratified the treaty negotiated between the United States and the Karuk Tribe and most of the Tribe's aboriginal lands along the Klamath River, above the Klamath Trinity Confluence, now form part of the Klamath National Forest.

The Karuk Tribe is known as the 'Fix the World People' due to their central role in the regional annual Pikiawish or World Renewal Ceremonies. Pikiawish traditionally began with the First Salmon Ceremony in the spring, followed by additional ceremonies in the summer and fall. The First Salmon Ceremony, which marked the arrival of spring-run Chinook salmon, was conducted downstream of the mouth of the Salmon River. The ceremony signaled the end of the winter steelhead season and the beginning of the salmon season. Although the Karuk Tribe has experienced a cultural revival and has been able to revive most ceremonies, they have not been able to reinitiate the First Salmon Ceremony at the correct time of year because of generally low numbers of spring-run Chinook salmon.

Any tribal share of the fishery and concomitant water rights to which the Karuk Tribe may be entitled have not yet been determined. The Karuk still fish for salmon at Ishi Pishi Falls using traditional dip nets. This fishery is recognized and permitted by the state of California.

Historical and Current Effects of Dams on the Karuk Tribe

Dam construction and operations have led to a reduction in spawning habitat and many other changes in the river system, such as water quality, water temperature, and flow regimes, which have affected the Karuk Tribe. These changes have created an environment in which it is difficult for many fish species to flourish. In addition to environmental effects, the changes in the river caused by the dams have been attributed by the Tribe to diminished physical, mental, and social health of the Karuk Tribe. Tribal ceremonies have been altered, not because of the lack of knowledge, but because of the lack of resources that were abundantly available before the Klamath Hydroelectric Project. The resources ranged from food to animals and birds used for regalia, to specific aquatic resources prescribed by the physical acts of the ceremonies (Craig Wood Reporting 2011).

Figure 4.4.2-8: Traditional Karuk tribal smokehouse. Greater fisheries abundance would bolster transmission of traditional knowledge to youth, including the important practice of giving fish to elders.

Regardless of the legal status of the Karuk fishery, the lack of fish in the local economy has been seen as having an effect on general tribal health and cultural well-being. The Karuk Tribe emphatically asserts that resources traditionally used by the tribe are affected by the current dam operations. During a government-to-government consultation, tribal representatives stated that water quality and fish returns have diminished and tribal members' quality of life has declined because of degraded water quality. Tribal members rarely bathe in the river, and, in an area with fewer available fish, they are likely to consume less of the traditional food base and pay less attention to the culturally inherited management traditions of a "Salmon People."

A person who is considered a member of the "Salmon People" has inherent responsibilities dependent on his or her specific participation in the Pikiawish. The Karuk social system depends on the handing down of cultural practices to the next generation. Creation stories, ceremonies, and daily activities are passed down generation to generation to ensure the next generation's physical and spiritual well-being.

The Karuk Tribe not only identify the water and the salmon fishery as tribal trust resources, but also as traditional food base species. These include Pacific lamprey, sturgeon, steelhead, resident trout, suckers, freshwater mussels and clams, regalia materials, and artisan species, and terrestrial animals associated with the river. The loss of these species and the resultant harvest opportunity are attributed to dramatic increases in diet related diseases among tribal members, such as heart disease, strokes, diabetes, obesity and mental illness such as depression.

Since the construction of the dams on the Klamath River, the numbers of a variety of river species have plummeted. Some of these species have traditionally been a source of food and used for cultural ceremonies and practices for the Karuk Tribe, as well as a means of trade and income. In addition to salmon declines, steelhead, sturgeon, and other fishes (such as suckers and lampreys), as well as clams, mussels, and other aquatic species, are also experiencing declining populations. These impacts are directly attributed to the effects of the dams on water flow and temperature and on the river environment, including accumulated toxicity in mussels and the contamination of plants growing adjacent to waterways, which tribal members process as basketry materials by passing them through their mouths. Moreover, the dams play a fundamental role in the life cycle of myxozoan parasites that infect and kill many fish. The tribe has also noticed a down river increase in invasive species such as bluegill, catfish, bass, sunfish, and perch, which thrive in the reservoirs.

For the Karuk, one of the most significant impacts of the Klamath dams is the way that the natural process of seasonal warming and cooling trends in the river is altered by the presence of the reservoirs. In effect, the reservoirs create a “thermal lag” in both the spring and the fall. This means that the river warms more slowly in the spring and cools more slowly in the fall. The result of these thermal effects is a delay in timing of migration of both juvenile and adult spring-run and fall-run Chinook salmon as well as an overall decline in their numbers. For Karuk, this translates into a near-zero opportunity to fish for spring-run Chinook salmon and a significantly shorter fishing season in the fall. In addition to limiting the number of fall fishing days, the opportunity to harvest spring-run Chinook salmon has been completely lost to the Karuk since construction of Iron Gate Dam in 1958.

Potential Effects of Dam Removal on the Karuk Tribe

Under the dams out scenario, fish and invertebrate populations will benefit through increased habitat, more suitable water temperature regimes, substrate movement affecting spawning habitat, improved water quality conditions, and less suitable conditions for the spread of diseases and parasites. These improved fish and invertebrate populations would be indicative of a healthier ecosystem. The traditional food base, regalia, and other symbolic ceremonial species should, over time, become adequate for subsistence and ceremonial needs. It is not only fish and aquatic invertebrates that are affected by the Klamath River; riparian vegetation and terrestrial resources that depend on aquatic resources for food are affected by the heavily managed and modified Klamath River. These resources would also benefit from the dam removal.

Populations of Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey are expected to increase, with a higher likelihood of viability in the Klamath River. Dam removal, with the KBRA, would reduce stress on the fishes and may be sufficient to bring the listed species to recovery. The KBRA would also provide funding to the Karuk Tribe for restoration projects and could create jobs for tribal members.

Under the dams out scenario, anadromous fish would no longer be restricted to the lower reaches of the Lower Klamath Basin. Removing the dams would restore historical access to at least 49 tributaries upstream of Iron Gate Dam providing for at least 420 miles (675.92 km) of additional habitat for anadromous fish (DOI 2007), including groundwater-fed areas resistant to water temperature increases caused by changes in climate (Hamilton et al. 2011). In addition, the mainstem downstream of Iron Gate Dam would reflect natural temperature regimes (Hamilton et al. 2011).

A successful anadromous fish restoration program has the potential to increase fish production by allowing anadromous fish to use historical production areas within and upstream of the Klamath Hydroelectric Project and would restore access to important thermal refugia, most notably in the J.C. Boyle Bypass Reach and in tributaries upstream of Upper Klamath Lake. Restoration of anadromous fish upstream of Iron Gate Dam could restore tribal and recreational fisheries over a very large geographical area.

This increase in anadromous fish populations means that piscivorous (fish-eating) birds and animals would benefit in terms of having increased food resources. With dams removed, flows will more closely mimic a natural hydrograph. The flows will change the geomorphology of the lower river, benefit riparian vegetation recruitment, increase river habitat heterogeneity, which provides higher quality basket-making and artisan materials, increase instream fish habitat structures, increase food web support, and improve water quality as described above. Benefits to the Klamath River and to the habitat and terrestrial species that depend on the Klamath River will occur.

It is the Tribe's belief that an increase in fish could improve the overall health of tribal members by increasing the salmon in their diets; providing jobs; decreasing social problems associated with the loss of the tribe's historical environment; and improving the sense of tribal unity by reducing the number of tribal members leaving the reservation.

Quartz Valley Indian Community

The Quartz Valley Indian Community of the Quartz Valley Reservation is a federally recognized tribe representing people of Middle Klamath (Karuk) and Shasta Indian ancestry. The Reservation was approved June 15, 1939, under the authority of the Indian Reorganization Act (Wheeler-Howard Act) of June 18, 1934 (DOI 2012a). A Tribal Constitution and by-laws were approved on the same day "in order to establish a community organization, to conserve and develop our lands and resources and to promote the welfare of ourselves and our descendants." (BIA 1939)

The original Quartz Valley Reservation was near the present-day Reservation but was terminated in the 1960s. In 1983, the termination was declared unlawful and the Reservation was legally reinstated (Stipulation and Order, *Tillie Hardwick et al. v. United States,* No. C-79-1710-SW [N.D. Cal. 1979]). The existing Quartz Valley Reservation is located in Siskiyou County near the community of Fort Jones. The population is around 126, with a tribal enrollment of about 150. Total Reservation size is 174 acres.

Some tribal members are descendants of the same tribal leaders that signed onto the unratified 1851 "Treaty R" negotiated between Indian Agent Redick McKee and Indian inhabitants of Scott Valley and the upper Trinity and Klamath rivers.

Historical and Current Effects of Dams on the Quartz Valley Indian Community

The Quartz Valley Indian Community does not have a reserved right to the Klamath River fishery. The tribe is not reliant on Klamath River water, nor does it retain Klamath River reserved water rights. The tribe's land base is not along the Klamath River but on a tributary to the Scott River, which is a tributary to the Klamath River. Therefore, there are no primary effects on Quartz Valley

Reservation trust resources, although there are effects on those Quartz Valley Reservation resources traditionally used by the tribe to maintain health, cultural values, and tribal well-being.

Traditionally used fish resources of the Scott River include Chinook salmon, coho salmon, steelhead and Pacific lamprey. The Quartz Valley Indian Community relies on these fish for sustenance and their spiritual wellbeing. These fish need to survive their migration through the Klamath River to and from the ocean. Therefore, the tribe has an interest in the health of the Klamath River.

Any Klamath River fishing and concomitant water rights to which the Quartz Valley Indian Community may be entitled have not yet been determined. However, members have historically fished for salmon, steelhead and eels (Pacific lamprey) in the Scott River and Shackleford Creek.

Despite the lack of a recognized fishing right by the United States or the state of California, many members of the tribe fish on the Klamath River, often with Karuk tribal members to whom many are related, and have done so in an unbroken tradition dating back to time immemorial. The Quartz Valley Indian Community consequently shares many of the same concerns expressed by the Karuk Tribe. Changes in the river caused by the dams have diminished the physical, mental and social health of tribe. Current operations of the four Klamath River dams adversely affect the resources traditionally used by the Quartz Valley Indian Community and, by extension, their cultural values.

Potential Effects of Dam Removal on the Quartz Valley Indian Community

Removal of the dams and implementation of the KHSA and KBRA, would, in the long-term benefit the water, aquatic, and terrestrial resources traditionally used by the Quartz Valley Indian Community.

Under the dams out scenario, fish and invertebrate populations will benefit through increased habitat, more suitable water temperature regimes, substrate movement affecting spawning habitat, improved water quality conditions, and less suitable conditions for the spread of diseases and parasites. The traditional food base, animals and birds used for regalia, and other symbolic ceremonial species may, over time, become adequate for subsistence and ceremonial needs. It is not only fish and aquatic invertebrates that are affected by the Klamath River; riparian vegetation and terrestrial resources that depend on aquatic resources for food are affected by the heavily managed and modified Klamath River. These resources would benefit from dam removal.

The KBRA has several programs that could result in effects to traditional resources used by the Quartz Valley Indian Community. Specific KBRA programs potentially affecting traditional resources include the Tribal Fisheries and Conservation Management Program. Other KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources. The KBRA may also provide funding to the Quartz Valley Indian Community for restoration projects and could create jobs for tribal members.

Hoopa Valley Tribe

The Hoopa Valley Tribe is federally recognized. The Hoopa Valley Indian Reservation[1] is located in the northeastern corner of Humboldt County in northern California, approximately 45 miles from the Pacific Ocean. The Reservation, known as "the 12-mile square," is laid out geometrically with sides approximately 12 miles in length for a total of nearly 144 square miles. The Reservation is approximately 90,000 acres in size and is the largest reservation in California. The Reservation encompasses a portion of Hupa aboriginal territory, which extended to the south and east of the current Reservation, and is bisected by the Trinity River. A small length of the northern border of the Reservation includes an approximately 0.3-mile stretch of the Klamath River called Saints Rest Bar. The 2000 U.S. Census counted 2,633 people on the Reservation, and the tribe listed an enrollment of 2,930 in 2010 (DOI 2012a).

Unemployment in the Hoopa Valley Tribe

There were 2,930 enrolled members of the Hoopa Valley Indian Tribe in 2010 and 2,633 people were counted in the 2000 Census on the Hoopa Reservation. Unemployment on the Hoopa Reservation was about three times the county and state rates, and the percentage in poverty was double that of the state, with the largest disparities between the Indian and general populations. (Reclamation 2011b)

The Hupa remained secluded in their remote valley until the middle of the 19th century. Like other Klamath Basin tribes, the discovery of gold in the area and an influx of non-Indians brought competition for land and resources. However, unlike the other Klamath Basin tribes, the Hupa experienced less historic cultural and social disruption resulting from Euroamerican contact. Indeed, the Hupa were able to continue a traditional lifestyle relatively uninterrupted by the influx of Euroamericans into the area.

In the mid-1800s, California limited Indian reservations to a handful of 'military reservations,' one of which was the Hoopa Valley Indian Reservation. The boundaries of the Hoopa Valley Indian Reservation were established by Executive Order of President Grant on June 23, 1876 (called Executive Order of June 23, 1876), pursuant to the Congressional Act of April 8, 1864 (13 Stat. 39). The Reservation was expanded by Executive Order in 1891 to connect the Klamath River Reservation with the Hoopa Valley Reservation. From 1891 through 1988 the Hoopa Valley Reservation was composed of the Hoopa Valley "12-mile square," the extension of the Reservation along the Klamath River, and the original Klamath River Reservation. This area encompassed most of the Yurok population that resides on the current Yurok Reservation. Confirmation of the sovereignty by the Hoopa Tribe of the Hoopa Valley Indian Reservation (the original square reservation area) came on October 31, 1988, when President Reagan signed Public Law 100-580, the Hoopa-Yurok Settlement Act, again separating the Reservation.

Hupa Elder, Byron Nelson, states:

Though many Hupa and Yurok still hold to traditional beliefs and engage in certain time honored practices such as shamanism and basketry, the decline of the rivers' health, the center of their culture and spirituality, has led to a loss of self esteem, an increase in cynicism, and has greatly hurt the cohesiveness and health of these tribal communities. The rivers are the focalizing element of the society; with their loss, it seems much of the hope has also been lost.

A lack of fish has resulted in the scaling down or even cancellation of ceremonies. The continual practice of ceremonies represents an important means for keeping tribal members who live off the reservations connected to their culture and families. However, without enough salmon, many do not come back; and the planning of ceremonies, once a time to appreciate nature's abundance and of spiritual celebration, often brings significant anxiety to the region's native peoples.

In the early 1960s, the fish runs in the Trinity River had declined following the construction of the Central Valley Project's Trinity River division. The Trinity River diversion not only eliminated 109 miles of important salmon habitat but also exported as much as 90 percent of the water flowing into the Trinity River to the Sacramento River at Lewiston. Congress enacted legislation for the restoration of fish populations in the Trinity River, including P.L. 102-575, § 3406(b)(23), which directed action "to meet Federal trust responsibilities to protect the fishery resources of the Hoopa Valley Tribe." A Record of Decision in 2000 governs the Trinity River Restoration Program, but the success of

[1] Hoopa is used when referring to the name of the Tribe, and Hupa is used when referring to the people, place, or culture.

restoration is affected by a lack of full funding for restoration actions, low water flows, and conditions conducive to the development and spread of fish disease (particularly in drought years) in the 42-mile reach of the Klamath River that fish traverse to reach the Trinity River. Consequently, the Trinity River and its fishery are affected by Klamath River conditions.

The Hoopa Valley tribal members continue to conduct many of their traditional religious ceremonies in spite of issues related to the health of the Klamath and Trinity rivers. Two major ceremonies are the White Deerskin Dance and the Jump Dance that celebrate world renewal. The White Deerskin Dance ceremony is conducted at village sites and resting places near the Trinity River. An unhealthy river system affects the ability of the Hupa to conduct their religious ceremonies. The Hupa claim that as the river's health has declined, their ability to practice these ceremonies and their overall cultural well-being has also declined.

Historical and Current Effects of Dams on the Hoopa Valley Tribe

During the tribal consultations for the removal of the Klamath River dams, the Hoopa Valley Tribe stated that the Tribal Trust Section of the *Trinity River Mainstem Fishery Restoration Environmental Impact Statement/Environmental Impact Report* prepared in 2000 adequately represented the effects on Hoopa trust resources (water, fish, and related cultural values) (DOI 2000). Current operations of the Four Facilities are more likely to affect resources of the Klamath River, but Klamath River water quality affects Hoopa Valley Tribe trust rights primarily by affecting fish destined for the Trinity River.

Hupa use of the river developed over a long period of time, as evidenced by the complexity of their religious ceremonies and practices. Early contact and early ethnographic periods, from 1850 to 1930, indicate that uses of the Trinity River by the Hupa were directed toward fisheries and religious ceremonies (ceremonies that involve prayers offered by people trained to make medicine), and that such activities were highly integrated (DOI 2012a).

The effects of the Klamath River dams on the cultural values of the people of the Hoopa Valley Tribe are stated as including emotional and physical health effects on tribal members such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members have experienced a loss of opportunity for intergenerational transmission of traditional knowledge. These conditions are considered reasons why tribal members, especially young people, leave the Reservation for opportunity elsewhere.

Potential Effects of Dam Removal on the Hoopa Valley Tribe

As one of the original stewards of the natural resources of the Klamath Basin, the Hoopa Valley Tribe holds a special position in the basin and has interests in and a traditional relationship to the basin ecosystem and its fisheries. The Hoopa Valley Tribe has a reserved right to water in the Klamath River to support the harvest of fish required to maintain a moderate standard of living. The tribe also has subsistence and ceremonial fisheries.

Removing the dams and reservoirs will result in water quality conditions that would provide the opportunity for improved Hoopa Valley tribal cultural values, such as conducting traditional bathing ceremonies, fishing, and enjoying the aesthetic qualities of the river. Algae, in particular, is a major problem for the Hoopa Valley Tribe for the approximately 1/3 mile of the Hoopa Valley Indian Reservation that is along the Klamath River because it degrades water for contact recreational and ceremonial uses and can produce toxins hazardous to fishes and humans. However, over time, successful implementation of dam removal would support beneficial uses by the Hoopa Valley Tribe.

Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey have been the main food sources for the Hupa. Under dam removal, increases in anadromous fish populations would likely benefit the Hoopa Valley Tribe and provide the opportunity to improve their standard of living through more stable commercial and subsistence fisheries, and would provide more salmon for tribal ceremonies. This increase in fish populations could provide the opportunity for improved health by increasing the ability for more salmon in their diets, decreasing discontent and depression, and improving the capability of intergenerational transmission of traditional knowledge. This sense of tribal unity has the potential to result in a reduction in the number of young people leaving the Reservation. Additionally, healthier riparian vegetation would improve the ability to gather and use plants in traditional ways that could be used for such things as baskets, medicine, utensils, regalia, and structures.

Yurok Tribe

The federally recognized Yurok Tribe is the largest tribe in California, with more than 5,600 members. The Yurok Reservation consists of about 57,000 acres within the approximately 350,000 acres of their ancestral territory along the lower Klamath River and 50 miles of Pacific coastline near the Klamath River Estuary. The Yurok Reservation extends from the estuary up the Klamath River for a distance of about 45 miles and extending inland for about one mile on both sides of the river. Yurok tribal fishing rights on the Klamath River are well established as a matter of Federal law. The Yurok Tribe has a reserved right to water in the Klamath River to support the harvest of fish required to maintain a moderate standard of living. The tribe also has subsistence and ceremonial fisheries. The Yurok Tribe maintains commercial and subsistence fishing rights.

In the 1850s, when conflicts with gold miners and settlers ensued, treaties were negotiated, and reservation lands were selected. The Federal government’s recognition of the central importance of rivers and fish to the Indian people of the Klamath-Trinity region is exemplified by the very shape and location of the lands first set aside for their reservations. The Secretary of the Interior’s instructions at the time were, “to select these reservations from such tracts of land adapted as to soil, climate, water privileges, and timber, to the comfortable and permanent accommodation of the Indians”.

Origins of the Federal government’s relationship with the Yurok Tribe are found in the negotiation of 18 treaties between the United States and the various

Unemployment in the Yurok Tribe

The BIA Labor Force Report reported Yurok service area Indian unemployment at 74% in 2005. The 2000 Census data showed 12.9% were unemployed on the Yurok Reservation, and the rate was higher for the Indian population at 17.2%. Based on Census data, the Yurok Reservation had some of the highest unemployment rates in the area, with the exception of the town of Klamath, CA and Klamath area; however, many Yurok and some Resighini Tribal members live in and around the town of Klamath. The Yurok Reservation and surrounding area unemployment rates were about double those of Del Norte and Humboldt counties, and about three times the California rate. Similarly, Yurok Reservation poverty rates were higher than surrounding areas, and in most cases were double other rates with greater disparities for Indian area populations. The Yurok Tribe conducted research that indicates that poverty rates are much higher, and estimated that food insecurity among its tribal members living throughout the ancestral territory is about three times the rates of the counties (Sloan 2011).

In 1855, when speaking of the Yurok, Indian Agent S. Whipple noted that: "The river is abundantly supplied with Salmon. A fine large fish quite easily taken by the Indians and which is very properly regarded by the Indian as his staff of life."

tribes of California between 1850 and 1852, although these treaties were never ratified by Congress. Subsequently, California limited Indian reservations to a handful of "military reservations," one of which was the Klamath River Reservation (not to be confused with the Klamath Reservation in Oregon), created in 1855 by Executive Order. It was a strip of territory that began at the Pacific Ocean and extended one mile in width on each side of the Klamath River for a distance of about 20 miles.

The Hoopa Valley Reservation on the Trinity River was created in 1864 for the Hoopa Valley Tribe. In 1891, the Klamath Reservation and Hoopa Valley Indian Reservation were combined as a result of President Harrison extending the Hoopa Valley Indian Reservation to the Pacific Ocean. This action effectively required that Yurok and the Hoopa Valley Tribes, two culturally distinct tribes, to occupy the same reservation. From the 1860s to the General Allotment Act of 1887, the Yurok people lost much of their land to homesteading and other development. In the late 1800s and early 1900s, the fisheries were exploited by non-Indians who operated canneries that soon resulted in over harvesting and a complete closure of the lower Klamath fishery by the California Department of Fish and Game in 1933. For many years, the Yurok and other Indians were prohibited from fishing for subsistence or commercial purposes. Ocean fisheries were never closed, and the recreational fishery was restored for non-Indians in subsequent years, but the practice of subsistence and commercial fishing by Yurok people was prohibited. Yurok people continued to fish the Klamath River as they always had, although the activity was deemed by state regulators as illegal.

By the 1970s, the fishing ban for Yuroks and other Indians created conflicts that escalated when a Yurok fisherman, Raymond Mattz, was arrested and decided to challenge state jurisdiction over Yurok fishing rights. The result was a legal battle that was brought before the U.S. Supreme Court and resulted in a 1973 ruling that reaffirmed Yurok fishing rights (Mattz v. Arnett, 412 U.S. 481). In 1977, the lower Klamath River was reopened for gill net subsistence and commercial fishing by Indians. In 1978, the DOI placed a "Conservation Moratorium" on the Indian commercial fishery, and it was closed until 1987 when the moratorium was lifted due to new allocation agreements and predictions of an increase in salmon. In 1988, the Hoopa-Yurok Settlement Act divided the Hoopa Valley Indian Reservation into two separate reservations and allowed the Yurok to govern themselves through the Yurok Tribal Government, and a tribal constitution that was adopted in 1993.

Since 1990, tribal commercial harvests have been marginal and have not provided a comfortable standard of living as originally envisioned for the Yurok in the Hoopa-Yurok Settlement Act. The 9th Circuit Court of Appeals confirmed that the Executive Orders creating the Yurok Reservation vested the Yurok Tribe with "federally reserved fishing rights." Parravano v. Masten, 70 F.3d 539, 541 (9th Cir. 1995), cert, denied, 518 U.S. 1016 (1996). The same court in 1981 observed that the salmon fishery of the Yurok Tribe is "not much less necessary to the existence of the Indians than the atmosphere they breathed" (Blake v. Arnett, supra, at 909). In 1993, the Solicitor of the DOI determined that the Yurok and Hoopa Valley Tribes are entitled to a sufficient quantity of fish to support a moderate standard of living, or 50 percent of the Klamath fishery harvest in any given year, whichever is less. However, current low numbers of fish have limited both tribal subsistence fishing and commercial operations. This situation has affected the economy of the tribe, and unemployment among the Yurok tribal members is high (Sloan 2011).

The Yurok participate in traditional dances and ceremonies along the banks of the Klamath River and are intricately tied to it. Consequently, changes to the river affect the ceremonial and traditional cultural practices of the Yurok. For example, the Yurok are so attuned to the river that they have a name for each characteristic of the water's movement and the Yurok word for salmon, nepu i, translates into "that which we eat." The Yurok continue to occupy village sites along the Klamath and lower Trinity rivers where they have lived, fished, gathered, prayed, and buried their dead for time immemorial. Water quality and spring-run Chinook salmon in the Klamath River are vital in Yurok ceremonies. In early spring, the first salmon to enter the Klamath River was speared and ritually eaten by Yurok medicine men, traditionally signifying the beginning of the fishing season for the Yurok and all other tribes upriver. Salmon are ritually managed to ensure that Yurok and upriver tribes have sufficient supplies of fish and that enough fish remain to repopulate the fishery. A strong belief still prevails that without the proper ceremonies, the salmon will not return in sufficient numbers.

The Yurok have many ceremonies in common with the Hupa and Karuk, such as the Jump Ceremony, the White Deerskin Ceremony, and the Boat Dance Ceremony. These ceremonies require the proper river setting and the availability of river resources. Baskets made of plant materials collected at the water's edge are used to hold food and other ceremonial items. Acorns are cooked in the baskets and converted into mush by adding hot rocks gathered from specific river bars to the baskets. Regalia that adorn the dancers is made from various plant and animal products obtained from the riverine environment. Ceremonial bathing in the river and its tributary creeks and listening to the sounds of the water are also requirements for some ceremonies and their participants. Today some ceremonial participants arrive by car, but many more still arrive by boat, which is the traditional means of transportation. Ceremonial hosts are expected to feed participants with salmon; failure to provide such traditional food is considered an insult.

The Yurok Tribe and its culture are intertwined with the Klamath River. A deceased tribal member's last worldly journey is a boat ride upriver. Several rocks in the river are etched with rare petroglyphs that offer instructions from the Creator to the Yurok people. One such message is a warning that when the rivers stop flowing it will mark the end of the Yurok world; some elders have prophesied that the manipulation of flows by damming represents the beginning of the end for the Yurok.

Yurok Traditional Culture

There are several rocks along the Klamath River etched with petroglyphs that provide instructions from the Creator to the Yurok. One message is a warning that when the rivers stop flowing the Yurok world will end. Yurok elders have prophesied that the manipulation of the river and its flows by damming is the beginning of the end for the Yurok.

Historical and Current Effects of Dams on the Yurok Tribe

The Yurok Tribe has a reserved right to water in the Klamath River to support the harvest of fish that the Yurok require to maintain a moderate standard of living. The tribe also has subsistence and ceremonial fisheries. However, the

Yurok Tribe asserts that trust resources are broader than fishing and water rights. The additional trust resources asserted are land, wildlife, minerals, and timber. The Yurok Tribe's assertion of trust resources is coupled with the assertion that the United States has a trust responsibility to protect these resources and ensure that they are managed for the beneficial use of the tribe and its membership. In addition, it was also stressed during recent government-to-government consultation that the Federal government has other trust responsibilities to the Yurok in the areas of social welfare, education, and health.

Hydrology and water quality throughout the Klamath River are important for supporting the aquatic ecosystems that support the fishery. Despite degradation of the Klamath River ecosystem during the late 19th and first half of the 20th centuries, the Yurok persist in their traditional reliance on the river and its resources. Many of today's older Yurok grew up with a strong physical connection to the river and a great appreciation for the traditions and riverine way of life of their ancestors. The Yurok continue to have a strong connection to the river. It has become increasingly difficult, however, for tribal members to continue to practice its ceremonies and religion; to gather vegetation for baskets, food, medicines, and other purposes; and to obtain a sufficient quantity of fish for subsistence and ceremonial activity. Regardless, Klamath River fish caught by the Yurok tribal fishers continue to be an important component of their diets. However, the Yurok associate the reduction in their intake of salmon with many current physical and emotional conditions experienced by the tribal members, such as increased heart disease, strokes, diabetes, obesity, and depression.

Potential Effects of Dam Removal on the Yurok Tribe

Algae are a major problem associated with the use of the Klamath River by the Yurok Tribe. Algae degrade water for recreational and ceremonial uses, and can produce toxins hazardous to fish and humans. The reservoirs produce annual blooms of blue-green algae that produce the toxin microcystin that can enter the river system resulting in the posting of warnings regarding use of the river and its water. The tribe believes that removal of the dams and reservoirs along the Klamath River and implementation of the KBRA would improve water quality, which would allow the Yurok Tribe to fish, conduct traditional bathing ceremonies, and enjoy the aesthetic qualities of the river. They also envision the KBRA as potentially providing funding for restoration projects that could create jobs for tribal members.

Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey have been the main food sources for the Yurok. By removing the Klamath River dams and increasing anadromous fish populations over time, the Yurok Tribe could have a more stable commercial and subsistence fisheries that could improve their standard of living. The Yurok Tribe also believes that an increase of fish in a healthy river could improve the overall health of tribal members by increasing the salmon in their diet, facilitate the practice of their traditional ceremonies, and increase opportunities for intergenerational transmission of traditional knowledge.

Under a dams out scenario, fish and invertebrate populations will benefit from increased habitat, more suitable water temperature regimes, and substrate movement, which will affect spawning habitat; improved water quality conditions, and less suitable conditions for the spread of disease and parasites. These improved fish and invertebrate populations are indicative of a healthier ecosystem. It is not only fishes and aquatic invertebrates that are affected by the Klamath River; riparian vegetation and terrestrial species that depend on aquatic resources for food are affected by the heavily managed and modified Klamath River. These resources would also benefit from dam removal.

Resighini Rancheria

The Resighini Rancheria consists of 239 acres located in Del Norte County, California. It is primarily settled by Yurok Indians affiliated with the Yurok Coast Indian Community (Davis, R. B., Letter to Acting Superintendent of Indian Affairs. (July 27, 1973)). The Resighini Rancheria has 132 enrolled members. A population of 36 was reported to live on Rancheria lands in the 2000 U.S. Census. The Resighini Rancheria is located several miles inland from the mouth of the Klamath River and rests on the southern banks of the Klamath River, completely surrounded by the Yurok Reservation.

The land for the Rancheria was purchased from ranch owner Augustus (Gus) Resighini by the Secretary of the Interior in 1938 under the authority of the Indian Reorganization Act. The Secretarial proclamation, deeming the land “reservation,” proclaimed the purchase was to “provide for the protection of the soil, the proper development of the land, and the equitable distribution of benefits from the land” (*Secretarial Proclamation proclaiming the purchased lands a reservation (October 21, 1939)).* The lands, although located mostly in the floodplain of the Klamath River, were productive hay fields and supported a substantial dairy farm. Additional letters between various Indian Agents and the central office of the Secretary, justifying the purchase, commented on the possibility of Rancheria members continuing to operate the dairy farm, produce hay, grow vegetable gardens, and perhaps receive jobs as fishing guides for the burgeoning recreational fishery that the Klamath River was, at that time, known for providing.

The original proposal to create the Resighini Rancheria described the “228-acre” (a resurvey in 1974 determined the size was actually 238.78 acres) tract of land as “agricultural” with conditions that are “ideal for farming or dairying”(*Merin (December 28, 1937))*. However, the value of the land as agricultural was directly connected to the loss of the traditional fisheries. During the settlement of this land, disastrous flooding periodically occurred, with a 100-year flood washing through in 1964. This natural disaster led to the removal and evacuation of Indian families to other local areas.

In 1975, a band of Yurok Indians stood together and formally created a non-traditional form of government with a constitution and bylaws, which were approved and ratified by Indian commissioner Bruce Thompson from the Department of the Interior. In 1979, the Indian people who chose to return to the Resighini Rancheria began the challenge of rebuilding.

Unemployment in the Resighini Rancheria

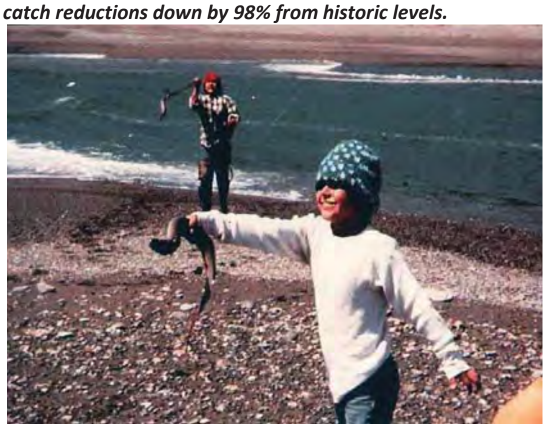
Although Census 2000 poverty percentages were not available for the Rancheria (only 36 people were counted on the Rancheria), unemployment was 20% based on Census data and 60% reported in the 2005 BIA Labor Force Report which is at least three to four times the rate of the town of Klamath, CA, (which is also relatively high), surrounding areas, and Del Norte County. The Resighini Rancheria had the highest unemployment rates and lowest per capita income in the area, which indicates that the Rancheria’s poverty rates are also likely much higher than surrounding areas and the county. Because the Rancheria is a relatively small land base, most members live in the town of Klamath and surrounding areas or otherwise off reservation, and Indian unemployment and per capita income disparities for the surrounding areas are about twice that of the general population (Reclamation 2011h).

In past years, commercial and subsistence fishing was a primary means of economic and subsistence support for the Yurok along the Klamath River. However, with the closure and restrictions on tribal fishing, the Yurok lost this means of support, although the "fish wars" and accompanying litigation of the 1970s and 1980s reinstated Yurok fishing rights and the 1988 Hoopa-Yurok Settlement Act further confirmed that the Yurok Tribe had fishing rights. Resighini Rancheria members were provided the option to join with the newly organized Yurok, but the Rancheria members largely rejected that option. The Resighini Rancheria remains a separate government distinct from the Yurok Tribe.

The Resighini members have supplemented their income with several businesses. These include a casino and a café, a campground, a small lumber mill, and a gravel extraction enterprise.

The Rancheria has surface and groundwater rights by virtue of the trust land status of the Rancheria. A 1974 BIA water study conducted for the reservation determined that the Resighini Rancheria has water rights, senior to other claims after 1939, to water from the two creeks that traverse the Rancheria. Any right to a tribal share of the salmonid fishery and concomitant water rights to which the Resighini Rancheria may be entitled have not yet been determined.

Figure 4.4.2-9: Resighini Rancheria members eel fishing at the mouth of the Klamath. An important part of traditional tribal diet is Pacific lamprey (eels). Tribes have reported eel catch reductions down by 98% from historic levels.



Resighini Rancheria tribal members assert that a reduction in the fishery affects the local economy, general tribal health, cultural well-being, and employment.

Historical and Current Effects of Dams on the Resighini Rancheria

The Resighini Rancheria asserts that Rancheria trust resources are gravel (minerals); water as it relates to groundwater for domestic, agricultural, and recreational (campground) uses; riparian plants; wetlands; fish; land; and wildlife. They also asserted that the United States has a trust responsibility to protect these resources and ensure that they are managed for the beneficial use of the tribe and its membership. In addition, tribal representatives stated during recent government-to-government consultation that the Federal government has trust responsibilities in the areas of social welfare, education, and health. Resighini Rancheria tribal members believe that the dams have altered the natural flows of the river, which has affected the formation of the sand spit in terms of sand buildup and the ability of the river to clear a path through the spit to the ocean. As a result of altered functions, including increased sand build-up coupled with seasonal low flows, the Rancheria has experienced more fall flooding of its lands. The Resighini Rancheria tribal members also believe that the Klamath River dams are responsible for erosion of lands, depletion of gravel extraction beds, low fish returns, degraded water quality, a lack of tribal economic stability, a degradation of overall health of tribal members due to a lack of fish in their diet, and a reduction of overall cultural well being that is causing members to leave the Rancheria.

In general, the Klamath River dams have reduced the ability of Rancheria members to engage in traditional and contemporary subsistence and religious practices. For example, limited access to traditional foods and basket-making materials on which these practices are based limits the opportunities of the

Resighini Rancheria tribal members to engage in their traditional cultural practices.

Potential Effects of Dam Removal on the Resighini Rancheria

Removal of the dams and reservoirs along the Klamath River and implementation of the KBRA would result in water quality conditions that could provide the opportunity for improved Resighini Rancheria cultural values, such as conducting traditional bathing ceremonies, fishing, and enjoying the aesthetic qualities of the river. Toxic algae are a problem for the Resighini Rancheria. Reservoir algae produce the toxin microcystin requiring warnings against contact with the river water each summer. Dam removal would support the cultural uses of the Klamath River by the Resighini Rancheria.

Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey were the main food sources for the Resighini Rancheria. Removing the dams, would increase anadromous fish populations and thus would likely benefit the Resighini Rancheria by improving the fisheries and by providing salmon for tribal ceremonies. This increase in fish populations could improve health by increasing the salmon in their diets, decreasing discontent and depression, and improve the opportunities for intergenerational transmission of traditional knowledge. This sense of tribal unity has the potential to reduce the number of young people leaving the reservation. Additionally, healthier riparian vegetation would improve the ability to gather plants that could be used for such things as baskets, medicine, utensils, regalia, and structures.

4.4.2.4 Summary

Benefits of Dam Removal and KBRA

Dam removal and implementation of the KBRA would help protect trust resources and address various social, economic, cultural, and health problems identified by the tribes in the Klamath Basin. Dam removal would have beneficial effects on water quality, fisheries, terrestrial resources, and traditional cultural practices. In addition, removal of the dams would enhance 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 for restoration projects that would create jobs for tribal members.

The KBRA is intended to restore and sustain fish production in the Klamath Basin, establish reliable water and power supplies, and contribute to public welfare and sustainability of Klamath Basin communities. Programs under the KBRA are grouped under fisheries programs, water and power programs, and county and Indian tribal programs.

The fisheries programs include an extensive habitat restoration program throughout the Klamath Basin, fisheries reintroduction programs, fisheries monitoring programs, and actions intended to increase flows and reliability of instream water in the Klamath River and its tributaries that directly affect Klamath Basin tribes.

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4.4.3 Prehistoric and Historic Cultural Resources

4.4.3.1 Prehistoric Resources

The history of human occupation along the Klamath River extends as far back as 12,000 years ago, based on archaeological evidence and Indian tribes' beliefs, traditions, and ceremonies (Cardno Entrix 2012). Relationships, interactions, and use of resources along the Klamath River, with salmon of high importance, are reflected in the documentation of cultural sites (approximately 650 sites), as well as in traditional and current use of the river and the area immediately surrounding it. Prehistoric cultural resources sites show evidence of short-term and long-term use in artifact scatters, camping and fishing sites, ceremonial sites, and village sites, some with human burials. One large and several other Traditional Cultural Properties (a property with traditional cultural significance derived from the role it plays in a community's historically rooted beliefs) customs, and practices (Parker and King 1998), are identified as associated with the Klamath River (Cardno Entrix 2012). A "riverscape" is identified along the entire length of the Klamath River as a potential Traditional Cultural Property composed of cultural and natural (salmon) resources of historical importance to the Indian tribal communities who live along the river (Gates 2003, King 2004). Through consultations for this study, continued ceremonial and traditional use of places along the Klamath River were identified as of great importance to all Indian tribes who use the river.

Types of Sites:

Prehistoric Sites

- Villages
- Traditional hunting and fishing sites
- Ceremonial sites
- Traditional Cultural Properties

Types of Historic Sites

- Hydroelectric facilities (e.g., dams)
- Logging facilities (e.g., sawmills)
- Agricultural and ranching facilities

4.4.3.2 Historic Resources

Euroamerican exploration of the Klamath Basin began in the early 19th century with a dramatic influx of Euroamericans in the 1850s due to the discovery of gold in California (Cardno Entrix 2012). Trails and roads were developed as travelers passed through or settled in the area. Communities sprang up, requiring supporting services such as farming, ranching, and logging. As mining proved less lucrative, logging and agriculture grew in importance. The Bureau of Reclamation's Klamath Project was authorized in 1905, and was developed to provide irrigation for farmlands in the Klamath Basin. With Upper Klamath Lake and storage created by Link River Dam as the principle water source, Reclamation's Klamath Project provides water to the Upper Klamath Basin, up river of the Four Facilities.

Initial hydroelectric development began in the Klamath Basin in 1891 to provide electricity to Yreka (Klamath Hydroelectric Project 2004). Four years later, the Klamath Falls Light & Water Company built a generating facility on the east bank of the Link River, known as East Side Powerhouse, to supply power to Klamath Falls. These ventures soon attracted competitors. By 1912, the California-Oregon Power Company (Copco) consolidated hydroelectric development in the region. Subsequently, Copco built hydroelectric facilities Copco 1 and Copco 2 in 1918 and 1925, respectively. After World War II, regional population growth prompted new hydroelectric power expansion such as Copco's Big Bend (now J.C. Boyle) (1958) and Iron Gate (1962) developments. While Iron Gate was under construction, Copco was merged with Pacific Power & Light to become PacifiCorp, the current owners and managers of the Four Facilities. The Klamath Hydroelectric Project was identified as a historic district due to its association with the industrial and economic development of southern Oregon and northern California (Kramer 2003a and 2003b).

4.4.3.3 Effects of Dam Removal

Dam removal and associated activities would have adverse effects on known significant cultural resources and, most likely, on as yet unidentified significant cultural resources. Through a number of previous cultural resources surveys, known resources have been recorded with varying status of evaluation for eligibility for listing on the National Register of Historic Places (National Register). Significant cultural resources are called historic properties, defined as listed or eligible for listing on the National Register under the criteria found at 36 CFR Part 60. The eligibility of many sites, such as the Klamath Hydroelectric Project Historic District, will need to be re-evaluated because their eligibility was never formalized through consultations with the California and Oregon State Historic Preservation Officers; or because sites may now meet the time criteria for evaluation; or because other components of the sites, such as transmission lines, were not considered in the original evaluations. The entire area of impacts from dam removal has not been surveyed for historic properties, including areas inundated by the reservoirs behind the four dams. Additional identification efforts, including surveys and subsurface exploration and re-evaluation of resources for eligibility for listing on the National Register, may need to be completed prior to dam removal if there is an Affirmative Secretarial Determination.

Known historic properties and unevaluated cultural resources potentially eligible for listing on the National Register represent the long history of human use of the wide variety of resources of the Klamath River. For the removal of the Four Facilities, the actual area of direct impacts to cultural resources will likely include the construction footprint around the facilities, the four reservoir drawdown zones, and the edges of the Klamath River between the reservoirs and downstream to the confluence with Shasta River. Anticipated impacts include damage from construction activities; erosion and exposure from reservoir drawdown; damage from changes in sediment as it dries out; damage from erosion due to changes in river flows; and potential vandalism and theft of exposed sites. Sixty-eight prehistoric sites, including camps, fishing locales, villages, and artifact scatters, are identified in this area of potential impact. Ten ethnographic village sites are identified beneath two of the reservoirs (Heizer and Hester 1970). Several Traditional Cultural Properties have also been identified, including the “riverscape” that extends the length of the Klamath River and includes both cultural and natural resources of importance to Indian tribes who view the river in this way. In addition to the Klamath Hydroelectric Project, twenty-two historic properties in the area of impact include: homestead and ranching remains; hotel ruins; trash scatters; remains of a lumber mill; and a road. Additional identification efforts, effects assessments, and potential mitigation measures will be addressed through additional NHPA Section 106 consultations if the Four Facilities are removed.

In addition to cultural resources sites, human burials have been identified individually, in village sites, and in cemeteries within the likely area of potential direct impacts. Prior to dam removal, plans and protocols for managing burials and coordinating and consulting on burials would need to be developed. The Native American Graves Protection and Repatriation Act applies to Federal and tribal lands and California and Oregon state laws apply to other lands, as appropriate.

4.4.3.4 National Historic Preservation Act Consultations

DOI is consulting with the Advisory Council on Historic Preservation, the California and Oregon State Historic Preservation Officers, Indian tribes, Native American organizations, and other interested parties under Section 106 of the NHPA (implementing regulations found at 36 CFR Part 800). DOI defines the current undertaking as the potential removal of the Four Facilities which may be a result of the Secretarial Determination. As allowed under 36 CFR §800.8(c), DOI elected to utilize the National Environmental Policy Act (NEPA) process to meet Section 106 of the NHPA compliance requirements. With Federal involvement in the potential removal of the Four Facilities, consultations under Section 106 of the NHPA would need to continue to comply with other applicable Federal laws including the Archaeological Resources Protection Act of 1979 and the Native American Graves Protection and Repatriation Act. The measures to avoid, minimize, or mitigate potential adverse effects associated with this undertaking would be incorporated into the Record of Decision and represent a binding commitment if an Affirmative Secretarial Determination is made. California and Oregon state laws regarding cultural resources, historic preservation, and burials would apply as appropriate to non-Federal lands.

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4.4.4 Previous PacifiCorp Analyses of Relicensing versus Removal of the Four Facilities and Public Utilities Commission Rulings

To assist the Secretary of the Interior in making a determination about whether dam removal is in the public interest, it is informative to summarize the changes that could occur in the future if relicensing of the Four Facilities was actively pursued by PacifiCorp rather than removal of the Four Facilities under the KHSA with customer surcharges. Such relicensing changes would include new operational requirements for the Four Facilities, capital expenditures for fish passage (such as fish ladders and screens) and water-quality 401 certifications with the states of Oregon and California, and additional operational and maintenance expenses. The TMT did not undertake an independent analysis of the costs of constructing fish ladders or obtaining 401 certification for the Four Facilities if PacifiCorp actively pursued relicensing. This section summarizes analyses prepared by PacifiCorp for the FERC relicensing process (FERC 2007) as well as information developed subsequently. PacifiCorp presented its analysis to both California and Oregon Public Utilities Commissions (PUCs).

A prerequisite to the customer surcharges necessary for KHSA implementation was concurrence with PacifiCorp's analysis from the California Public Utilities Commission (CPUC) and the Oregon Public Utilities Commission (OPUC) that implementing the KHSA would be in the best interest of its customers and that the incremental increases were fair and reasonable. PacifiCorp's records and testimony before both commissions compared two scenarios: (1) customers' costs and risks under the KHSA dam removal scenario, and (2) customers' costs and risks from relicensing the Four Facilities. Both PUCs ruled that implementing the KHSA with customer surcharges would result in the best financial outcome for PacifiCorp's customers when compared to the estimated costs and future risks of relicensing the Four Facilities.

The surcharge amount negotiated in the KHSA was $200 million (in 2020 dollars), with about $184 million and $16 million coming from Oregon and California PacifiCorp customers, respectively. Favorable PUC rulings were required for PacifiCorp to begin collecting surcharges in trust funds. The PUCs decisions are discussed in further detail below (see Section 4.4.4.4, *Public Utilities Commission Rulings on Facilities Removal under KHSA*). The following sections describe the two scenarios presented by PacifiCorp.

4.4.4.1 PacifiCorp Customer Implications with FERC Relicensing

Several aspects contribute to uncertain conditions and implications for PacifiCorp customers under a scenario where FERC issues a new long-term license to PacifiCorp for operation of the Four Facilities. As described in more detail below, the need to meet DOC and DOI mandatory conditions, and CWA Section 401 Water Quality certification would increase the costs to PacifiCorp and its customers.

During the previous relicensing application filed in 2006 (see Section 1.2.6, *Conditions Leading to the Development of the KHSA*), DOC and DOI filed a series of mandatory conditions relating to fish passage (ladders and screens) at the Four Facilities and additional flows through the J.C. Boyle bypass. These mandatory conditions were subsequently challenged and upheld in a trial-type hearing (Administrative Law Judge 2006). PacifiCorp assumed in its analyses of the impacts of potential FERC relicensing that these mandatory conditions would be required in any long-term FERC license for the Four Facilities.

In addition to the mandatory conditions, and required before FERC could issue a long-term license, the states of Oregon and California must issue Water Quality certification for the Four Facilities under Section 401 of the CWA. Impounding water in the facilities' two largest reservoirs (Copco 1 and Iron Gate) contributes to water quality issues in the Klamath River including low dissolved oxygen; elevated water temperatures in the late summer and early fall; growth of algae due to high nutrient concentrations in the Klamath River; and production of algal toxin (microcystin) (see Section 4.1.1.4, *Water Quality* and Section 4.4.10, *Algal Toxins*). PacifiCorp's testimony to the CPUC described that "because the CWA Section 401 Water Quality Certification process for the [Klamath Hydroelectric] Project is not yet complete, the water quality measures necessary to obtain a new [FERC] license remain highly uncertain" (Scott 2010). Neither Oregon nor California have issued CWA Section 401 Water Quality certification for the relicensing of the Klamath Hydroelectric Project. This fact creates considerable uncertainty as to the actual costs that would be required to remedy these water quality impairments, or whether the Four Facilities can be relicensed at all if these problems prove intractable. In the case that the CWA Section 401 Water Quality certifications were not issued by the states, "FERC would be unable to issue a new license, yet maintains that it has the authority to require the owner to decommission and remove the project facilities at the owner's expense" (Scott 2010).

PacifiCorp (FERC 2007) reported that implementation of the mandatory conditions as prescribed in 2006 would result in the overall loss of 24 percent of hydropower generation at the Four Facilities. PacifiCorp later updated this forecasted loss of power generation to 20 percent (Scott 2010). In PacifiCorp's 2010 testimony before the CPUC, the company estimated it would cost in excess of $400 million (2010 dollars) to construct fish passage facilities, install other resource mitigation and recreation improvements, and remedy water-quality issues in the reservoirs and below Iron Gate Dam. In addition, the company estimated it would cost in excess of $60 million for additional operation and maintenance expenses (Scott 2010). As described in PacifiCorp's testimony to the OPUC, there is also substantial uncertainty and financial risk in the event that the implementation of measures prescribed under a new FERC license is unsuccessful. For example, if fish passage measures are unsuccessful, new facilities, upgraded facilities, or altered hydroelectric operations could be required. The onus of responsibility for correcting any such future problems from failed attempts to meet conditions of a license would be borne solely by PacifiCorp and its customers (Brown 2010).

4.4.4.2 PacifiCorp Customer Implications with Removal of the Four Facilities

Removal of the Four Facilities, as envisioned in the KHSA, also carries cost implications for PacifiCorp and its customers. However, testimonies from PacifiCorp (Scott 2010) and OPUC (Brown 2010) described that the cost cap measure of the KHSA would limit financial risks compared to the risks possible under FERC relicensing.

In PacifiCorp's analysis of the impacts of dam removal (as defined in KHSA) to its customers, and in its testimony to the PUCs, the company assumed the Four Facilities would continue to generate power for 9 years (2011 through 2019), until dam removal began, at a mean annual generation similar to what has occurred in previous years[1]. PacifiCorp assumed that customer costs and future liabilities associated with dam removal, including mitigation measures, would be capped at $200 million (in 2020 dollars). Dam removal costs beyond the $200 million (up to $250 million in 2020 dollars) would be borne by California taxpayers through a bond measure or other appropriate financing mechanisms. PacifiCorp and its customers would carry no residual liabilities following transfer of the Four Facilities from PacifiCorp to a DRE on or before 2020.

The cost of implementing "interim measures" under the KHSA (identified in Appendix C and D of the KHSA) includes about $9 million in capital costs (2010 dollars) and about $70 million in costs characterized as operation and maintenance (O&M) (Scott 2010); these costs would be passed along to PacifiCorp customers. The majority of the capital costs relate to water quality and aquatic habitat improvements and funding for fish hatchery improvements and operations. Increased funding for hatchery programs and fish production following dam removal represents approximately half of the O&M costs. Other O&M costs include restoration actions; land and cultural resources actions; aquatic habitat enhancement; and, water quality monitoring and improvements. Many of these interim measures have cost caps. For the interim measures that do not have a cost cap, the relative cost risk is much less than under relicensing given the extensive scope and costs associated with measures required under relicensing (Scott 2010).

4.4.4.3 Summary of PacifiCorp Customer Implications

Table 4.4.4-1 provides a summary of PacifiCorp's analysis of the above two scenarios in terms of operational changes, costs, risks, and liabilities to its customers. FERC relicensing could cost PacifiCorp customers in excess of $460 million over a 40-year license term. This number is compared to approximately $251 million for removal of the Four Facilities and implementation of Interim Measures as envisioned under the KHSA (Scott 2010). Under the KHSA, PacifiCorp customers would also have a responsibility to pay for replacement power after the Four Facilities are removed. PacifiCorp's analysis submitted to the PUCs demonstrated that the KHSA resulted in less cost for PacifiCorp

[1] Some minor modifications of power generation could occur when implementing Interim Measure 5 (Iron Gate Flow Variability, Appendix C of KHSA) and as a result of increased instream flow releases pursuant to Interim Measure 17 (Fall Creek Flow Releases, Appendix D of KHSA).

customers as compared to FERC relicensing even with the inclusion of costs associated with replacement power from the Four Facilities.

Table 4.4.4-1: Operations, costs, risks, and liabilities for FERC relicensing and for removal of the Four Facilities, based on PacifiCorp analyses

PacifiCorp's Future Klamath 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 quality issues below Iron Gate Dam and in the reservoirs.	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 is 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).

Sources: Scott 2010 and KHSA 2010

Note: Numbers are in 2010 base year dollars unless otherwise noted.

4.4.4.4 Public Utilities Commission Rulings on Facilities Removal under KHSA

As described above, to collect PacifiCorp customer surcharges necessary for KHSA implementation, the CPUC and OPUC had to concur that implementing the KHSA would be in the best interest of PacifiCorp customers and that the incremental PacifiCorp customer rate increases were fair and reasonable. The following sections describe this process in front of the two PUCs.

California Public Utilities Commission

On March 18, 2010, PacifiCorp filed an application to the CPUC for a proposed customer rate increase pursuant to the terms of KHSA to institute a surcharge of $13.76 million on its California customers for removal of the Four Facilities. This surcharge translates to approximately $1.53 million per year over nine years for a projected total of $16 million at the end of the nine years and a per residential customer amount of approximately $1.61 per month. Despite a formal motion to hold in abeyance the decision to raise customer rates by the Division of

Ratepayer Advocates, in May 2011 the CPUC issued a final order authorizing the collection of the dam removal surcharge from California customers pursuant to the terms of the KHSA and found that the KHSA "provides the most cost effective method of collecting the funds necessary to resolve conflicts over resources in the Klamath Basin. If the KHSA surcharge is not instituted… ratepayers would be exposed to an uncertain amount of costs in addressing what to do with PacifiCorp's Klamath assets" (CPUC 2011).

The CPUC found that dam removal costs under the KHSA were distributed among a number of parties, while relicensing costs, including compliance with Water Quality certification under Section 401 of the CWA, construction of fish passage facilities, or potentially decommissioning the dams, would most likely be the sole responsibility of PacifiCorp and its customers. The CPUC approved the collection of surcharges that capped customer exposure for dam removal, as defined in the KHSA (CPUC 2011).

PacifiCorp specified that the surcharge amount collected from California customers "may have to be adjusted in the future to reflect variations in load forecasts, but will not exceed 2 percent of the authorized revenue requirements as of January 1, 2010" (CPUC 2011). In their 2011 ruling, the CPUC endorsed the surcharge amount and nine-year timeframe for collection. They also endorsed the 2 percent authorized revenue requirement in order to support the KHSA removal start date, and to accrue sufficient interest to make up the difference between the surcharge collected from customers and the amount identified in the KHSA (CPUC 2011).

Oregon Public Utilities Commission

In 2009, the Oregon Senate passed Senate Bill 76 which directed the OPUC to review the collection of surcharges from PacifiCorp customers for the purpose of establishing a fund for the removal of the Four Facilities in accordance with the KHSA. Before making its decision on rate increases in accordance with Senate Bill 76, the OPUC conducted a hearing pursuant to ORS § 757.210 to determine whether the surcharge to fund dam removal proposed by PacifiCorp was "fair, just, and reasonable."

In the OPUC's staff testimony before the PUC, staff reported that they believed the costs estimated by PacifiCorp for relicensing the Four Facilities (potentially in excess of $400 million [2010 dollars] in capital costs over the 40 year license term) were reasonable given the existing uncertainties and quantified risks (Brown 2010). Staff for the OPUC stated there was substantial risk to PacifiCorp and its customers from the denial of CWA 401 Water Quality Certification from the states of California or Oregon for relicensing of the Four Facilities. OPUC staff also indicated there was substantial financial risk associated with implementation of fish passage and fish protection measures. PacifiCorp would be financially responsible if initial measures prescribed by the FERC license were unsuccessful. The responsibility for future problems and cost escalations from failed attempts to meet conditions of a new license would be borne solely by PacifiCorp and its customers (Brown 2010).

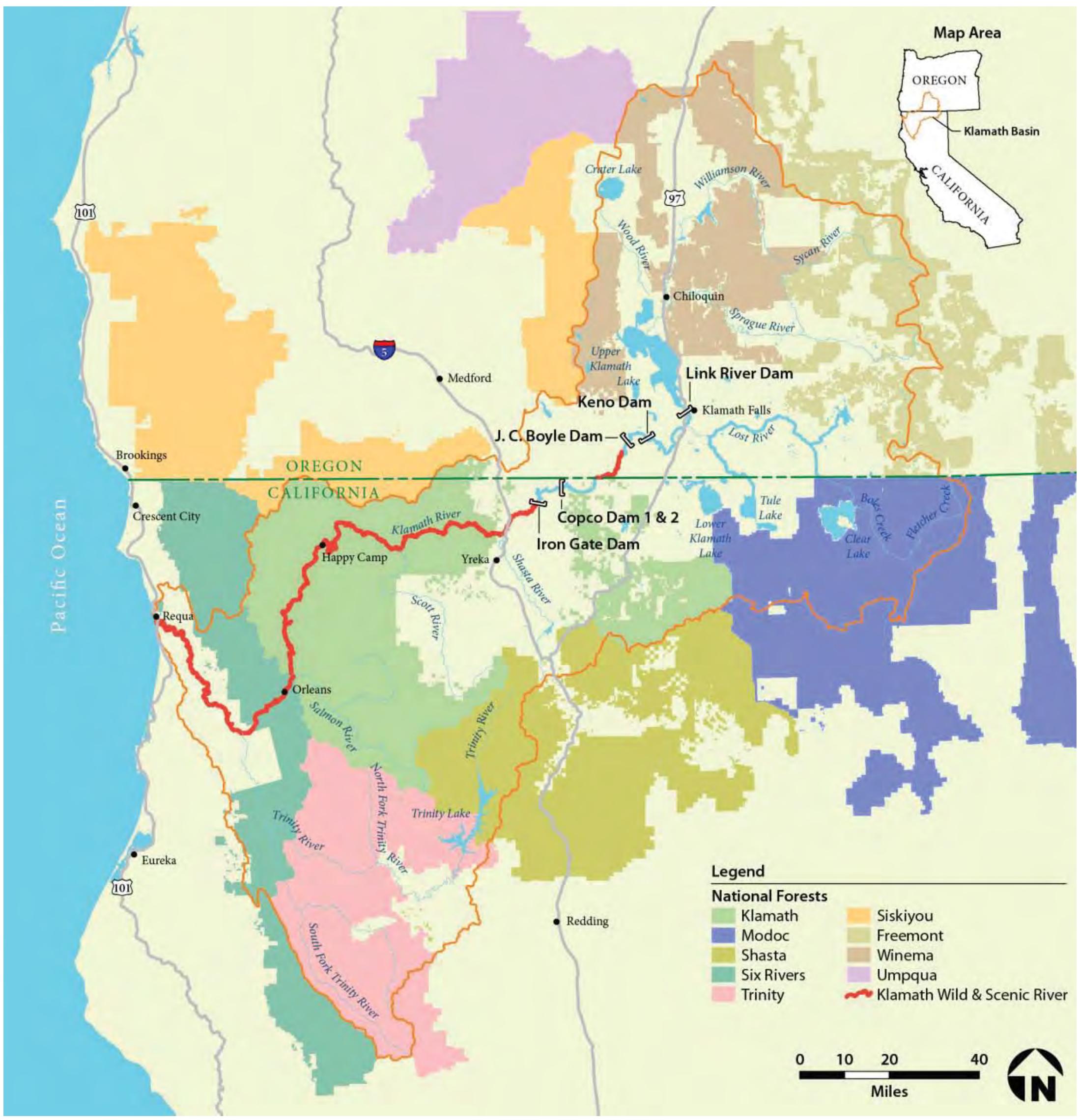
The OPUC concluded that removal of the Four Facilities, as envisioned under the KHSA, “mitigates the risks associated with decommissioning and removal of the facilities for PacifiCorp, and is therefore the least risky alternative for customers compared to relicensing” (Brown 2010). In Order No. 10-364 (September 16, 2010), the OPUC affirmed customer surcharges required by Senate Bill 76 and adopted a process to annually review and, if necessary, update the approved surcharges associated with removal of the Four Facilities under the KHSA. On May 25, 2011 the OPUC approved Order No. 11-174 affirming the surcharges to establish a fund ($184 million) for the removal of the Four Facilities (OPUC 2011).

4.4.5 Wild and Scenic River

This section describes the National Wild and Scenic River (WSR) values on the Klamath River and potential effects to these values as a result of the removal of the Four Facilities. The National WSR System was created by Congress through the Wild and Scenic Rivers Act (WSRA) in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations.

The sections below describe the two segments of the WSR system that would be affected by removal of the Four Facilities; the location of these river segments in the Klamath Basin are shown on Figure 4.4.5-1.

Figure 4.4.5-1: Location of Wild and Scenic River segments on the Klamath River



4.4.5.1 Oregon WSR

An 11-mile segment of the Klamath River in Oregon was designated as a component of the National WSR System in September 1994. The designation was made by the Secretary of the Interior, at the request of the Governor of Oregon, under Section 2 (a) (ii) of the WSRA. The 11-mile segment, extending from 0.25 miles below the J.C. Boyle powerhouse to the Oregon-California state line, is classified as scenic. The segment was designated as a WSR to protect and enhance the following outstandingly remarkable values (ORVs): recreation, wildlife, fish, scenic, prehistoric, and traditional use by Indian tribes in the basin. The Oregon WSR is located in the Hydroelectric Reach of the Klamath River between J.C. Boyle Dam and the Oregon-California state line. The State of Oregon and Bureau of Land Management (BLM) share river management responsibilities for the Oregon Klamath WSR.

4.4.5.2 California WSR

A 189-mile segment of the Klamath River in California was designated as a component of the National WSR System in January 1981. The designation was made by the Secretary of the Interior at the request of the Governor of California, also through Section 2(a)ii) of the WSRA. Classified as recreational, this California Klamath WSR component begins approximately 0.68 below Iron Gate Dam and ends at its confluence with the Pacific Ocean. It was designated primarily to protect and enhance its outstandingly remarkable anadromous fishery. The California Klamath River WSR includes portions of its three principal tributaries, the Scott and Salmon Rivers and Wooley Creek, for a total of 286 miles. The California Klamath River WSR segment is located downstream of the Four Facilities. The US Forest Service, BLM and National Park Service share river management responsibilities for the California Klamath WSR.

4.4.5.3 Determination of Consistency with WSRA

The Federal agencies responsible for Klamath WSR management are required by Section 7(a) of the WSRA to make a determination whether certain projects are consistent with its river-resource protection requirements. A *Preliminary WSRA Section 7(a) Determination* is being developed to address WSRA consistency prior to a Determination by the Secretary on removal of the Four Facilities. The WSRA consistency determination will follow an evaluation of the effects of dam removal on Klamath River WSR values as prescribed by the WSRA. 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.

4.4.5.4 WSR Effects Criteria and Evaluation

The evaluation criteria for the Preliminary WSRA Section 7(a) Determination include the following:

WSR Scenery Evaluation Criteria

- Water flow character (river flows and accompanying river width, depth and channel inundation or exposure)

- Water appearance (clarity, turbidity, depth of view, color, prominence of algae)
- Fish and wildlife viewing
- Riparian vegetation
- Natural appearing landscape character (the visual effects of facilities and structures as viewed from the designated WSR)

WSR Recreation Evaluation Criteria

- Whitewater boating
- Recreational fishing
- Other recreational activities (water play, swimming, camping)
- Recreational setting (water quality related aesthetic odors, tastes, contacts, and public health and safety aspects)

WSR Fisheries Evaluation Criteria

- Stream flow regime
- Water temperature
- Water quality (physical, biological and chemical)
- Aquatic habitat (geomorphic condition, sediment transport regime and substrate quality)
- Fish species population conditions, specifically:
    a. Anadromous salmonid fish species
    b. Resident fish species
    c. Species traditionally used and culturally important to Indian tribes

Wildlife Value Evaluation Criteria

- Changes in habitat for affected species

4.4.5.5 Summary of Project Effects to WSR River Values

This section presents a summary of the effects of removal of the Four Facilities on scenery, recreation, fish, and wildlife river values of the Oregon and California Klamath WSRs.

Scenery

For both the Oregon and California Klamath WSRs, short-term negative effects are expected due to the increase in suspended sediments which would impair water clarity. In the long-term, removal of the Four Facilities would improve water clarity; result in more frequent fish and riverside wildlife viewing opportunities; and, restore natural river processes that would re-establish natural riverine scenery conditions.

Recreation

For both the Oregon and California Klamath WSRs, short-term negative effects to recreation opportunities are expected during the deconstruction process from increased turbidity and suspended sediment within river recreation settings.

Currently the Oregon Klamath WSR provides a unique recreation opportunity in the region; specifically, high-quality, sustained Class IV whitewater boating (Hell's Corner) throughout the summer and fall months. Following dam removal the seasonal availability of these unique whitewater flows would be reduced, and would be less predictable in the summer-fall period (Section 4.4.6, *Recreation* describes these impacts in greater detail). There would be some continued opportunity for whitewater boating in the range of these unique Class IV flows, primarily earlier in the year and as a function of a more natural hydrograph. Boating and all other recreational opportunities would benefit from improved water quality due, in part, to the elimination of toxic algae produced in the Klamath Hydroelectric Project reservoirs in the summer and fall months and transported downstream. The Oregon Klamath WSR's recreational fishing opportunities would also improve due to increased fish species and abundance, particularly salmon, steelhead, and redband trout.

For the California Klamath WSR, long-term recreational boating opportunities would not be affected. Long term improvements in fish populations and water quality would result in beneficial effects to recreational boating, fishing, waterplay and all other recreation opportunities.

Fish

For both the Oregon and California Klamath WSRs, there would be short-term (<2 years following dam removal) negative water quality effects on fish habitat during dam deconstruction and reservoir drawdown. In the long-term (2-50 years following dam removal) removal of the Four Facilities would result in increased fish habitat as well as improvements in stream flow, water quality, and other aquatic habitat. These long-term effects would contribute to increased fish species diversity and abundance for both WSR segments.

Wildlife

Removal of the Four Facilities would have short-term negative effects to wildlife habitat due to increased SSC in the river system during reservoir draw down and dam removal. In the long-term, removal of the Four Facilities would improve riparian habitat and increase forage opportunities for wildlife species that depend on fish.

4.4.5.6 Wild and Scenic River Effects Summary

Table 4.4.5-1 summarizes the changes expected to WSR resources as a result of dam removal.

Table 4.4.5-1: Long-term Changes Expected to WSR Resources as a Result of Dam Removal

	Scenery Value	Recreation Value	Fish Value	Wildlife Value
Oregon Klamath WSR	Improved	Whitewater boating opportunities would be reduced, fishing and other recreational opportunities would be improved	Improved	Improved
California Klamath WSR	Improved	Improved	Improved	Improved

4.4.6 Recreation

This section discusses the effects to recreation from removal of the Four Facilities. Dam removal would result in the loss of the four Klamath Hydroelectric Project reservoirs as well as changes to river flows and water quality conditions. Correspondingly, these changes would result in partial reduction or complete loss of some recreation opportunities. In addition, changes resulting from dam removal could lead to the improvement or addition of other recreation opportunities along the Klamath River and in the Klamath Basin.

4.4.6.1 Reservoir Recreation

Existing popular reservoir recreation activities include power boating, waterskiing, lake swimming, and flat-water boat angling at J.C. Boyle, Copco 1, and Iron Gate reservoirs. These reservoirs are also popular areas for sightseeing, camping, and wildlife viewing; attracting visitors primarily from the surrounding communities in Klamath and Jackson counties in Oregon and Siskiyou County in California. Figure 4.4.6-1 and Table 4.4.6-1 provide an overview of the reservoirs and lakes in the Klamath Basin and the surrounding region that provide flat-water recreational opportunities.

Removal of the Four Facilities would result in loss of the reservoir recreation activities at the Klamath Hydroelectric Project reservoirs.

In addition to the loss of open water and flat-water recreation at the reservoirs, some campgrounds, day-use areas, and boat launches that would no longer have immediate access to water would be permanently removed as part of dam removal. Table 4.4.6-2 summarizes the recreation facilities that would be removed.

Figure 4.4.6-1: An overview of regional recreational reservoirs and lakes.

Table 4.4.6-1: Comparison of Klamath Hydroelectric Project Reservoirs and Regional Low and Moderate Visitor Use In Reservoirs and Lakes Providing Comparable Recreational Opportunities

Lake or Reservoir	Distance from Nearest Subject Reservoir (miles)	Surface Water (acres)	Number of Developed Campsites	Number of Developed/ Improved Boat Launches	Number of Developed Picnic Areas	Generalized Use Levels
Subject Reservoirs						
J.C. Boyle	N/A	420	16	2	4	Low
Copco 1	N/A	1,000	0	2	2	Low
Copco 2	N/A	40	0	0	0	Low
Iron Gate	N/A	944	37	3	6	Moderate
Other Lakes and Reservoirs in the Region						
Fourmile Lake	26	740	25	1	0	Low
Agency Lake	28	5,500	43	3	0	Low
Applegate Reservoir	36	988	66	3	1	Low
Medicine Lake	46	408	72	1	1	Low
Hyatt Reservoir	15	1,250	172	2	1	Moderate
Emigrant Lake	16	806	110	2	2	Moderate
Howard Prairie Reservoir	17	2,000	303	4	1	Moderate
Upper Klamath Lake	20	85,120	269	6	1	Moderate
Gerber Reservoir	62	3,830	50	2	1	Moderate
Trinity Lake Unit	73	16,535	500	7	2	Moderate
Whiskeytown Lake	87	3,200	139	3	1	Moderate

Source: PacifiCorp 2004; Jackson County Parks 2010; VisitUSA.com 2010

Table 4.4.6-2: Recreation Facilities Removed as Part of Dam Removal

Site Name	Existing Facilities	Facilities Following Dam Removal
Sites at J.C. Boyle Reservoir (Oregon)		
Pioneer Park	Two day-use areas with picnic tables, fire rings, and portable toilets	All facilities would be removed
Sites at Copco 1 Reservoir (California)		
Mallard Cove	Day-use picnic area and boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted.
Copco Cove	Picnic area and boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted.
Sites at Iron Gate Reservoir (California)		
Wanaka Springs	Day-use area, campground, boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted
Camp Creek	Day-use area, campground, boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted
Juniper Point	Primitive campground and boat dock	All facilities would be removed. Parking area would be regraded, seeded, and planted
Mirror Cove	Campground and boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted
Overlook Point	Day-use area	All facilities would be removed. Parking area would be regraded, seeded, and planted
Long Gulch	Picnic area and boat launch	All facilities would be removed. Parking area would be regraded, seeded, and planted
Dutch Creek	Day-use area	All facilities would be removed. Parking area would be regraded, seeded, and planted

Source: Reclamation 2012e

Following removal of the Four Facilities, the reservoirs and the recreational benefits they currently provide throughout the region, including regional economic benefits related to tourism (addressed in Section 4.4.1, *Economics*), would no longer be provided along the free-flowing river and would be permanently lost.

As indicated in Table 4.4.6-1, there are at least 11 comparable lakes and reservoirs in the region that have similarly low to moderate visitor use levels compared to the Klamath Hydroelectric Project reservoirs and provide equivalent open water and flat-water recreation opportunities as well as developed campsites and boat launches. These regional resources could compensate, in part, for the loss of the Klamath Hydroelectric Project reservoirs and recreational facilities; however, it is unknown to what degree other regional lakes and reservoirs would be used by recreationalists who currently favor the Klamath Hydroelectric Project reservoirs.

4.4.6.2 Changes to Whitewater Boating Resources

In addition to the loss of the Klamath Hydroelectric Project reservoirs, removal of the Four Facilities would eliminate the daily peaking flows from J.C. Boyle Dam and would return the river to a more natural flow regime. Currently, the daily hydropower peaking flows provide for an extended and predictable whitewater boating season at the popular Hell's Corner Reach. Dam removal would reduce the whitewater boating season somewhat in the Hell's Corner Reach. Downstream of Iron Gate Dam to the estuary there would be little change to the number of whitewater boating days. Following removal of the reservoirs and restoration of the formerly inundated river channel, it is expected there would be additional whitewater boating opportunities on those reaches. Water quality improvements, as well as changes in flows subsequent to dam removal, will likely enhance whitewater boating in some reaches.

Existing Whitewater Boating

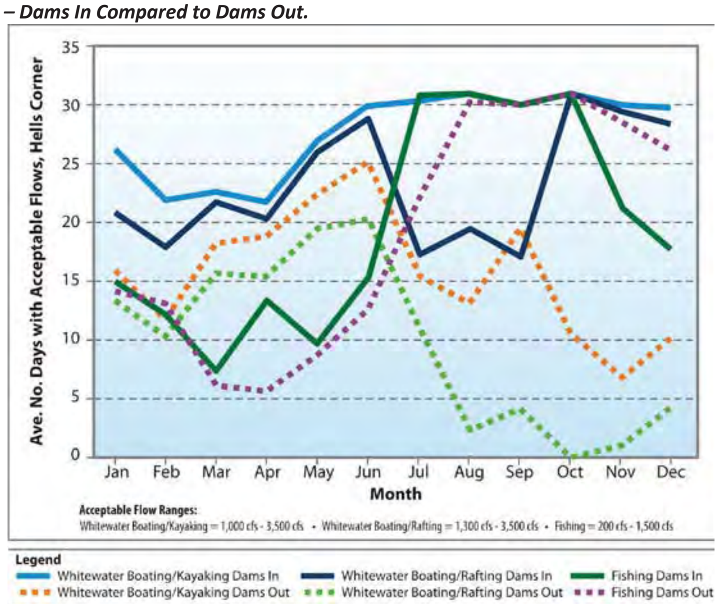
Whitewater boating along the Klamath River currently takes place at the J.C. Boyle Bypass Reach, Hell's Corner Reach, Copco 2 Bypass Reach, and downstream of Iron Gate Dam.

The Hell's Corner Reach currently provides Class III to V rapids during daily peaking flows from the PacifiCorp hydropower operations (typically between 10 a.m. and 2 p.m.). Acceptable whitewater boating flows range from 1,300 cubic feet per second (cfs) to 3,000 cfs (PacifiCorp 2004). Outside the daily peaking flows from hydropower operations, flow rates within this reach typically do not meet the acceptable range to create or enhance whitewater boating opportunities. From 1994 to 2009, there was an average of 4,414 recreation days per year, peaking in the mid-1990s at around 6,000 recreation days per year. Whitewater boating use typically occurs from April through October, with about 80 percent of the commercial rafting use occurring from July through September. Commercial boating use accounted for about 93 percent of the whitewater boating use on this reach (DOI 2012b).

Whitewater Boating Following Dam Removal

The DOI modeled the average number of days with acceptable river flows in specific reaches each month for specific recreational activities, both with and without dam removal (DOI 2012b). Table 4.4.6-3 lists the percent change in the estimated annual average number of days meeting the range of acceptable flows for whitewater boating and fishing activities on the Klamath River. The most marked changes would occur in the J.C. Boyle and Copco 2 bypass reaches, where additional flows would increase recreational opportunities, and in the existing Hell's Corner Reach where the loss of peaking flows would decrease whitewater boating opportunities.

Figure 4.4.6-2: Comparison of Average Number of Days per Year with Acceptable Flows for Whitewater Boating and Fishing in the Hell's Corner Reach – Dams In Compared to Dams Out.



The Hell's Corner Reach is unique within the region in that it provides Class IV-V rapids during the late summer months (August and September). Reductions in acceptable whitewater flows at Hell's Corner Reach, both for kayaking and commercial rafting, would occur throughout the year (see Figure 4.4.6-2). For commercial rafting, the largest flow reductions would be seen in August and September with declines of 88 percent and 76 percent, respectively (DOI 2012). For kayaking, the largest flow reductions would be seen in October through December with declines ranging from 66 percent (October and December) and 77 percent (November) (DOI 2012b).

For the Keno Reach and the reaches downstream of Iron Gate Dam, the availability of flows within the acceptable flow ranges for whitewater boating opportunities would essentially remain the same if dams are removed.

Table 4.4.6-3: Estimated Change in Number of Days Meeting the Range of Acceptable Flows for Recreational Activities on Klamath River Reaches

River Reach	Activity	Total Avg. No. of Days Annually (Dams Remain)	Total Avg. No. of Days Annually (Dam Removal)	Percent Change
Keno Reach	Whitewater Boating	151	139	-7.9%
	Fishing	246	238	-3.5%
J.C. Boyle Bypass Reach	Whitewater Boating	5	41	794%
	Fishing	107	142	33%
Hell's Corner Reach	Whitewater Boating/Kayaking	332	189	-43%
	Whitewater Boating/Commercial Rafting	278	119	-57%
	Fishing	234	228	-2.7%
Copco 2 Bypass Reach	Whitewater Boating	10	223	2,080%
	Fishing	14	3	-79%
Iron Gate to Scott River	Whitewater Boating/Fishing	278	281	1.0%
Scott River to Salmon River	Boating	243	246	1.4%
	Fishing	175	182	4.2%
Salmon River to Trinity River	Whitewater Boating/Fishing	207	211	1.8%
Trinity River to Ocean	Whitewater Boating/Fishing	239	238	-0.2%

Source: DOI 2012b

If dams were removed, the changes in flows in Hell's Corner Reach would result in a loss of visitors travelling to the area for whitewater boating on the upper Klamath River. Figure 4.4.6-3 shows regional rivers with whitewater boating opportunities. However, while these regional whitewater boating locations (see Table 4.4.6-4 and Figure 4.4.6-3) could substitute for the loss of flows at Hell's Corner, visitors specifically seeking Class IV-V rapids during the late summer might choose not to visit the Klamath Basin. In addition, there would no longer be predictable flows in terms of known timing for flow releases, as under existing conditions. The known timing of the releases allows the commercial outfitters to provide whitewater boating opportunities on a regularly scheduled basis. Figure 4.4.6-3 illustrates the location and generalized use levels of rivers in the Klamath Basin and the surrounding region that provide whitewater boating opportunities.

Figure 4.4.6-3: Whitewater boating opportunities in the Klamath Basin and in the region

Table 4.4.6-4: Regional Rivers with Whitewater Boating Opportunities

River	Generalized Use Levels	Boating Class Type[1]	Miles of Boatable Whitewater	Factors Affecting Use Levels
Clear Creek	Low	III-V	7	Difficult access
North Umpqua River	Moderate	II-IV	32	Easy access, most skill levels, scenery, boatable year round, shoreline suitable for camping
McCloud River	Moderate	II-IV	35	Proximity to I-5, most skill levels, low flows in summer
Pit River	Low	IV-V	34	Fragmented/short runs with long stretches of flat-water between, remote location
Rogue River	High	II-V	100+	Easy access, most skill levels, scenery, boatable year round, shoreline suitable for camping, many commercial outfitters
Salmon River	Moderate	II-V	44	Requires advanced/expert boating skills, commercial use
Scott River	Low	III-V	20	Recommended for expert boaters only
Smith River	Low	II-V	100+	Requires advanced/expert boating skills, low summer flows
Upper Sacramento River	Low	III-V	36	Proximity to I-5, average solitude
Trinity River	Moderate	II-V	100+	Most skill levels, easy access, commercial use

Source: FERC 2007
[1] As rated by the American Whitewater International Scale of Difficulty (American Whitewater 1998).

Whitewater Boating Summary

Dam removal would decrease whitewater boating in the Hell's Corner Reach by about 43 percent for kayaking and 57 percent for commercial rafting. However, changes in the location and amount of acceptable whitewater boating flows, combined with other regional whitewater opportunities (see Table 4.4.6-4), could be expected to reduce the effects of the loss of current whitewater flows created by hydropower peaking operations.

Dam removal would likely result in increases in the availability of whitewater boating flows within the acceptable flow range in both the J.C. Boyle and Copco 2 bypass reaches. Based on DOI modeling, there would be a substantial increase in whitewater boating flows within the acceptable flow range for both of these bypass reaches. It is also likely that additional opportunities would present themselves in those reaches of the river presently inundated by the reservoirs, although those specific opportunities remain uncertain.

Flows for whitewater boating would remain essentially unchanged below Iron Gate Dam. It is anticipated that improvements in water quality if dams were removed would improve the whitewater boating experience below Iron Gate Dam and could increase the numbers of visitors, particularly in late summer.

4.4.6.3 Changes to Recreational Fishing Resources

In addition to effects on whitewater boating opportunities, removal of the Four Facilities and corresponding changes in Klamath River would change recreational fishing resources and opportunities, including the loss of flat-water fishing on three reservoirs and an increase in river-based fishing opportunity.

Reservoir Based Recreational Fishing

Removal of J.C. Boyle, Copco 1, and Iron Gate reservoirs would result in the complete loss of habitat for introduced, non-native, warm water fish species, which are considered an important recreational fishing resource in the region. This loss would be permanent and would represent a considerable effect to anglers who value this fishery. In addition to the direct effects on individual anglers, the disappearance of recreational fisheries as well as the loss of other recreational opportunities at these reservoirs would result in a decline in the number of visitors to the reservoirs as well corresponding losses to the regional economy (Reclamation 2012f).

As described in Section 4.4.1.2, *Regional Economic Development (Reservoir Recreation)*, the recreation survey completed by PacifiCorp in 2002 found total visitation at J.C. Boyle, Copco 1, and Iron Gate reservoirs to be 95,470 recreation days. Section 4.4.1.2, *Regional Economic Development* also describes the projected visitation, using PacifiCorp's annual activity-specific growth rates, and the corresponding total reservoir recreation economic value for 2020-2061 under both dam removal and dams in scenarios.

As a result of dam removal and the loss of reservoir recreation, including perch and bass fishing, there would be an annual decline of visitor days at the reservoirs. The economic analysis assumes an average annual reduction of 40,901 recreation visits.

River Based Recreational Fishing

Removal of the Four Facilities and corresponding changes including long-term improvements in water quality, changes in river flows to a more natural regime, and access to habitat above the dams would improve habitat conditions and increase the area available for native fish populations. These changes are anticipated to increase the abundance and extent of native fish fisheries, such as salmon, steelhead, and redband trout, and related in-river recreational fishing opportunities (NOAA Fisheries Service 2012c).

Dam removal would increase free-flowing redband/rainbow trout habitat approximately 43 miles downstream of Keno Dam by restoring river channel habitat inundated by reservoirs, eliminating extreme daily flow fluctuations in the J.C. Boyle Peaking Reach, and increasing flows in the J.C. Boyle Bypass Reach. This could expand the current distribution of the existing trophy redband trout fishery seven-fold (Buchanan et. al. 2011) from downstream of Keno Dam to the Iron Gate Dam site (see Section 4.1, *Expected Effects of Dam Removal and KBRA on Physical, Chemical, and Biological Process that Support Salmonid and Other Fish Populations*). Dam removal would also benefit Chinook salmon and steelhead by restoring river channel habitat inundated by reservoirs, improving water quality, modifying flows, reducing disease (primarily for salmon), and reestablishing access to hundreds of miles of historical habitat (see Section 4.1, *Expected Effects of Dam Removal and KBRA on Physical, Chemical, and Biological Process that Support Salmonid and Other Fish Populations*).

While there would be a complete loss of the warm water non-native fishery in the reservoirs upon dam removal, increases in recreational fishing for salmon, steelhead, and redband trout could offset some or all of those losses.

Recreation Effects Summary

Table 4.4.6-5 summarizes the expected changes to recreational resources as a result of dam removal. As shown in Table 4.4.6-5, the major recreational resources analyzed in this section were open water recreation; camping and day-use recreation; whitewater boating; flat-water fishing; and, in-river fishing. Open water recreation currently enjoyed at the Klamath Hydroelectric Project reservoirs would be permanently lost following dam removal; however, there is potential for regional lakes and reservoirs to compensate for this loss. Similarly, camping and day-use opportunities, while eliminated at the Klamath Hydroelectric Project reservoirs, could be partially replaced by regional recreation resources or new Riverfront facilities. Whitewater boating would be reduced in the Hell's Corner Reach; however, removal of the Four Facilities would result in changes in flows in the Copco 2 and J.C. Boyle bypass reaches that could improve whitewater boating conditions, and opening river channels currently inundated by reservoirs. Finally, flat-water fishing opportunities would be lost at the reservoirs, while habitat improvements for salmonid and other anadromous fish species would likely increase in-river fishing opportunities.

Table 4.4.6-5: Expected Changes to Recreational Resources as a Result of Dam Removal

Resource	Effect of Dam Removal
Open water recreation	Permanently lost at Klamath Hydroelectric Project reservoirs; potential for replacement recreational opportunities at lakes and reservoirs in the region.
Camping and Day-Use	Many opportunities lost at Klamath Hydroelectric Project reservoirs; potential for replacement recreational opportunities at other sites in the region and recreation sites to be constructed along the newly exposed river reaches.
Whitewater Boating	A considerable loss in the Hell's Corner Reach. Considerable increases in the Copco 2 and J.C. Boyle bypass reaches.
Flat-water Fishing	Permanently lost at Klamath Hydroelectric Project reservoirs.
In-River Fishing	Modeled increases in salmonid and other anadromous fish species and associated in-river recreational fishing opportunities.

4.4.7 Real Estate

Three main categories of lands are involved in the potential removal of the Four Facilities. These include: 1) lands inundated by the reservoirs and other properties owned by PacifiCorp (Parcel A and B lands); 2) lands required temporarily or permanently for dam and facility removal; and 3) privately owned lands (other than PacifiCorp-owned) adjacent to or influenced by the reservoirs and the Klamath River (see sidebar). The summary of expected impacts to these lands presented in this section are described in more detail in *the Iron Gate and Copco Dams Removal, Real Estate Evaluation Report, Siskiyou County, California* (Bender Rosenthal, Inc. [BRI] 2011); *Dam Removal Real Estate Evaluation Update Report, December 2004 & 2006, Siskiyou County, California* (BRI 2012); and the *Assessment of Potential Changes to Real Estate Resulting from Dam Removal: Klamath Secretarial Determination Regarding Potential Removal of the Lower Four Dams on the Klamath* (DOI 2012c).

Land Categories

PacifiCorp owns approximately 11,000 acres in Klamath County, Oregon and Siskiyou County, California that are not directly associated with its Klamath hydroelectric facilities, and that are generally not included within the existing FERC project boundary. The KHSA describes this property as Parcel A. Implementation of the KHSA would have no effect on disposition of Parcel A lands, which would be disposed of by PacifiCorp subject to applicable Public Utilities Commission approval requirements (KHSA Section 7.6).

PacifiCorp also owns approximately 8,000 acres in Klamath County, Oregon and Siskiyou County, California that are associated with the Klamath Hydroelectric Project and/or included within the FERC project boundary. The KHSA describes this property as Parcel B lands. Of these lands, approximately 2,000 acres are currently inundated by reservoirs.

Dam removal would require the temporary use of public roads, PacifiCorp lands, and Federal lands for construction-related activities and the storage of construction materials. New roads would need to be created to provide access to the Klamath Hydroelectric Project facilities during dam decommissioning and removal. New temporary and permanent roads would be constructed on formerly inundated lands.

4.4.7.1 PacifiCorp Owned Property at the Reservoirs

According to the KHSA (Section 7.6.4), Parcel B lands (see sidebar) would be transferred to the respective state (Oregon or California) or a designated third party before facilities removal. The lands would then be managed for public interest purposes such as fish and wildlife habitat restoration and enhancement, public education, and public recreational access. The states have no detailed plans at present for the use and management of these lands, but indicate that the Parcel B lands would be managed consistent with the public interest purposes mentioned above. These Parcel B lands include approximately 2,000 acres of inundated lands which would be restored per the Reservoir Area Management Plan (Reclamation 2011g). There are also several houses owned by PacifiCorp on the Parcel B lands near Iron Gate and Copco 1 facilities that would transfer to the State of California. The State of California has not made any decision regarding their future disposition. PacifiCorp owns electric transmission and distribution facilities, which would remain under the company's ownership (KHSA Section 7.6.1).

The Keno Facility title would be transferred from PacifiCorp to the Federal government to be managed by DOI based on terms agreed to by both parties (KHSA Section 7.5). An Agreement in Principle for this transfer has been prepared.

In addition to the above categories of lands, the KHSA identifies three PacifiCorp owned tax lots in the vicinity of the East Side/West Side Powerhouse lands near Klamath Falls, Oregon. These lands may be transferred to DOI if the Four Facilities are removed (KHSA Section 6.4.1.C).

4.4.7.2 Private Property at Copco 1 and Iron Gate Reservoirs

Recreational uses on and around the reservoirs including power boating, waterskiing, lake swimming, and flat water boat angling (described in Section 4.4.6, *Recreation*) have led to private residential development along the shores and in the vicinity of the reservoirs. Removal of the four dams and appurtenant facilities, including the reservoirs, would result in changes to the recreational opportunities, viewshed, and other natural amenities currently provided by

Copco 1 and Iron Gate reservoirs. Studies have shown that amenities provided by proximity to a lake have a positive correlation with land values. Thus, the loss of reservoirs could result in declines in private land values.

To more fully understand the potential impacts to private property values around Copco 1 and Iron Gate reservoirs, the following studies were completed:

1. A parcel-level real estate evaluation of properties adjacent to or influenced by the two reservoirs. In accordance with established appraisal theory, view and locational attributes are associated with the land component of the real property interest and not the improvement component. Therefore it was determined that it was not necessary to analyze the entire house/lot component but rather only the land component to assess the potential impact of dam removal on the affected parcels.

2. Two literature reviews were conducted. The first examined the impacts of dam removal on private property values, and the second examined the impacts of wildfires on private property values. Wildfires were evaluated as a possible comparable event to dam removal because they can lead to loss of natural resource amenity values, which can in turn affect real estate values. However, the potential or realized effects of wildfires on personal safety and amenity values versus the potential effects of dam removal on amenity values proved too dissimilar to be relevant and useful and are not discussed further in this analysis.

The following sections describe the work completed by the Real Estate Sub-team, the main conclusions that could be drawn, and the limitations in the data.

Real Estate Evaluation Reports

Two valuation impact studies for private parcels at Copco 1 and Iron Gate reservoirs were completed, one in March 2011 (BRI 2011) and a second in June 2012 (BRI 2012). The studies looked at three baseline dates of property values; the June 2012 study reported on December 2004 and December 2006 dates of value, and the March 2011 study reported on an April 2008 date of value.

The studies included private parcels with reservoir views of Iron Gate Reservoir and private parcels with reservoir views and frontage on Copco 1 Reservoir. These two groups of properties could be affected by dam removal due to a change in either reservoir view or frontage if the dams were removed. Parcels were excluded from the initial list of potentially impacted properties if they were (1) publicly owned; (2) PacifiCorp owned; (3) had no assessed value; (4) in an area influenced by a river view (i.e. had river views prior to dam removal, and would therefore not be impacted by losing a reservoir view); and/or, (5) too far from the reservoirs to be affected by dam removal. Based on these criteria, the study identified 1,467 parcels that potentially could be affected by the removal of Iron Gate or Copco 1 reservoirs (BRI 2011). Of the 1,467 parcels, about 46 percent (668) were determined to have a measurable effect from dam removal. Parcels determined not to have a measurable impact from dam removal included those that were larger than 50 acres, located east of Copco Bridge (i.e. parcels with river frontage under existing conditions), land determined unbuildable or had no view of the reservoirs. Table 4.4.7-1 shows affected private parcels by land use category. The majority of the applicable private parcels are either vacant residential land (518 parcels) or single-family residential (127 parcels).

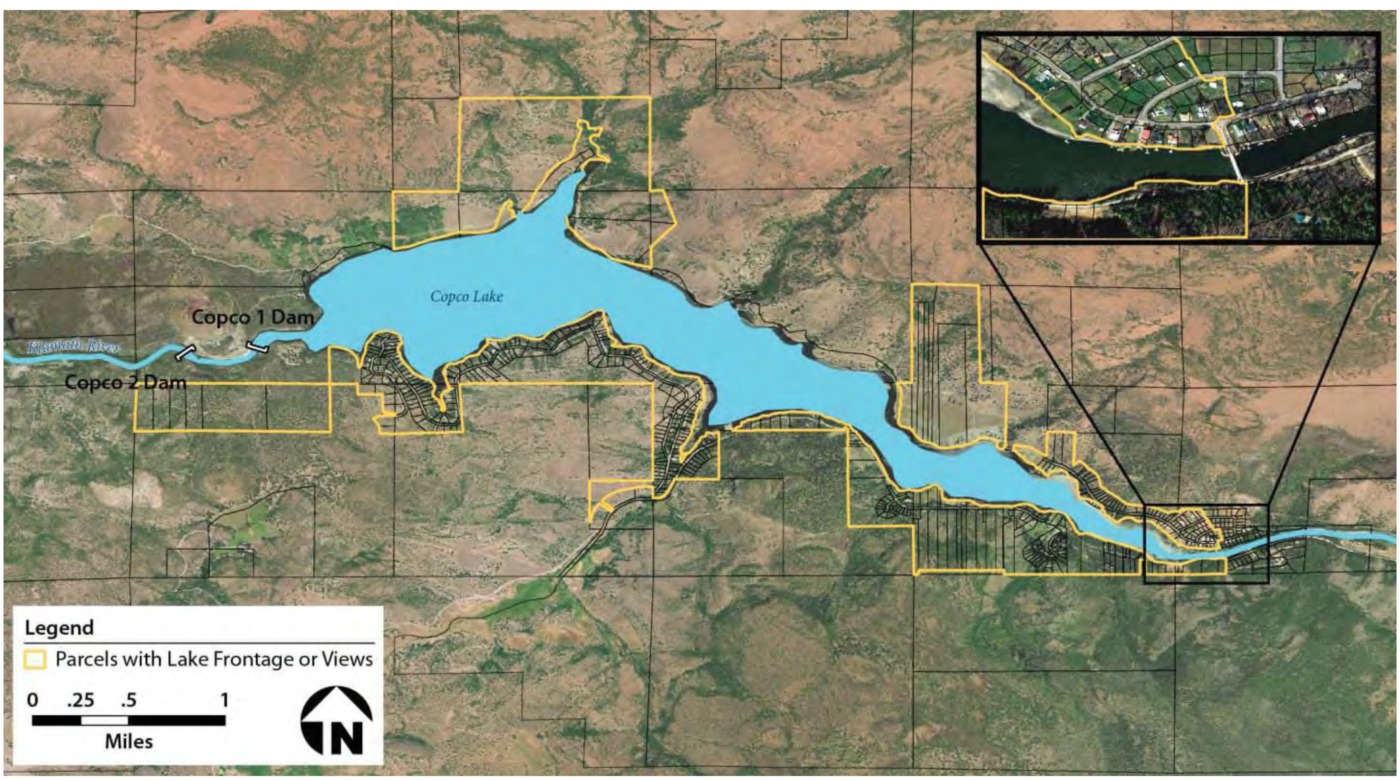
Table 4.4.7-1: Land Use Designations of Privately Owned Parcels around Copco 1 and Iron Gate Reservoirs

Land Use	Total Parcels	Affected Parcels
Timber	1	0
Rural Single-Family Residential	3	0
Vacant Commercial	4	2
Commercial	5	5
Rural (Minimum of 20 acres)	5	3
Agricultural	7	0
Vacant Rural Land (Minimum of 20 acres)	33	13
Single Family Residence	167	127
Vacant Residential Land	1,246	518
Total	1,467	668

Source: BRI 2011

Figure 4.4.7-1 depicts the privately owned parcels and improved lots around Copco 1 Reservoir, with an emphasis on the cluster of private homes near the eastern end of the reservoir. There are no privately owned parcels immediately fronting Iron Gate Reservoir; the majority of this land is owned by PacifiCorp and some is under public ownership.

Figure 4.4.7-1: The location of parcels around Copco 1 Reservoir potentially affected from changes to water access and/or views.



While the Dam Removal Real Estate Evaluation Reports (BRI 2011 and BRI 2012) used data from individual parcels, the appraisal was completed for groups of parcels based on common attributes and/or physical characteristics. Parcels were grouped according to water-frontage, access (property access by paved road as well as to utilities), and location. Further, the median size of parcels in each group was calculated and this size was valued for each group. To evaluate the impact of dam removal on private properties around Iron Gate and Copco 1 reservoirs, this study compared a before dam removal condition with a hypothetical after dam removal condition. The after dam removal condition assumes that the reservoirs are drained and the river has returned to its original channel with the land under the reservoirs is revegetated and restored to its native condition. It is anticipated that land values would reach a low point soon after the reservoirs were drained, exposing a denuded landscape, and that they would progressively increase in value until the time the terraces above the river were revegetated and the river channel was fully recovered. The differences in land value through time in this interim period could not be quantified, and the amount of time it would take for a fully recovered river channel to develop is unknown, but would likely take years.

To estimate the potential property value decline following dam removal, prices per acre of reservoir frontage and reservoir view properties were compared to prices per acre of river view and no reservoir view properties. The valuation assessment assumed reservoir frontage in the before dam removal condition would change to river view in the after dam removal condition. In addition, reservoir view in the before dam removal condition was assumed to change to no reservoir view or river view in the after dam removal condition. Both of these comparisons were completed for 2004, 2006, and 2008. Table 4.4.7-2 and 4.4.7-3 summarize the findings of value adjustments based on these amenity changes.

Table 4.4.7-2: Property Value (land only) Adjustments Based on Changed Amenities

Valuation Year	Discount from reservoir view to no view	Discount from reservoir frontage to river view
2004	45%	25%
2006	35%	25%
2008	35%	25%

Source: BRI 2011 and 2012

Table 4.4.7-3: Estimated Aggregate Market Impact (land only) Before and After Dam Removal for the 668 Potentially "Affected" Parcels around Copco 1 and Iron Gate Reservoirs (rounded estimates)

Valuation Year	Aggregate Value "Before"	Aggregate Value "After"	Difference	Percent Difference
2004	$6,785,000	$4,553,000	$2,232,000	32.9%
2006	$8,411,000	$5,915,000	$2,496,000	29.7%
2008	$9,007,000	$6,341,000	$2,666,000	29.6%

Source: BRI 2011 and 2012

It is important to note the following assumptions and findings from the Real Estate Evaluation Reports (BRI 2011 and BRI 2012):

1. The data reflects changes in land values only, not values associated with homes or other improvements on the land, because the value of amenities are attributable to the land component of a real property interest and not to the improvement component.

2. The findings of the discount from reservoir frontage to river view are based on an extremely small data set due to lack of available property sales data.

3. As described above, the after dam removal condition values assume the river and land under the reservoirs are fully restored to their native condition; however, there would be a period during and soon after dam removal, and before this restoration process is complete, when it is anticipated that land values could be even lower. It is unknown how long this restoration would take and what the property value impacts would be during this interim period.

Dam Removal Literature Review

To supplement the findings from the valuation impact study, a literature review was conducted to find dam removal case studies from around the country. The literature on previous dam removals and impacts to private property values is limited. The most frequently cited case studies that exist are from the Kennebec and Penobscot Rivers in Maine (Lewis, Bohlen, and Wilson 2006; Bohlen and Lewis 2008) as well as multiple dam removals in Wisconsin (Sarakinos and Johnson 2003; Provencher et al. 2006). The majority of previous studies on the impacts of dam removals on private property values were done on small dams and small reservoirs, and several authors noted the general lack of data and studies about property value impacts from dam removal and draining reservoirs (Provencher, et al. 2006; Pennsylvania Organization for Watersheds and Rivers no date). In terms of the direct impacts to private property values, some studies reported increases in values following dam removal (i.e. Bohlen and Lewis, 2008; Born et al. 1998). Increases in values were generally related to improvements in water quality, removal of nearby dam structures, and enhancements to the natural riparian environment. Other studies described private property values decreasing briefly and regaining value by the end of two years (Kruse and Scholz 2006). These previous studies should be interpreted with caution due to the small size of the impoundments. It is questionable such conclusions can be extended to large impoundments (like Copco 1 and Iron Gate reservoirs) where activities such as fishing, boating, and swimming are popular (Provencher et al. 2006).

One study, Kruse and Ahmann (2009), examined the characteristics of lot size and proximity to the Klamath River, Copco 1 or Iron Gate reservoirs on private residential property values (land values only). This study was based on reported sales data between 1998 and 2006. Using the hedonic pricing method, this study developed a statistical relationship between sales values and a set of variables that were modeled as “indicator variables” which took on values of 1 or 0 for the following categories:

- On the shore of the reservoir
- Across the road from the reservoir
- View of either Copco I or Iron Gate reservoirs
- On the Klamath River

The authors found that in the case of the Klamath River, results of the hedonic pricing model demonstrate that reservoir adjacency does have a positive and significant impact on residential property values and that, all else being equal, properties on a reservoir (frontage), with reservoir proximity, or with a reservoir view are worth more than properties without these characteristics. Based on their model of reservoir adjacency, Kruse and Ahmann (2009) predicted a decrease in the per acre land value of lake frontage properties following dam removal of 52 percent with all else being held constant. They also predicted the value of properties across the road from a reservoir to decrease by 40 percent, and properties with reservoir views to decrease by 21 percent. The authors also attempted to look at property value impacts associated with river frontage; however, there was an insufficient sample size to estimate any positive effect associated with river front properties adjacent to the Klamath River downstream of Iron Gate Dam. The study concluded that lake adjacency does have a positive and significant impact on residential property values and that, all things being equal, properties on a lake, with lake proximity or with a lake view are worth more than properties without these characteristics.

While property values based on proximity to the reservoirs can be expected to decline with dam removal, the amount and timing of these changes were not analyzed. Kruse and Ahmann’s study did not address how property values would change if a different set of environmental values developed in the future if the dams were removed. Their quantitative findings did not take into account potential future access, uses, or amenities/dis-amenities of the reservoir lands and the river after dam removal, which could influence overall results.

Real Estate Effects Summary

Dam removal and draining Iron Gate and Copco 1 reservoirs could affect the land values of about 668 parcels that have frontage, proximity, or view of the reservoirs. Of these parcels, about 19 percent (127 parcels) have been developed as single-family residences. About 518 parcels are currently vacant residential land. Each of the studies described above lead to a similar conclusion as to the impacts of dam removal and the loss of natural amenities on private property values (land values only).

The Real Estate Evaluation Reports (BRI 2011 and BRI 2012) compared reservoir view properties to no reservoir view or river view properties, and reservoir frontage property values to river view properties. With a limited amount of data for the 3 years examined, the studies identified a discount in land value based on a potential change from reservoir view to no view, or reservoir frontage to river view, ranging from 25 to 45 percent. These estimates assume the river and land under the reservoirs are fully restored to their native condition for the after dam removal land value estimates. Depending on the year of valuation used in the analysis (2004, 2006, or 2008), the change in amenities from before dam removal to a hypothetical condition following dam removal (assuming a fully restored river), would decrease the aggregate value of these 668 parcels by about $2.2 to 2.7 million dollars, or about 30 percent.

Real estate values adjacent to the reservoirs are expected to decline in the short-term with landscape changes from an open water surface to a denuded landscape with reservoir draw down. The loss in value of these properties may be partially offset over the long term as the formally inundated areas become re-vegetated open space with upland and riparian vegetation. However, some of this loss is likely to be permanent with the shift from reservoir view to no view or from reservoir frontage to river view with open space, as estimated in Tables 4.4.7-2 and 4.4.7-3. It is anticipated that land values would reach a low point soon after the reservoirs were drained and that they would progressively increase in value until the time the terraces above the river were revegetated and the river channel was fully restored to native conditions. This analysis, however, could not estimate the value of this low point or the number of years before the river channel was fully restored. The Kruse and Ahmann (2009) study was completed in a similar location as the Real Estate Evaluation Reports (BRI 2011 and BRI 2012) and it identified that proximity to the reservoirs had a positive and large effect on land values. Lake frontage had the largest effect on property sale value. Proximity to, or a view of, the reservoirs had a positive but less effect on sale value. Kruse and Ahmann note, however, that the study did not address long-term changes (either increases or decreases) related to the future condition and use of lands exposed after dam removal.

Parcels downstream of Iron Gate Dam that experience river water quality improvements and/or improved fisheries from dam removal and implementation of the KBRA may experience positive changes in value in the long-term. However, data were not available on the timing, magnitude, and spatial extent of these changes in order to quantify these effects.

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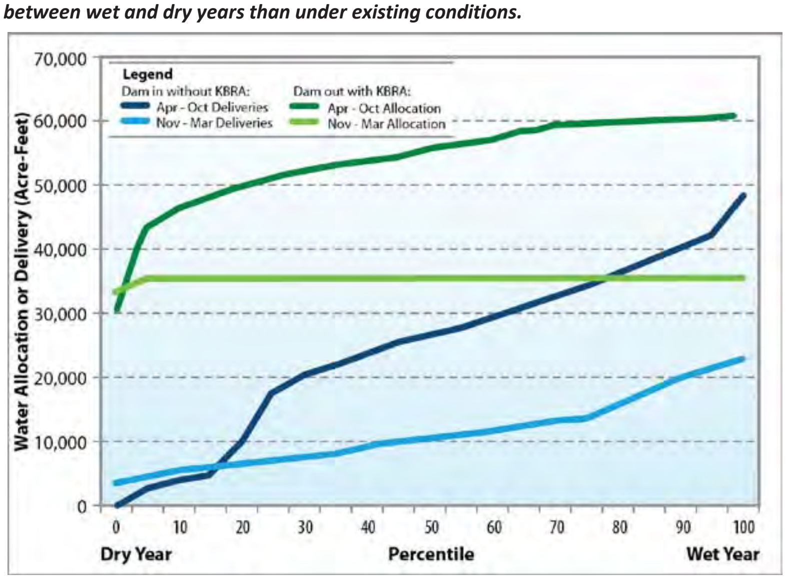
4.4.8 Refuges

The KBRA would provide for modification of the authorized purpose of Reclamation's Klamath Project, to add fish and wildlife uses, assuring that the refuge water allocation would be equal in priority to the irrigators' allocation. The KBRA would allow refuge managers to call for water when it is needed, which would give them the flexibility to create optimum habitat conditions. The findings in this section are largely drawn from Mauser and Mayer 2011.

The refuge managers would gain the ability to order water delivery through Reclamation's Klamath Project facilities. Management of refuge lease lands would remain subject to the National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57), the Kuchel Act (P.L. 88-567), and all other applicable laws, regulations and policies. The parties would pursue collaborative conservation measures on the lease lands, including walking wetlands (as described below), and other practices beneficial to wildlife. The FWS would maintain the ultimate administrative control over the lease lands. As described in Appendix A of the KBRA, the Kuchel Act provides that the refuges would receive 20 percent of net lease revenues for implementation of conservation practices on the refuges. In 2009, the refuges' share would have been approximately $343,000.

With dam removal and implementation of the KBRA, the Lower Klamath National Wildlife Refuge (NWR) would, for the first time in more than 100 years, have a high certainty of a water delivery in the critical April through October time period, even in most dry years. The April through October allocation would equal or exceed 48,000 acre feet in 88 percent of the years, an allocation that meets the needs of the refuge. This allocation increases incrementally up to a maximum of 60,000 acre-feet (April – October) in wet years (see Figure 4.4.8-1). Historically, the April through October allocation of water met the needs of the refuge in less than 10 percent of the years, with deliveries less than 20,000 acre-feet in most years. With dam removal and implementation of KBRA, the November through March delivery of water to this refuge would be much higher, averaging about 20,000 acre-feet and nearly 30,000 acre-feet in the driest years (see Figure 4.4.8-1).

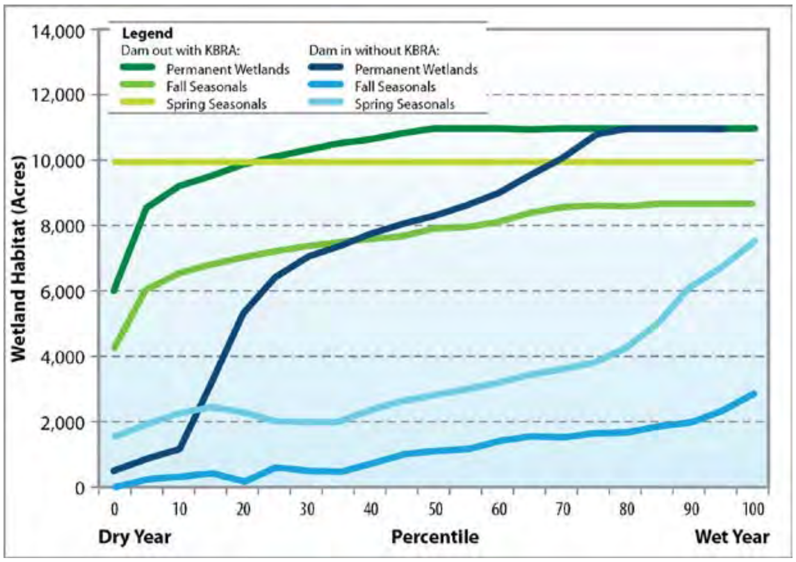
Figure 4.4.8-1: The Lower Klamath NWR would receive more water (measured in acre-feet) through the Refuge Allocation under KBRA than under dams remaining without the KBRA in both summer and winter seasons. Water deliveries with the KBRA would also vary less between wet and dry years than under existing conditions.



The Drought Plan developed under the KBRA addresses occasions when water is in extremely short supply and states how shortages would be shared among agricultural and refuge uses. The NWRs would receive sufficient water for wildlife purposes in nine of ten years, according to modeling (Mauser and Mayer 2011). If the KBRA had been in effect in 2009, the summer water delivery to Lower Klamath NWR would have been 48,000 acre-feet, which is about twice as much water as the refuge actually received in 2009.

The "Walking Wetlands" program that would benefit from the Refuge Allocation under the KBRA is a program that creates wetlands by flooding land to various degrees and rotates these wetlands into commercial crop rotation cycles. Lands in the program benefit from increased yields and reduced needs for fertilizers and soil fumigation following a wetland cycle. Waterfowl benefit from increased wetland acreage available for habitat. Because not all lands in the program would be in a wetland cycle during the same year, the program results in wetlands that "walk" from place to place. Walking wetlands would receive water from both the Lower Klamath allocation (1 acre-foot/acre) and the irrigator's available supply (2 to 2.5 acre-feet/acre). Through this program, the refuge would gain additional wetland habitat (see Figure 4.4.8-2) for a relatively minor cost in terms of water allocation, and Reclamation's Klamath Project irrigators would not be penalized for using additional water to provide wetlands on private lands. This provision would apply to "walking wetlands" on both private lands and lease lands on Tule Lake NWR. Use of the Lower Klamath NWR allocation for walking wetlands must be approved by the Refuge Manager.

Figure 4.4.8-2: With implementation of the KBRA, the Lower Klamath NWR would be able to provide more acres of permanent wetland habitat during dry years and the same number of acres during the wettest years as under existing conditions. With the KBRA, the number of acres of fall and spring seasonal wetlands would be greater than without the KBRA in both wet and dry years. More acres of wetland habitat would result in larger numbers of waterfowl and other wetland species supported by the NWR.



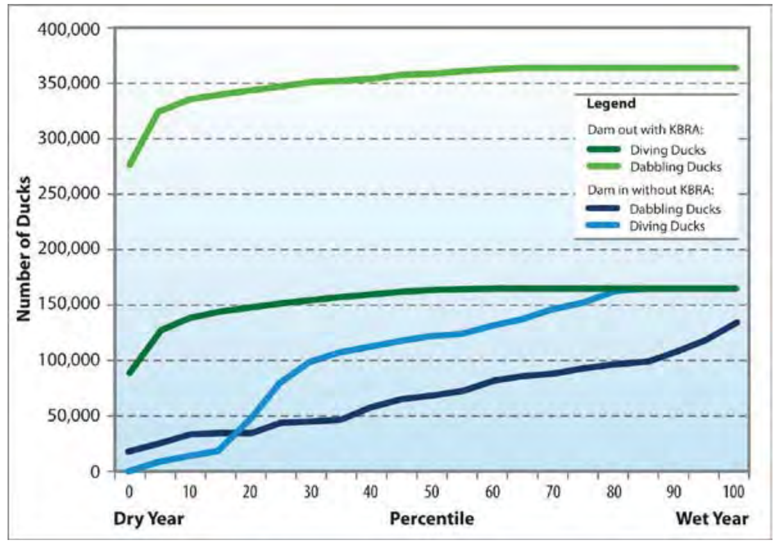
The Lower Klamath NWR is listed in the National Register of Historic Places as both a National Historic Landmark and a National Natural Landmark. Implementation of the KBRA would help preserve the functionality of the site for its listed purposes. Implementation of the KBRA would result in increases in migratory waterfowl, non-game water birds, wintering bald eagles and other sensitive species because of the additional deliveries of water and acres of wetland habitat (see Figures 4.4.8-1 and 4.4.8-2).

4.4.8.1 Waterfowl

The Klamath Basin forms a natural funnel for the Pacific Flyway waterfowl migration corridor, as migratory waterfowl transition from northern breeding areas to major wintering sites in the Central Valley of California and Mexico. Tule Lake and Lower Klamath NWRs are considered some of the most important waterfowl refuges in the United States and are major fall and spring staging areas within the Pacific Flyway. In the fall, when wetland acres available at the refuges are reduced due to a lack of water, these waterfowl continue south. As large numbers of waterfowl head into the Central Valley of California, they may come into conflict with agricultural operations, and overcrowding early in the fall may reduce their ability to survive the winter.

To estimate the ability of the Lower Klamath NWR to support migratory waterfowl, the FWS used a model based on food resources provided in wetlands and refuge agricultural fields. Under an average water year with implementation of the KBRA, additional water deliveries to Lower Klamath NWR would result in food resources sufficient to support more than 336,000 fall migrating ducks, compared to 189,000 fall migrating ducks under existing conditions. The difference in waterfowl carrying capacity is even more pronounced in drier years (see Figure 4.4.8-3). Water allocations under the KBRA would allow Lower Klamath NWR to better serve as a major waterfowl migration area in the Pacific Flyway. Without the KBRA, the decline in wetland habitats would significantly reduce the carrying capacity of the refuge and the Pacific Flyway for waterfowl.

Figure 4.4.8-3: 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.

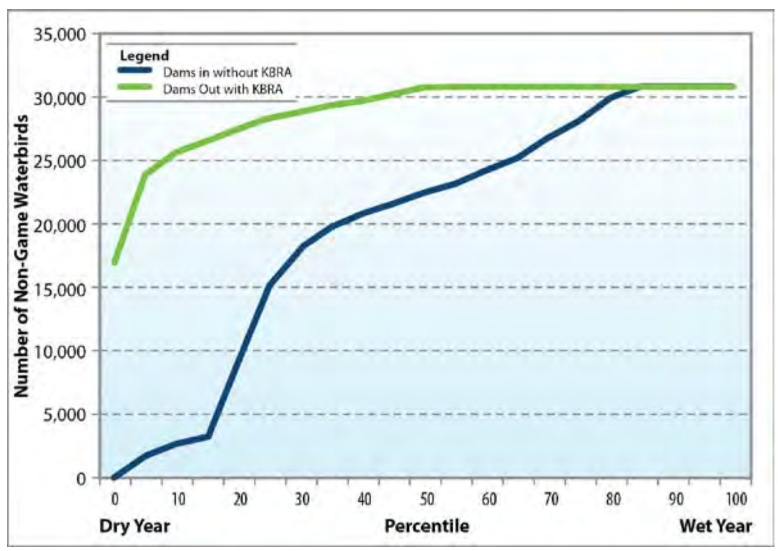


4.4.8.2 Nongame Waterbirds

Nongame waterbirds include shorebirds, gulls, terns, cranes, rails, herons, grebes, egrets, and ibis. Loss of historic wetland and unregulated market-hunting at the historic Tule and Lower Klamath Lakes early in the 20th century resulted in major declines in waterbird abundance in the Klamath Basin, particularly of colonial nesting species. Lower Klamath NWR, in particular, was established largely to protect nesting colonies from unregulated hunting. Intensive wetland habitat management on Lower Klamath NWR provides habitat for remaining populations, and it is considered the most significant waterbird nesting site in California.

Water supplies under KBRA in an average water year would result in significantly more wetland habitats, estimated to provide habitat for more than 8,000 additional nongame waterbirds compared to existing conditions. The increase in non-game waterbird numbers is even greater in drier years (see Figure 4.4.8-4), often exceeding 20,000 nongame waterbirds compared to existing conditions.

Figure 4.4.8-4: Late summer (August) carrying capacity for nongame waterbirds on the Lower Klamath NWR would be greater with implementation of the KBRA during dry and average years. The carrying capacity would be about the same as currently exists during wet years.



4.4.8.3 Bald Eagles

The mild winters and abundant wintering waterfowl, which serve as food sources for eagles in the Upper Klamath Basin, attract the largest wintering population of bald eagles in the United States outside of Alaska. Eagles from as far away as Northeastern Alaska, Northwest Canada, and the Pacific Northwest, as well as from further south in California and Arizona, have been documented to use the Klamath NWRs. Areas that support large wintering concentrations of eagles are relatively uncommon.

The refuge water allocation under the KBRA would provide additional water and wetland habitats that would result in larger populations of waterfowl on the refuges. This would provide a larger and more reliable food resource base for wintering bald eagles and enhance the value of the refuges as an overwintering location. With implementation of the KBRA, there would be an increase in the number of wintering bald eagles, particularly in dry years.

4.4.8.4 Other Birds and Wildlife Species

Lower Klamath, Tule Lake, and Upper Klamath NWRs support a number of species that are considered threatened or endangered by the Federal and/or state governments (Oregon and California). In addition, the refuges also support 84 focal or priority species identified by Federal or state governments, as well as several conservation organizations (Mauser and Mayer 2011). These focal or priority species, while not listed as endangered or threatened, are generally facing one or more threats to their populations or habitats. They include a diversity of birds, mammals, fish, and reptiles. The additional water provided under the KBRA, especially to the Lower Klamath NWR, would result in sufficient water such that the refuges could provide enhanced habitats for these species.

4.4.8.5 Refuge Effects Summary

In summary, dam removal and KBRA implementation would allow the refuges associated with Reclamation's Klamath Project to have greater certainty about water deliveries with newly established allocations, even during drought years, and increased flexibility in the timing of water deliveries. Full refuge needs would likely be met in 88 percent of years; currently refuge needs for water are met in less than 10 percent of the years. Dam removal and KBRA implementation would also define and maintain the habitat benefits of walking wetlands and provide the refuges revenues from leased lands. The additional water deliveries—and the increased predictability of those deliveries—would mean that greater numbers of migratory waterfowl, non-game water birds, wintering bald eagles, and other sensitive species would be supported by the refuges (Mauser and Mayer 2011). These NWRs wetlands are critical components of the Pacific Flyway, the corridor for migrating birds from as far away as Alaska and Mexico.

4.4.9 Chemicals in Reservoir Sediments

The sediments trapped behind the Four Facilities have been screened to identify the potential for adverse ecological or human health effects from the presence of chemicals. Reservoirs can trap sediments, which can be contaminated before they enter the reservoir or become contaminated once trapped. If the dams are removed, portions of the trapped sediments would be flushed downstream and some sediment would remain behind on newly exposed land surfaces beneath the existing reservoirs.

This section summarizes the results of a screening-level evaluation that was performed to identify potential adverse effects from exposures to sediments if: (1) dams are removed and sediments flush downstream or are exposed as new land surfaces; and (2) the reservoirs remain in place along with their associated sediments. This study was designed to inform the larger decision about dam removal under the Secretarial Determination, and determine whether sediments trapped in the reservoirs contain chemicals at concentrations that would preclude their release downstream under an Affirmative Secretarial Determination. This study does not constitute a formal ecological or human health risk assessment. The following is a summary of the report entitled *Screening-Level Evaluation of Contaminants in Sediments from Three Reservoirs and the Estuary of the Klamath River, 2009–2011* (CDM 2011e).

Sediment Assessment Terms

Bioassay: Experiments that use living organisms to test their response to chemical exposure.

Elutriate: The water sediment mixture that represents the reservoir bottom sediments when they are mixed into a water column.

Biota: The combined flora and fauna of a region.

Bioaccumulation: The accumulation of a substance (such as a pesticide) in a living organism.

Suspended Sediment: Particles of rock, sand, soil, and organic detritus carried in suspension in the water column, in contrast to sediment that moves on or near the streambed.

4.4.9.1 Exposure Pathways Evaluated

If the facilities are removed, about 36 to 57 percent of the trapped sediments, depending on hydrology, are expected to erode from the reservoirs and be transported through the Klamath River and estuary, and into the Pacific Ocean (Reclamation 2012g). A large proportion of the sediment (about 85 percent) is characterized as a small size fraction such as silt and or clay (see Section 4.1.3.1, *Reservoir Sediment Volume, Composition, and Erosion Potential*); consequently, with reservoir drawdown, much of the sediment would be suspended and transported to the ocean, where it would be further dispersed by currents (Reclamation 2012g, Stillwater 2008). Some of the remaining trapped sediments would be exposed to air, becoming new land surfaces and other sediments would continue to be slowly eroded as the Klamath River cuts a new channel through the reservoir bed. Movement of reservoir sediments would be greatest within the first three months after reservoir drawdown begins and would continue to a lesser extent over a 2-year period (Reclamation 2012g).

Most of the eroded fine-grained sediments are expected to remain in suspension on their way to the ocean; however, some could form small or temporary deposits in the river, or be deposited on river bank, in the estuary, or in the near shore area of the Pacific Ocean. These potential depositional areas could provide opportunities for exposure to sediments and any chemicals associated with them. Five pathways for potential exposure to reservoir sediments with dams in place and dam removal are shown schematically in Figure 4.4.9-1. These pathways were selected to represent the most likely potential exposures to reservoir sediments for biota and humans, as follows:

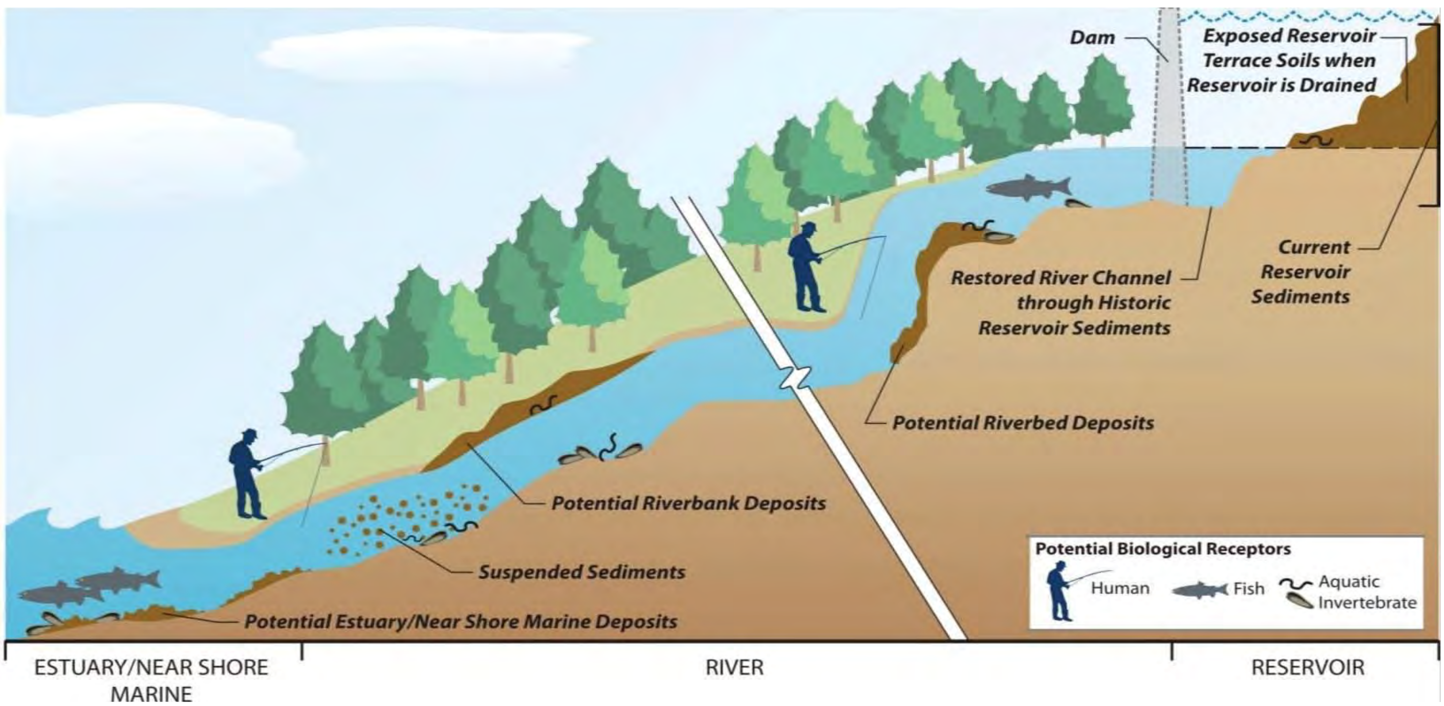
Dam Removal:

- Exposure Pathway 1 – Short-term exposure of aquatic biota to suspended sediments flushed downstream in the water column
- Exposure Pathway 2 – Long-term exposure of land-based biota and humans to exposed reservoir terrace deposits and river bank deposits
- Exposure Pathway 3 – Long-term exposure of aquatic biota and humans to river bed sediment deposits
- Exposure Pathway 4 – Long-term exposure of aquatic biota to marine, near shore sediment deposits

Dams Remain:

- Exposure Pathway 5 – Long-term exposure of aquatic biota and humans (via fish consumption) to reservoir sediments if the dams remain in place (current conditions)

Figure 4.4.9-1: Multiple exposure pathways evaluated in and along the Klamath River, the Klamath River Estuary and the near shore of the Pacific Ocean that could potentially allow contaminated sediments to cause adverse ecological or human health effects.



Source: CDM 2011e

4.4.9.2 Evaluation Process

The evaluation of sediments trapped behind the Four Facilities generally followed guidelines outlined by the Sediment Evaluation Framework (SEF) for the Pacific Northwest (Regional Sediment Evaluation Team [RSET] 2009), including evaluation of sediments using identified screening level values. The SEF framework was developed to determine how best to manage or dispose of sediments from dredging or similar projects where discharge of sediments back into an aquatic environment is proposed. The SEF process also addresses sediment characterization and disposal issues in accordance with applicable state and Federal regulatory programs, and thus is helpful in informing decisions regarding the release of trapped sediments with dam removal.

For this evaluation process, four assessments were performed following the SEF:

- **Level 1**: Project definition and a review of existing information.
- **Level 2A**: Screening assessment to compare past and recently collected reservoir sediment chemistry data to available and appropriate sediment screening values, including chemical-specific marine screening levels (maximum levels and bioaccumulation triggers), and SEF freshwater and marine screening levels.
- **Level 2B**: Screening assessments to compare elutriate chemistry, sediment and elutriate laboratory bioassays, and laboratory bioaccumulation to appropriate screening levels (see text box for definitions).
- **Special study of reservoir fish tissues**: In response to public questions about chemicals detected in reservoir bottom sediments, this study compared concentrations of bioaccumulative chemicals in fish tissue to screening levels for fish consumption, to evaluate potential human exposure to these chemicals from eating resident reservoir fish.

Although existing data from the Klamath Hydroelectric Project reservoir sediments were evaluated under SEF Level 1 and indicated limited potential for sediment toxicity (Shannon and Wilson 2006), the data were not considered sufficient to represent the full spatial extent of sediments in the reservoirs or evaluate all chemicals of interest for the Secretarial Determination. Thus, the process moved to SEF Level 2 and prompted additional sampling and study.

Additional sediment and elutriate samples were collected from J.C. Boyle, Copco 1, and Iron Gate reservoirs as well as the Klamath River Estuary in 2009 and 2010 (Reclamation 2011j). A total of 77 sediment cores were collected at various reservoir and estuary locations; 501 analytes were quantified across the samples, including metals, poly-aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides/herbicides, phthalates, volatile and semi-volatile organic compounds (VOCs, SVOCs), dioxins, furans, and polybrominated diphenyl ethers (PBDEs) (i.e. flame retardants). Elutriate samples were collected concurrent with the 2009-2010 sediment samples and subjected to analysis for a subset of 384 chemicals including all of the chemical groups listed above. Sediment and elutriate sample analytical results were evaluated following SEF Levels 2A and 2B guidelines.

For the screening bioaccumulation assessments (SEF Level 2B), standardized tests were performed using black worms and Asian clams that were exposed to reservoir sediments in the laboratory and then analyzed for metals, PAHs, dioxins, furans, PCBs, pesticides, and PBDEs. Laboratory toxicity bioassays were

Aquatic Health Screening Levels

Dredge Materials Management Program (DMMP) Marine Screening Levels. These are maximum levels for disposal of materials in marine environments. Developed by the DMMP in Puget Sound as part of the SEF, these represent the highest Apparent Effects Threshold for each chemical, at which biological indicators show adverse effects. They include screening levels (SLs), bioaccumulation triggers (BTs), and maximum levels (MLs). Exceedance of the DMMP MLs would require mitigation or consideration of alternate methods of disposal (USACE 2008).

Freshwater (SEF SL1) and Marine (SEF SL1) Screening Levels (RSET 2009). If all chemicals are below these levels, sediments pose a low toxicity and are suitable for unconfined aquatic disposal. If SL1s are exceeded, the need for alternate lines of evidence including biological testing is indicated (RSET 2009).

ODEQ Bioaccumulation Screening Level Values (BSLVs). *See description of Human Health Screening Levels (next page).*

also performed using invertebrates and fish that were exposed to elutriates or sediments.

For the special study of reservoir fish tissue, yellow perch and bullhead were collected in 2010 from J.C. Boyle, Copco 1 and Iron Gate reservoirs and their tissues analyzed for metals, dioxins, furans, PCBs, pesticides, and PBDEs (CDM 2011e). The findings for chemicals in tissues of reservoir fish are applicable to current conditions with the dams in place, and cannot be translated to conditions if the dams were removed due to the changes in species and exposure conditions.

Six consulted Federal and state agencies (USEPA, NCRWQCB, ODEQ, USGS, USFWS, and NOAA Fisheries Service) provided input on the use of specific screening levels to assess the five exposure pathways. The screening values were used in a prioritized, step-wise manner, to identify any chemicals potentially needing further evaluation. Chemical screening level explanations that were used are summarized in sidebars in this section. Sediment screening levels are derived to be protective of sensitive receptors (e.g. fish, mammals, or humans) and are defined in many different ways, depending on exposure mechanisms and durations, or the mode of toxicity of the individual chemicals. Therefore, the presence of a chemical at concentrations in excess of the indicated screening levels does not necessarily indicate that adverse impacts to biotic or human health are occurring or will occur but typically suggests that further evaluation is warranted, to take into consideration site specific exposure factors and factors affecting chemical concentrations over time such as environmental degradation, mixing and dilution of sediments. Additional details on the screening levels used and the stepwise process for comparisons to sediment, elutriate, and tissue concentrations are provided in CDM (2011e).

4.4.9.3 Results

The 2009-2010 monitoring studies generated multiple lines of evidence that were used collectively to evaluate the chemistry of trapped reservoir sediments and their potential to affect the environment and human health under both current conditions and the removal of the Four Facilities. The evaluations were based upon potential effects using the five exposure pathways discussed above.

No chemicals were detected in sediment at concentrations exceeding the DMMP Marine MLs (see sidebar for explanation of these screening levels), and no other preclusions to releasing the reservoir sediments to the freshwater or marine environment were identified based on screening levels used in the SEF approach for this study. A number of chemicals and common classes of chemicals were detected; however, these results are neither surprising nor unusual. Many of the detected compounds have natural sources or are broadly distributed around the earth (e.g., arsenic, metals, legacy organochlorine insecticides like DDT, and dioxins and furans), and are known to be present at trace or background concentrations in soils, streams and biota across the United

Human Health Screening Levels

USEPA Regional Screening Levels (RSLs) – RSLs for residential exposure to soil were used to assess sediments. These are very protective, assuming children and adults would be exposed to the sediments as soil in residential settings, via oral, dermal and inhalation exposures. RSLs are based on exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long term/chronic exposures and are likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA 1991, 1996, 2002).

ODEQ Bioaccumulation Screening Level Values (SLVs). These are non site-specific, protective, risk-based sediment screening levels to determine if chemicals in sediment have the potential to bioaccumulate to the point where they adversely affect the health of animals or humans resulting from consumption of fish or other biota. For Human Health, BSLVs are referred to as ODEQ BSLV H-S (human subsistence fish consumption) and ODEQ BSLV H-G (human general fish consumption). BSLVs for birds, mammals, and fish were also utilized (ODEQ 2007). In addition to SLV analyses, existing bioaccumulation bioassay data may be used, if available, or biological tests may be performed to evaluate site-specific bioaccumulation potential (ODEQ 2007).

States. Others are commonly found downstream of areas with significant histories of land disturbance and urbanization, industrial development, and agriculture. Figure 4.4.9-2 summarizes the evaluation results for the five exposure pathways and the multiple lines of evidence. The effects range from no adverse effect (black dots) to potential for limited or minor effects from one or more chemicals (green dots). No significant adverse effects (red dot) were identified as a result of exposure to chemicals in sediments.

Figure 4.4.9-2: Summary results of the screening-level evaluation that was performed to identify potential adverse effects from exposures to reservoir sediments.

	Exposure Pathway	Freshwater biota	Marine biota	Terrestrial biota	Humans
Pathway 1	Short-term exposure to sediments flushed downstream	● (green)	● (blue)	--	--
Pathway 2	Long-term exposure to exposed reservoir terrace and or river bank deposits	--	--	● (black) (1)	● (blue) (2)
Pathway 3	Long-term exposure to new river channels and river bed deposits	● (blue)	--	--	● (blue)
Pathway 4	Long-term exposure to marine / near shore deposits	--	● (blue)	--	--
Pathway 5	Long-term exposure to reservoir sediments	● (green)	--	--	● (green)

● (black)	No adverse effects based on lines of evidence
● (blue)	One or more chemicals present, but at levels unlikely to cause adverse effects based on the lines of evidence
● (green)	One or more chemicals present at levels with potential to cause minor or limited adverse effects based on the lines of evidence
● (red)	At least one chemical detected at a level with potential for significant adverse effects based on the lines of evidence
--	This exposure pathway is incomplete[3] or insignificant[4] for this receptor group

Note:
This does not include an evaluation of the physical effects (e.g., dissolved oxygen in the water, suspended sediment)
(1) Qualitative evaluation conducted for this exposure pathway
(2) Limited quantitative, along with qualitative evaluations conducted for this exposure pathway
(3) Incomplete - receptor group is unlikely to come in contact with sediment-associated contaminants under this exposure pathway
(4) Insignificant - exposure pathway not considered a major contributor to adverse effects in humans based on best professional judgment

Source: CDM 2011e

Figure 4.4.9-3: Sediment chemistry sampling in J.C. Boyle Reservoir, Oregon, during October 2009.

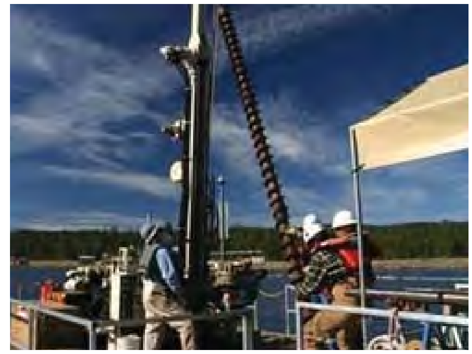


Figure 4.4.9-4: A large bullhead sampled for contaminants in fish tissues from Iron Gate Reservoir during September 2010.

Absolute concentrations of most chemicals in the reservoir and estuary sediments were generally relatively low compared to the screening levels, with no consistent pattern of elevated chemical composition observed within a given reservoir or between reservoirs. No chemicals were identified at levels associated with significant adverse effects (see Figure 4.4.9-2). However, some compounds were identified at levels “unlikely to cause adverse effects” (blue dots), or with “potential to cause minor or limited adverse effects” for aquatic receptors (see Table 4.4.9-1) or humans (see Table 4.4.9-2) (green dots) under either the current, dams remain condition (Exposure Pathway 5) or in the short term (1-2 years) following dam removal (Exposure Pathway 1). The magnitude of the potential effect of a given detected chemical was dependent on the exposure pathway and the assumptions related to the screening levels exceeded (e.g., Human Health RSLs assume a residential scenario with chronic lifetime exposure to sediments).

Table 4.4.9-1: Exposure pathways and expected effects for contaminants exceeding freshwater and marine screening levels for aquatic health in sediments in J.C. Boyle, Copco 1, and Iron Gate reservoirs, 2009-2010

Contaminant Name	Units	No. of Samples	No. of Detec-tions	Measured Concentration		Relevant Exposure Pathways	Explanation
				Median	Maximum		
Dieldrin	µg/kg	6	1	ND	3.4	4	One sample in J.C. Boyle Reservoir exceeded the Pacific Northwest primary screening level (SEF-SL1) for marine sediments (1.9 µg/kg) at concentrations that are unlikely to adversely affect biota.
DDT	µg/kg	48	1	ND	4.14	2,3 and 5	One sample in J.C. Boyle Reservoir exceeded the more protective Oregon BSLVs for freshwater fish (1.17 µg/kg) at concentrations with potential to cause minor or limited effects to biota under Exposure Pathway 5 and that are unlikely to adversely affect biota under Exposure Pathways 2 and 3. Similar concentrations were detected for the metabolic breakdown products of DDT, from the same location in J.C. Boyle Reservoir.
Dioxin (2,3,7,8-TCDD)	pg/g	9	1	ND	0.19	2,3 and 5	One sample in J.C. Boyle Reservoir exceeded the more protective Oregon BSLVs for mammals (individuals) (0.05 pg/g) at concentrations with potential to cause minor or limited effects to biota under Exposure Pathway 5 and that are unlikely to adversely affect biota under Exposure Pathways 2 and 3.
Furan (2,3,4,7,8-PeCDF)	pg/g	9	5	0.7	1.9	3 and 5	Samples from each reservoir slightly exceeded the more protective Oregon BSLVs for freshwater fish (1.1 pg/g) at concentrations with potential to cause minor or limited effects to biota under Exposure Pathway 5 and that are unlikely to adversely affect biota under Exposure Pathway 3.
Copper (Cu)	mg/kg	47	47	28	38	1, 2,3 and 5	Samples from each reservoir and the estuary exceeded the threshold effect level for freshwater sediments (Cu=16 mg/kg, Fe=20,000 mg/kg) at concentrations with potential to cause minor or limited effects to biota under Exposure Pathways 1 ,2 and 5, and that are unlikely to adversely affect biota under Exposure Pathway 3.
Iron (Fe)	mg/kg	47	47	22,000	37,000		

Notes and Abbreviations:
Refer to Figures 4.4.9-1 and 4.4.9-2 for Exposure Pathways.
ND = Not Detected; DDT = 4,4' DDT; mg/kg = milligrams per kilogram, equivalent to parts per million; µg/kg = micrograms per kilogram, equivalent to parts per billion; pg/g = picograms per gram, equivalent to parts per trillion. Refer to CDM (2011e) for detailed analysis

Table 4.4.9-2: Contaminants exceeding human health screening levels in sediments in J.C. Boyle, Copco 1, and Iron Gate reservoirs and the Klamath River Estuary, 2009-2010

Contaminant Name	Units	No. of Samples	No. of Detections	Measured Concentration		Relevant Exposure Pathway	Explanation
				Median	Maximum		
Arsenic	mg/kg	46	46	8.9	15	2	Samples from each reservoir and the estuary exceeded the US Environmental Protection Agency RSLs (0.39 mg/kg) for lifetime exposure by humans to contaminated soils in residential settings, at concentrations that are unlikely to have adverse effects under Exposure Pathway 2 because of limited duration of exposure.
Nickel	mg/kg	47	47	25	110	2	Samples from each reservoir and the estuary exceeded the US Environmental Protection Agency RSLs (0.38 mg/kg) for lifetime exposure by humans to contaminated soils in residential settings, at concentrations that are unlikely to have adverse effects under Exposure Pathway 2. Levels were highest in the estuary.
Pentachlorophenol	µg/kg	48	1	ND	34	2, 3, 5	One sample in J.C. Boyle Reservoir exceeded the more protective Oregon BSLVs for Human-Subsistence (30 µg/kg) at concentrations with potential to cause minor or limited effects to humans under Exposure Pathway 5 and that are unlikely to adversely affect humans under Exposure Pathways 2 and 3.
Dieldrin	µg/kg	6	1	ND	3.4	2,3,5	One sample in J.C. Boyle Reservoir exceeded the more protective Oregon BSLVs for Human-General (0.008 µg/kg) at concentrations with potential to cause minor or limited effects to humans under Exposure Pathway 5 and that are unlikely to adversely affect humans under Exposure Pathways 2 and 3.
DDT	µg/kg	48	1	ND	4.1	2,3,5	One sample in J.C. Boyle Reservoir exceeded the more protective Oregon BSLVs for Human-General (0.33 µg/kg) at concentrations with potential to cause minor or limited effects to humans under Exposure Pathway 5 and that are unlikely to adversely affect humans under Exposure Pathways 2 and 3.
TEQs for Dioxins, Furans, and Dioxin-Like PCBs	pg/g	9	9	3.3	8.3	2, 3, 5	Samples from each reservoir exceeded the more protective Oregon BSLVs for mammals (individual) (0.05 pg/g) at concentrations with potential to cause minor or limited effects to humans under Exposure Pathway 5 and that are unlikely to adversely affect humans under Exposure Pathways 2 and 3.

Notes: A special evaluation of human health was conducted outside of the normal Sediment Evaluation Framework.
ND = Not Detected; DDT = 4,4' DDT; mg/kg = milligrams per kilogram, equivalent to parts per million; µg/kg = micrograms per kilogram, equivalent to parts per billion; pg/g = picograms per gram, equivalent to parts per trillion; ND = Not Detected; Refer to CDM (2011e) for detailed analysis.

Table 4.4.9-1 shows chemicals that exceeded one or more of the adopted aquatic health screening levels, which included the Pacific Northwest SEF-SL1s for freshwater and/or marine sediments, and/or the ODEQ Bioaccumulation Screening Level Values (SLVs) (see sidebar for the various screening levels definitions). These included, in J.C. Boyle Reservoir, the metals copper and iron, the legacy organochlorine insecticides dieldrin and DDT (or its breakdown products), and dioxins/furans. These chemicals were present at levels "unlikely to cause adverse effects" to aquatic biota if dams were removed (Exposure Pathways 2, 3, and 4), and with the "potential to cause minor or limited effects" to biota if the dams remain (Exposure Pathway 5). In Copco 1 and Iron Gate reservoirs, only copper, iron, and furans were detected at levels with "potential to cause minor or limited adverse effects" to aquatic biota, depending on the exposure pathway. Iron and copper concentrations were highest in the Klamath River Estuary.

Human health screening levels were exceeded (see Table 4.4.9-2) for 6 chemicals at various places in the reservoirs and/or the estuary, at concentrations "unlikely to cause adverse effects" (blue dot) if the dams are removed (Exposure Pathways 2 or 3). Four chemicals were detected at levels with "potential to cause minor or limited adverse effects" (green dot) for current conditions with the dams in place (Exposure Pathway 5). The same samples from J.C. Boyle Reservoir that exceeded aquatic health screening levels for dieldrin and for DDT, also exceeded the Oregon BSLVs for these chemicals and pentachlorophenol. Toxicity Equivalence Quotients, or TEQs, calculated from dioxins, furans, and dioxin-like PCBs (CDM 2011e), in J.C. Boyle and Copco 1 reservoirs, were slightly higher than background values reported by USEPA for the Pacific Southwest (i.e., 2 to 5 ppt), the Pacific Northwest (i.e., 4 ppt), and for non-impacted lakes of the United States (i.e., 5.3 ppt) (USEPA 2010). TEQs also exceeded the Oregon BSLVs in all samples.

The trace elements arsenic and nickel also exceeded the USEPA's Human Health RSL for lifetime residential soil exposure in all locations including the estuary; however, these concentrations (median and maximum) are similar to those found in soils in the Klamath Basin (see text box). ODEQ recommends a default background concentration of 7 mg/kg (ODEQ 2007), and the use of background concentrations as the screening levels when natural background exceeds a screening level. Therefore the potential effects of exposure to reservoir sediment with dam removal (Exposure Pathways 2 or 3) are similar to those that currently exist from exposure to soils in the basin. These human health screening evaluations reflect conservative assumptions (i.e., chronic exposure to soil in a residential setting); any future evaluations addressing sediment release and deposition and predicted exposures would most likely demonstrate less potential to cause adverse effects.

Klamath Basin Soils: Comparison of Arsenic and Nickel Concentrations

	Klamath Basin Soils (in mg/kg)		
	Reservoir Sediments[1] (n = 45)	USGS Data[2] (n =27)	ODEQ Data[3] (n = 103)
Median & Maximum Arsenic Concentrations	8.9/15	4.3/12.2	1.6/20.7
Median and Maximum Nickel Concentrations	25/110	65.7/1810	26/154

Sources:
[1] CDM 2011e
[2] Smith et al 2009; David Smith, USGS, written communication, June 25 2012
[3] GeoEngineers 2011; David Anderson ODEQ, written communication, June 25 2012

In addition to the chemicals previously indicated, the Marine SEF SL1 was exceeded in a sample from the Klamath River Estuary, for the plasticizer bis(2-ethylhexyl) phthalate. This chemical is not shown in Tables 4.4.9-1 and 4.4.9-2 because screening level exceedances that only affect the estuary during current, dams remain conditions are not relevant to the release of sediments from the reservoirs; however, they do indicate that the estuary can contain slightly elevated chemical concentrations that are different from the reservoirs. Similarly, the highest concentrations of nickel, chromium, and iron occurred in the estuary.

During dam removal, reservoir sediments would be entrained with inflowing water and reservoir water, mixed with normally occurring sediment loads, and primarily carried downstream throughout the length of the river to be widely dispersed in the marine near-shore environment. Screening level modeling indicates that during a winter dam removal the mobilized sediments would be mixed and thus diluted from their initial concentration at the point of release by 48- to 66-fold depending on streamflows. These actions would reduce the effective concentrations and hence the potential for toxicity by chemicals associated with the sediments. Therefore, exposure to the reduced chemical concentrations is expected to be diminished to levels at or below those that could cause minor or limited adverse effects for Exposure Pathways 1-4 in Figure 4.4.9-2.

Figure 4.4.9-5: Yellow perch sampled for contaminants in fish tissues from Copco 1 Reservoir during September, 2010.

Some chemicals also were present in reservoir fish at concentrations that exceeded one or more established screening levels, but were below levels that would indicate an unacceptable level of concern for effects on human health under current conditions. These analytes include the metals arsenic and mercury, the legacy insecticides DDT and dieldrin, and PCBs. These findings were generally consistent across the reservoirs or species examined. The findings for reservoir fish are not applicable to evaluate the dam removal pathways, as species, sediment concentrations and exposure scenarios are not comparable.

Finally, some chemicals had laboratory detection limits for sediments or tissues that were unable to meet several of the more protective screening levels considered (i.e., their detection limits were higher than the screening levels), making the results inconclusive for those chemicals. To accommodate this concern, the results from the bioassays, laboratory bioaccumulation analyses, and/or fish tissue samples were considered collectively to indicate likely effects from these chemicals (see SEF Level 2B description in Section 4.4.9.2, *Evaluation Process*). These results are incorporated into Figure 4.4.9-2. Bioassay results supported the chemistry evaluation's conclusions, confirming that only a minor or limited degree of effects would be expected if trapped sediments were released as part of dam removal. Additional details on contaminants in tissues and on bioassays can be found in CDM 2011e.

4.4.9.4 Chemicals in Reservoir Sediments Effects Summary

The lines of evidence used to evaluate Exposure Pathway 1 suggest that planning for the drawdown of the Four Facilities during winter to late spring would provide hydrologic conditions that are sufficient to minimize the potential short-term adverse effects for freshwater organisms during the initial period following dam removal, especially at locations immediately downstream of the dams, where the concentration of suspended sediments would be the highest (Reclamation 2012g). This time period provides the greatest river flow as well as sediment mobilization, which would help minimize short-term adverse effects through averaging of sediments from all reservoirs and direct dilution by water, as well as the greatest transport of sediment and contaminants through the river system. The direct physical effects to fish from the released sediments (see Section 4.1.3, *Effects of Sediment Release on Fish Following Dam Removal*) are expected to be greater than short-term sediment toxicity during the dam removal period. Under Exposure Pathways 2 through 4, the lines of evidence suggest long-term adverse effects for humans or biota would be unlikely from the chemicals present in the new river channel and downstream areas as a result of dam removal (CDM 2011e).

Exposure Pathway 5 evaluates dams remain conditions. This is the existing condition, where resident aquatic biota experience long-term exposure to undiluted reservoir sediments. The results of the evaluation suggest that this exposure pathway may be associated with minor adverse effects to both freshwater organisms and humans, based on: (1) the presence of a few chemicals in sediment and fish tissue that exceed screening levels; (2) minor sediment toxicity to benthic organisms in portions of one reservoir; and (3) the long-term exposure of resident organisms (because they cannot migrate out of the reservoirs) resulting in higher exposures to chemicals that bioaccumulate (CDM 2011e).

Overall, on the basis of the extensive information gathered in this study and evaluation of multiple lines of evidence, the Four Facilities' reservoir sediments can be considered to have contaminant levels that are below critical guidelines for the release of sediment downstream.

4.4.10 Algal Toxins

Algae are critical and natural components of riverine and lacustrine (lake-like) ecosystems, affecting food web dynamics as well as physical water quality parameters (e.g., dissolved oxygen, pH, turbidity, and nutrients) through rates of photosynthesis, respiration, and decay of dead algal cells (Horne and Goldman 1994). Cyanobacteria (blue-green algae) are also photosynthetic and can often occur in large seasonal blooms that form floating green scums at the water surface (see Figure 4.4.10-1). Large-scale cyanobacterial blooms are likely to be more prevalent in lacustrine environments where turbulence is low, nutrients are abundant, and light availability and water temperature are high. In addition to negatively influencing water quality, large blooms of some cyanobacteria species, such as *Microcystis aeruginosa*, can produce a toxin (microcystin) in concentrations that become an ecological and public health concern. This toxin can cause irritation, sickness, or in extreme cases, death to exposed organisms, including humans, pets, or livestock (World Health Organization [WHO] 1999). Microcystin can also bioaccumulate (the accumulation of a substance, such as a pesticide, in a living organism) in the tissues of aquatic organisms, such as shellfish, fish, and marine mammals (Kann 2008, Miller et al. 2010, Kann et al. 2011, Vanderkooi et al. 2010), potentially harming these organisms as well as the humans that consume them (see Algal Toxins and Aquatic Biota sidebar under Section 4.1.1.4, *Water Quality*).

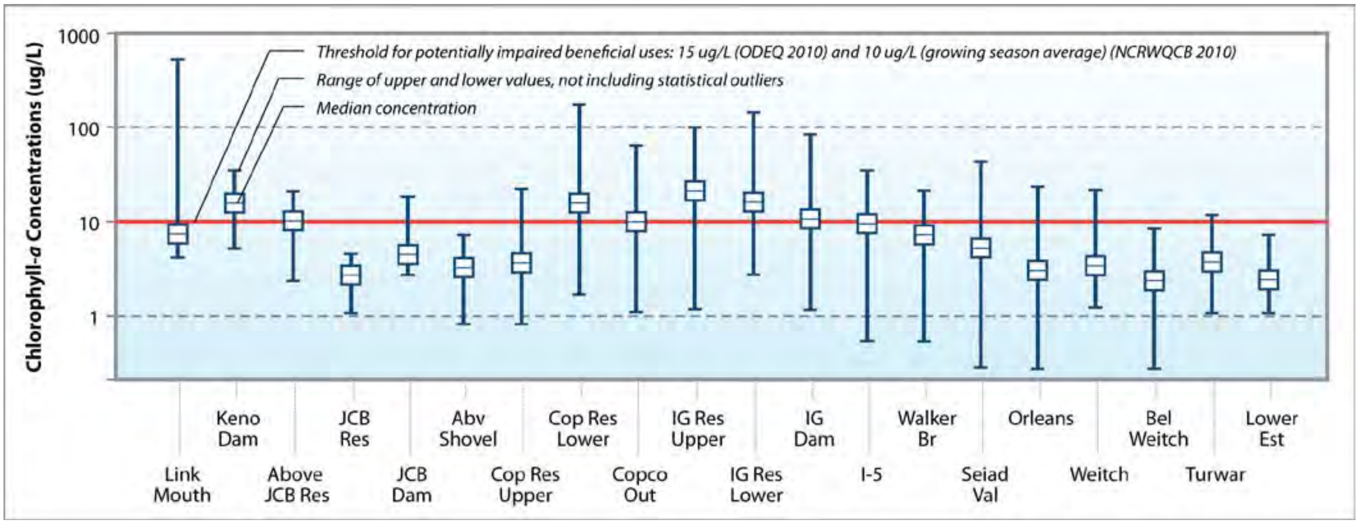
Figure 4.4.10-1: Biologist collects water samples from Iron Gate Reservoir during a summer algae bloom. (Photo courtesy of Karuk Tribe)

Upper Klamath Lake has large seasonal blooms of cyanobacteria, primarily composed of the species *Aphanizomenon flos-aquae*. The strain of this species found in Upper Klamath Lake typically does not produce toxins. *M. aeruginosa* blooms also occur in the lake in some years and are believed to have been responsible for the production of microcystin at concentrations equal to or greater than the WHO limit for drinking water (1 µg/L) and greater than the Oregon Department of Public Health guidelines for issuing public health advisories (8 µg/L) during 2007–2008 (Vanderkooi et al. 2010). Both algal species are exported from Upper Klamath Lake through the Link River and downstream into the Keno Impoundment (including Lake Ewauna).

Figure 4.4.10-2: 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. (Photo courtesy of Karuk Tribe)

Large algal blooms also occur in the calm, lacustrine environments of Copco 1 and Iron Gate reservoirs during the summer months (see Figure 4.4.10-2). The blooms result in reservoir chlorophyll-*a* concentrations that are 10 to 100 times greater than those in the mainstem river and exceed the California Regional Water Quality Control Board's threshold for potentially impaired beneficial uses (see Figure 4.4.10-3). Data collected from 2004 through 2011 indicate that high *M. aeruginosa* cell counts and microcystin concentrations occur on an annual basis during summer months in Copco 1 and Iron Gate reservoirs (Kann 2007a–2007d, Jacoby and Kann 2007, Kann and Corum 2009, Raymond 2010, NCRWQCB 2010b), and regularly exceed WHO numeric targets (Kann and Corum 2009) and California voluntary guidance levels (State Water Resources Control Board, California Department of Public Health and Office of Environmental Health and Hazard Assessment 2010) in these reservoirs.

Figure 4.4.10-3: Median chlorophyll-concentrations in Copco 1 and Iron Gate reservoirs are two to ten times greater than those documented in the mainstem river and exceed the threshold for potentially impaired beneficial uses for biota and humans, including aquatic habitat, recreation, agricultural supply, and fishing. Keno Impoundment (including Lake Ewauna) concentrations are similarly high.



Source: NCRWQCB 2010b.

Figure 4.4.10-4: Algal toxin health advisory postings have occurred since 2005 at Copco 1 and Iron Gate reservoirs. These toxins can be transported into downstream reaches of the Klamath River.

4.4.10.1 Health Effects

During large blooms, health advisories warn against recreational use, drinking, and cooking with water from Copco 1 and Iron Gate reservoirs, as well as consumption of fish that are exposed to the toxins (see Figure 4.4.10-4). Large blooms of *M. aeruginosa* could have also been regularly transported to downstream river reaches and prompt similar health advisories in the lower Klamath River (Kann 2010b) and, in some cases, even the Klamath Estuary.

4.4.10.2 Tribal Effects

The seasonal presence of algal toxins in the Klamath River has impaired the ability of the Klamath, Resighini Rancheria, Karuk, Hoopa, and Yurok Indian tribes to use the river for cultural purposes. 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 (see Section 4.4.2, *Tribal*). Currently, drinking river water as a ceremonial practice often cannot occur because blooms of *M. aeruginosa* result in frequent summertime health advisories on long stretches of the river below Iron Gate Dam.

4.4.10.3 Algae Effects from Dam Removal and the KBRA

Removal of Copco 1 and Iron Gate reservoirs would eliminate the lacustrine environment that currently supports ideal growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa*. While relatively small amounts of algal toxins and chlorophyll-*a* produced in Upper Klamath Lake may still be transported into the Klamath River downstream of Keno Dam, existing data indicate that concentrations of microcystin leaving Upper Klamath Lake have rarely, if ever, been measured at levels that exceed water quality objectives for Oregon and California. In contrast, cyanobacterial blooms growing in Iron Gate and Copco 1 reservoirs have been documented as the cause of observed public health guideline exceedances within the Klamath Hydroelectric Project reservoirs and the Klamath River downstream of Iron Gate Dam. With dam removal, the production of toxins and chlorophyll-*a* associated with suspended algae in Copco 1 and Iron Gate reservoirs would be eliminated.

Additionally, resource management actions implemented under KBRA, such as off-stream livestock watering, grazing management, floodplain rehabilitation, livestock exclusion, and road decommissioning in the Upper Klamath Basin, would decrease nutrient loading to Upper Klamath Lake (see Section 4.1.1.4, *Water Quality*), which would decrease the incidence of toxic cyanobacterial algal blooms and high chlorophyll-*a* levels in the lake. Implementation of the KBRA would accelerate the pace of achieving these water quality improvements and increase the likelihood of approaching TMDL targets for chlorophyll-*a* (see sidebar) by the end of the analysis period (i.e., 2061) (Water Quality Sub-team (WQST) 2011).

4.4.10.4 Algal Toxin Effects Summary

In summary, 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 and sport fishing (see sidebar).

More on Beneficial Uses and TMDLs in the Klamath Basin

As described in Section 4.1, *Expected Effects of Dam Removal and KBRA on Physical, Chemical, and Biological Processes that Support Salmonid and other Fish Populations*, the Klamath River is included on the 303(d) lists for both California and Oregon. In addition to not meeting numerous fisheries-related beneficial uses described in Section 4.1, the Klamath River does not meet the following human health related beneficial uses due to water quality impairments, including the presence of algal toxins (i.e., microcystin):

- Indian Culture
- Water Contact Recreation
- Non-Contact Water Recreation
- Municipal & Domestic Supply
- Shellfish Harvesting
- Aquaculture
- Agricultural Supply
- Commercial and Sport Fishing

The Oregon, California, and Hoopa Valley Tribe criteria for posting public health advisories for recreational use of water are all 40,000 cells/mL *M. aeruginosa or* 8 µg/L microcystin. The Klamath River TMDLs include water quality targets thresholds of 20,000 cells/L *M. aeruginosa* or 4 µg/L microcystin for the California reservoirs during the growing season.

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4.4.11 Greenhouse Gases

A quantitative greenhouse gas (GHG) emissions inventory was completed to estimate emissions from power replacement following the removal of the Four Facilities. Additionally, the emissions inventory calculated the offset provided by the elimination of reservoir methane emissions that would no longer be produced following removal of the Four Facilities. The complete analysis is presented in the *Greenhouse Gas Emissions from Power Replacement, Technical Memorandum* (CDM 2011a).

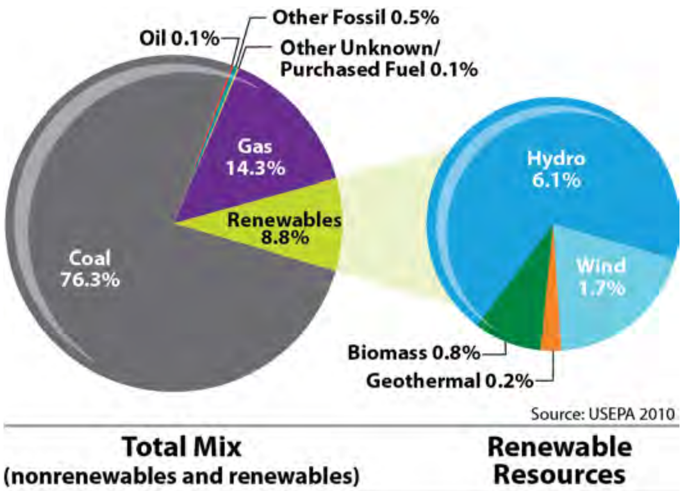
Greenhouse gases from replacement power include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); all typical byproducts of combustion. Each GHG contributes to climate change differently, as expressed by its global warming potential (GWP). GHG emissions are presented as carbon dioxide equivalent (CO_2e) emissions, which is determined by multiplying the mass of each GHG by its GWP[1]. This analysis uses the GWP figures from the Intergovernmental Panel on Climate Change (IPCC) *Second Assessment Report* (IPCC 1996) to calculate CO_2e.

Emission factors were developed using the Emissions & Generation Resource Integrated Database (eGRID) (USEPA 2010) for 2007. Using eGRID data was consistent with inventory requirements of multiple voluntary and mandatory reporting protocols and provides a conservative (worst-case) estimate of emissions that would occur if the Four Facilities were removed in 2020.

The average amount of electricity generated and consequently needing replacement if the Four Facilities were removed was derived from the Bureau of Reclamation's *Hydropower Benefits Technical Report: For the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon* (Reclamation 2012c). Monthly hydropower generation estimates were calculated for the 50-year period of analysis (from 2012 to 2061). To bookend the GHG emissions quantification between a high and low emission estimate, this analysis presents two different scenarios for the mix of replacement power for the lost hydropower, as discussed below.

[1] As an example, CH_4 has a GWP of 21, as specified in the Intergovernmental Panel on Climate Change's *Second Assessment Report* (1996). One metric ton of CH_4 is equal to 21 metric tons of CO_2e (1 metric ton x 21).

Figure 4.4.11-1: PacifiCorp Power Control Area Generation Resource Mix (for 2007)



Source: USEPA 2010

4.4.11.1 No Change to PacifiCorp Resource Generation Mix

This scenario assumes that there would be no change in the current renewable energy portfolio for the PacifiCorp Power Control Area (PCA). A PCA is a region of the power grid in which all power plants are centrally dispatched. As shown in Figure 4.4.11-1, the 2007 electricity generation resource mix for the PacifiCorp PCA (estimated from eGRID) is dominated by coal (76 percent), natural gas (14 percent), and hydroelectricity (6 percent), with the remainder made up of smaller sources such as wind, biomass and geothermal (USEPA 2010). The data provided is the most recent data available from the USEPA (2010) and represents the resource mix that would be available if any replacement energy was obtained from PacifiCorp's resource mix as of 2007.

4.4.11.2 Renewable Portfolio Goals Met By PacifiCorp

A second scenario assumes that PacifiCorp complies with California's Renewable Portfolio Standard (RPS) goal in 2020 when the dams would be removed. PacifiCorp is under obligation to meet the RPS goals in California and Oregon. The RPS goal for California is to have 33 percent of an electricity seller's load served with renewable power by 2020 (Executive Order S-14-08; and SBX1 2), while Oregon's RPS goal is for 25 percent of a utility's retail sales of electricity to be from renewable energy by 2025 (Senate Bill 838). While PacifiCorp serves customers in both states, the company would be required to comply with California's 33 percent RPS goal for their entire portfolio in order to sell electricity in the state.

4.4.11.3 Greenhouse Gas Emissions Quantification

On average, the Four Facilities are estimated to generate 909,835 MWh annually over the 42-year period after dam removal (2020 through 2061) (Reclamation 2012c). This annual generation number is higher than has been reported in the past for the Four Facilities because it assumes efficiency upgrades to turbines and generators that PacifiCorp is currently making and would continue to make in the future if the facilities were to remain in place until 2061 (Reclamation 2012c). With removal of the Four Facilities, approximately 526,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) per year would be emitted from replacement power assuming PacifiCorp's current resource generation mix. This number would decrease to approximately 451,000 $MTCO_2e$ per year (14 percent reduction) under the scenario where PacifiCorp meets California's RPS goal. Removal of the reservoirs would reduce these emissions by approximately 4,000 to 14,000 $MTCO_2e$ per year (1 to 3 percent) based on the reduction of methane gas emitted from reservoir bottom sediments (Karuk Tribe of California 2006).

To place the scope of the GHG emissions from replacement power into context, the Bay Area Air Quality Management District and the South Coast Air Quality Management District, both in California, have established significance thresholds of 10,000 $MTCO_2e$ per year. Although not finalized, the Council on Environmental Quality recommended that climate change be discussed in any National Environmental Policy Act analysis if GHG emissions exceed 25,000 $MTCO_2e$ per year.

The California Air Resources Board (CARB) developed some metrics to convert one million $MTCO_2e$ to familiar equivalents. CARB estimated that one million $MTCO_2e$ per year would be equivalent to the following (CARB 2007):

- Annual emissions from 1.5 state-of-the-art 500 MW combined-cycle gas-fired power plants.
- 114 million gallons of gasoline per year
- 2.3 million barrels of oil per year

Removing the Four Facilities in 2020 would result in a substantial increase in GHG emissions from replacement power sources for the period 2020 to 2061. GHG emission increases would range from 451,000 to 526,000 $MTCO_2e$ per year, depending on the percentage of renewable power sources assumed in the replacement power. Although the reservoirs do emit the GHG methane, removing the reservoirs would offset power replacement GHG by about 1 to 3 percent.

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4.4.12 Societal Views on Dam Removal and the KBRA

Studies conducted for the Secretarial Determination did not include separate public opinion surveys; however, expressions of household views on dam removal and ecosystem restoration in the Klamath Basin were a part of a study on the nonuse values survey, the results of which are reported in *Klamath River Basin Restoration Nonuse Value Survey Final Report* (RTI International 2011) (see Section 4.4.1.1, *National Economic Development)*. Also, in 2010, ballot measures in Klamath County, Oregon and Siskiyou County, California addressed the proposed actions of the KBRA and dam removal, respectively. The ballot measures did not ask the same questions as the nonuse survey, and the nonuse survey questions represent responses by households, not by individuals. The results of the survey and ballot measures are presented in this section to provide additional information regarding the public's views on the decision before the Secretary of the Interior.

The National Economic Development (NED) benefits from dam removal, including use and nonuse values, are discussed in detail in Section 4.4.1, *Economics*. The nonuse benefit estimates are based on a stated preference (SP) survey of households throughout the United States (RTI International 2011). The survey was mailed to a random sample of U.S. households. To capture potential differences among respondents based on proximity to the Klamath River, the overall target population sampled was divided into three geographic strata: the 12-county area around the Klamath River[1], the rest of Oregon and California, and the rest of the United States. Table 4.4.12-1 below shows the survey response rate for each stratum. The Klamath survey response rates were slightly higher than what was projected at the survey development and approval stages. As such, more than a sufficient number of responses were received to allow for statistically valid estimates to be computed.

Table 4.4.12-1: Klamath Nonuse Value Survey Response Rates

Strata	Total Number of Surveys Mailed (less undeliverables)	Number of Paper Survey Responses	Number of Web Survey Responses	Total Responses	Response Rate[1]
12-County Klamath Area	2,496	985	42	1,027	41.1%
Rest of CA & OR (Excluding the 12-County Klamath Area)	3,932	1,105	76	1,181	30.0%
Rest of the U.S. (Excluding CA & OR)	3,849	1,100	64	1,164	30.2%
Total	10,277	3,190	182	3,372	32.8%

[1] Response rate = total surveys completed/ (total surveys mailed – undeliverable surveys).

Nonuse benefits to households that value Klamath Basin environmental restoration, as measured by willingness to pay (WTP), are a monetary

[1] The 12-County Klamath Area includes 5 counties in southern Oregon (Lake, Klamath, Douglas, Jackson, and Josephine counties) and 7 counties in northern California (Modoc, Siskiyou, Del Norte, Humboldt, Trinity, Shasta, and Tehama counties).

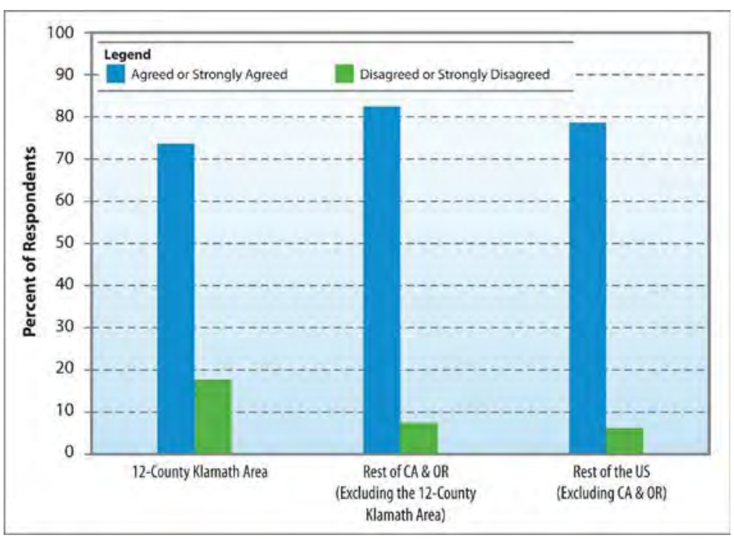
expression of preferences by the survey respondents. The expression of WTP requires a respondent to first understand how the good or service under consideration affects their satisfaction in the context of all goods and services the respondent "consumes." A respondent must then translate their satisfaction into a monetary value that can be compared to the payment proposed in the survey for an Action plan. The nonuse survey included a number of questions that helped establish the context for scenarios to restore the Klamath Basin that were subsequently presented.

The survey also allowed individuals to express their preferences in terms of agreement or disagreement with statements of concern about declines in the number of fish in the Klamath River and risk of extinction. Responses to statements of concern with agreement or disagreement are indicators of value in nonmonetary terms that do not require the extra step of translating preferences into willingness to pay. Therefore, agreement with statements of concern on the survey cannot be used to place a monetary value on dam removal, but can be used as a general measure of views on dam removal and represent qualitative indicators of value.

4.4.12.1 Respondent Concern Regarding the Declines of Chinook Salmon and Steelhead in the Klamath Basin

The nonuse survey included a question asking respondents about their level of concern with declines in the number of Chinook salmon and steelhead trout that return to the Klamath each year[2]. A total of 73.8 percent of those responding to the survey from the 12-County Klamath Area agreed or strongly agreed with the statement of concern while 17.9 percent disagreed or strongly disagreed with the statement. More than four times the number of respondents were concerned about declining Chinook salmon populations in the Klamath River than those that were not concerned.

Figure 4.4.12-1: Survey results regarding concern about the declines in Chinook salmon and steelhead that return to the Klamath Basin.



Source: RTI International 2011

The survey results were similar for concern about Chinook salmon decline by respondents from the rest of Oregon and California and the rest of the United States. Of those responding to the survey, 82.5 percent from the rest of Oregon and California agreed or strongly agreed with the statement of concern while 7.6 percent disagreed or strongly disagreed with the statement. A total of 78.8 percent of those responding from the rest of the United States agreed or strongly agreed with the statement of concern while only 6.2 percent disagreed or strongly disagreed. The survey results indicate that there is overall concern about declines in Chinook salmon regardless of where the respondents live. Survey results regarding concern about Chinook salmon and steelhead trout are presented graphically in Figure 4.4.12-1.

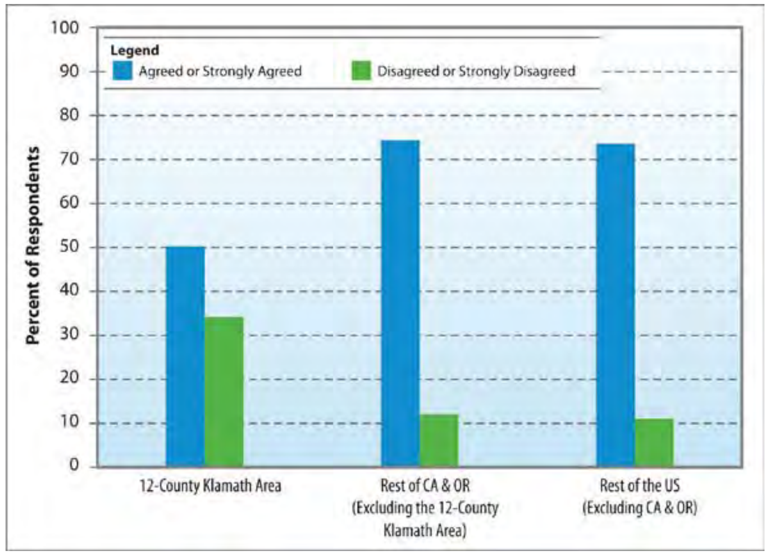
[2] The actual wording of the question was: Please rate how much you agree or disagree with the following statement. I am concerned about declines in the number of Chinook salmon and steelhead trout that return to the Klamath River each year. Choices of responses were: Strongly agree, Agree, Disagree, Strongly disagree, and No opinion.

4.4.12.2 Respondent Concern Regarding the Potential Extinction of Shortnose and Lost River Suckers in the Klamath Basin

The nonuse value survey also asked respondents how concerned they were that shortnose and Lost River suckers are at very high risk of extinction[3]. Of those responding to the survey from the 12-County Klamath Area, 50.4 percent agreed or strongly agreed with the statement of concern while 34.0 percent disagreed or strongly disagreed with the statement. The statement of concern was not as overwhelming as for Chinook salmon, but the number of respondents that were concerned was nearly 50 percent higher than those who disagreed with the statement of concern.

Of those responding to the survey from the rest of Oregon and California, 74.3 percent agreed or strongly agreed with the statement of concern regarding shortnose and Lost River suckers at a very high risk of extinction while 11.9 percent disagreed or strongly disagreed with the statement. A total of 73.9 percent of those responding from the rest of the United States agreed or strongly agreed with the statement of concern while 10.8 percent disagreed or strongly disagreed. Survey results regarding concern about shortnose and Lost River suckers are presented graphically in Figure 4.4.12-2.

Figure 4.4.12-2: Survey results regarding concern about the shortnose and Lost River suckers that are at very high risk of extinction.



Source: RTI International 2011

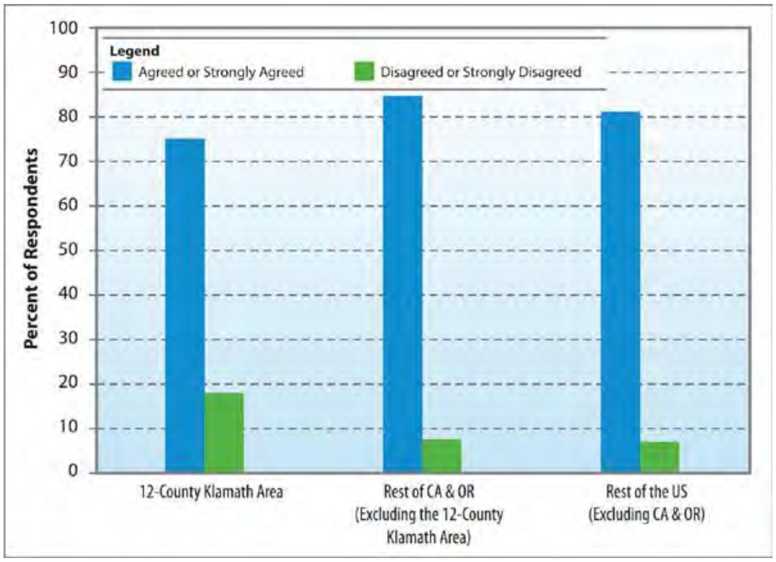
4.4.12.3 Respondent Concern Regarding the Potential Extinction of Klamath Coho Salmon

The nonuse value survey included a question about agreement with concern that Klamath coho salmon are at a high risk of extinction[4]. An estimated 75.6 percent of those households responding to the survey from the 12-County Klamath Area agreed or strongly agreed with the statement of concern while 17.7 percent disagreed or strongly disagreed with the statement. The statement of concern for Klamath coho salmon was nearly identical as for Chinook salmon and steelhead trout.

[3] The actual wording of the question was: Please rate how much you agree or disagree with the following statement. I am concerned about the shortnose and Lost River suckers that are at very high risk of extinction. Choices of responses were: Strongly agree, Agree, Disagree, Strongly disagree, and No opinion.

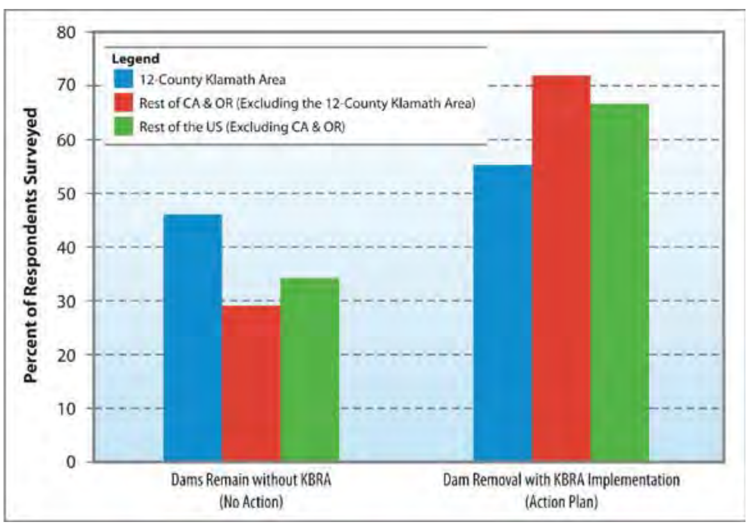
[4] The actual wording of the question was: Please rate how much you agree or disagree with the following statement. I am concerned about the Klamath coho salmon that are at high risk of extinction. Choices of responses were: Strongly agree, Agree, Disagree, Strongly disagree, and No opinion.

Figure 4.4.12-3: Survey results regarding concern about the Klamath coho salmon that are at high risk of extinction.



Source: RTI International 2011

Figure 4.4.12-4: Survey results regarding an Action plan for dam removal and Klamath Basin Restoration.



Source: RTI International 2011

Of those households responding to the survey from the rest of Oregon and California, 85.2 percent agreed or strongly agreed with the statement of concern regarding Klamath coho salmon at a high risk of extinction, while 7.2 percent disagreed or strongly disagreed with the statement. A total of 81.2 percent of those responding from the rest of the United States agreed or strongly agreed with the statement of concern, while 6.9 percent disagreed or strongly disagreed. Survey results regarding concern about Klamath coho salmon are presented graphically in Figure 4.4.12-3.

4.4.12.4 Respondent Preference Regarding an Action Plan for Dam Removal and Klamath Basin Restoration

The majority of respondents surveyed indicated that an Action plan to remove the dams and restore the basin was preferred to a No action plan. A No action plan was defined as not implementing an agreement that includes dam removal, fish restoration, and a water sharing agreement. A total of 54.7 percent of respondents from the 12-County Klamath Area voted for an Action plan, 71.3 percent of respondents from the rest of Oregon and California voted for an Action plan, and 66.3 percent of respondents from the rest of the United States voted for an Action plan (see Figure 4.4.12-4). These results suggest that a substantial number of households place a positive value on implementing an Action plan to improve the environmental resources in the Klamath Basin.

4.4.12.5 Other Indication of Public Views on Dam Removal and the KBRA

Other indicators of support or non-support for Klamath Basin restoration or dam removal include advisory votes on KBRA participation in Klamath County, Oregon and dam removal in Siskiyou County, California, held on November 2, 2010. Siskiyou County Measure G asked if the Klamath River dams (Iron Gate, Copco 1, and Copco 2) and the associated hydroelectric facilities should be removed. A vote in favor was for removing the dams and a vote against was for keeping the dams. Measure G failed by a vote of 78.8 percent against and 21.2 percent for the measure. This vote indicated that in Siskiyou County voters strongly do not favor dam removal.

Klamath County Measure 18-80 asked if Klamath County should discontinue its participation as one of the parties in the KBRA agreement. A yes vote would advise officials to stop participating in the KBRA, while a no vote would advise officials to continue their participation with the KBRA. Measure 18-80 failed with 48.3 percent voting yes and 51.7 percent voting no. The results of measure 18-80 indicated that, while close, a majority of Klamath County voters expressed support for continued participation with the KBRA. Oregon ballot measures require wording where a “yes” vote approves or adopts a new position. Klamath County signed the KBRA in February 2010 and therefore voters needed to vote “yes” if they wanted change from this earlier position.

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