

The Environmental, Engineering and Economic Analysis of Large Scale Dam Removal on the Klamath River

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ABSTRACT

In January 2010, representatives of more than 40 organizations, including federal agencies, the states of California and Oregon, Indian tribes, counties, agricultural irrigators, and conservation and fishing groups signed the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA). The purpose of the agreements was to restore and sustain salmonid and other fisheries throughout the Klamath Basin; establish reliable water supplies for sustainable agriculture, communities, and National Wildlife Refuges; and contribute to the public welfare and the sustainability of all Klamath Basin communities.

As a part of a collaborative federal and state program - including agency representatives from the Department of Commerce, the Department of Agriculture, and the California Department of Fish and Game - the Department of Interior, led by the U.S. Geological Service, is conducting a dual-track evaluation of the KHSA and KBRA. They will consider whether the agreements will advance fish populations, are in the public's and tribes' interest, and can be done within the program's cost cap of \$450 million. Answers to these questions will support the Secretary of Interior's Decision on whether to remove four large PacifiCorp dams on the Klamath River. The first track consists of a set of scientific and engineering studies addressing biology, hydrology, economics, and dam removal technology to inform the Secretary of the Interior on the complex issues resulting from large dam removal. The second track of study is the preparation of environmental compliance documents under the National Environmental Policy Act and California Environmental Quality Act to fully assess the environmental and social effects of dam removal.

The Klamath Dam removal program would be the largest potential dam removal action of its kind ever undertaken. The dual science and environmental process forms a future model for other large restoration programs that present complicated and sometime conflicting scientific, engineering, and economic uncertainties that must be understood to promote informed decisions by policy makers at both the state and federal levels.

This paper presents a brief history of the events that led to development of the KHSA and KBRA, an outline of the agreements themselves, and the process and results of scientific and engineering studies under development by the joint federal and state team.

INTRODUCTION

Disputes over water in the Klamath River Basin between varying water interests including commercial salmon fisherman, farmers, tribes, and wildlife refuges have resulted in years of litigation and unsuccessful attempts at compromise. The potential for compromise between the opposing factions was ultimately forged following irrigation supply cuts in the Upper Klamath Basin in 2001 for the purposes of Endangered Species Act (ESA) compliance and a major salmon die-off in the following year. These events signaled an unsustainable status quo and the potential for a mutually beneficial compromise.

Negotiations on basin wide solutions were initiated at the same time that the Federal Energy Regulatory Commission (FERC) began the relicensing process for PacifiCorp's Klamath Hydroelectric Project 2082. As a part of the relicensing process, FERC and other Federal resource agencies identified endangered species mitigation actions including provisions for fish passage around four dams (J.C. Boyle, Copco No. 1, Copco No. 2 and Iron Gate) on the mainstem of the Klamath River (see Figure 1). These environmental provisions were projected to reduce revenues from hydropower production below their cost of operation. The potential high cost of relicensing the hydroelectric project encouraged PacifiCorp to enter the KHSA negotiations to identify other viable alternatives to river restoration and power generation consistent with the company's business portfolio.

After multiple years of negotiations, two linked agreements, the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA) were endorsed by farming and ranching interests, three tribes, commercial and sport fishing groups, river conservation groups, Klamath and Humboldt counties, the governments of California and Oregon, PacifiCorp and the federal government.



Figure 1. Klamath River System

The agreements outline three major actions:

- Removal of the four PacifiCorp dams to allow volitional fish passage,
- Allocation of water supplies in the Upper Klamath Basin among farmers, wildlife refuges, and fishing interests in a way acceptable to the signatories to the agreements, and
- Federal funding of a 10-year habitat restoration effort (elements of the KBRA) in the upper and lower basin focused on fisheries restoration.

SECRETARIAL DETERMINATION PROCESS

The KHSA outlines a scientific and engineering analysis process to provide the information necessary for the Secretary of the Interior (Secretary) to assess whether facilities removal³:

- Will advance restoration of the salmon fisheries of the Klamath Basin, and
- Is in the public interest, which includes consideration of potential impacts on affected communities and local tribes.

The scientific, engineering, and environmental compliance studies required to support the Secretarial Determination are being prepared by a team composed of nine federal agencies⁴ from three federal departments⁵. The federal team is developing the scientific and engineering studies and the environmental compliance documents in two parallel and interconnected tracks. The scientific and engineering studies are focusing on answering the questions of whether facilities removal will advance salmon restoration and is in the public's interest, while the NEPA and CEQA environmental documents are being prepared to describe the potential environmental effects of dam removal under the KHSA and the restoration actions outlined in the connected KBRA.

The scientific and engineering studies will be compiled and synthesized in the Secretarial Determination Overview Report and the environmental compliance studies will be presented in an Environmental Impact Statement/Environmental Impact Report (EIS/R).

The scientific and engineering studies under development by the federal team are being prepared with a commitment to stakeholder involvement with regular stakeholder updates, public meetings, and government to government consultations with six federally-recognized tribes in the project area. The investigations and technical reports are also subject to the 2004 Office of Management and Budget

³ Facilities removal is defined in the KHSA as the physical removal of all or part of each of the four PacifiCorp dams to achieve at a minimum, a free-flowing condition and volitional fish passage, site remediation and restoration, including previously inundated lands, and measures to avoid or minimize adverse downstream impacts

⁴ U.S. Forest Service, National Oceanic and Atmospheric Administration Fisheries Service, Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, National Park Service, U. S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S. Geological Survey

⁵ Department of Interior, Department of Agriculture, and Department of Commerce

Memorandum (OMB 2004) on peer review of highly influential scientific information. The peer review will be completed by experts selected based on subject matter expertise, with consideration of each reviewer's independence and any potential for conflict of interest.

LARGE RESTORATION PROGRAM/COMPLIANCE CHALLENGES

Removal of the four PacifiCorp dams represents what would be the largest dam removal action completed in the United States and would be expected to generate a wide range of environmental effects and potential benefits. While facilities removal would create additional anadromous fish habitat, it would also eliminate approximately 170 megawatts of hydroelectric power generation and existing flat water recreation at three of the four reservoirs, while affecting warm water fisheries that inhabit the reservoirs and property values of homes adjacent to the reservoirs.

The short and long term effects related to dam removal will generate a wide range of legal and regulatory compliance issues including compliance with both the federal Endangered Species Act (ESA) and California ESA, the Federal Clean Water Act (CWA), and protection of Indian Trust Assets (ITAs).

Endangered Species Act. The Klamath River Basin provides habitat to multiple aquatic and terrestrial species including Coho Salmon and Lost River Suckers. The presence of the four PacifiCorp dams on the Klamath River has been attributed to the decline of the Klamath River Salmon fishery (NRC 2004) and improvement of habitat conditions for the federally endangered Coho Salmon run is one of the driving forces behind the dam removal effort. In the Upper Klamath Basin the Shortnose and Lost River Sucker (federally listed species) currently inhabits Upper Klamath Lake, Lake Ewauna, and the four PacifiCorp reservoirs proposed for removal.

Historically the sucker's range did not extend downstream of Lake Ewauna (FWS 2008). However, the PacifiCorp reservoirs present a suitable low energy environment that now supports the fish.

Dam removal, for the purpose of improving habitat conditions for the listed Coho species and other unlisted anadromous fish species, presents a 'tradeoff' with the loss of sucker habitat in the



Figure 2. Lost River Sucker

reservoirs. Even though the dams create an artificial habitat for suckers, the reservoirs' removal creates the potential for the take of a federally endangered species and a fully protected California endangered species. The California Endangered Species Act does not allow for the permitting of the take of a fully protected species. The KHSA includes language outlining California's plans to remove the sucker from the fully protected list, an action requiring approval of the Fish and Game Commission or the legislature.

Clean Water Act. The Klamath River downstream of the PacifiCorp reservoirs is frequently subjected to impaired water quality conditions including increased instream temperatures, depressed dissolved oxygen levels, and high pH that have contributed to fish mortality from diseases (QVIR 2006). In addition to impairments created by the PacifiCorp reservoirs, Lake Ewauna and Upper Klamath Lake also experience summer blooms of blue-green algae (*Microcystis aeruginosa*) which produce the hepatotoxin microcystin. Microcystin adversely affects organisms including fish, invertebrates, and humans (Yurok Tribe Environmental Program 2008).

The long term improvement to water quality conditions in the PacifiCorp's reservoirs and in the Klamath River downstream of the reservoirs has been cited as one of the most significant benefits of dam removal. In the short term, dam removal has the potential to adversely affect downstream water quality conditions with the erosion of sediment trapped behind three⁶ of the four reservoirs.

The total volume of sediment behind the reservoirs has been estimated in excess of 20 million cubic yards with an estimated erodible volume on the order of 20 to 50 percent of this total volume. The trapped sediment is primarily composed of silt and clay fraction with a lesser amount of organic matter. The sediment composition presents potential deleterious effects to aquatic resources through elevated total suspended solids from Iron Gate dam to the Pacific Ocean and potentially decreased dissolved oxygen content for an unknown distance below Iron Gate Dam.



Figure 3. Algae bloom on Upper Klamath Lake

⁶ Sediment has not accumulated behind Copco 2

Facility removal will require a Water Quality Certification from the State of California under the CWA Section 401 and Porter-Cologne Water Quality Control Act. The certification process ensures that proposed activities comply with State and federal water quality standards. Specifically, the decommissioning action will be required to comply with the North Coast Regional Water Quality Control Board's (NCRWQCB) Basin Plan for the discharge of sediment to the Klamath River and to the Pacific Ocean. Presently, the NCRWQCB's Basin Plan limits sediment discharge that causes nuisance, adversely affects beneficial uses, or increases turbidity by more than 20% above naturally occurring ambient conditions. The dam removal action will discharge sediment at concentrations far in excess of current Basin Plan standards.

Tribal Trust Responsibilities. The federal government through treaty and other legal obligations holds trust responsibilities for six federally recognized tribes in the Klamath Basin. These tribal trust obligations include the responsibility to ensure access to tribal fish species through maintenance of adequate river water quality to maintain species health. Facilities removal has the potential to generate a short term adverse affect on these tribal resources through impaired water quality and potential loss of fish. Both Coho and Chinook salmon have life stages ranging from egg incubation through adult spawners that occur throughout the entire calendar year. Short term impacts to water quality from dam removal has the potential to impact one or more of these life stages based upon the timing and duration of the dam removal action.

PRELIMINARY RESULTS

The federal team has started to release preliminary findings on the predicted effects of dam removal on fish populations in presentations to stakeholders and through its website KlamathRestoration.Gov. These preliminary results include data from sediment sampling efforts in the reservoirs, and analysis of predicted changes in fish diseases in the river following dam removal.



Figure 5. Tribal trust tights include the obligation to provide access to tribal fisheries

Sediment Contaminant Sampling. The federal team completed a geologic investigation that included the sampling of sediments at a total of 55 locations in the

reservoirs and five locations in the Klamath River Estuary and Klamath River in the zone from the estuary to seven miles upstream of the estuary. The preliminary findings from contaminant sampling analysis identified no human health risk from sediment exposure. The sampling results did indicate the presence of very low levels (less than 10 micrograms per kilogram) of bioaccumulative chemicals including PCBs, legacy insecticides, and dioxins/furans (USGS, USEPA, USFWS 2010). The federal team is conducting additional analysis on the aquatic risk that the sediment might pose to the river, the estuary, and the ocean if released downstream.

Fish Disease. Salmon in the Klamath River have the capacity to survive in water quality conditions that include low levels of fish diseases. The Klamath River fish are known to have evolved with these diseases and at low concentrations they do not present a threat to salmon survival (USFWS, 2003). At higher concentrations and during periods when other water quality conditions in the river produce stress on the salmon (elevated water temperatures and low water flows) these fish diseases can be fatal to salmon present in the river. Preliminary information being presented by the federal team includes the identification of zones in the river of higher infectiousness, and the identification of temperature and river flow ranges in which the diseases spread and are fatal to fish (Bartholomew and Foott, 2010). These findings are supporting estimates of future fish disease prevalence with and without dam removal.

REVIEW AND DECISION MAKING PROCESS

The removal of the Klamath dams represents a great deal of uncertainty related to the future health of fisheries and how local and tribal economies will benefit from dam removal. These uncertainties are complicated by future climate change scenarios that could increase overall river water temperatures and reduce water supplies to farms and the environment. The public and basin stakeholders are justifiably concerned about the federal team developing the correct conclusions and stating the uncertainties related to dam removal. At stake is the health of the river and watershed and the long term sustainability of a large agricultural community, and extensive tribal, commercial, and recreational salmon fisheries.

To address these uncertainties, the Department of the Interior, led by the US Geological Survey, has established a scientifically transparent process to analyze many of the significant uncertainties with the dam removal.

Federal agencies and the states of California and Oregon are conducting detailed technical studies in the areas of hydrology, engineering, water quality, fisheries, economics, recreation, real estate, and tribal trust interests to address whether dam



Figure 5. Agriculture in the Upper Klamath Basin

removal provides a benefit to fisheries and communities verses leaving the dams in place.

These studies are being compiled under the umbrella of the Obama Administration's executive order requiring transparency and scientific integrity in scientific studies. (White House Memorandum for the Heads of the Executive Departments and Agencies on "Scientific Integrity", issued on March 9, 2009). The core elements of the Klamath dam removal program include an extensive public and stakeholder engagement process and rigorous peer review of technical document consistent with OMB Final Information Quality Bulletin for Peer Review. Public and stakeholder engagement allows for the review and comment on all of the significant scientific studies and identification of significant effects of dam removal.

The above technical studies will be combined into a single synthesized report (Secretarial Determination Overview Report) detailing the benefits and risks of dam removal. A separate EIS and EIR will be prepared on the dam removal action utilizing the best available scientific and technical information to assess of the environmental and social effects of the dam removal action.

Making the Decision to Remove the Dams The Secretary of the Interior (Secretary) and the governors of both California and Oregon will have the responsibility of making the final decision on dam removal. They will utilize the Secretarial Determination Overview Report, along with the results of the EIS/R and public input and comments received during both processes. The decision is scheduled for March 30, 2012. Elevating the decision to the Secretary and Governors of California and Oregon reduces potential conflicts over a decision made at the local level where interests potentially stand to gain or lose and also elevates the financial,



Figure 6. Copco 1 Dam

regulatory, environmental, and social commitment that will be needed by the states and the Federal Government for either a positive or negative decision.

CONCLUSION

Large restoration programs like the Klamath dam removal program present many challenges to resource agencies and local communities that struggle to assess the benefits and impacts that a large program may provide. In the Klamath basin, many people in the community have become accustomed to the reservoirs as a way of life and the removal of the dams represents a significant change and disruption to the status quo. Demonstrating that dam removal will improve fisheries and benefit the local economies must be done in an open and transparent process backed by technical analysis.

Resources agencies also have to balance the effects to changing resources conditions both in the short and long-term. Dam removal may improve future aquatic habitat for fisheries, but it also will impact listed ESA species in the short term. The science must demonstrate that the short term impacts are worth the long-term gains from an economic, environmental, and social perspective.

The dual science and environmental process used for the Klamath Dam removal program forms a future model for other large restoration programs that present complicated and sometime conflicting scientific, engineering, and economic uncertainties that must be understood to promote informed decisions by policy makers at both the state and federal levels.

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