Klamath Tribes Fishery Socioeconomics Technical Report

For the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon

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31 August 2012

Abbreviations and Acronyms

DRA	Dam Removal Alternative
EDRRA Model	Evaluation of Dam Removal and Restoration of Anadromy Model
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
IGD	Iron Gate Dam
KBRA	Klamath Basin Restoration Agreement
KRFC	Klamath River Fall Chinook
NAA	No Action Alternative
NMFS	National Marine Fisheries Service
PFMC	Pacific Fishery Management Council
SONCC Coho	Southern Oregon Northern California Coast Coho
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service

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I. Introduction

In accordance with the terms of the Klamath Hydroelectric Settlement Agreement and contingent on Congressional authorization, the Secretary of the Interior will make a determination regarding whether removal of four Klamath River dams (Iron Gate, Copco 1, Copco 2 and J.C. Boyle) owned by the utility company PacifiCorp advances restoration of salmonid fisheries and is in the public interest. This report analyzes the effects of three alternatives that will be considered by the Secretary as they pertain to fishing opportunities for the Klamath Tribes:

- Alternative 1 – No Action: This alternative involves continued operation of the four dams under current conditions, which include no fish passage and compliance with Biological Opinions by the U.S. Fish and Wildlife Service (USFWS) and NOAA National Fisheries Service (NMFS) regarding the Bureau of Reclamation's Klamath Project Operation Plan.

- Alternative 2 – Full Facilities Removal of Four Dams: This alternative involves complete removal of all features of the four dams, implementation of the Klamath Basin Restoration Agreement (KBRA 2010), and transfer of Keno Dam from PacifiCorp to the Department of the Interior (USDOI).

- Alternative 3 – Partial Facilities Removal of Four Dams: This alternative involves removal of selected features of each dam to allow a free flowing river and volitional fish passage for all anadromous species. Features that remain in place (e.g., powerhouses, foundations, tunnels, pipes) would be secured and maintained in perpetuity. KBRA and transfer of Keno Dam are also part of this alternative.

Throughout this report, Alternative 1 is referred to as the no action alternative and Alternatives 2 and 3 as the action alternatives.

Section II discusses the Klamath Tribes' historical reliance on fish and tribal cultural and social practices associated with fish. Section III focuses on changes in fisheries and related practices that have occurred since the historical period. Section IV evaluates the effects of the no action and action alternatives on fisheries of the Klamath Tribes and associated cultural and social practices. Section V summarizes results and conclusions of the previous sections, and Section VI provides a list of references cited in the report. Appendix A discusses the biological assumptions that underlie the analysis of tribal fishery effects.

II. Historical and Cultural Context

II.A. Fish

The Klamath Tribes consist of three historically separate tribes: the Klamath Tribe, the Modoc Tribe, and the Yahooskin band of Snake Indians. The Klamath Tribes once occupied large areas of the Upper Klamath Basin – including Upper Klamath Lake, Klamath Marsh and the Williamson River. The Tribes historically engaged in a seasonal round of harvest that included suckers (mullet), trout, and spring and fall Chinook. Fishing was often a large-scale affair, as large numbers of salmon and mullet spawned in the Upper Basin at roughly the same times and locations and were followed by trout who consumed the spawn of both species (Deur 2011).

Historical fish abundances were notably high in the Upper Klamath Basin:

- "Cope (1884) noted that Upper Klamath Lake sustained a 'great population of fishes' and was 'more prolific in animal life' than any body of water known to him at that time. Gilbert (1898) noted that the Lost River sucker was 'the most important food-fish of the Klamath Lake region.' At that time, spring sucker runs in 'incredible numbers' (Gilbert 1898) were relied upon as a food source by the Klamath and Modoc Indians and were taken by local settlers for both human consumption and livestock feed (Cope 1897, Coots 1965, Howe 1968)" (Stubbs and White 1993, p 4).

- "Those who like to see fish, immense congregations of them, all alive and running and most of them weighing from 2 to 6 pounds apiece, ought to be here now. Five minutes walk from Main Street brings one to the shores of the Klamath rapids, where every little nook, bay and tributary creek is so crowded with mullets that their backs stick out of the water" (Klamath Republican, March 21, 1901 as cited in Lane and Lane 1981, p 47).

- Lost River sucker was "the most important food-fish of the Klamath Lakes region….It is of vast importance to the Klamath Indians, who, during the spring run, catch it in immense numbers and cure it for winter use" (Jordan and Everman 1923: 54-56 as cited in Lane and Lane 1981, pp 48-49)

Salmon played a pivotal role in the seasonal round of harvest and the location of winter villages:

- "Tribal consultants largely agreed that most large-scale fishing of suckers and trout within the upper Klamath Basin traditionally was timed to coincide with salmon runs….ancillary activities, such as the hunting of large and small game, plant gathering, and a variety of social, economic, and cultural activities were timed to coincide with these major fish harvests, effectively making the salmon harvest the temporal foundation of much of traditional Klamath tribal life" (Deur 2011, pp 12-13).

- "Springtime salmon fishing marked the end of the lean winter months, and close proximity of winter villages to salmon fishing sites ensured that salmon would be detected and available from the onset of each year's spring run (an important point, as the exact dates of the first run varied)" (Deur 2003, p 17).

- "We have emphasized the comment about summer and autumn being especially the time for preparing a supply of fish for winter use. An important part of that supply was almost certainly salmon. Being relatively large fish and, being 'dry', having lost fat in their journey far up the river from the sea, they were efficiently prepared and not being fat, they kept well" (Lane and Lane 1981, p 83).

The Klamath Tribes were well known for their diverse and specialized fishing technology:

> "Over time, living in intimate association with their waterways and depending upon them for the major portion of their subsistence, the Klamath Basin peoples have selected, refined, and adapted fishing technology to make it pre-eminently suited to their particular environment to the point that almost every observant person who visited them and observed their culture has commented upon this adaptation" (Lane and Lane 1981, p 74).

Specialized gear adaptations served to facilitate harvest of particular species in particular locations. For instance, large triangular dipnets fastened to two 12-foot poles were used on open lake waters and in larger deeper streams; a smaller version was used in shallower areas. Large rectangular nets fastened to two poles were used in rivers; two men would wade in the water to maneuver the poles while others drove the fish into the net. Small-meshed set gillnets – 40 feet long, three feet wide – were staked to lake or river bottoms, with sticks used as floats and rocks as sinkers. For fishing in tules adjoining the lakes, a canoe-shaped basket was submerged 2-3 feet into the water and covered with dried fish eggs chewed and spit by fishermen into the water over the basket. When the fish congregated over the eggs, fishermen would trap the fish by raising the basket suddenly out of the water. Circular scoop nets were used to harvest suckers and trout from rocks in turbulent waters adjoining waterfalls. Spear fishing was limited to situations where visibility was adequate. Spears in varying configurations were used to harvest bottom-dwelling lake species such as suckers or when ice fishing for salmon; dipnets were another ice fishing method (Spier 1930, pp 150-153).

The Klamath Tribes adapted their fishing methods to technological change. In the mid-19th century, bone and wood spear points were replaced with steel, and torches were replaced with oil lamps for night fishing. Processing methods, which originally included drying and smoking, later expanded to include salting and canning. However, as noted by Deur (2011, p 20) "Despite all of these adaptions of pre-contact fishing technologies, many tribal members preferred to use time-honored methods, particularly spearfishing, to catch salmon until their extirpation from the upper Klamath Basin in the early 20th century. Traditional spearfishing methods are still employed by many contemporary tribal members in the procurement of other fish, principally native trout."

Fishing was more than a means of physical sustenance. It was accompanied by behaviors and beliefs intended to honor the fish and their role in the ecosystem.

- "Salmon fishing, like trout and mullet fishing, was said to be guided by certain protocols, which ritualistically acknowledged the spirited and sentient qualities of these fish, and regulated human exploitation of these fish. A number of potentially offensive behaviors were strictly prohibited before and during the salmon harvest, including public displays of irreverence or disrespect" (Deur 2011, pp 25-26).

- "Respecting any fish that is caught with difficulty, for instance those speared through the ice, its gall (bis) must be thrown back into the water else others will cease to come….This practice is called notowa'ble a'mbotot, to throw back into the water" (Lane and Lane 1981, p 75).

The Klamath Tribes did not recognize exclusive rights to harvest or to specific fishing spots:

> "There is no individual ownership of fishing places, as with dams. Nor, for that matter, are there proprietary rights to hunting territories, berry or seed patches. A chief has no control, no ownership of fishing rights. Even those whose permanent dwellings are near the dams have no particular claim to them. To be sure, one might ask those who live near-by to fish in the spot for him, but solely because they know best now to use the nets there. One reason for this is that the fish dams date from remote antiquity. They are, in fact, said to have been built by Kemŭ'kŭmps. They are quite common in the rivers wherever a shelf of rock in the stream bed favors their construction. Their purpose is to create an eddy of still water in which the fish can be netted when they take refuge from the swift current. Most of them have been destroyed by the loggers who have cleared the channels of obstructions to float their logs. Gatschet seems to doubt that these are artificial constructions, but it is clear that only the foundation is a natural configuration….Weirs are not used in connection with dams; in fact they are unknown to the Klamath" (Spier 1930, p 149).

II.B. Associated Cultural and Social Effects

According to Deur (2011, p 33), "Prior to the construction of the Klamath hydroelectric dams, the harvest of this dietary staple [salmon] was the focus of a wide range of social, cultural and economic activities that extended into every aspect of daily life." The arrival of the spring run was of particular significance.

> "A number of tribal members spoke of first salmon ceremonies conducted at the beginning of each year's run to ritually distribute the salmon fish and honor the salmon. Ceremonies were said to last two or three days, and involved large salmon feasts celebrating the return of the salmon and the end of winter hunger" (Deur 2003, p 29).

"Despite the clear pre-contact importance of trout and suckers, it was only after salmon was unavailable…that these other fish became as central within the diet of the Klamath Tribes as was seen in the 1920s, 1930s, and 1940s " (Deur 2011, p 31). At that time, first salmon ceremonies were supplanted by a first sucker ceremony.

> "In place of the first salmon ceremony common among the Northwest Coast tribes, the Klamath have an observance over the first sucker. The locale is wo'kstat on the bank of Sprague river near the settlement komă'ĕksi, south of Braymill. Above this spot is a cave styled the home of Kemŭ'kŭmps, the culture hero. The first sucker is roasted and allowed to burn to ashes. Those that follow must not be taken home but roasted there, else no more will come" (Spier 1930, pp 148-149, written after construction of the Copco 1 dam blocked access of anadromous fish to the upper Basin).

Salmon also served to foster cultural values and cement social relationships within the community and with trading partners:

- "Salmon was also typically shared within the community, with tribal members catching surplus salmon to feed the elderly, children, and those with disabilities that prohibited participation in the salmon harvest. This practice received frequent mention by tribal

members participating in the current study, but also appears in classic ethnographic treatments of the Klamath Tribes (e.g., Gasquet 1890: 136; Barker 1963a: 135). This redistribution cemented social bonds within and between communities, in addition to insuring the food security of the community as a whole" (Deur 2003, p 23).

- "Tribal groups with salmon fishing rights along the Klamath Canyon traded dried salmon with tribal groups visiting from other areas with little or no salmon, such as Paiute and interior Achumawi communities. Trade, consultants indicated, was 'not only economic, but a social exchange.' Families and communities often participated in trade even when there were no particular economic incentives, to cement social bonds, mediate disputes, or to maintain economic alliances that might, at some future time, prove valuable" (Deur 2003, pp 9-10).

The decline in spring run Chinook began prior to the construction of Copco 1 Dam due to factors such as mining and unregulated cannery operations at the river mouth (Snyder 1931). Construction of Copco 1 eliminated much of the spawning and rearing habitat for the spring run (Hamilton *et al*. 2011) and eliminated access of the Klamath Tribes to both fall and spring Chinook . The abrupt loss of this important food source necessitated rapid changes in dietary habits and livelihoods. Adaptive strategies included intensified harvest of less desired species (mullet, trout, deer), diversion of fishing effort to other areas (e.g., upper Rogue River), and attempts to obtain salmon through barter arrangements. Out-of-area fishing and barter proved to be untenable as a regular practice – due to the distances traveled, the relatively small amounts of salmon obtained, and the need to meet obligations closer to home. Moreover, salmon obtained elsewhere did not have the same cultural significance as salmon harvested by tribal members on their own fishing grounds. After almost a century without salmon, first salmon ceremonies have ceased and been replaced by ceremonies focused on other species or prayers for the return of salmon. Efforts by the Klamath Tribes to educate the younger generations regarding the cultural and social importance of salmon are challenged by the lack of direct experience with salmon in their daily lives (Deur 2011).

III. Recent History
III.A. General Conditions

The Klamath Tribes currently own approximately 600 acres in Klamath County, Oregon. Tribal enrollment was 3,579 in 2005. The unemployment rate (defined as the percentage of adults who are available for work but unemployed, regardless of whether or not they have recently looked for work) was 21 percent in 2005 (BIA 2005). Per capita income of Indians residing in Chiloquin, Oregon (predominantly members of the Klamath Tribes) and Indians residing in Klamath County (including but not limited to Klamath Tribes members) in 1999 was $8,646 and $10,457 respectively – both lower than per capita income of the general population of Klamath County ($16,719). The percent of the population below the poverty level follows a similar pattern: 40 percent of Indians in Chiloquin, 40 percent of Indians in Klamath County, and 17 percent of the general Klamath County population (U.S. Census 2000).

III.B. Fish

As indicated in Section II.B, Lost River (c'waam) and shortnose (qapdo) suckers became increasingly important sources of sustenance after the loss of salmon harvest opportunities. At that time, suckers were also harvested in non-tribal recreational and commercial fisheries. Studies conducted by the Klamath Tribes, Oregon Department of Fish and Wildlife and the U.S. Fish and Wildlife Service in the early 1980s confirmed the poor status of these populations. The Klamath Tribes curtailed their sucker fishery in 1985 and closed it entirely in 1986 (Markle and Cooperman 2001). In 1988, Lost River and shortnose suckers were listed as 'endangered' under the ESA. The only fish species currently available to the Klamath Tribes is redband trout. Klamath Tribe regulations allow subsistence harvest of trout – five fish per day on the Williamson River and up to ten fish per day in other areas (Buchanan *et al*. 2011).

III.C. Associated Cultural and Social Effects

Loss of access to salmon and mullet has had profound effects on the dietary habits and well-being of the Klamath Tribes – as well as their cultural, ritualistic and social lives.

- "Entire domains of traditional ceremonial practice were largely eliminated by these changes, with most tribal members discontinuing salmon-related ritual entirely" (Deur 2011, p 44).

- Diabetes, hypertension, obesity, and related cardiovascular ailments are described as being particularly widespread, reflecting dramatic changes in food consumption and procurement patterns" (Deur, 2011, p 41).

- "Many consultants noted that, in addition to a regional decline in the availability of salmon, barter has been declining in recent decades due in part to a reduction in the availability of mullet, deer and other items traditionally used for barter by members of the Klamath Tribes" (Deur 2003, p 34).

Despite these challenges, members of the Klamath Tribes have been persistent in ensuring continuation of practices and values that have been a part of their world view for many centuries.

- It has been almost a century since access to salmonids have been lost to the Klamath Tribes. "Still, past studies of ceremonial activities of the Klamath Tribes have demonstrated that shocks associated with the loss of salmon stimulated heightened religious activities in key ceremonial centers of the tribe….People have applied portions of salmon-related ritual to other species, or have shifted their ritual activities to efforts to 'pray…for the salmon to return'" (Deur 2011, p 44).

- "Similar ritual traditions tied to mullet and trout still persist" (Deur 2011, p 27). Every spring the Klamath Tribes release two suckers (c'waam) raised in their Aquatic Research Center into the river as part of their Return of the C'waam Ceremony. Such rituals are directed toward recovery of a species and fishery that has been lost over the past 25 years.

- "Ritual efforts to influence water levels and water quality for the benefit of fish are also conducted by contemporary tribal members" (Deur 2003, p 29).

- "…tribal members insist of the major traditional fishing stations, that 'they are all being used today,' whether for subsistence purposes, ceremonial activities, historical memorialization, or instruction of children on tribal history and culture" (Deur 2011, p 47).

- "These practices [sharing fish with elders and other community members] are still a source of pride among tribal members today. A number of consultants describe how young people still share the catch of other fish species, especially trout and mullet, in the traditional manner….Young men who go on salmon fishing trips outside of the upper Klamath basin often redistribute modest quantities of salmon among tribal members, and such salmon is highly prized" (Deur 2003, p 23).

IV. Effects of Alternatives
IV.A. Alternative 1 – No Action
IV.A.1. Fish

Little change in harvest opportunity is expected under the no action alternative:

- Chinook: "Under conditions with dams, commercial and in-river harvest would continue as restrictions and quotas (met before escapement) allow as has occurred in the past" (p 4 of "Questions for Expert Panel on Chinook Salmon in the Klamath Basin" – Goodman *et al*. 2011).

- SONCC coho ESU: The Southern Oregon Northern California Coast (SONCC) coho Evolutionarily Significant Unit (ESU)[1] was listed as 'threatened' under the Endangered Species Act (ESA) in 1997. Based on viability criteria specified by Williams *et al.* (2008), the SONC coho ESU is not likely to be de-listed under current conditions (see Appendix A.1).

- Steelhead: "Current Conditions will not, in the short to medium term, result in an expansion of the [steelhead] fishery. Projecting harvest under the Current Conditions depends on the fate of the hatcheries and specifics of harvest policies into the future, which are insufficiently defined at this time" (Dunne *et al*. 2011, p 58) (see Appendix A.3.a).

- Pacific lamprey: "In the absence of dam removal, the habitat conditions described previously [for Pacific lamprey] will persist with only subtle changes due to foreseeable hydrological changes" (Close *et al*. 2011, p 23) (see Appendix A.4).

- Suckers: Lost River sucker (LRS) and shortnose sucker (SNS) were listed as 'endangered' under the ESA in 1988. "With declining populations [of suckers] under the current

[1] An Evolutionarily Significant Unit is a population or group of populations that is reproductively isolated and of substantial ecological/genetic importance to the species (Waples 1991).

conditions, there are no opportunities for tribal or recreational harvest" (Buchanan *et al*. 2011, p 71) (see Appendix A.5).

- Redband trout above Keno Dam: "Under the Current Conditions with Dams, distribution and abundance of Lake/River redband/rainbow trout is expected to remain stable…." (Buchanan *et al*. 2011, p 72) (see Appendix A.6).

IV.A.2. Associated Cultural and Social Efffects

Consistent with the lack of change in harvest opportunities expected under the no action alternative, little change in associated cultural and social practices (as described in Section III.B and III.C) is likely to occur under this alternative.

IV.B. Alternative 2 – Full Facilities Removal of Four Dams
IV.B.1. Fish

Sedimentation and water quality changes associated with dam removal may have adverse short term effects on fish stocks that inhabit areas below the dams. However, these effects are generally expected to be short-lived:

- Chinook salmon: "Dam removal does not have a substantial multi-year adverse impact on mainstem Chinook salmon" (Goodman *et al.* 2011, p ii) (see Appendix A.2.d).

- SONCC coho ESU and steelhead: "The short-term effects of the sediment release will be sediment concentrations in the range of 1,000 to more than 10,000 milligrams per liter (mg/L), which will be injurious to upstream migrants of both species [coho and steelhead], and especially to any adult steelhead or 'half pounders' that hold or spawn in the mainstem. However, these high sediment concentrations are expected to occur for periods of a few months in the first two years after the beginning of reservoir lowering and sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, especially in high flow conditions, but not injurious to fish" (Dunne *et al*. 2011, pp 18-19) (see Appendices A.1. and A.3.a).

- Pacific lamprey: "Because they live burrowed in the soft sediments, there will likely be minimal increases in larval mortality rates of existing Pacific lamprey larvae in the mainstem Klamath River after dam removal. The larvae will likely relocate or adjust their burrow tubes to maximize feeding and respiration" (Close *et al*. 2010, p 33) (see Appendix A.4).

- Suckers: "Short-term impacts of dam removal on LRS and SNS are minimal because most adults currently found in all the reservoirs downstream of Keno Dam will be captured and relocated to Upper Klamath Lake" (Buchanan *et al.* 2011, p 65) (see Appendix A.5).

- Redband trout: "The population of redband/rainbow trout found in the reach between Keno Dam and J.C. Boyle Reservoir would not be directly impacted by the short-term effects of dam removal because they are upstream of all proposed activities. Redband/rainbow trout

found in the free-flowing reaches between the other downstream reservoirs would be directly impacted during dam removal….the major effects would come through sediment flushing….The duration of the sediment plume would be the primary factor determining how large of an adverse effect this would have on the fish populations" (Buchanan *et al*. 2011, p 66) (see Appendix A.6).

Over the longer term, dam removal and successful implementation of the KBRA are expected to increase harvest opportunities for the Klamath Tribes (for species other than coho). These effects can be summarized as follows:

- Chinook: The Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model projects a 50 percent increase in tribal harvest under the action alternative; this increase is relative to the current allocation of Klamath fall Chinook received by the Yurok and Hoopa Valley tribes (Appendix A.2.a). What this 50 percent increase means for each individual tribe in the Basin is not clear. For members of tribes with federally recognized fishing rights, expanded harvest opportunity will likely take the form of additional subsistence and/or commercial fishing. Members of tribes without such rights are still able to fish recreationally and thus receive some (albeit smaller) benefit. Such harvest opportunities are much more likely to be realized on the Klamath River (rather than the Trinity), since the restoration associated with the action alternatives would occur on the Klamath. Thus Chinook availability is assumed to increase for each tribe residing on the Klamath River relative to what that tribe currently harvests.

  Fall run Chinook (which includes hatchery as well as wild fish) is currently a much larger component of tribal harvest than spring Chinook, which is at low levels of abundance. A modest harvestable surplus of spring Chinook may become available under the action alternatives. This harvest opportunity would largely accrue to inriver (including tribal) fisheries, as the season structure of ocean fisheries does not provide much opportunity to harvest spring Chinook before they return to the river. Spring-run Chinook salmon are highly desirable for their fat content and have the potential to expand inriver harvest opportunities beyond the current season (see Appendix A-2).

- SONCC coho ESU: The SONCC coho ESU is comprised of coho populations both inside and outside the Klamath Basin. The action alternatives are expected to lead to an increase in the viability of Klamath River coho populations and advance the recovery of the ESU. However, since these alternatives do not include coho restoration outside the Klamath Basin, they alone will not create conditions that would warrant de-listing of the SONCC coho ESU throughout its range (see Appendix A.1).

- Steelhead: 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 promising but less certain (see Appendix A.3).

- Pacific lamprey: Pacific lamprey harvest potential below 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 above Keno Dam is possible but less certain (see Appendix A.4).

- Redband trout: Redband trout is expected to increase in abundance and distribution in Upper Klamath Lake and its tributaries and also below Keno Dam (see Appendix A.6).

- Suckers: Sucker populations in the Upper 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 (Appendix A.5).

Harvest opportunities associated with the return of salmonids to the Upper Basin would represent a major change for the Klamath Tribes, who have not had a salmonid fishery for almost a century. Should spring Chinook become sufficiently abundant to support subsistence, it would also lengthen the duration of the seasonal round for salmon. Opportunities for subsistence harvest of redband are likely to increase, and harvest of suckers (which has not occurred since 1986) may increase over the long term.

IV.B.2. Associated Cultural and Social Effects

The return of salmonids to the Upper Basin (even in small numbers) would be a notable event for the Klamath Tribes, who have not seen any returns for almost a century.

- "Certainly, the enduring cultural significance of salmon today is enhanced significantly for some tribal members by an awareness that the Klamath Basin anadromous salmonids are the direct descendants of the same salmonid populations that sustained their ancestors" (Deur 2011, p 25).

- "The return of sustainable salmon populations even below a harvestable threshold is seen by some as a correction of some of the cultural and spiritual losses associated with the extirpation of anadromous salmonids from the upper Klamath Basin. However, the restoration of a robust fishery in the Klamath Basin is widely believed to have potentially restorative functions that will reverse some (though not all) of the adverse cultural, social, and economic impacts of salmon extirpation over the last century" (Deur 2011, p. 48).

Benefits to be derived from this increased access to fish include greater social and cultural cohesion associated with harvesting activities and associated ceremonies. Spring Chinook is of particular importance, as it would allow for the revival of the First Salmon Ceremony. Increased harvest opportunities would also increase the ability of tribal members to provide food security for the community, demonstrate respect for tribal elders, transmit cultural values and practices to the younger generation, and engage in trade and barter. Poverty and rural isolation have constrained the ability of tribal members to replace fish with healthy food alternatives. Improved fishing opportunities would increase opportunities for healthy food consumption.

The KBRA provides a number of benefits to the Klamath Tribes, including: (1) funding for fish habitat restoration and development and administration of fishery reintroduction and monitoring programs; (2) funding for long-term economic revitalization; (3) funding to facilitate acquisition

of the Mazama Forest Project, which lies within the historical territories of the Klamath Tribes; and (4) establishment of an interim fishing site below Iron Gate Dam (IGD) (KBRA 2010, Part VII, pp 170-171). These provisions would be significant steps toward enhancing economic self-sufficiency and self-determination, enabling the Klamath Tribes to more fully engage in fishery and habitat management and allowing for greater cultural expression related to the harvest of fish.

The Mazama Forest acquisition has social and cultural as well as economic implications:

- "Despite the ubiquitous distribution of salmon fishing sites within the upper Klamath Basin, Klamath Tribes consultants typically convey greater knowledge and stronger sentiments regarding sites within or close to the former Reservation boundary. This reflects a long history of land and resource dispossession within the Basin" (Deur 2003, p 26).

- "Places with enduring public access have retained a higher level of use by tribal members, and tribal members retain subsistence fishing rights in locations within the 1954 Reservation boundary; in turn this has arguably fostered the enduring cultural significance of sites on public or former tribal lands" (Deur 2003, p 27).

IV.C. Alternative 3 – Partial Facilities Removal of Four Dams

Alternative 3 is intended to provide the same habitat conditions as Alternative 2 (i.e., fish passage unencumbered by dams and a free-flowing river), as well as benefits of the KBRA. Thus the effects of this alternative on harvest opportunities for the Klamath Tribes are expected to be the same as Alternative 2.

IV.Summary and Conclusions

For the Klamath Tribes, the action alternatives are expected to create salmonid harvest opportunities that have been lost for almost a century, allow for eventual subsistence harvest of suckers (which has been lost for 25 years), increase self-sufficiency and self-determination through acquisition of ancestral lands (Mazama Forest), expand engagement in resource monitoring and management, enhance cultural values and practices and their transmission to the next generation, generate jobs and income, and provide greater opportunity for healthy food consumption (Table V-1).

Table V-1. Effects of the no action and action alternatives on the Klamath Tribes.

Indicator	*No Action*	*Change from No Action*
Harvest opportunities		
• Chinook	No access to spring or fall Chinook	Return of salmon to Upper Basin would be first time in almost a century. Interim fishing site below IGD would provide first Chinook harvest opportunity in almost a century.
• 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
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.
Engagement in resource 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).
Cultural practices	First C'waam Ceremony held annually. No First Salmon Ceremony due to lack of access to spring Chinook. Loss of fishing opportunities over past century impairs ability to practice and transmit traditional harvest methods and values (sharing fish with elders) to younger generation.	Enhanced significance of First C'waam Ceremony associated with improvement in status of sucker populations. Return of spring Chinook would allow for revival of First Salmon Ceremony. Return of salmonids to Upper Basin would provide new opportunities to engage in traditional harvesting, ceremonial and cultural practices and teach those practices to younger generation. Mazama Forest Project (KBRA Section 32.2) would provide access to culturally important sites and land base for engagement in traditional practices.
Employment, income, standard of living	Employment provided by Klamath Tribes' Natural Resources Department. Subsistence fishery for redband trout provides modest contribution to 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). Increased subsistence fishing opportunities would improve standard of living, expand opportunities for trade and barter, and enhance food security for

		tribal members (particularly important for elders).
Health	Subsistence fishing limited to modest amounts of redband trout. Poverty and rural isolation constrain ability to replace fish with healthy food alternatives.	Greater opportunity for healthy food consumption associated with interim fishing site (KBRA Section 34) and increased subsistence fishing opportunities.

VI. References

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Appendix A – Biological Assumptions

This Appendix discusses the effects of the no action and action alternatives on a number of species historically and/or currently harvested by the Klamath Tribes: SONCC coho, Klamath River fall and spring Chinook, steelhead , Pacific lamprey, Lost River and shortnose suckers, and redband trout. A number of expert panels were convened to evaluate these effects. The conclusions of those panels, as well as advice from the Biological Subgroup (a team of federal biologists) and results of several biological models, were used to inform this evaluation.

A.1. SONCC Coho

The SONCC coho ESU consists of 28 coho population units that range from the Elk and Rogue Rivers in southern Oregon to the Eel River in Northern California, including the coho populations in the Klamath Basin. NMFS' framework for assessing the biological viability of the SONCC coho ESU involves categorization of these component populations into seven diversity strata that reflect the environmental and genetic diversity across the ESU. Risk of extinction is evaluated on the basis of measurable criteria that reflect the biological viability of individual populations, the extent of hatchery influence, and the diversity and spatial structure of population units both within and across diversity strata (Williams *et al*. 2008).

The Klamath diversity stratum includes five population units, three of which (Upper Klamath, Shasta, Scott) are potentially affected by the action alternatives. According to the Biological Subgroup, "None of the population units of Klamath River coho salmon is considered viable at this point in time" (Hamilton *et al*. 2011, p 89) and "…all five of these Population Units have a high risk of extinction under current conditions" (Hamilton *et al*. 2011, p 90).

According to the Coho/Steelhead Expert Panel, adverse effects of dam removal on coho would likely be short-lived:

> "The short-term effects of the sediment release will be sediment concentrations in the range of 1,000 to more than 10,000 milligrams per liter (mg/L), which will be injurious to upstream migrants of both species [coho and steelhead], and especially to any adult steelhead or 'half pounders' that hold or spawn in the mainstem. However, these high sediment concentrations are expected to occur for periods of a few months in the first two years after the beginning of reservoir lowering and sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, especially in high flow conditions, but not injurious to fish" (Dunne *et al*. 2011, pp 18-19).

The Expert Panel noted the likely continuation of poor coho conditions under the no action alternative and a modest to moderate response of coho under the action alternatives (the moderate response being contingent on successful KBRA implementation):

> "Although Current Conditions will likely continue to be detrimental to coho, the difference between the Proposed Action and Current Conditions is expected to be small, especially in the short term (0-10 years after dam removal). Larger (moderate) responses are possible under the Proposed Action if the KBRA is fully and effectively implemented and mortality caused by the pathogen *C. shasta* is reduced. The more likely small response will result from

modest increases in habitat area usable by coho with dam removal, small changes in conditions in the mainstem, positive but unquantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat. Very low present population levels and low demographic rates indicate that large improvements are needed to result in moderate responses. The high uncertainty in each of the many individual steps involved for improved survival of coho over their life cycle under the Proposed Action results in a low likelihood of moderate or larger responses….Nevertheless, colonization of the Project Reach between Keno and Iron Gate Dams by coho would likely lead to a small increase in abundance and spatial distribution of the ESU, which are key factors used by NMFS to assess viability of the ESU" (Dunne *et al*. 2011, p ii).

The Biological Subgroup also notes the benefits of the action alternatives on coho viability:

> "Reestablishing access to historically available habitat above IGD will benefit recovery of coho salmon by providing opportunities for the local population and the ESU to meet the various measures used to assess viability (e.g., abundance, productivity, diversity, and spatial structure (Williams *et al*., 2006). Thus there would be less risk of extinction when more habitat is available across the ESU" (Hamilton *et al*. 2011, p 92).

The action alternatives are expected to improve the viability of coho populations in the Klamath Basin and advance the recovery of the SONCC coho ESU. However, since the action alternatives do not include coho restoration actions outside the Klamath Basin, they alone will not bring about the conditions that would warrant de-listing of the SONCC coho ESU throughout the species range.

A.2. Klamath River Spring and Fall Chinook

Biological effects of the no action and action alternatives on Klamath River Chinook are evaluated on the basis of two models – the Evaluation of Dam Removal and Restoration of Anadromy Model (Hendrix 2011) and a habitat-based model (Lindley and Davis 2011) – and conclusions of the Biological Subgroup (Hamilton *et al*. 2011) and an Expert Panel convened in January 2011 to evaluate the effects of the alternatives on Klamath River Chinook (Goodman *et al*. 2011).

A.2.a. Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) Model

The Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model (Hendrix 2011) is a simulation model that provides 50-year projections of Klamath Chinook escapement, as well as separate harvest projections for the ocean troll, ocean recreational, inriver recreational and tribal fisheries under the no action alternative and dam removal alternatives (denoted as NAA and DRA respectively by Hendrix). Projections from the EDRRA model begin in 2012 (the year of the Secretarial Determination) and span the period 2012-61. The harvest projections for the DRA reflect the following assumptions: (i) active introduction of Chinook fry to the Upper Basin beginning in 2011, (ii) short-term effects on Chinook of sedimentation associated with

dam removal, (iii) gains in the quantity and quality of salmonid habitat associated with dam removal and KBRA beginning in 2020, and (iv) loss of Iron Gate as a production hatchery in 2028.

The 50-year escapement and harvest projections provided by the model were each iterated 1000 times to capture the influence of uncertainties in model inputs on model outputs. The harvest projections pertain to Klamath/Trinity River Chinook and do not distinguish between spring and fall runs. Klamath/Trinity Chinook harvest (all fisheries combined) is estimated for each simulated year on the basis of the KRFC harvest control rule recommended by the PFMC to NMFS in June 2011 as part of a pending amendment to the Pacific Salmon Fishery Management Plan (Figure A-1). As an added constraint, the model also caps the forecast harvest rate for age-4 KRFC in the ocean fishery at 16 percent to address the consultation standard for California Coastal Chinook (listed as 'threatened' in 1999).

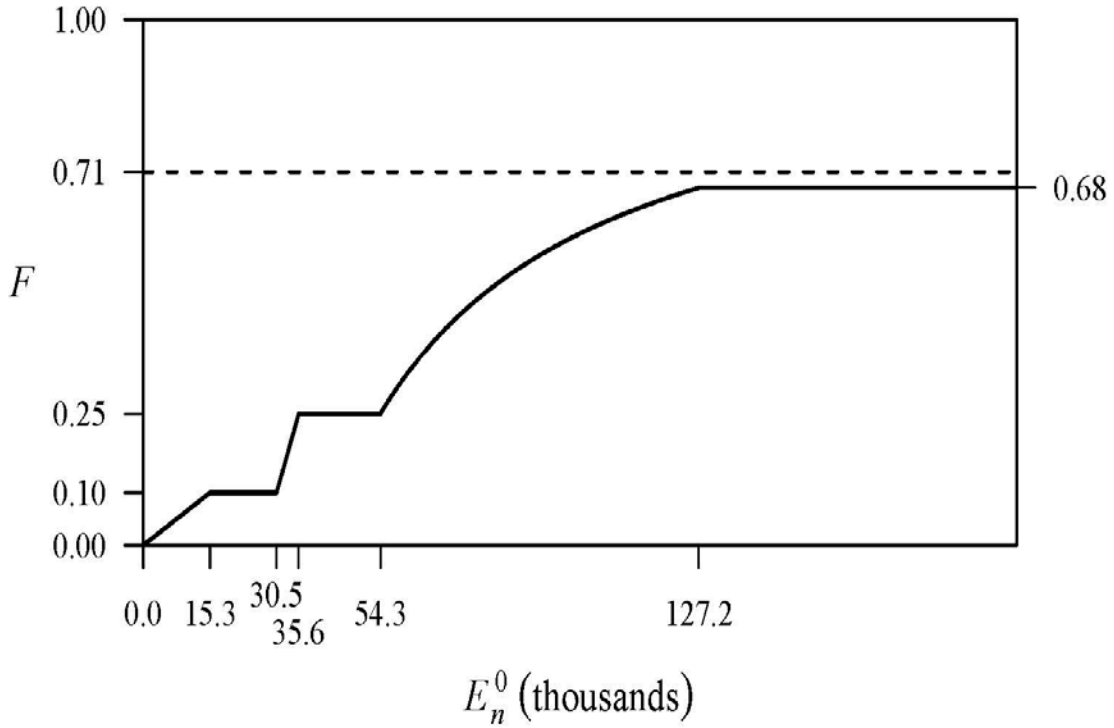

Figure A-1. Harvest control rule used in the EDRRA model (E_n^0 = natural area adult escapement in the absence of fisheries, F = exploitation rate) (graphic by Michael Mohr, NMFS).

Consistent with PFMC practice, the model distributes the allowable harvest among fisheries as follows: 34.0 percent to the ocean commercial fishery, 8.5 percent to the ocean recreational fishery, 7.5 percent to the inriver recreational fishery (up to a maximum of 25,000 fish – with any surplus above 25,000 allocated to escapement), and 50.0 percent to tribal fisheries. The 50 percent tribal share is a 'hard' allocation specified by the Department of the Interior (USDOI 1993) on behalf of the Yurok and Hoopa Valley tribes. The distribution of the remaining 50.0 percent among the three non-tribal fisheries represents customary practice rather than mandatory conditions.

Table A-1 summarizes model results for the entire 50-year projection period (2012-61) and for the following subperiods: (i) 2012-20 (pre-dam removal, hatchery influence); (ii) 2021-32 (post-dam removal, continued hatchery influence), and (iii) 2033-61 (post-dam removal, no hatchery influence).[2]

The EDRRA model assumes that ocean abundance is known without error and that the harvest control rule exactly achieves the escapement objective (Hendrix 2011). Given that the absolute harvest projections provided by the model are an idealized version of real world conditions, model results are best considered in terms of relative rather than absolute differences between alternatives. The average percent difference between EDRRA's 50th percentile harvest projections for the NAA and DRA is +50 percent for the tribal fishery. The annual increase varies by subperiod, with harvest increasing by +8 percent prior to dam removal (2012-2020), peaking at +68 percent during the 12 years after dam removal when the fishery is still influenced by hatchery production (2021-32), then diminishing somewhat to +55 percent during 2033-61 after hatchery influence dissipates in 2032. The average harvest increases during the latter two subperiods (+68 percent during 2021-32, +55 percent during 2033-61) are higher than the average +50 percent increase experienced over the entire period (Table A-1).

Table A-1. EDRRA model results for the tribal fishery under the no action alternative (NAA) and dam removal alternative (DRA)

Model Results	*Time Period*			
	2012-61	*2012-20*	*2021-32*	*2033-61*
50th percentile harvest: % diff between NAA and DRA	+50%	+8%	+68%	+55%
5th percentile harvest: % diff between NAA and DRA	-60%	-81%	-50%	-58%
95th percentile harvest: % diff between NAA and DRA	+886%	+512%	+1000%	+955%
Average # years when DRA harvest > NAA harvest: % diff between NAA and DRA	70%	54%	78%	72%
Average # years when pre-harvest adult natural spawning escapement ≤ 30,500: % diff between NAA and DRA	-66%	-4%	-79%	-80%

Source: EDRRA model outputs provided by Hendrix (2011).
2012-61: 50-year projection period
2012-20: pre-dam removal
2021-32: post-dam removal, hatchery influence
2033-61: post-dam removal, no hatchery influence

EDRRA model results indicate that the 5th percentile harvest value for the DRA is 60 percent lower than the 5th percentile value for the NAA and that the 95th percentile harvest value is 886 percent higher; that is, the DRA harvest distribution is positively skewed and exhibits a high degree of overlap with the NAA harvest distribution. The EDRRA model also provides information regarding the percent of simulated years in which DRA harvest exceeds NAA harvest (50 percent indicating no difference between the two alternatives). These paired comparisons were made possible by applying the parameter draws associated with each iteration

[2] The model assumes that Iron Gate would cease to operate as a production hatchery in 2028. Hatchery influence on the fishery would continue for another 3-4 years (the length of the life cycle of the last year class released from the hatchery).

of the simulation to both the NAA and DRA. The results in Table A-1 indicate virtually no difference between the alternatives during 2012-20 (54 percent) but higher harvests under DRA in the two subsequent subperiods (2021-32 and 2033-61) in a notable majority of years (78 percent and 72 percent respectively).

The harvest control rule incorporated into the EDRRA model (Figure A-1) limits the harvest rate to 10 percent or less when pre-harvest escapements fall below 30,500 adult natural spawners. Escapements this low would likely be accompanied by major regulatory restrictions and adverse economic conditions for the fishery. Such conditions occur in 66 percent fewer years under the DRA than the NAA – with the greatest declines (-79 percent during 2021-32, -80 percent during 2033-61) occurring in the post-dam removal years (Table A-1).

A.2.b. Biological Subgroup

According to the Biological Subgroup, the action alternatives are expected to provide habitat favorable to spring Chinook:

> "If dams were removed it is reasonable to expect reestablished spring-run Chinook salmon to synchronize their upstream migration with more natural flows and temperatures. The removal of Project reservoirs would also contribute important coldwater tributaries (e.g., Fall Creek, Shovel Creek) and springs, such as the coldwater inflow to the J.C. Boyle Bypassed Reach, to directly enter and flow unobstructed down the mainstem Klamath River, thereby providing thermal diversity in the river in the form of intermittently spaced patches of thermal refugia. These refugia would be useful to migrating adult spring-run Chinook salmon by extending opportunities to migrate later in the season. The thermal diversity would also benefit juvenile salmon" (Hamilton *et al*. 2011, p 87).

A.2.c. Lindley/Davis Habitat Model

The Lindley/Davis habitat model focuses on potential Chinook escapement to the Upper Basin above Iron Gate Dam (IGD). The analytical approach involved compilation of escapement and watershed attribute data for 77 fall and spring Chinook populations in various watersheds in Washington, Oregon, Idaho and Northern California, and comparison of those attribute sets with the attributes of Upper Basin watersheds. Based on their analysis, the authors concluded that Upper Basin attributes fall well within the range of spring bearing watersheds.

According to Lindley and Davis:

> "Our model predicts a fairly modest increase in escapement of Chinook salmon to the Klamath basin if the dams are removed. The addition of several populations of spring-run Chinook salmon with greater than 800 spawners per year to the upper Klamath would significantly benefit Klamath Chinook salmon from a conservation perspective, in addition to the fishery benefits….The last status review of the UKTR [Upper Klamath and Trinity Rivers] ESU expressed significant concern about the very poor status of the spring-run component of the ESU (Myers *et al*. 1998). Viable populations of spring-run Chinook

salmon in the upper Klamath would increase the diversity and improve the spatial structure of the ESU, enhancing its viability (McElhaney *et al*., 2000) and improving the sustainability of the ESU into the uncertain future" (Lindley and Davis 2011, p 13).

A.2.d. Chinook Expert Panel

With regard to short term impacts of dam removal, the Chinook Expert Panel indicated that "Dam removal does not have a substantial multi-year adverse impact on mainstem Chinook salmon" (Goodman *et al.* 2011, p ii).

With regard to longer term effects, the Panel concluded that "The Proposed Action offers greater potential for increased harvest and escapement of Klamath Chinook salmon than the Current Conditions" (Goodman *et al*. 2011, p 16). More specifically, the Panel noted that

> "…a substantial increase[3] in Chinook salmon is possible in the reach between Iron Gate Dam and Keno Dam. A modest or substantial increase in Chinook upstream of Keno Dam is less certain. Within the range of pertinent uncertainties, it is possible that the increase in Chinook salmon upstream of Keno Dam could be large, but the nature of the uncertainties precludes attaching a probability to the prediction by the methods and information available to the Panel. The principal uncertainties fall into four classes: the wide range of variability in salmon runs in near-pristine systems, lack of detail and specificity about KBRA, uncertainty about an institutional framework for implementing KBRA in an adaptive fashion, and outstanding ecological uncertainties in the Klamath system that appear not to have been resolved by the available studies to date" (Goodman *et al*. 2011, p 7).

With regard to spring Chinook, the Panel noted:

> "The prospects for the Proposed Action to provide a substantial positive effect for spring Chinook salmon is much more remote than for fall Chinook. The present abundance of spring Chinook salmon is exceptionally low and spawning occurs in only a few tributaries in the basin. Under the Proposed Action, the low abundance and productivity (return per spawner) of spring Chinook salmon will still limit recolonization of habitats upstream of IGD. Intervention would be needed to establish populations in the new habitats, at least initially. Harvests of spring Chinook salmon could occur only if spring Chinook salmon in new and old habitats survive at higher rates than at present. Therefore, habitat quality would need to be higher than at present, and KBRA actions would need to greatly improve survival of existing populations of spring Chinook salmon. Factors specifically affecting the survival of spring Chinook salmon have not been quantified" (Goodman *et al*. 2011, p 25).

[3] The Panel defined the term 'substantial increase' to mean 'a number of fish that contributes more than a trivial amount to the population' and cited 10 percent of the average number of natural spawners or 10,000 fish as a rough approximation to what they mean by 'substantial'. As indicated in their report, "The Panel does not suggest that this figure is a likely increase or a minimum increase that is expected. It is only used as a benchmark for our discussions and to provide a basis for interpreting our response to the question" (Goodman *et al*. 2011, p 7, footnote 3).

A.3. Steelhead

Biological effects of the alternatives on Klamath River steelhead are evaluated on the basis of results of an Expert Panel convened in December 2010 to evaluate the effects of the alternatives on steelhead and coho (Dunne *et al*. 2011) and conclusions of the Biological Subgroup (Hamilton *et al*. 2011) regarding steelhead.

A.3.a. Coho/Steelhead Expert Panel

The Coho/Steelhead Expert Panel did not expect current conditions to be conducive to expansion of the steelhead fishery:

> "Current Conditions will not, in the short to medium term, result in an expansion of the fishery. Projecting harvest under the Current Conditions depends on the fate of the hatcheries and specifics of harvest policies into the future, which are insufficiently defined at this time" (Dunne *et al*. 2011, p 58).

Dam removal activities are expected to be injurious to steelhead; however, these effects are expected to be short-term.

> "The short-term effects of the sediment release will be sediment concentrations in the range of 1,000 to more than 10,000 milligrams per liter (mg/L), which will be injurious to upstream migrants of both species [coho and steelhead], and especially to any adult steelhead or 'half pounders' that hold or spawn in the mainstem. However, these high sediment concentrations are expected to occur for periods of a few months in the first two years after the beginning of reservoir lowering and sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, especially in high flow conditions, but not injurious to fish" (Dunne *et al*. 2011, pp 18-19).

The Panel anticipates a long-term increase in abundance and distribution of steelhead under the action alternatives, provided certain conditions are met.

> "If the Proposed Action is implemented effectively, and the other related actions occur [e.g., Total Maximum Daily Load (TMDL)], then the response of steelhead may be broader spatial distribution and increased numbers of individuals within the Klamath system. This assessment is based on the likelihood of steelhead being given access to substantial new habitat, steelhead being more tolerant than coho to warmer water, the fact that other similar 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, p ii-iii).

The Panel notes, however, that long-term positive effects are subject to a number of uncertainties:

> "The Panel identified six principal obstacles to drawing convincing conclusions between the two alternatives: (1) insufficient specificity of the KBRA; uncertainties about (2) fish passage through Keno Reservoir and Upper Klamath Lake, (3) hatchery effects, (4) disease, and (5) water demand responses to KBRA; and (6) limited understanding about coho and

steelhead abundances, migration patterns, and factors affecting survival at each life stage" (Dunne *et al.* 2011, p iii).

A.3.b. Biological Subgroup

The Biological Subgroup concluded that the action alternatives would likely lead to expansion of the steelhead fishery above the current dam sites.

> "…it is likely that access under the without dams and with the KBRA management scenario would create a sport fishery for anadromous species, in particular steelhead, above IGD [Iron Gate Dam]" (Hamilton *et al*. 2011, p 68).

The Subgroup expects the action alternatives to be more beneficial to steelhead than to other anadromous species due to steelhead's habitat adaptability and disease resistance.

- "Because of their ability to navigate steeper gradient channels and spawn in smaller and intermittent streams (Platts and Partridge 1978), steelhead would realize the extent of anadromous habitat gain to a greater degree than other species" (Hamilton *et al*. 2011, p 51).

- "For steelhead, habitat above IGD [Iron Gate Dam] has the potential to increase returns by 6,800 to 20,000 spawners (Table 1). Disease problems in the Klamath River are far less likely to interfere with steelhead returns than with salmon returns, as Klamath steelhead trout are resistant to *C. Shasta* (Administrative Law Judge 2006)" (Hamilton *et al*. 2011, p 112).

A.4. Pacific Lamprey

Biological effects of the alternatives on Pacific lamprey are evaluated on the basis of results of an Expert Panel convened in July 2010 to evaluate the effects of the alternatives on that species (Close *et al*. 2010). The Panel distinguished between short and long term effects and effects downstream and upstream of Keno Dam.

The Panel expects the short-term adverse effects of sedimentation associated with dam removal to be minimal:

> "Pacific lamprey larvae utilize soft fine substrate for approximately 4-6 years in freshwater streams. Because they live burrowed in the soft sediments, there will likely be minimal increases in larval mortality rates of existing Pacific lamprey larvae in the mainstem Klamath River after dam removal. The larvae will likely relocate or adjust their burrow tubes to maximize feeding and respiration" (Close *et al*. 2010, p 33).

The Panel also considered long term effects, distinguishing between areas downstream and upstream of Keno Dam. While noting a potential 14 percent increase in Pacific lamprey habitat downstream of Keno, the Panel indicated that harvest potential would be somewhat less:

> "However, larval habitat quality in the reach between Iron Gate Dam and Keno Dam will be less desirable than in downstream reaches currently available to anadromous lamprey,

making the increase in lamprey production as the result of dam removal and KBRA in this reach alone less than 14 percent. When also considering that Conditions without Dams and with the KBRA might lead to an increase in productivity below Iron Gate Dam also (due to a potential increase in spawning habitat upstream of Iron Gate Dam and reestablishment of natural sediment dynamics downstream of Iron Gate Dam), the Panel then roughly estimated that there might be a total increase of production of outmigrant lamprey (and hence harvest potential) in the range of 1 to 10 percent relative to Conditions with Dams. Within the range of 1 to 10 percent, the production of lamprey in this extended range downstream of Keno Dam will depend on the survival of adults in the ocean and the success of the KBRA (Close *et al*. 2010, pp 45-46).

The Panel also noted the potential for Pacific lamprey to colonize the area above Keno Dam:

> "This area [upstream of Keno] was historically accessible to anadromous fishes, but the historical occurrence of Pacific lamprey is unresolved and investigations have only confirmed Pacific lamprey up to at least Spencer Creek. Nevertheless, improvements to fish passage scheduled for Keno Dam may open the upper Klamath River Basin to Pacific lamprey irrespective of their historical occurrence[4]….but the Panel does not know to what extent or over what time frame such increases could translate into increased harvest potential" (Close *et al*. 2010, p 46).

A.5. Suckers

Lost River suckers (LRS) and shortnose suckers (SNS) were listed as 'endangered' in 1988: Biological effects of the alternatives on these two species are evaluated on the basis of results of an Expert Panel convened in August 2010 to evaluate the effects of the alternatives on resident fish (suckers and redband trout) (Buchanan *et al*. 2011).

The Resident Fish Expert Panel expressed serious concerns about the status of both LRS and SNS:

> "Available data show that both LRS and SNS are declining under current conditions and that they could become extinct in the near future unless a major recruitment event occurs soon" (Buchanan *et al*. 2011, p 76). Given these circumstances, harvest opportunities are precluded: "With declining populations under the current conditions, there are no opportunities for tribal or recreational harvest" (Buchanan et *al*. 2011, p 71).

[4] Larval pheromones that guide lamprey to a given river are not species-specific. Thus Pacific lamprey could potentially colonize an area not previously occupied based on pheromones emitted by other lamprey populations that inhabit that area (Close *et al*. 2010, p 32).

The Panel notes that dam removal may negatively impact resident species below Iron Gate Dam but that this effect will likely be short-lived:

> "Immediately after dam removal, high suspended sediments may adversely affect resident species located below and near Iron Gate Dam, but the resident fish abundances are likely to quickly recover and increase as the resident fish population moves into the dam removal reach" (Buchanan *et al*. 2011, p 70).

The Panel anticipates the possibility of future harvest under the action alternatives, but cautions that such harvest should not occur until a long-term positive trajectory has been established for the sucker populations.

> "Under KBRA, populations are likely to increase beginning about 2022 based on increased survival of larval and juvenile suckers and recruitment of new adult year classes….However, until population monitoring indicates an upward trend in the population over at least a decade with major recruitment events and multiple age classes, harvest would reduce or negate population growth. Since suckers have high reproductive potential, population numbers can increase rapidly if favorable conditions are reestablished. For instance, from the late 1980s until the mid 1990s LRS and SNS populations increased from a few thousand to upwards of 100,000. However, if unfavorable conditions return, then numbers can crash to unsustainable levels as demonstrated in the 2002-2007 period. Therefore, these short-term rapid increases should not be used as a basis for establishing harvest of these species. 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, pp 71-72).

A.6. Redband Trout

The Resident Fish Expert Panel was convened in August 2010 to evaluate the effects of the no action and action alternatives on resident fish, including redband/rainbow trout and sucker species. The Panel distinguished the effects in two locations; (i) above Keno Dam in Upper Klamath Lake and the lower Williamson and Wood Rivers, and (ii) below Keno Dam in the Keno Reach of the Klamath River.

The Panel expected redband trout populations to be stable under the no action alternative:

> Above Keno Dam: "Under the Current Conditions with Dams, distribution and abundance of Lake/River redband/rainbow trout is expected to remain stable…." (Buchanan *et al*. 2011, p 72).
>
> Below Keno Dam: "Under current conditions the population of redband/rainbow trout, and therefore the harvest level, in the area immediately downstream of Keno Dam (in the free-flowing 5.9 mi or 9.5 km) is influenced by adverse water quality but the population appears to be stable…." (Buchanan *et al*. 2011, p 73).

The Resident Fish Expert Panel predicted marked improvement in the redband trout fishery under the action alternative both above and below Keno Dam:

Above Keno Dam: "The distribution and abundance of resident adfluvial trout in Upper Klamath Lake, and the lower Williamson and Wood rivers, three very important areas for harvest, are also expected to expand….Under successful implementation of KBRA measures, the large size of resident trout within these areas is expected to remain stable" (Buchanan *et al*. 2011, p 73).

Below Keno Dam: "While there would be short-term adverse impacts from dam removal …, the Proposed Action would likely create significant increases in the size, abundance, and distribution of resident trout in the 43 mi (69.2 km) of the Klamath River between J.C. Boyle Reservoir and Iron Gate Dam" (ibid, p 73). The Panel further noted that, "It is expected that eventually the entire reach downstream of Keno Dam would be capable of supporting a resident redband/rainbow trout fishery after the removal of the four dams. It is possible that the trophy fishery will expand seven times from below Keno Dam to the Iron Gate reach" (Buchanan *et al*. 2011, p 74).