Resighini Rancheria Fishery Socioeconomics Technical Report

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

Prepared by

Cynthia Thomson
NOAA National Marine Fisheries Service
Southwest Fisheries Science Center
Fisheries Ecology Division
Santa Cruz, California

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
TMDL	Total Maximum Daily Load
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service

Contents

Tables

Figure

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 Resighini Rancheria:

- 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 U.S. 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 Resighini Rancheria's historical relationship to 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 Rancheria 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.[1]

[1] Concerns of the Resighini Rancheria regarding impaired water quality include effects on fish populations and associated ceremonies and practices but also extend to issues pertaining to groundwater, flooding and gravel replenishment on the Rancheria. This report focuses largely on fisheries; the latter issues are discussed more thoroughly in other reports (e.g., Gates and Novell 2011).

II. Historical and Cultural Context
II.A. Fish

The Resighini Rancheria was settled in the late 1930s by Yurok Indians affiliated with the Yurok Coast Indian Community. "The 1988 Hoopa-Yurok Settlement Act provided Rancheria members with the option of merging with the newly organized Yurok Tribe. None selected that option, and the Rancheria remains a separate government distinct from the Yurok Tribe" (Gates and Novell 2011, p 3-16),

Unlike the Yurok Tribe, the Rancheria does not have federally recognized fishing or water rights. However, "The Indians of the Resighini Rancheria are Yurok people and thus share their cultural practices and values with the general culture described for the Yurok Tribe. Resighini tribal members have always participated in the ceremonies" (Gates and Novell 2011, p 3-17).

II.B. Associated Cultural and Social Effects

Like other Yuroks, Rancheria members view fishing as more than just a means of physical sustenance. Fishing is often accompanied by ceremonies, involves social obligations (e.g., sharing fish with elders), is an opportunity to practice good stewardship and convey cultural values to the next generation, and provides a vehicle for trade and barter.

III. Recent History
III.A. General Conditions

The Resighini Rancheria is a 239-acre reservation located near the mouth of the Klamath River and surrounded by the larger Yurok Reservation. Tribal enrollment was 111 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 60 percent in 2005 (BIA 2005). Per capita income of Resighini Rancheria residents and Indians residing in Del Norte County (including but not limited to Resighini Rancheria members) in 1999 was $6,925 and $9,638 respectively – both lower than per capita income of the general population of Del Norte County ($14,573) (U.S. Census 2000).

The Rancheria operates a small campground for tourists who come to the Klamath for fishing and other outdoor activities.

III.B. Fish

Fish population abundances have declined considerably relative to the historical period. As indicated above, the Resighini Rancheria does not have a federally recognized fishing right. "Nevertheless, the lack of fish in the local economy has effects on general tribal health and cultural well-being" (Gates and Novell 2011, p 3-17).

III.C. Associated Cultural and Social Effects

Historical declines in water quality and fish populations have affected the Resighini Rancheria in a variety of ways:

- "As a tribe that lives along the river, their aesthetic quality of life has diminished. The Rancheria people are at risk when they bathe in the river, tourists are less interested in visiting the Klamath River and staying in the campground, and in an area with few available fish, tribal members are likely to consume less of the traditional food base" (Gates and Novell 2011, p 3-17).

- "Additionally, the tribal members experience a loss of opportunity for intergenerational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunity elsewhere" (Gates and Novell 2011, p 3-18).

Despite these challenges, Rancheria members continue to engage in fishing, basket weaving and other traditional activities. The World Renewal Ceremonies, which had not been conducted since 1912, were revived in 2000 (Sloan 2011, p 43). Rancheria members regularly attend these Ceremonies, which are hosted in the lower Basin in alternate years by the Yurok Tribe and the Hoopa Valley Tribe.

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)[2] 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).

[2] 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).

- 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

Water quality improvement plans (known as Total Maximum Daily Loads or TMDLs) are in effect for various water bodies of the Klamath Basin. Water quality conditions that affect tribal cultural practices would continue to be impaired until such time as beneficial effects of the TMDLs are felt. Such beneficial effects are subject to considerable uncertainty and would not be fully realized for a number of decades (Water Quality Sub Team 2012). Consistent with the lack of change in harvest opportunities and the pace of water quality improvements, little change in cultural and social practices of Rancheria members (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).

Over the longer term, dam removal and successful implementation of the KBRA are expected to affect the harvest potential of Klamath River fish 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 means for each individual tribe in the Basin is not clear. For members of tribes with federally recognized fishing rights, expanded harvest opportunity may take the form of increased 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 opportunity is much more likely to be realized on the Klamath River (rather than the Trinity), since the restoration actions (dam removal and KBRA) 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 Southern Oregon Northern California Coast (SONCC) coho Evolutionarily Significant Unit (ESU) is listed as 'threatened' under the Endangered Species Act (ESA). This 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).

IV.B.2. Associated Cultural and Social Effects

Dam removal and KBRA are expected to expedite water quality improvements (TMDLs) being undertaken on the Klamath River under the no action alternative (Water Quality Sub Team 2011). These changes are expected to affect Rancheria members in several ways.

- "Removing the project reservoirs will result in water quality conditions that would provide the opportunity for improved Resighini Rancheria cultural values, such as conducting traditional bathing ceremonies, fishing, and enjoying the aesthetic qualities of the river" (Gates *et al.* 2011, p 4-29).

- "The Dams Out Scenario…would increase anadromous fish populations and thus would likely benefit the Resighini Rancheria by improving the fisheries and by providing salmon for tribal ceremonies. This increase in fish populations would improve health by increasing the salmon in their diets, decreasing discontent and depression, and improving the opportunities for intergenerational transmission of traditional knowledge. This sense of tribal unity has the potential to reduce the number of young people leaving the reservation. Additionally, healthier riparian vegetation would improve the ability to gather plants that might be used for such things as baskets, medicine, utensils, regalia, and structures" (Gates *et al.* 2011, p 4-30).

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 Resighini Rancheria are expected to be the same as Alternative 2.

V. Summary and Conclusions

For the Resighini Rancheria, the action alternatives are expected to result in increased harvest opportunities, enhance cultural values and practices, generate a modest increase in income associated with campground use, and provide greater opportunity for healthy food consumption (Table V-1).

Table V-1. Effects of the no action and action alternatives on the Resighini Rancheria.		
Indicator	*No Action*	*Change from No Action*
Harvest opportunities:		
• Chinook	Very low abundance of spring Chinook, moderate abundance of fall Chinook	Potential adverse short-term effect due to sedimentation associated with dam removal. Some increase in spring and fall Chinook after dam removal. Spring Chinook particularly valued for high fat content and potential to extend salmon season.
• Coho	ESA-listed	Improved viability of Klamath Basin coho but no change in listing status
• Pacific lamprey	Very low abundance	One to ten percent increase in harvest potential
• Sturgeon	Very low abundance	No change
• Eulachon	ESA-listed	No change
Cultural practices	Active attendance at World Renewal Ceremonies held by Yurok Tribe and Hoopa Valley Tribe. Cultural practices (e.g., basket weaving, medicinal plants) impaired by poor water quality.	Return of spring Chinook would provide opportunity to attend revival of First Salmon Ceremony. Increase in fish populations and expedited water quality improvements would enhance opportunities to engage in traditional harvesting, ceremonial and cultural practices and transmit those practices to younger generation.
Employment, income, standard of living	Modest income provided by Resighini Rancheria's campground.	Increase in fishing opportunities may modestly increase campground usage.
Health	Subsistence fishing opportunities very limited. Poverty and rural isolation constrain ability to replace fish with healthy food alternatives.	Greater opportunity for healthy food consumption associated with higher fish abundance.

VI. References

Bureau of Indian Affairs. 2005. *2005 American Indian Population and Labor Force Report*.

Close, D. *et al*. 2010. *Klamath River Expert Panel Final Report – Scientific Assessment of Two Dam Removal Alternatives on Lamprey*. With the assistance of PBS&J, an Atkins company. Portland, OR.

Dunne, T. *et al*. 2011. *Klamath River Expert Panel Final Report – Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead*. With the assistance of Atkins (formerly PBS&J). Portland, OR.

Gates, T. and M. Novell. 2011. *Current Effects of PacifiCorp Dams on Indian Trust Resources and Cultural Values: Background Technical Report Informing the Secretarial Determination Overview Report*. Prepared for Department of Interior, Cultural/Tribal Sub-team, Sacramento, California, Contract GS-10F-0008S.

Gates, T. *et al*. 2011. *Potential Effects of Implementing the KHSA and KBRA on Indian Trust Resources and Cultural Values; Background Technical Report Informing the Secretarial Determination Overview Report*. Prepared for Department of Interior, Cultural/Tribal Sub-team, Sacramento, California. Contract GS-10F-0008S.

Goodman, D. *et al*. 2011. *Klamath River Expert Panel Addendum to Final Report – Scientific Assessment of Two Dam Removal Alternatives on Chinook Salmon*. With the assistance of Atkins (formerly PBS&J), Portland, OR.

Hamilton, J. *et al*. 2011. *Synthesis of the Effects to Fish Species of Two Management Scenarios for the Secretarial Determination on Removal of the Lower Four Dams on the Klamath River – FINAL*. Prepared by the Biological Subgroup (BSG) for the Secretarial Determination (SD) Regarding Potential Removal of the Lower Four Dams on the Klamath River.

Hendrix, N. 2011. *Forecasting the response of Klamath Basin Chinook populations to dam removal and restoration of anadromy versus no action*. R2 Resource Consultants, Inc., Redmond, WA. (Review draft May 16, 2011).

Klamath Basin Restoration Agreement for the Sustainability of Public and Trust Resources and Affected Communities. Feb 18, 2010.

Lindley, S.T. and H. Davis. 2011. *Using model selection and model averaging to predict the response of Chinook salmon to dam removal*. Fisheries Ecology Division, NMFS Southwest Fisheries Science Center, Santa Cruz, CA. (Review draft May 16, 2011).

Sloan, K. 2011. *Yurok and the Klamath River: Yurok Historical Context and Data for Assessing Current Conditions and the Effects of the Proposed Klamath Restoration Project on Yurok Tribal Trust Assets and Yurok Resources of Cultural and Religious Significance*. Report prepared for the Department of the Interior, Bureau of Indian Affairs, for use in the Secretarial Determination Overview Report and NEPA/CEQA Analysis under Grant #81333AG053 from U.S. Fish and Wildlife Service.

U.S. Census Bureau. 2000. *Table DP-3. Profile of Selected Economic Characteristics.* American FactFinder.

U.S. Department of the Interior, Office of the Solicitor. 1993. Memorandum M-36979 on the subject of "Fishing Rights of the Yurok and Hoopa Valley Tribe".

Waples, R.S. 1991. *Definition of "Species" Under the Endangered Species Act: Application to Pacific Salmon*. NOAA Technical Memorandum NMFS F/NWC-194. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA.

Water Quality Sub Team. 2011. *Assessment of Long Term Water Quality Changes for the Klamath River Basin Resulting from KHSA, KBRA, and TMDL and NPS Reduction Programs: Klamath Secretarial Determination Regarding Potential Removal of the Lower Four Dams on the Klamath River*, 21 p. + Appendices.

Williams, T.H. *et al*. 2008. *Framework for Assessing Viability of Threatened Coho Salmon in the Southern Oregon/Northern California Coast Evolutionarily Significant Unit*. NOAA NMFS Technical Memorandum. NOAA-TM-NMFS-SWFSC-432.

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 Resighini Rancheria: 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 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).

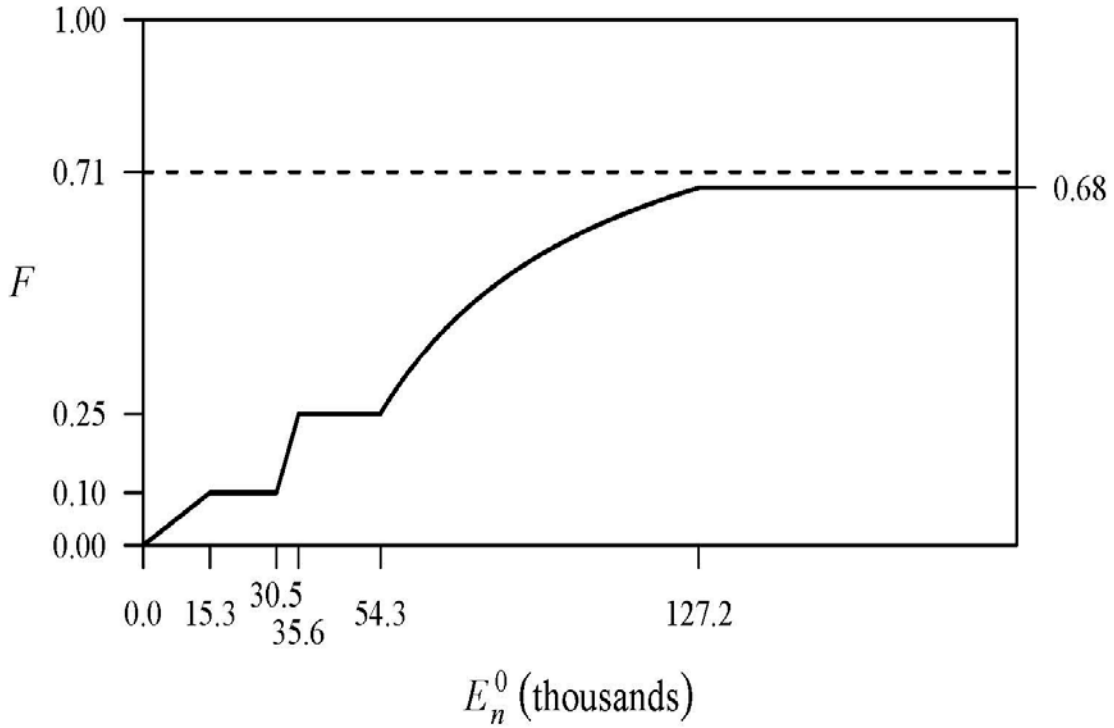

Figure A-1. Harvest control rule used in the EDRRA model (E_n^0 = natural area adult escapement in the absence of fisheries, F = exploitation rate) (graphic by Michael Mohr, NMFS).

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).[3]

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

[3] 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[4] 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).

[4] 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[5]….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).

[5] 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).