Hoopa Valley Tribe 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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Abbreviations and Acronyms

CDFG	California Department of Fish and Game
DOI	Department of the Interior
DRA	Dam Removal Alternative
EDRRA Model	Evaluation of Dam Removal and Restoration of Anadromy Model
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fishery Management Plan
IGD	Iron Gate Dam
KBRA	Klamath Basin Restoration Agreement
KMZ	Klamath Management Zone
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
USFWS	U.S. Fish and Wildlife Service

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I. Introduction

In March 2012, the Secretary of the Interior – in consultation with the Secretary of Commerce – 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. One of the entities potentially affected by the Secretarial Determination is the Hoopa Valley Tribe. This report analyzes the effects of three alternatives that will be considered by the Secretary as they pertain to fishing opportunities for the Hoopa Valley Tribe:

- <u>Alternative 1 – No Action:</u> 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 Marine Fisheries Service (NMFS) regarding the Bureau of Reclamation's Klamath Project Operation Plan.

- <u>Alternative 2 – Full Facilities Removal of Four Dams:</u> 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).

- <u>Alternative 3 – Partial Facilities Removal of Four Dams:</u> 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. The 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 Hoopa Valley Tribe's 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 Hupa fisheries 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

The Hoopa Valley Tribe views fish as an integral component of the Trinity River ecosystem.

> "The Trinity River is of unique and irreplaceable value to the Hupa. It is a vital natural resource that is the foundation of their social and cultural way of life. At its most basic level, the river has always been a source of food and other necessities of daily Hupa life. The river

also provides basket materials, fishnet materials, and a means of transportation. Even rocks from the river are used by Hupa people to practice their cultural ways. That every traditional Hupa village was located and built along the Trinity River underscores the vital importance of the river to Hupa culture and traditions….The Trinity River is traveled during religious ceremonies and in recreational activities; it is integral to the Hupa language and its oral tradition and truly represents the binding force of their community" (USFWS *et al*. 1999, p 3-215).

II.A. Fish

The Hupa people historically relied on a seasonal round of fishing that focused largely on salmon but also included steelhead, Pacific lamprey, sturgeon (Wallace 1978, p 164-165). The Hupa harvested these species for ceremonial, subsistence and/or commercial use. A variety of fishing fishing methods were used that were tailored to particular species and fishing location:

> "During the spring run fishermen, standing on platforms erected over suitable pools and eddies, dipped out the salmon with long-handled nets. When the river was low in the fall, a weir of poles and withes was built across it….Fish swarming against the obstruction were scooped up by men strategically positioned on small platforms along its top. The weir was constructed communally and placed in alternate years near one of two principal settlements. Other methods of capturing salmon included gillnets set in still pools and long dragnets hauled by groups of fishermen. Where water conditions permitted, salmon were impaled with bone-pointed harpoons" (Wallace 1978, p 165).

Operation of the Hupa weir was timed to occur after the Yurok Tribe constructed their weir downriver at Kepel. The Hupa weir remained in place until washed out by high waters (USFWS *et al.* 1999, p 3-215). Fishing at the weir was subject to rules and common understandings that ensured the long-term sustainability of the fishery:

- "… salmon runs historically were protected by a very strict series of laws and traditional mores prohibiting over-fishing and ensuring that only the amount needed by tribal communities was taken. Laws also served to guarantee that upstream people received a fair share of the salmon, and most importantly, that weir gates (i.e., fish dams) were kept opened for extended periods during harvest time to ensure that adequate numbers of salmon could reach their spawning grounds. Other management activities included the clearing of smaller tributaries to facilitate fish migration. Furthermore, the tribes heeded tales that warned against eating too much and wasting food lest it run out, and they had a belief system that stated that the salmon would be withheld if abused or mistreated (Lewis 1994). Such prohibitions continue to be voiced today by tribal elders (USFWS *et al.* 1999, p 3-214).

II.C. Associated Cultural and Social Effects

Fish (most notably salmon but also eels) was a major focus of the Hupa's cultural and ceremonial life:

- "The abundance of salmon has always been an important measure of tribal well-being – where feasting is not simply an exercise in eating, but has deep rooted connections to the vitality of the Earth and a traditional connotation of community health (Gunther 1926). The timing and cycle of many tribal societal, religious, and economic activities were made to closely coincide with the seasonal and geographic variations in fish runs, particularly the arrival of the first salmon (USFWS *et al*. 1999, p 3-214).

- "The Acorn Feast was celebrated in the autumn when the nuts began to fall from tan oaks; the First Salmon ceremony took place when the spring run of fish began (Goddard 1903-1904: 78-81); Kroeber and Gifford 1949: 57-60). The acorns or salmon were obtained and ritually cooked by a regular officiant who also repeated a lengthy formula, said prayers, and executed various sacred acts. Until these procedures were completed, no one ate the food. The first eel taken in the spring received similar treatment" (Wallace 1978, p 174).

Fish was also used for trade and barter:

> "During the pre-Euro-American contact period, fisheries were an essential part of the economy of the region's tribes. The sharing, trading, and consumption of fish was so important that fishing places were acquired as property. Fish were also used for commercial purposes, and were traded in substantial volume. Northwest California Indians have been catching salmon for trade with other times since time immemorial. Trade enabled them to acquire food, raw materials, and manufactured goods. The trade, which involved both necessities and luxuries of native life, existed because of the variation in available local resources. Food preservation methods were developed, which allowed fish to be stored throughout the year and transported over great distances" (USFWS *et al*. 1999, p 3-215).

III. Recent History

IV. III.A. General Conditions

The Hoopa Valley Tribe is located on the Trinity River (the major tributary of the Klamath). Their 90,000-acre reservation – also known as the 'Hoopa Square' – is the largest in California. Tribal enrollment was 1,893 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 40 percent in 2005 (BIA 2005). Per capita income of Indians residing on the Hoopa Valley Reservation and Indians residing in Humboldt County (including but not limited to Hoopa Valley tribal members) in 1999 was $9,757 and $11,532 respectively – both lower than per capita income of the general population of Humboldt County ($17,203). The percent of the population below the poverty level follows a similar pattern: 34 percent of Indians on the Hoopa Valley Reservation, 31 percent of Indians in Humboldt County, and 20 percent of the general Humboldt County population (U.S. Census 2000).

III.B. Fish

According to Snyder (1931), the first non-Indian commercial fishery for salmon on the Klamath River was established in 1876. The first cannery opened at Requa in the late 1880s; cannery production peaked during 1912-15. Although the canneries were owned by non-Indians, all of the fish received by the canneries and most of the cannery labor were provided by Indians, who were the only people allowed to fish inriver. Several decades later, the State of California closed the inriver fishery:

> "With little regulation or coordination of in-River and particularly, ocean fishing activities, the Klamath and Trinity River stocks were fished to the limit during the first several decades of the 20th century. In 1933, the State of California, opting to halt the precipitous decline of both rivers' fisheries as a result of fishing, mining, logging and farming banned the use of gill-nets on the lower 20 miles of the Klamath (even for subsistence fishing), closed the canneries and prohibited the sale of river-caught salmon. This had severe implications for the tribes, as they were increasingly dependent on the economic opportunities provided by their fishery resources" (Sloan 2011, p 49).

In subsequent decades, citations issued by California Fish and Game wardens to Hupa and Yurok tribal members for illegal gillnetting on the lower Klamath was a source of ongoing tension and confrontation. In 1969, Yurok fisherman Raymond Mattz challenged State jurisdiction over Indian fishing on the Reservation. The case was lost in two lower courts. In 1973 the U.S. Supreme court reversed the lower court decisions, and in 1977 the DOI reopened the lower Klamath to Indian gillnet subsistence and commercial fishing. DOI subsequently imposed a moratorium on the tribal commercial fishery during 1978-1986 for conservation reasons (Sloan 2011, pp 49-52). The moratorium was lifted in 1987, with subsequent tribal harvests based on an allocation agreement brokered by the Klamath Fishery Management Council (KFMC). In 1993, the DOI Office of the Solicitor issued an opinion requiring that 50 percent of the allowable harvest of Klamath-Trinity salmon be reserved for the Yurok and Hoopa Valley tribes (DOI 1993). This was considerably higher than the 30 percent tribal reserve brokered by the KFMC during 1987-91 (Pierce 1998). The Hoopa Valley Tribe receives 20 percent of the tribal reserve, i.e., 10 percent of the total allowable harvest of Klamath-Trinity salmon.

Fish abundances have declined considerably from the historical period: "Today, Candlefish (once an important subsistence food) no longer exists in the Klamath River. Coho Salmon and Green Sturgeon are on the Endangered Species list. Pacific Lamprey has experienced dramatic decreases and Chinook salmon has declined to such numbers that only a short commercial season can be practiced for the fall run, and all other runs have diminished to the extent that they are no longer viable for economic harvest" (Sloan 2011, p 5). Today Hupa harvest consists largely of fall run Chinook.

Poor water quality conditions affect not only fish populations but the operation of the fishery:

> "Even when there are salmon in the rivers, tribal nets fill with moss because flows aren't adequate to keep the water cool, a depressing reminder that the rivers are no longer healthy" (Jill Sherman as quoted in USFWS *et al.* 1999, p 3-224).

As part of their stewardship responsibilities, the Hoopa Valley Tribe is actively involved in Trinity River restoration. In terms of fishery management, a Hupa tribal biologist serves on the Pacific Fishery Management Council's Salmon Technical Team, provides tribal harvest and biological data that help determine the status of stocks, and advises the Council on scientific and regulatory matters. The Hoopa Valley has a Fisheries Department that conducts biological research and data collection, collects creel data, and monitors tribal fisheries on the Reservation.

III.C. Associated Cultural and Social Effects

Historical declines in habitat conditions and fish populations have had cultural and social as well as fishery effects:

- "Hupa and Yurok rarely left their territories. Today, the inability to meet subsistence needs from the fishery, a perception that the rivers are dirty, and a general malaise in our communities have compelled many to seek employment and community elsewhere. Even tribal health has experienced a decline as processed foods have replaced the fish and other natural foods that were once a staple of our diets (Byron Nelson as quoted in USFWS *et al.* 1999, p 3-225).

- While the First Salmon Ceremony is currently not practiced, the World Renewal Ceremonies, which had not been conducted since 1912, were revived in 2000 (Sloan 2011, p 43). The World Renewal Ceremonies and other rituals (including the Brush Dance and Flower Dance) involve the use of basket materials that grow along the river and immersion of some ceremonialists in the river. Low flows and poor water quality at certain times of year affects the quantity and quality of basket materials and also exposes basket makers (who wade in the river and also strip willows and other materials with their teeth) and ceremonialists (who engage in ritual immersion) to adverse water conditions. Gathering and use of medicinal plants is also adversely affected.

- The Hoopa Valley Tribe hosts the World Renewal Ceremonies (including the Deerskin Dance and Jump Dance) in the lower Basin every other year in rotation with the Yurok Tribe. When fish harvest is low, the harvest must be supplemented with sources off the reservation to meet the tribal obligation to share salmon and other food with ceremonial participants and attendees (USFWS et al. 1999, Gates and Novell 2011). "Both the White Deerskin Dance and the Jump Dance depend on a healthy river for fish, basket materials, bathing, and ambiance. The flows of the river itself are also a central element of these dances as it influences the dancer's ability to travel the river as did their ancestors. The Hupa claim that as the river's flows have declined, so have the Hupa's ability to practice these ceremonies" (USFWS *et al*. 1999, p 3-217).

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).

IV.A.2. Associated Cultural and Social Effects

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

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

Alternative 2 is expected to lead to an increase in the viability of Klamath River coho populations and advance the recovery of the SONCC coho ESU. However, since this alternative does not include coho restoration outside the Klamath Basin, it will not create conditions sufficient to warrant de-listing of the ESU throughout its range (see Appendix A.1). Chinook, steelhead and perhaps Pacific lamprey are also expected to benefit under Alternative 2 (see Appendices A.2, A.3 and A.4). However, given that dam removal and KBRA would occur on the Klamath River (not the Trinity), the benefits of such restoration will accrue to Klamath (not Trinity) River stocks.

Although Alternative 2 is unlikely to affect the productivity of Trinity River stocks, there may be circumstances where it affects survival of anadromous Trinity River fish, which must pass through 42 miles of the Klamath River on their return to the Trinity:

- Trinity River fish migrating through the lower river may experience short term adverse effects from sedimentation associated with dam removal. These effects, however, are expected to diminish in the lower reaches of the river (Reclamation 2011) and to be short-lived (see Appendices A.1, A.2.d, A.3.a and A.4).

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[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).

- In 2002, an unprecedented fish kill occurred on the lower 36 miles of the Klamath River. The California Department of Fish and Game identified the cause as follows:

  > "River flow and the volume of water in the fish-kill area were atypically low. Combined with the above average run of salmon, these low-flows and river volumes resulted in high fish densities….Presence of a high density of hosts and warm water temperatures caused rapid amplification of the pathogens ich and columnaris, which resulted in a fish-kill of over 33,000 adult salmon and steelhead" (CDFG 2004, p iii).

  The fish kill impacted Trinity as well as Klamath stocks:

  > "Although a larger number of Klamath River fall-run Chinook died, a greater proportion of the Trinity River run was impacted by the fish-kill, because the Trinity run is substantially smaller than the Klamath run on an annual basis and the peak of the Trinity run was present during the height of the fish-kill" (CDFG 2004, p iii).

  Dam removal and KBRA are expected to expedite water quality improvements (Total Maximum Daily Loads) being undertaken on the Klamath River under the no action alternative (Water Quality Subteam 2011). To the extent that such improvements reduce the likelihood of future fish kills, they may benefit anadromous stocks on the Trinity as well as the Klamath River.

IV.B.2. Associated Cultural and Social Effects

Given the limited effects of Alternative 2 on Hupa fisheries, little if any effects on cultural and social practices are likely to occur under this alternative.

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), for the Klamath River (excluding the Trinity). Therefore the effects of this alternative on Hupa fisheries are expected to be the same as Alternative 2.

V. Summary and Conclusions

The action alternatives are not expected to affect the long-term productivity of Trinity River stocks but may affect stock survival under some narrowly defined circumstances. For instance, sedimentation associated with dam removal may adversely affect survival of anadromous Trinity River fish migrating through the lower river; such effects are expected to be modest and short-term. To the extent that water quality improvements associated with the action alternatives reduce the incidence of fish kills in the lower river, they may beneficially impact Trinity fish. Under most circumstances, however, Trinity River stocks and the Hupa fisheries that depend on those stocks are unlikely to be affected (positively or negatively) by the action alternatives.

Table V-1. Effects of the no action alternative and changes from the no action to the action alternatives on the Hoopa Valley Tribe.

Indicator	*No Action*	*Change from No Action*
Harvest Opportunities:		
• Chinook	Very low abundance of spring Chinook, moderate abundance of hatchery-dominated fall Chinook	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 below 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 below 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
Engagement in resource monitoring and management	Active engagement in data collection, research and management pertaining to fish, wildlife, habitat and fisheries.	No change
Cultural practices	No First Salmon Ceremony. Participation in ceremonies (e.g., World Renewal, Brush Dance, Flower Dance – including ritual immersion of ceremonialists and daily feasting) and other cultural practices (e.g., basket weaving, medicinal plants) impaired by limited fish abundance and poor water quality on the Trinity River.	No change in Trinity River water quality or associated cultural practices.
Employment, income, standard of living	Employment provided by Hoopa Valley Tribal Fisheries Program and participation of tribal	Little if any change in Trinity River fishing opportunities or associated employment.

	members in commercial fishery. Subsistence fishery contributes to standard of living.	
Health	Subsistence fishery provides limited but healthy source of sustenance. Poverty and rural isolation constrain ability to replace fish with healthy food alternatives.	Little if any change in availability of Trinity River fish as healthy source of subsistence.

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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 Klamath Basin tribes: SONCC coho, Klamath River fall and spring Chinook, steelhead , and Pacific lamprey. 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 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" (Biological Subgroup 2011, p 89) and "…all five of these Population Units have a high risk of extinction under current conditions" (Biological Subgroup 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 injurious to upstream migrants of both species [coho and steelhead]…. 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" (Biological Subgroup 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. The potential for coho harvest under the no action and action alternatives is evaluated in the context of this conclusion.

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 FMP (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).

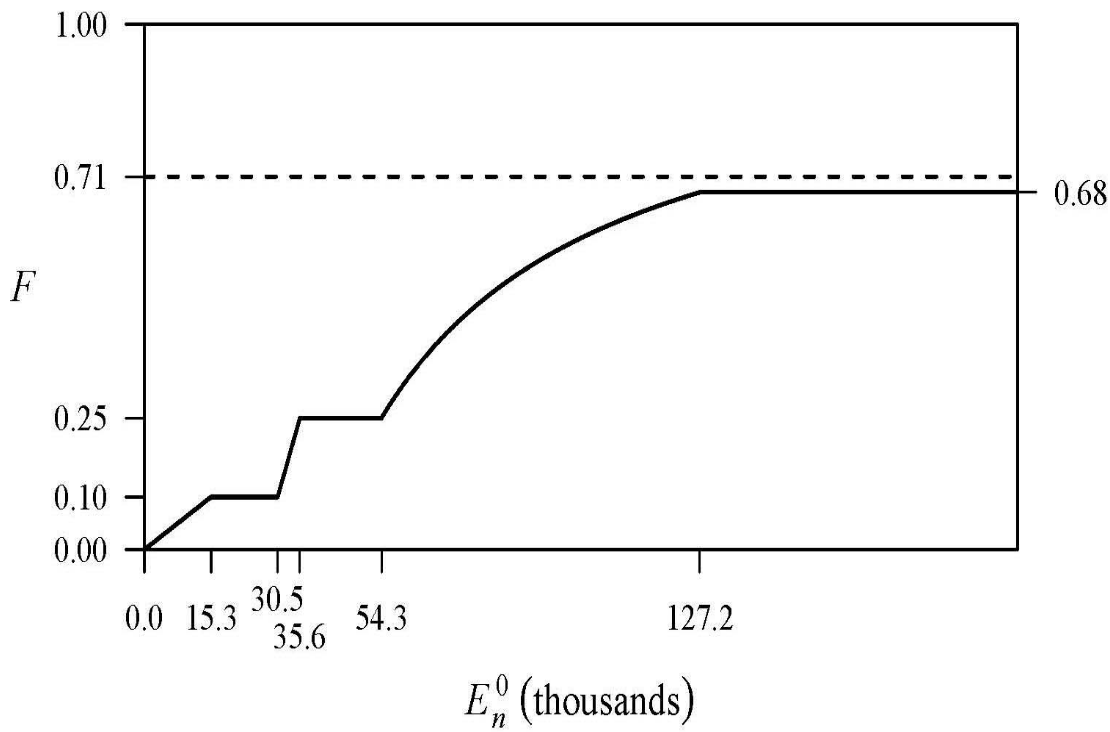

Figure A-1. Harvest control rule used in the EDRRA model (E_n^0 = annual escapement to natural areas prior to ocean or inriver harvest, F = harvest rate) (graphic by Michael Mohr, NMFS).

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 III-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

The Chinook Expert 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).

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

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[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).

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 but 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, 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 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).

[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).