Preliminary Economic Assessment of Dam Removal: The Klamath River

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1. INTRODUCTION

The Klamath River flows over 250 miles from its headwaters in southwestern Oregon through northern California to the coast, where it drains into the Pacific Ocean. The Klamath is one of only three rivers to pass through the Cascades and is the second largest river in California. It is divided into two distinct sections, the Upper and the Lower. A significant amount of water is diverted from the Upper Klamath River for agricultural irrigation within the federal Klamath Irrigation Project, while much of the Lower Klamath runs through the Klamath National Forest. The river and its fish, particularly salmon, are considered sacred by the Native Tribes that live nearby, including the Yurok, Hupa, Karuk and Klamath Tribes.

Historically, the river was considered prime habitat for a variety of species including: Chinook salmon, coho salmon, silver salmon, steelhead trout and Pacific lamprey. Once the third-largest river for salmon spawning on the West Coast, the Klamath River now produces only a fraction of its historic levels. Six dams, constructed between 1908 and 1962, truncate the river and prevent salmon, as well as other anadromous species, from moving upstream. The lowest dam, Iron Gate, sits at river mile 190 and is the current limit of upstream passage for fish moving upstream.

Before construction of the dams began, approximately 600 miles of river and stream channel above Iron Gate were accessible by anadromous fish runs.[1] Significant habitat still exists upstream of the Iron Gate Dam that is not being utilized, and the Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program identified the current lack of upstream passage created by the Iron Gate Dam as a significant impact on the Klamath River anadromous fishery.[2]

The original operating license for the Klamath River Hydropower Project received final approval in 1956 and is set to expire in February 2006. The Federal Energy Regulatory Committee (FERC) is currently overseeing the renewal process for another dam operating license. The Project, which includes the 6 dams on the Klamath River, is currently owned and operated by PacifiCorp, a subsidiary of Scottish Power. The dams collectively generate 151 megawatts of electricity, less than two percent of the power 8,300 megawatts generated by PacifiCorp facilities servicing customers in Oregon, Wyoming, Washington, California, Utah and Idaho.[3]

The FERC renewal application, completed in 2004 by PacifiCorp, did not include any provisions for passage of salmon to rivers and streams above the Iron Gate Dam. For a variety of reasons – including ecological, cultural, and economic factors – stakeholders, including tribes, conservationists, and commercial fishermen, contend that the removal of up to four dams would be a desirable outcome of the re-licensing process.

The purpose of this study is to provide a preliminary assessment of removal of the four Lower Klamath River dams. It will identify and begin to quantify the likely economic impacts, both positive and negative, that dam removal would have on local stakeholders, particularly Siskiyou County, as three of the four dams being considered for removal are located within its borders.

The specific objectives of this study are:

1. identify and quantify both the market and non-market values of dam removal to local stakeholders and to the region;
2. assess the economic impact dam removal would have on Siskiyou County;
3. ascertain the likely impact of dam removal on residential river-front properties; and
4. perform a comparative analysis that examines the costs and benefits associated with both the “status quo” and “without dam” scenarios.

Section 2 of this report examines the value of the Klamath River in its present state and the likely costs and benefits associated with a change in the status quo, as caused by removal of the four lowest dams. The costs of dam removal are discussed in Section 3; in particular, those associated with dam deconstruction, alternative power sources and property values. Section 4 identifies likely benefits of dam removal including: return of a free-flowing river, increases in fish populations and benefits to local Native tribes. When possible, the benefits are discussed in economic terms and quantified. The conclusion summarizes the likely impacts of dam removal on Siskiyou County and also notes topics for continued research.

2. PROPOSING A CHANGE

The North Coast Regional Water Quality Control Board (NCRWQCB) basin plan lists the following existing beneficial uses of the Klamath River[4], in no particular order:

- Municipal and domestic supply
- Agricultural supply
- Industrial service supply
- Industrial service
- Groundwater recharge
- Freshwater replenishment
- Hydropower generation
- Recreation, water contact and non-water contact
- Habitat, cold freshwater and warm freshwater
- Habitat, wildlife
- Preservation of rare and endangered species
- Migration of aquatic organisms
- Spawning, reproduction and/or early development

These multiple uses benefit an equally numerous and varied group of stakeholders including: local communities, Native tribes, farmers, commercial and sport fishermen, outdoor enthusiasts and conservationists, to name a few. Changes in river dynamics, including dam removal, have the potential to impact some, or all, of the benefits currently provided by the Klamath River, and ultimately local and regional stakeholders. For this reason, it is important to identify and, when possible, quantify the likely costs and benefits associated with removing the four lower dams on the Klamath River.

This study specifically examines the likely costs and benefits to Siskiyou County, California. It is important to note that as such there are some benefits to the County that may be costs to others. For example, the benefits the County would receive from spending associated with dam deconstruction also would be a cost to the entity responsible for paying for the removal. In instances where such a discrepancy occurs, we will try to describe the likely group(s) of gainers and/or losers.

2.1 Identifying Costs and Benefits

When considering the impact of dam removal, costs and benefits are normally associated with changes in a good or service. These goods and services (henceforth termed ”goods”) fall into two categories –

market goods and non-market goods. Market goods are defined as those that are bought and sold in a market setting and whose value is typically determined using the price associated with the good. In the case of dam removal, hydropower and commercial fishing are examples of goods and in both cases market transactions provide the data necessary to calculate the estimated costs and benefits.

There are also goods, such as recreational opportunities, subsistence fishing and environmental aesthetics, for which markets do not exist. These goods are known to have value to society, either positive or negative, and changes in their quantity or quality will affect those values. However, market data does not exist to measure the impact of such changes. To address this deficiency, a variety of non-market valuation techniques have been developed by economists and several will be discussed later in this study.

2.2 Estimating the Costs of Dam Removal

Dam removal costs can be broken down into three major categories; dam deconstruction, lost services and external. Dam deconstruction includes all costs directly associated with removal of the physical structure, and may include such things as removal of the physical structure, sediment disposal and storage, and the disposal of waste materials. In the case the four Klamath River Dams, the total value of deconstructing and removing the dams has been estimated by one study to be $35.6 million.[5] This particular estimate was based on the two assumptions; 1) sediments could be naturally eroded downstream, and 2) spoil sites could be located within 10 miles of each dam, and also does not include the costs associated with permitting, restoration or mitigation. These additional considerations have the potential to significantly increase the actual cost of removal.

A more recent study, though yet unpublished, estimates the total cost of removal for the four dams to be $100 million.[6] Both of these cost estimates will be discussed in greater detail in a subsequent section of the study.

The cost of removal, however, is not likely to be born by Siskiyou County, but rather produce benefits for the county through spending and job opportunities related to dam deconstruction. These benefits will be discussed in greater detail in the next section. It is important though to recognize that ultimately someone will be responsible for the cost of dam removal and for that entity the cost would be significant.

Description	Iron Gate	Copco 2	Copco 1	J.C. Boyle
Uses	Hydropower/ Flow	Hydropower	Hydropower	Hydropower
Year Built	1962	1925	1918	1958
River Mile	190	198.3	198.6	224.7
Generating Capacity (MW)	18	27	20	80
Material	Rockfill	Concrete	Concrete	Earthfill
Upstream Fish Passage	No	No	No	Yes
Downstream Fish Passage	No	No	No	Yes

Table 1: Klamath River dams considered for dam removal

Lost services provided by the dam are included in the second category of costs. Again, Siskiyou County would not be directly responsible for establishing an alternative power source, someone must. This cost could indirectly affect both Siskiyou County and its residents if changes in electricity costs were to occur because of the loss of hydroelectric power from the four dams and the switch to an alternative power source. For that reason, the value of lost services is also discussed here.

In the case of the four dams being considered for removal on the Klamath, this value would include the cost of finding an alternative source of energy that provides *at least* the same level and quality of power output. PacifiCorp's Final License Application estimates the annual cost of producing power under the new license to be $23.3 million, or almost $700 million for the entire life of the project.

Assuming a total generating capacity of 147.2 MW for the entire length of the project, Table 2 shows the PacifiCorp study estimates for replacing project power with power generated using alternative sources.

Source[7]	Estimated Annual Cost (in millions)
PacifiCorp Hydropower	$23.3
Natural Gas	$27.7
Cogeneration	$31
Wind	$26.7
Coal	$21.6

Table 2: Annual cost of power replacement using alternate fuel sources

A comparison of the estimated cost of the current project with the estimated costs using alternative sources suggests that using the most expensive alternative source (Cogeneration) would lead to increase in costs of $7 million per year. These estimates include both the initial outlay of capital for alternative resource development as well as the annual operating costs for the projects. As a cautionary note, increases in the cost of alternative power sources (i.e. increased cost of coal or natural gas) would almost certainly increase the actual cost of using an alternative power source.

However, the estimated annual cost of $23.3 million to continue the project does not include the installation of fish ladders and screen turbines on the four dams, which federal agencies could make a requirement of the relicensing agreement. PacifiCorp ran computer simulations to estimate the additional cost of such installations and put the figure at $100 million.[8] An addition of this type to the project would increase the annual cost of the project up another $3 million per year.[9] Inclusion of fish ladders and screen turbines as part of the relicensing agreement is a realistic assumption and is supported by the California Energy Commission (CEC). A recent CEC study concluded that, independent of a decision to relicense or decommission the Klamath dams, habitat improvement and restoration projects will be needed to mitigate currently degraded salmon habitats and address water quality issues.[10]

Another important Klamath River species is the Pacific lamprey, whose historic spawning habitat reached far up the river. Also known as "eel", the Pacific lamprey is an important subsistence food source for local Tribes along the Klamath River and its major tributaries, especially during the winter and early spring months when other fresh food sources such as salmon were not available. Local knowledge data gathered during interviews with tribal members suggests that dam installation is a major cause of declining lamprey populations.[11]

In January 2002, a petition was sent to the United States Fish and Wildlife Services for the listing of four lamprey species, including the Pacific lamprey, as "Endangered" throughout their range under the Endangered Species Act. The same year the Oregon Fish and Wildlife Commission added the Pacific lamprey to Oregon's protected species list.

Given this concern over the Pacific lamprey, it has been suggested that provisions for license re-approval may include not only fish ladders, but also ladders for the Pacific lampreys, which are

considerably more expensive.[12] While cost estimates for these ladders are not currently available, the inclusion of these ladders in the re-licensing agreement would increase the cost of an approved project.

The final category of costs includes any external costs of removing the dam, such as costs resulting from changes in the environment, local economies, and/or jobs. Possible environmental effects of removing these dams may include loss of wildlife habitat on the reservoirs behind the dams, temporary mud flats, and the loss of a "lake view" for residential property owners with waterfront property, which will be discussed in greater detail later. Other concerns frequently related to dam removal are increased risk of flooding and loss of irrigation ability.

One misconception about the four lower dams is that their removal would have a negative impact on water supply for irrigation and/or increase the likelihood of flooding in the region. While the dams generate power, they do not supply flood control or water supply benefits.[13] A recent study concluded that even under a worst-case scenario, the likely effects of downstream sediment deposition and flooding risk would be minimal, so they will not be discussed here.[14]

According to the PacifiCorp Final Technical Report on Socioeconomic Resources, 19 individuals are currently employed in operation and maintenance on the Hydropower Project – 11 are full-time employees and 8 are seasonal.[15] The annual payroll for these employees is approximately $820,000. Estimates of employment levels under the proposed Project could not be found, but with the expected decommissioning of at least two developments (East Side and West Side) it is reasonable to assume that the number of employees is not likely to be greater than the current number. Removal of the dams, or the non-relicensing of the Project would almost certainly eliminate all existing jobs.

For the fiscal year 2002–03, Siskiyou County property taxes totaled in excess of $2.9 billion and revenues from PacifiCorp properties accounted for approximately 3.8%, paying $1.1 million in taxes.[16] Again, these values are for the current Project, not the proposed Project, but should accurately reflect revenue generated from a relicensed Project in that the only dam decommissioning proposed occurs outside of Siskiyou County.[1]

From a market cost-efficiency perspective, if the cost of continued operations becomes greater than the cost of dam removal and replacement of lost services, it may make economic sense for PacifiCorp to not renew their license.

2.3 Property Values

Another issue to consider is the effect dam removal would have on adjacent property values. Because the long-run impacts cannot be determined prior to dam, there is considerable uncertainty associated with this issue, and understanding the likely effects may be of critical importance for owners of bordering properties. While dam reservoirs are really an extension of the river, these property owners may view their property as "lake front" rather than "river front" and as such, worry that dam removal and the subsequent loss of the reservoir created by the impoundment will have a negative effect on property values.[17]

The literature on this issue is limited at best, but preliminary studies in Wisconsin, mainly on small dam removals, found that adjacent property values either remained constant or decreased briefly, but regained their entire value by the end of two years.[18] In fact, one study concluded that property values

[1] While not in the specific scope of this research, Klamath County, Oregon would lose approximately $70,050 (2002–03 dollars) in tax revenues from the removal of the J.C. Boyle Dam.

may actually increase after a dam removal that leads to improvements in water quality, river ecosystem restoration and/or provides new or improved recreational opportunities.[19]

Evidence is mixed, however, and the conclusions and recommendations of existing studies on the subject suggest the impact of dam removal on property values is best done on a case by base basis, and that what happens in one place will not necessarily hold true in another.

The difficulty with assessing the impact of dam removal on property values is two-fold. First, it requires calculation of property values over time, both before and after dam removal. It requires patience, as using only the assessed value of the home may not account for aesthetic changes to the property caused by dam removal and to gather sale prices after dam removal takes time and is dependent on the sale of homes in the area. To date, few opportunities have presented themselves where this type of time series research could be conducted.

Secondly, there are a significant number of variables affecting the value of any residential property including the real estate market, and the numerous characteristics of the property – location, square footage, acreage, number of bedrooms, number of bathrooms – to name a few. Frontage on water is only one of these characteristics. And to make matters more confusing, qualitative data from a Wisconsin study suggests that adjacency to any body of water, whether a lake or a river, is considered valuable.[20]

A joint publication by American Rivers and Trout Unlimited provided a series of questions for stakeholders to ask when considering the effect of dam removal on property values:

1. Who will own the reclaimed land following dam removal?
2. If the reclaimed land changes hands, will the new landowner pay local property taxes?
3. Will landowners gain a scenic view of the stream or river and associated riparian areas (e.g. wetlands and waterfowl)?
4. Will landowners have access to the restored river and reclaimed land for recreation? Will the public?[21]

Answers to questions such as these will not provide a definitive answer, but will help stakeholders and policymakers better understand whether the impacts on property values are more likely to be positive, negative or neutral.

Before delving deeper into possible changes in property values on the Klamath River, there are several related issues that first need to be addressed. The first is ownership of exposed lands. There are two reservoirs on the Lower Klamath with adjacent private residences; Copco Lake and Iron Gate Lake. Dam removal would eliminate these bodies of water, except for the natural riverbed, and submerged lands under the lakes would become exposed. PacifiCorp is the owner of the land under the reservoirs and therefore would be the owner of any land exposed by the draw-down of either the Copco or Iron Gate Lakes.

The final ownership of this land will inevitably impact surrounding property values. There are a variety of options for the previously inundated land, all of which would impact adjacent property values. PacifiCorp could 1) do nothing, 2) convert the land into a park or conservation easement, 3) sell the land, or 4) transfer the land to property owners or to the county. Conversion of the land to a park or conservation easement would provide non-market benefits to society and would likely help mitigate the negative impacts of dam removal on property values. Transfer of the land to the county, presumably to

be used in a public capacity, or to private lake-front property owners as an extension of their current lot, would help mitigate lost property value and/or the associated property taxes.

If lakeside property owners obtain ownership of the previously inundated land either by purchase or through transfer, it would provide increased lot size, and a transition from lake-front to river-front property. In a conversation with the Siskiyou County assessor, Mike Mallory, he cautioned that many of the properties adjacent to the lake have long, narrow parcels with the residences set near the lake, and draw-down of the reservoirs could leave a distance of a quarter to half a mile between many of the homes and the new river channel.[22] Such a distance would likely prevent a river-view for owners able to purchase the uncovered land.

Property owners unable to gain ownership of the previously inundated land would lose both their lake frontage and river view/access. For these individuals, loss of access to water would likely lead to a decline in property values. This would be especially true if the land between their property and the river was purchased and/or developed by other individuals.

The impact of development on existing properties is uncertain, but the price received from the sale and development of the land would be counted on the benefit side of a cost-benefit analysis. This development could also increase property tax revenue from the area. In a conversation with Mike Mallory, he noted that there are a variety of obstacles to development in the area that should be considered though before assuming that the value of development will be sufficient to offset the property values lost by lake-front owners.[23]

Another group of property owners to consider are those that do not have lake-front properties, but own properties with lake-views. Properties with lake-views that do not gain river-views or river access after the dam removal may experience a decrease in property values also.

There is a second property value issue that deserves further analysis – poor water quality of the reservoirs, especially during the summer months when toxic algal blooms have occurred in recent years.[24] Studies examining the impact of water quality on property values found that water quality is a significantly explanatory variable in determining lakefront property values.[25], [26] A question to consider is what impact, if any, does the poor water quality of the Copco and Iron Gate Lakes have on property values, and would the improved water quality resulting from dam removal help offset the potential loss in value due to the removal?

3. Estimating the Benefits of Dam Removal

The primary benefits of dam removal are associated with the ability of the river to return to a free-flowing state. Reconnection of what were previously upstream and downstream sections of a river allows for the restoration of a variety of environmental services such as water quality, aquatic habitat, riparian species, etc. In economic terms, the values of restored environmental functions associated with dam removal fall into two main categories: market values and non-market values, which were discussed previously.

3.1 Klamath Fisheries

The Klamath was historically one of the largest salmon spawning rivers in the United States. According to Glen Spain, Northwest Director of the Pacific Coast Federation of Fishermen's Association, the river once produced an average of 880,000 spawning salmon and steelhead each year.[27] Another estimate

suggests that historic counts of spawning salmon alone for the Klamath-Trinity system were between 650,000 and 1,000,000.[28]

Protecting and restoring natural ecosystem services, including salmon populations, in the Klamath River Basin is vitally important to a variety of local stakeholders as well as conservationists. Commercial and sport fishermen rely on the annual spawning runs to keep salmon fishing sustainable. For Native American tribes the river is the centerpiece of their culture, as well as a source of livelihood and subsistence food.

There are a variety of factors that have likely contributed to declining salmon populations, including dam installation, logging activity near the river and the Klamath Irrigation Project in the Upper Klamath, as well as the low water flows and agricultural run-off associated with it. Evidence suggests though that dam installation is a major contributor to declining salmon populations. Removal of the four lowest dams, among other things, will open additional stretches of river for spawning of anadromous fish. Contrary to speculation, the conclusions of a 2005 study found that salmon, steelhead, Pacific lamprey and other species all historically migrated to these parts of the river and that there is currently unutilized spawning habitat available above the dams.[29]

It is generally agreed that dam removal would lead to an increase in salmon populations. What is not known is to what degree, or how quickly. The Pacific Fisheries Management Council keeps annual counts of the in-river salmon run. Counts for fall Chinook salmon, by far the largest run, are available from 1978 though 2004. Over that time the average in-river run was 107,100 salmon. However, recalculating the estimates using only the last 10 years (1995–2004), the average run increased to 145,200.

The Pacific Fisheries Management Council currently manages the fisheries of the Klamath River System. The paragraph below is taken directly from the PFMC 2005 Pre-season report and describes the current allocation with respect to the Klamath River fall Chinook salmon stocks.

- 50% (8,300 fish) of the available harvest to the Indian tribes of the Klamath-Trinity River Basin with Federally-recognized fishing rights (Yurok and Hoopa Valley tribes);
- 15% (1,200 fish) of the non-Indian harvest to the Klamath River recreational fishery;
- 85% (7,100 fish) of the non-Indian harvest to the ocean fisheries;
- 17.1% (1,200 fish) of the ocean harvest to the KMZ recreational fishery; and
- 50% each (2,200 fish) of the ocean commercial harvest of Klamath River fall Chinook in all areas to the States of California and Oregon.[30]

The earliest posted pre-season report (2001) has the same allocation split for Indian harvest and non-Indian harvest; each received 50% of the available harvest. However, distribution between ocean fishery and recreational fishery was different than that of 2005, with 39.5% of the non-Indian harvest going to the Klamath River recreational fishery and 60.5% going to the ocean fishery. The share of the ocean recreational fishery was the same, receiving 17% of the ocean allocation.

Because of these differences, and because allocation were not available for years before 2001, percent of allocation was determined by taking a 10-year average of percentages harvested by in-river recreation and Indian harvest. For the years 1994–2004, recreational fishermen on average caught 6% of the in-river run for fall Chinook salmon, while Native Tribes caught 19%. These values then allow us to estimate the average ocean fishery allocation (13%). The assumption that actual harvest level equals allowable harvest level will serve the purpose of this analysis by allowing catch rates to serve as a proxy for allocation rates.

While unutilized anadromous fish habitat currently exists above the Iron Gate Dam, the author was not able to locate information on the likely impact access to this section of the river would have on salmon populations. Based on the historic rates of 800,000 to 1,000,000, a reasonably conservative assumption would be that salmon populations would, on average, double. This assumption will be used in the following series of estimates.

Using the assumption that the average in-river runs of fall Chinook salmon double, the increases in harvest by the various fisheries (based on 25-year average and 10-year averages and a 72% spawning escapement rate) are shown in Table 3 below. This exercise is intended to be used only as a demonstration that increases in salmon will lead to increased harvest rates, and as discussed later, increases jobs and economic value.

	Percent of Allocation (10-year average)		100% increase (10-year average)
Total In-river Run	**100%**		**290,440**
Escapement Rate (10-year avg.)	72%		209,117
In-river Fisheries		28%	81,323
Non-landed Fish Mortality	2%		5,809
Native Tribes	19%		55,184
In-river Recreation	6%		17,426
Ocean Fisheries - Total	13%		37,757
▪ Ocean Recreation		17%	6,419
▪ Ocean Commercial		83%	31,338

Table 3: Estimated allowable harvest given a 100% increase in in-river run

While currently known for its fall Chinook salmon run, the Klamath River serves as habitat and spawning grounds for a variety of other fish species; spring Chinook salmon, coho salmon, silver salmon, Pacific lamprey, rainbow trout, and steelhead trout to name a few. The spring Chinook salmon, also known as "Springers" historically were more abundant than the fall Chinook. They are prized and revered by the local Klamath Tribes, but recent population surveys show they annual in-river runs have decreased to returns of only several hundred fish.[31]

Another species, the Klamath River coho salmon has had such severe population declines that it is currently listed as a threatened species under the Endangered Species Act (ESA). Steelhead populations have also experienced a serious decline, with the Klamath Mountain Province steelhead currently listed as a candidate for listing as a threatened species. As mentioned previously, the Pacific lamprey is also being considered for listing under the ESA.

Dam removal would almost assuredly have a positive impact on these and other Klamath River species and would most likely help to restore population counts. While these positive impacts have not been estimated or quantified here, these are values that need to be included on the benefit side of any cost-benefit analysis of dam removal.

3.2 Economic Benefits

The purpose of this section is to examine the economic impact of dam removal on Siskiyou County. Included in this analysis are changes in jobs and income related to expenditures associated with dam removal.

3.2.1 Jobs Related to Dam Removal-Related Expenditures

Three types of jobs need to be considered with calculating the economic impact of increased expenditures related to dam deconstruction: those directly created, those indirectly created, and those "induced" through the multiplier effect. For example, dam deconstruction would directly create jobs related to demolition of the dams and processing/transportation of materials and sediment. Those indirectly created in support industries might include jobs such as heavy equipment maintenance and repair, and project monitoring jobs. The final category of jobs is created not by the initial expenditures related to dam removal, but on expenditures made by those directly and indirectly employed in the deconstruction process. These jobs would most likely be in industries such as entertainment, food services, hotels and real estate. The multiplier effect accounts for each successive round of expenditures related to the initial expenditure. For example, a multiplier of 2 means that for each dollar spent initially, the successive rounds of spending lead to another dollar of spending, for an overall increase of two dollars to the local economy.[32]

This study uses the Regional Input-Output Modeling System (RIMS) II Multipliers for the State of California, as prepared by the CA Technology, Trade and Commerce Agency, Economic Strategy and Research.[33] Three of the dams considered for removal are located in California (Siskiyou County), while the fourth is located in Oregon. County-specific multipliers could not be found, nor Oregon multipliers and for this reason, California multipliers are used, which will provide at least a rough estimate.

Expenditures on dam deconstruction are assigned as "Construction" related spending. For this industry, it is estimated that for every $1 million spent there are approximately 21.5 jobs are created and that for every direct job created in the construction sector, there are an estimated 2.1249 indirect and induced jobs created for the total economy.

The California final demand multiplier for output is 2.3574. This represents the dollar change in output by the total economy for each $1 increase in the construction sector output. Using the estimate of $35.6 million as the value of expenditures related to dam deconstruction, the total economic benefits of the project can be calculated using the RIMS II multipliers. It is estimated that an additional 765 jobs will be created and the increase in economic out will be just under $84 million (See Table 5).

Another study[34] estimates the cost to be $100 million for removal of all four dams (See Table 4 for breakdown by dam). Using this estimate and the RIMS II multipliers, the economic benefits of dam removal can be estimated again. The number of jobs created is estimated to be 2,150, while total benefits to the economy exceed $235 million (See Table 5).

Dam	Estimated Cost (in millions)
Iron Gate	$54
Copco 2	$20
Copco 1	$9
JC Boyle	$17
TOTAL	$100

Table 4: Estimate of dam removal (Greinan, 2005)

If the estimated $17 million dollar cost for deconstruction of the JC Boyle dam is taken out of the calculations, the cost of removal for the three dams located in Siskiyou County is estimated at $83 million. While it is unlikely that the economic benefits of dam removal would be split directly down

state or county lines, Table 5 also provide the estimated increase in jobs and economic output based only on removal of the Siskiyou County dams (Copco 1, Copco 2, and Iron Gate).

		Estimated Economic Benefit		
	Multiplier	Cost: $35.6 million (4 dams)	Cost: $100 million (4 dams)	Cost: $83 million (3 dams)
Total jobs created (per $1m)	21.5	765 jobs created	2,150 jobs created	1785 jobs created
Total increase in economy (per $1)	2.3574	$83,923,440	$235,740,000	$195,664,200

Table 5: Estimated economic benefits of dam removal

3.2.2 Estimates of the Value of Salmon

A 2001 study of the Upper Klamath Basin found the increasing salmon populations could also lead to an increase in jobs, with each additional 1,000 commercially caught salmon generating 1.5 jobs, while each 1,000 salmon caught recreationally support another 4 jobs.[35] Using the estimated harvests calculated previously, we can now estimate the associated increase in jobs.

	Current (10-year avg.)	100% Increase (10-year avg.)
Total in-river run	145,220	290,440
Native Tribes	27,592	55,184
In-river Recreation	8,713	17,426
Ocean Fisheries - Total	18,879	37,757
Ocean Recreation	3,209	6,419
▪ Ocean Commercial	15,669	31,338

Table 6: Estimated allowable harvests based on 100% increase in fall Chinook salmon runs

Using the 10-year average calculations, the resulting increase in commercially harvested salmon would be almost 16,000 and in recreational fisheries would be over 12,000 (combining ocean and in-river sport fishing). The associated increase in jobs would be 48 from recreational fisheries and 24 from commercial fisheries, for an estimated total of 71 additional jobs created by increased salmon harvests.

The same study provided estimates for the value of increased salmon harvest to the economy and calculated that if salmon populations increased in the Klamath River, each additional fish caught by anglers would be worth approximately $200 and $5–70 if caught by commercial fishers. The data in Table 6 show the estimate value to society of a 100% increase in salmon populations.

Fishery	Estimated value (based on 10-year avg.)
Recreation ($200/fish)	$4,417,592
Commercial ($5/fish)	$78,346
Total Value	$4,495,939

Table 7: Estimated value of increased recreational and commercial Chinook salmon harvests

These calculations are intended to serve as an example. Because it is not known exactly what increase in salmon populations will occur, we cannot give precise estimates. Those above are based on the

assumption of a 100% increase in fall Chinook salmon populations, and do not account for increase in other Klamath River fisheries such as steelhead or rainbow trout. Increases in the populations of these species would undoubtedly lead to increased harvests and associated economic benefits as well.

3.2.3 Non-Use Value of Returning the Lower Klamath to a Free-Flowing River

Individuals may value dam removal even if they have never visited nor intend to visit the Klamath River. This type of value is known as a non-use value because an individual(s) can receive benefits even if there is no use of the good or resource. In other words, individuals may have a value for a free-flowing river even if they never fish, raft, swim or even visit the river. Included in the general definition of non-use values are existence values and bequest values. Existence value is frequently mentioned with respect to endangered resources, or when the proposed action may affect a resource in an irreversible way. Similarly, bequest value relates to the notion of preserving the good for use by future generations.

This analysis replicates the methods used for a study of non-use values related to dam removal on the Lower Snake River and uses benefit transfer methodology.[36] The goal of benefit transfer is to use existing values from a specific site(s) and transfer those values to another site with similar resource and policy conditions. Ideally, a non-use valuation study would be conducted in the Lower Klamath region and would gather data and values specific to that dam removal scenario. In this case, both time and financial constraints prevent such an analysis, so benefit-transfer will be used. While not exact, the approach provides a likely range of estimates associated with increased salmon populations resulting from dam removal.

Independent of the use values associated with dam removal on the Lower Klamath is the non-use value associated with restoring the river to a natural free-flowing form. This type of value may also include related benefits, such as ecosystem restoration and improved water quality that are associated with the return of the river to a more natural condition. In this analysis, rough estimates will be calculated though an application of results from existing literature to measure the non-use value of dam removal on the Lower Klamath.

A 1999 study in Colorado found that annual willingness-to-pay (WTP) for non-use values was $77 in 1983, or $147 in 2005, accounting for inflation.[37] In order to calculate the value per mile this value is divided by 555, the number of river miles being valued in the study. This yields a value of 26 cents per mile. Multiplying this by 35 river miles that would be opened by removal of the four lower dams yields a value of $9.10 per household per year.

According to the 2000 U.S. Census, the number of households in California was 11,502,870. Subtracting the number of households in the counties surrounding the Lower Klamath River yields a total of 11,351,108 households. Multiplying this by $9.10 yields an estimated non-use value for restoring the Lower Klamath River of $104,507,239.

Another study estimated the value of preserving the Black Canyon of the Upper Snake River from development.[38] This survey found that non-users had an annual WTP of $58 for preservation. Updating to account for inflation, and dividing by the number of river miles being valued, yields a per mile value of $1.06. This value is higher that that of the previous study because only residents of counties adjacent to the river were sampled. Again, multiplying this by the 35 river miles of the Lower Klamath yields a per household value of $37.10. This value can then be multiplied by the number of non-user residents in Siskiyou County, as the Lower Klamath River flows directly through it, and the surrounding counties of Modoc, Del Norte, Humbolt, Trinity and Shasta. The purpose of including only non-user residents is to avoid double counting.

No statistics were available for the number of users versus non-users in these counties, so estimates were calculated assuming that 50% of residents were users. Multiplying by $37.10 yields a non-user value by adjacent residents of just over $2,815,200. Even assuming 75% of the residents in these six counties were Klamath River users, the non-use value would be $1,407,600.

The aggregate non-use value by the region is finally calculated by adding the two estimates, or $107,322,424, for the return of a free-flowing Lower Klamath River. Even if 100% of residents in the surrounding six counties were users, the estimate non-use value for a free-flowing river would still be $104,507,200.

This is a conservative estimate in the sense that it does not include individuals who use the river for recreation but still independent of their usage still value the existence of a free-flowing river. However, the population of California is very diverse both in terms of socioeconomics and adjacency to the river and because of this, it is possible the estimate may overestimate the total value of a free-flowing river if WTP varies because of differences across different subcategories of the population. Finally, It should also be noted that this value is independent of any effect of dam removal on salmon populations and accounts only for the return of the river to its natural state.

3.2.4 Cultural and Tribal Values

Removal of the four dams on the Lower Klamath will provide a variety of positive benefits to local tribes. In the long run dam removal will provide the return of traditional fishing grounds and increased salmon harvests for ceremonial, subsistence and commercial use. Increased salmon consumption would also likely help improve diet and health of local Tribal members. The conclusions of a recent study of the Karuk diet found that their traditional diet has shifted dramatically.[39] In recent years, the primary cause has been denied access to traditional foods, of which salmon is a primary component. The study stated "the decline of eel and salmonoid populations that once supplied over half the Karuk diet has occurred within the lifetime of most adults today."[40] This altered diet has led to serious health affects, including increased rates of diabetes and heart disease, among Tribal members.

This lack of access to subsistence salmon also affects the ability of tribes to harvest for commercial purposes. At least for the Hoopa Tribe, there is currently no designation between catch for commercial, subsistence, or ceremonial purposes. Indian commercial catch is simply the amount of fish harvested that is not used for subsistence or ceremonial purposes.[41]

Increased salmon harvests would help mitigate the current situation, which forces tribe to choose between using salmon for subsistence or selling it commercially. Diet would also undoubtedly be improved with increased access to traditional foods such as salmon and eel.

The phrase "improvements to subsistence, commercial, and ceremonial salmon harvests" does not adequately describe the varied positive benefits local Tribes would see from dam removal. Further research is necessary to identify and, if possible quantify, those benefits, as the few mentioned here only begin to cover the issue.

3.2.5 Other Recreational Activities (Non-Fishing)

While ocean and river recreational sportfishing are two of the most popular recreational activities, the Klamath River also offers a variety of other recreational activities for outdoor enthusiasts. Whitewater rafting, boating, camping, gold mining, hiking and wildlife watching are all popular activities. Dam removal would inevitably impact reservoir activities such as water-skiing and boating, but it is difficult

to assess what impact, if any, dam removal would have on participation levels and/or visitor days to the area. Preliminary evidence from personal communications suggests that whitewater rafting outfitters feelings are mixed on the subject, with some believing it will improve rafting experience and others wondering if flow levels will be too low during certain parts of the year.

The decrease in users or visitors days associated with reservoir loss may be offset or augmented by new users coming to sport-fish, and this is an area that requires further consideration and analysis. Impacts on recreation, either positive or negative, need to be identified and included in any cost-benefit assessment.

4. CONCLUSION

This analysis is a first-cut effort to identify and, when possible, quantify a number of the likely costs and benefits associated with removing the four lower dams on the Klamath River. This dam removal scenario involves a number of complex variables, and as it typical with dam removal decision-making, likely changes involve a great deal of uncertainty. The findings of this analysis are based on our best efforts to obtain and use current and relevant existing data; continued research on this topic would likely benefit from continued data collection and analysis. The purpose of this analysis is to increase understanding and decrease uncertainly related to the likely economic impacts of dam removal.

Table 7 lists the likely impacts of dam removal and based on the results of this study, the likely direction of the impacts for Siskiyou County in particular. Table 8 lists like impacts for other stakeholders.

Impact	Siskiyou County	In Economic Terms
Dam Deconstruction	▪ Positive – Jobs and Spending	(See local economy)
Power	▪ Neutral – Not responsible for finding alternative source ▪ Negative – If electrical rates increase	Unknown
Property Values	▪ Negative – Loss of lake view, uncertainty over property rights of land under reservoirs	Unknown
Fish Populations	▪ Positive	$4.5 million[2]
Local Economy	▪ Positive – Spending and jobs from deconstruction, increased tourism, visitors ▪ Negative – Loss of jobs and taxes from hydropower project	$172million[3] plus -$2million
Commercial Fishing	▪ Positive	(See fish populations)
Recreational Fishing	▪ Positive	(See fish populations)
Subsistence Fishing	▪ Positive	(See fish populations)
Cultural Values	▪ Positive	Unknown
Recreation (non-fishing)	▪ Unknown	Unknown
Free-flowing River	▪ Positive	$104 million

Table 8: Summary of the costs and benefits of dam removal to Siskiyou County

[2] Assuming a 100% increase in fish populations
[3] Assuming a dam deconstruction cost of $73 million

	Other Stakeholders
Dam Deconstruction	▪ Negative – PacifiCorp or other entity responsible for cost
Power	▪ Negative – PacifiCorp – If alternative power source costs more to operate ▪ Neutral to Positive – PacifiCorp –If alternative power source is cheaper
Property Values	▪ Negative – Property owners – Loss of lake view, uncertainty over property rights of land under reservoirs
Fish Populations	▪ Positive – Fisheries, Visitors, Environmentalists, Fish
Commercial Fishing	▪ Positive – Commercial fishers, processing plants
Recreational Fishing	▪ Positive – Sportfishers
Subsistence Fishing	▪ Positive – Local tribes
Cultural Values	▪ Positive – Local tribes
Recreation (non-fishing)	▪ Unknown
Free-flowing River	▪ Positive – Anyone who value a free-flowing river

Table 9: Summary of the costs and benefits of dam removal to other stakeholders

The issue of dam removal is complex and removal of a dam(s) has the potential to create a variety of impacts, some positive and some negative. Stakeholders and decision-makers alike would undoubtedly benefit from continued and/or additional research of the topics listed below.

- Estimate the current value of subsistence harvests and the increased value that would result from dam removal and the associated increase in salmon harvests
- Identify the likely direction (positive or negative) and magnitude of impact dam removal would have on recreational activities.
- Quantify the associated economic gain (loss) to the local economy based on visitor days and average visitor spending.
- If possible, quantify of the cultural and tribal values associated with dam removal.
- Estimate the impact of dam removal other species, not just fall Chinook salmon.
- Estimate the non-use value for salmon restoration/preservation
- Narrow down the estimated range of costs for dam removal and the estimated increase in salmon populations. Use these values to quantify the impact of such changes on the economy of Siskiyou County.
- Quantify the impact of increased salmon harvest on recreational and commercial fisheries and the associated benefits to Siskiyou County.

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