Economic Benefits to Mendocino and Lake Counties from Removing the Dams on the Eel River

A Report Prepared by

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Preface

Restoration of natural ecosystems is not an abstract, purely idealistic and altruistic gesture; rather, restoration of natural ecosystems materially benefits living things, including people, and results in tangible economic and social improvement.

This report supplements and complements our study *A River in the Balance: Benefits and Costs of Restoring Natural Water Flows to the Eel River*. That report focused on the benefits of restoring natural flows downstream of the Potter Valley Project (PVP) dams. This report focuses on the benefits to Mendocino and Lake Counties of physically removing the PVP dams, restoring the affected watershed, and increasing nature-based tourism. Furthermore, this report illustrates the significant magnitude of these benefits and shows how water demands can be more than satisfied by the abundant water resources available in the Upper Russian River basin. Because these benefits from removing the PVP dams and restoring the Eel River have not been analyzed previously, they are the subject of the present report. It is beyond the scope of this report, however, to examine in detail all impacts related to removing the PVP dams and restoring the Eel River: such an examination would more properly belong to a full environmental impact assessment.

Again we wish to thank all the Friends of the Eel River for providing the opportunity and resources for us to conduct this study. We hope it makes a worthwhile contribution toward the better use of the Eel and Russian River systems, while at the same time helping to restore humans to balance with the natural world on which we and all life depend.

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Executive Summary

The mouth of the Eel River, the third-largest river in California, is nearly two hundred miles north of the mouth of the Russian River, yet high up at the rivers' headwaters, only two miles naturally separates these two rivers (see map, Figure 1). In 1908 humans breached that separation, completing a tunnel to link the two river systems. Eel River water travels through this tunnel to turn turbines to generate electricity below, in Potter Valley. After being used for this purpose, Eel River water is released to flow into the East Fork of the Russian River.

The complex of facilities (including dams, reservoirs, tunnel, and machinery) used to store water and generate electricity is currently owned by PG&E and is known collectively as "The Potter Valley Project" (PVP). The Potter Valley Project has been characterized in a Sonoma County Water Agency Report as "not economic as a hydroelectric project." Furthermore, the dams have contributed to the collapse of the Eel River salmon populations which once "supported runs of salmon and steelhead trout that were estimated to exceed one-half million fish" (Dept. Fish and Game 2001, p. 57).

Our previous study primarily examined the downriver impacts on salmon and other market and non-market values related to restoration of natural water flows to the Eel River. This report focuses on the benefits to Mendocino and Lake Counties from removal of dams on the Eel River. Our major findings are summarized below:

<u>Direct PVP dam removal costs are estimated to be $33 million</u>. This includes both physical removal of the dams and other facilities, and addressing sediment and restoration needs.

<u>A total of nearly 600 jobs could be directly and indirectly created during the dam deconstruction and habitat restoration project period.</u> The study estimates that 467 local temporary jobs[1] will be directly created by this deconstruction and restoration. An additional 112 local jobs are estimated to be indirectly created from the increased demand on support industries to the project.

<u>The direct and indirect economic impact from the Project is estimated to total $49 million</u>.

<u>Because of the timeline for applying for relicensing of hydroelectric facilities, now is not too early to consider deconstruction and financing of the deconstruction of the PVP dams.</u> Prior to PG&E's filing for bankruptcy it was attempting to sell by auction its hydroelectric facilities. Now that PG&E has emerged from bankruptcy, questions become increasingly important and timely as to who pays for deconstructing hydroelectric facilities, including aging dams. In addition, if the PVP cannot be sold, and if operation and maintenance costs exceed revenue, PG&E might decide to cease operating PVP. This would bring its current license into question and invite the proponents of restoration to push even harder for dam removal. Planning for deconstruction takes time, and the many sources for financing deconstruction of the PVP need to be investigated and developed.

[1] "Job is defined here as "one job for one year"—i.e., the equivalent of one person employed full-time for a year. A local job is defined as a job in Mendocino and Lake Counties.

Nature-based tourism benefits to Mendocino and Lake Counties, counting both rafting and increased fishing, are estimated to exceed $2,000,000 annually. The value of nature-based tourism and recreation can be measured in several different ways: expenditures per day per angler, expenditures per fishing trip, the value of the time and travel to and from the fishing site, the value to anglers in excess of what they spend, the willingness of anglers to pay so that a fishing opportunity can exist, and the value from fishing associated with increased stream flow. Benefits from increased rafting opportunities have previously been estimated to be over $3,000,000, approximately half of which would benefit Mendocino County (the remainder going to Humboldt County) (CEED 2002). In addition, there is "passive" or intrinsic value in increased fish populations. Increased revenue from sports fishing from removal of Matilija dam on the Ventura is estimated to be $600,000 annually (Heinz Center, 2002).

There is abundant water supply in Mendocino County; annually an average of 1 million acre-feet of water falls in the Upper Russian River basin, which is in Mendocino County.
Annual water demand in Mendocino is very small compared to the water that is available. Water demand in 2020 from water suppliers in the Upper Russian River Basin portion of Mendocino County is estimated to be 36,000 acre-feet a year (Sommarstrom, 1986). In an average year the natural flow into Lake Mendocino (without diversion of water from the Eel River) is about 90,000 acre-feet.

Even in critically dry years, the water flow requirements of Lake Mendocino can be met without Eel River water. With the addition of Eel River water, current Russian River summer flows are much higher than the natural flows to which Russian River salmonids are adapted, and it has been found that "currently, high summer flows (generally exceeding 125 cfs) result in an adverse effect to juvenile salmonid habitat in the Russian River" (NMFS, 2002). Even in a "critically dry year," if Russian River minimum flows were reduced to a more natural level to benefit Russian River fisheries, current Upper Russian River water withdrawal demands could be satisfied without Eel River water.

Several options exist for matching water supply with water demand for the upper Russian River basin. These options include:

1. Revise and improve water storage and water release management of Lake Mendocino
2. Develop more groundwater sources
3. Use excess winter runoff to recharge the groundwater reservoir
4. Increase efficiency of water use
5. Extend existing water supply through the use of reclaimed water

Overall, water in the Upper Russian River basin is relatively abundant, not scarce. For the months of the year when there is no or little rainfall and during the years of exceptionally low rainfall, improved management of release of water from Lake Mendocino can increase water supply available during dry months. Such improved management of water release from lake Mendocino coupled with improvements in water efficiency can match the water naturally available to the Upper Russian River Basin with humans' social and economic needs.

In conclusion, removing the PVP dams on the upper Eel not only benefits fish and fisheries in the Eel River ecosystem, but also benefits the Mendocino and Lake County economies through the jobs created by deconstruction and through an increase in nature-based tourism. Meanwhile, local water needs remain satisfied even without Eel River water coming into Lake Mendocino.

I. Introduction: Why Consider Decommissioning the PVP Dams?

"Dams are not America's answer to the pyramids of Egypt. We did not build them for religious purposes and they do not consecrate our values….Dams do, in fact, outlive their function. When they do, some should go."

—Interior Secretary Bruce Babbitt

The mouth of the Eel River, the third-largest river in California, is nearly two hundred miles north of the mouth of the Russian River, yet high up at the rivers' headwaters, only two miles naturally separates the upper Eel River from the East Fork of the Russian River (see map, Figure 1). In 1908 humans breached that separation, completing a tunnel a little longer than one mile to link the two river systems. Eel River water travels through this tunnel to turn turbines to generate electricity. After being used for this purpose, Eel River water is released to flow into the East Fork of the Russian River. The complex of facilities (including dams, reservoirs, tunnel, and machinery) used to store water and generate electricity is currently owned by PG&E and is known collectively as "The Potter Valley Project" (PVP). (From CEED, *River in the Balance,* 2002.)

Dams can serve a variety of functions, including:

- Electricity production
- Flood control
- Water storage
- Water diversion
- Reservoir-based recreation
- River-based transportation enhancement (not applicable to the Eel River)

But if a dam ceases to provide any of these benefits, or the negative impacts of a dam exceed the value of the benefits, dam removal should be considered.

The American Society of Civil Engineers has noted that

> It may be appropriate to consider retirement options [for dams and hydroelectric facilities] at various project life cycle milestones such as capital investment, relicensing, or transfer of ownership. (American Society of Civil Engineers, 1997, p. 7.)

So even setting aside relicensing issues, the possible transfer of ownership of a hydroelectric facility suggests that consideration of the "retirement" or decommissioning or removal option regarding PVP dams and hydroelectric facilities may be appropriate.

In the distant past it may have appeared to make economic sense to dam the Eel River and divert water to the Russian River basin. But things have changed. Now, there is no economic sense in extending the operation of outdated, unprofitable electric generators (and the subsidies to some users of scarce, valuable water). The resulting inefficiencies penalize the economy, lowering incomes and creating unnecessary barriers to the development of new jobs. (From CEED, *River in the Balance,* 2002.)

What, though, are the impacts on Mendocino and Lake Counties of removal of the PVP dams on the Eel River?[2] This report quantifies the benefits from the removal of these dams and examines how water needs can be met from the abundant water within the Upper Russian River Basin.

Figure 1
Map

2 It should be noted that deconstruction and restoration economic impacts would be distributed among Mendocino, Lake, and Humboldt Counties. This report focuses on the combined impacts on Mendocino and Lake Counties. This report does not examine the distribution of these impacts among these counties. The water supply-and-demand issues discussed in this report pertain to Mendocino County, as there is little question of Lake County meeting its water needs.

II. Economic Impacts

A. Deconstruction of PVP and Restoration

1. Cost of Deconstructing PVP

PVP deconstruction direct costs are estimated here to be $33 million. This includes deconstruction of the dams and other facilities and addressing sediment and restoration needs.

Estimating the cost of deconstructing a dam is complex. In addition, every dam is different, having varied site characteristics and also varying as to the material with which they are constructed. Many are concrete; others earthen; some small dams are wooden; some are a combination of materials. For our purposes, dams are best compared in terms of variables such as the following: height, material volume, storage capacity, drainage area, and mean depth.

The Potter Valley Project includes two dams: Scott Dam, which forms Lake Pillsbury in Lake County, and Cape Horn Dam, which forms Van Arsdale Reservoir in Mendocino County. Scott Dam is a concrete gravity dam 130 feet high and 805 feet long. Lake Pillsbury has a current storage capacity of about 68,000 acre-feet. Cape Horn Dam consists of a 283-foot-long concrete gravity section with a maximum height of 63 feet, and a 237-foot-long earth-fill section with a concrete core. Van Arsdale Reservoir has a storage capacity of 700 acre-feet. Other characteristics are summarized in Table 1.

TABLE 1: PVP DAMS

Scott Dam, Lake Pillsbury, Lake County	**Cape Horn Dam, Van Arsdale Reservoir, Mendocino County**
Uses: Storage and Power Year Completed: 1921 Type: Gravity Parapet Type: Yes Length: 805 ft Total Freeboard: 24.6 ft Height: 130 ft Material Volume: 107,599 cubic yards Crest Width: 13 ft Operating Freeboard: 13.4 ft Drainage Area: 288 sq miles Reservoir Area: 2,000 acres Storage Capacity: 68,000 acre-feet Mean Depth: 40.2 ft	Uses: Storage, Power, and Diversion Year Completed: 1907 Type: Gravity Parapet Type: No Length: 520 ft (283 ft concrete, 237 ft earth) Total Freeboard: 28.5 ft Height: 63 ft Material Volume: 40,000 cubic yards Crest Width: 10 ft Operating freeboard: 24.5 ft Drainage Area: 345 sq miles Reservoir Area: 163 acres Storage Capacity: 700 acre-feet Mean Depth: 4.3 feet

(California Department of Water Resources, Data Exchange Center, http://cdec.water.ca.gov/cgi-progs/damSearch; FERC, 2000; FERC, 1978)

The following estimate illustrates the economic impact of deconstruction of the PVP dams. It is not an estimate based on an engineering analysis of the particular work needed to deconstruct the PVP dams. Instead it employs a method economists use called the "hedonic regression method" (see Hackett, 2001, pp. 148-150). In the hedonic regression method, an overall value or cost of an entity is decomposed into its attributes. These attributes are then statistically analyzed to determine their relationship to the overall value or cost. For example, a house might be broken down into square footage, number of bedrooms, number of bathrooms, and other attributes (possibly size of yard, age, number of floors, distance to some point, absence or presence of a view etc.). In this case these attributes are then statistically analyzed in reference to some overall value such as home sale price. The result is an estimation of the relationship between the attributes and the sale price. In particular, coefficients are statistically analyzed for each of the attributes. The sale price can then be estimated for any house that can be described in terms of the relevant attributes. This is done by multiplying the quantity for the attributes of a house by its the statistically estimated coefficients and totaling the resulting products to reach an estimate of the house sale price.

In the case of deconstructing dams in general—and for estimating the cost of deconstructing the PVP dams, in particular—two difficulties emerge. First, costs (either actual or estimated) are only available for a few dams between 40 and 200 feet high, which is the range that would include the 63-foot Van Arsdale and the 130-foot Scott Dam. Second, there are even fewer examples of dams for which relevant variables such as reservoir sediment and type of sediment removal process required are readily available. A regression analysis was performed on the ten dams for which we were able to obtain deconstruction costs. When several alternatives and alternative costs were given to decommission a dam, a single cost was chosen. Costs were regressed, i.e., statistically analyzed, in relation to dam height.

Table 2: Characteristics of Dams Used in Regression Analysis

Dam	Height (ft)	Length (ft)	Impoundment	Status	Cost (actual or estimated)	Date (of removal or estimate)	Inflation index	Cost (actual or estimated) 2004 $
Mounds	58	430	57 acres	Removed	$170,000	1998	1.1084	$188,428
Willow Falls	60	160	100 acres	Removed	$450,000	1992	1.2409	$558,405
Lewiston	45	1060		Removed	$633,428	1973	3.456	$2,189,127
Bluebird	56	200		Removed	$1,500,000	1990	1.3199	$1,979,850
Two-mile	85	720	500af	Removed	$3,200,000	1994	1.1879	$3,801,280
Marmot	47	195	18 acres	Slated	$17,060,000	2003	1.0131	$17,283,486
Condit	125	471		Slated	$13,650,000	1999	1.0941	$14,934,465
Elwha	105	450	8,100af	Slated	$25,600,000	1995	1.1634	$29,783,040
Glines Canyon	210	270	30,000af	Slated	$40,300,000	1995	1.1634	$46,885,020
Matilija	190	620	1,800af (7,018af)	Notched, slated	$53,795,553	2003	1.0131	$54,500,275

The result was that: for each foot of dam height above 41 feet, deconstruction costs increase $301,522. For the 63-foot-high Cape Horn Dam, this equation implies a deconstruction cost of $6,627,000, and for the 130-foot-high Scott Dam, a deconstruction cost of $26,829,000. This gives a combined deconstruction cost of $33,456,000. The graph of the exact regression equation is shown in Figure 2.

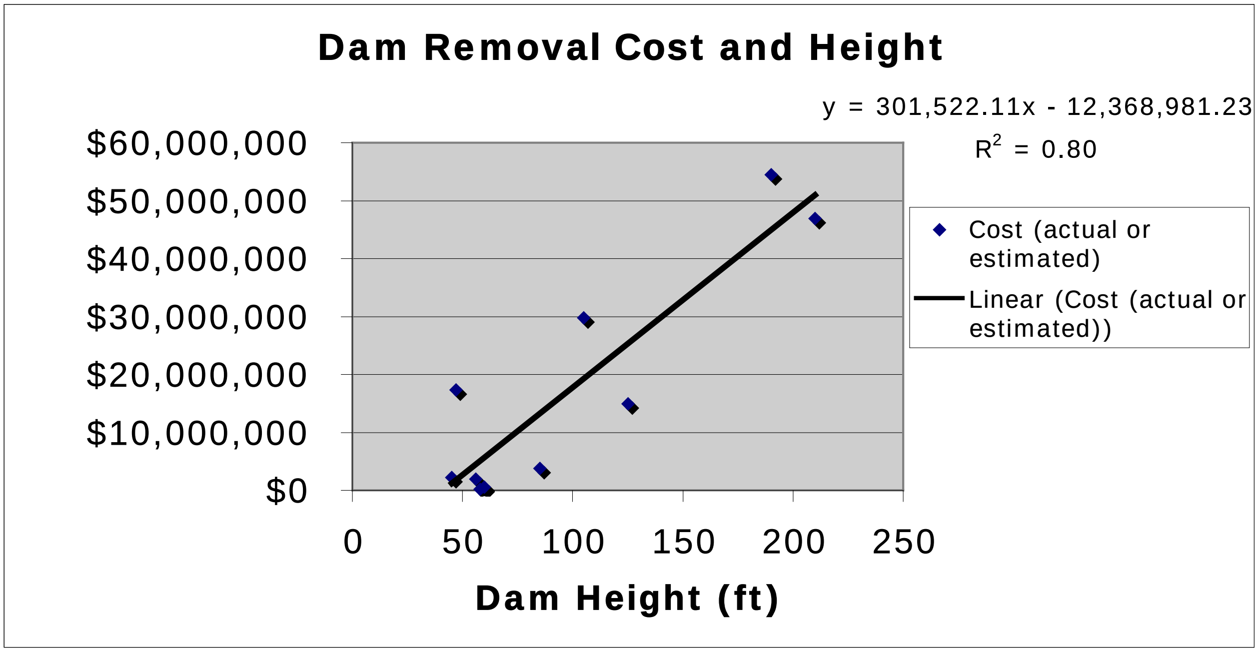

Figure 2: Graph of Removal Cost as a Function of Dam Height

In addition to the dam itself, the reservoirs associated with dams vary as to the amount and nature of sedimentation they contain. Because of this variation, different techniques are used to address sedimentation. The sediment contained in some reservoirs is of a quantity and quality such that the sediment can be released downstream. With such "natural river erosion" the dam is removed in stages to control the rate of reservoir draw-down and sediment erosion. "[Such low breaching rates are likely to release less sediment during a given period than high breaching rates]" (ASCE, p. 18). In other cases, mechanized removal is used. Four types of mechanized removal are: conventional excavation, mechanical dredging, hydraulic dredging, and sediment conveyance. These are described in Appendix 2. What should be noted is that the costs associated with sediment in reservoirs will vary with the approach chosen.

Using only one dependent variable implies that dam height captures other variables such as the cost of dealing with the sediment that has accumulated in the reservoir. "Accumulated deposits of sediment in [Lake Pillsbury] were determined to be 7,600 acre-feet by the United States Geological Survey in 1959" (PG&E 1968, p. 15). "Water storage capacity in Lake Pillsbury has decreased over time as increased silt and sediment loads into the reservoir have resulted in shallower water depths. This sediment rate is estimated at 230-280 acre-feet/year (SCWA 1998a)." (PVP FEIS 2000, pp. 2-3.) This would imply that in 2003 there would be an accumulation of 18,850 acre-feet of sediment in Lake Pillsbury.

Since there are 1613 cubic yards in acre foot, 18,850 acre-feet equals 30.4 million cubic yards of sediment. For comparison, the Elwha Dams have trapped 18 million cubic yards of sediment, Matilija has 6 million, and Condit has 2.42 million. Cost for treatment of sediment varies greatly, depending on type of treatment (see Appendices 1 and 2). A combination of treatments could be applied to a dam's sediment. The overall removal cost estimate for the Potter Valley Project dams includes sediment management costs.

An estimate of costs for deconstruction of the PVP dams can also be made by dividing the set of 10 dams used in the regression into two groups: those closer in size to Cape Horn Dam (the six dams between 45 and 85 feet high) and the four dams closer in height to Scott Dam (those between 105 and 210 feet high). The costs associated with the dams in a group are totaled and then divided by the total of the height of the dams, and an average cost per foot of height is calculated. When applied to Cape Horn Dam, this results in an estimate of approximately $4.7 million and for Scott Dam, approximately $30.1 million, for a total of $34.8 million for deconstruction of the two dams. This is higher than the regression estimates of $6.6 million and $26.8 million for the previously estimated total of $33.4 million.

2. Jobs related to dam removal-related expenditures

Almost 600 jobs could be directly or indirectly created during the dam deconstruction and habitat restoration period.

Jobs are created in three ways from any expenditure: those directly created, those indirectly created in support industries, and those "induced" through the multiplier effect of the initial expenditures. The jobs directly created would be involved with demolition of the dams, processing concrete and other materials into transportable loads, transporting these materials, terracing to stabilize sediment, etc. The jobs indirectly created, for example, would include jobs in sale, repair and maintenance of heavy equipment; nursery-related jobs providing plants for restoration; jobs providing tools and materials used in terracing; jobs supervising the above work; and jobs monitoring its progress and impacts. Yet other jobs are induced from the expenditures made by those employed in jobs directly or indirectly related to deconstruction and restoration expenditures. Such expenditures would be on food, housing, clothing, entertainment, and other goods and services *and* the successive rounds of such local expenditures, i.e., the multiplier effect. A multiplier of 1.5 means that for every initial dollar spent, successive rounds of spending result in an overall increase of another 50 cents, for a total increase of $1.50 to the local economy.

In regard to jobs directly created, ECONorthwest estimated that the $859 million in construction expenses for bypassing the four lower Snake River Dams would create "approximately 12,000 jobs" in a concentrated nine-year period. This implies one job for every $71,583 in construction expenditure or 14 jobs per million dollar of construction expenditures. Applying this same ratio to the estimated $33,456,000 construction expenditures for the PVP dams yields an estimate of 468 jobs.

This $71,583 per job is a somewhat higher ratio of jobs to construction expenditures than that estimated in a study completed by the University of Alaska Institute of Economic and Social Research in 1997. That study noted that the Alaskan "construction industry contributed $1,248 million to the state gross product in 1996. The Alaska Department of Labor reported that there were 12,600 construction workers in 1996. The amount of gross state product per construction worker for 1996 is estimated at $99,048. This number implies that 1 construction worker is supported for approximately every $100,000 spent on construction projects" (University of Alaska, 1997) or 10 jobs per million dollars spent on construction projects.

The State of Wyoming Department of Transportation estimated that "For every one million dollars ($1,000,000) spent on construction, approximately 9.6 direct jobs are created." (Sones, 2002.) This would also imply approximately 1 direct job per $100,000 expended. The ECONorthwest estimate is based on dam-related construction expenditures rather than an aggregated statewide estimate over all types of construction work and may be more applicable to deconstruction of the Potter Valley Project Dams.

The Wyoming Department of Transportation (DOT) in addition also "…estimated 7.7 …[induced] jobs [are] created for every $1,000,000 spent on construction" for a total of 17.3 direct and indirect jobs per $1,000,000 spent on construction. The ECONorthwest estimate implies 14 jobs created per million spent on construction and a higher percentage of construction expenditures going for direct job payroll. Using the total 17.3 jobs directly and indirectly created per million dollars of construction expenditures implies 579 jobs created directly and indirectly for a construction project of $33,456,000.

Table 3 shows the multipliers used by the Wyoming Department of Transportation and the economic benefit implied by these multipliers.

Table 3: Job and Income Multipliers
(from Wyoming Department of Transportation Estimates)

Multipliers:	
Direct Job Earnings (DJE) (per $1M)	0.436
Total Increase in Average Household Income (per $ of DJE)	1.56
Total Increase in Economic Output (per $1M)	1.46
Estimated Economic Benefit	
Direct Job Earnings (DJE)	$436,000
Total Increase in Household Income (Multiplier * DJE)	$680,000
Total Increase in Economic Output (Multiplier per $1M)	$1,460,000

The result of applying these multipliers to the PVP deconstruction expenditures is shown in Table 4.

Table 4: Economic Benefit of PVP Deconstruction Expenditures
(based on expenditures of $31,075,000)

Direct Job Earnings (DJE)	$15,255,936[3]
Total Increase in Household Income (Multiplier * DJE)	$23,799.260[4]
Increase in Economic Output (Multiplier per $1M)	$48,845,760

The total direct and indirect economic impact from the Project is estimated to be $49 million, divided among three counties.

[3] The above implies earnings of $31,218 for each of the 434 direct jobs created.

[4] The job and expenditure multipliers for Mendocino and Lake County may be different from that of Wyoming -- an isolated state far from major population centers—which could contribute to leakages from the Wyoming economy being both greater, or less, than that of the Mendocino-Lake County economy. This could contribute both to more leakage of imports of inputs into the Wyoming economy and to less leakage from residents and businesses in Wyoming making purchases outside of Wyoming compared, for example, to people in Mendocino and Lake Counties making expenditures in other San Francisco Bay counties. Still the multipliers of 1.56 and 1.46 are not much higher than the multipliers for other largely rural California counties such as Humboldt County.

3. Financing Deconstruction

Because of the timeline for applying for relicensing of hydroelectric facilities, now is not too early to consider deconstruction and financing of the deconstruction of the PVP dams.

PG&E is the largest private owner of hydroelectric facilities in the US. PG&E filed for bankruptcy in 2001 and formally emerged from bankruptcy protection in the Spring of 2004. Prior to its filing for bankruptcy, PG&E sought to auction off its hydroelectric facilities. PG&E's emergence from bankruptcy and the renewed possibility of the sale of its hydroelectric facilities make the question of who pays for decommissioning and deconstructing hydroelectric facilities increasingly important and timely. In addition, if the PVP cannot be sold, and, if operation and maintenance costs exceed revenue, PG&E might decide to cease operating PVP. Such a termination of operation would bring its current FERC (Federal Energy Regulatory Commission) license into question. Even if the current FERC license were to run its course, the application process for relicensing begins several years before the expiration date. For all these reasons it is not too early to start considering financing of deconstruction.

American Rivers' *Paying for Dam Removal: A Guide to Selected Funding Sources* (2000) (which is available on-line) devotes 109 pages to addressing financing deconstruction. In a survey of 25 case studies, American Rivers (2000) found that frequently dam removals have been funded by multiple sources, and for 7 large dam removal projects (over $1 million in removal costs), corporations and the federal government were the two largest sources of funding. American Rivers (2002) lists 46 different federal funding programs that could be used to help pay for dam removal projects, most of which can be applied for by state or local governments, tribes, and organizations.

It is important to note that while "FERC has the authority to mandate owner-financed removal of a dam during the relicensing process, as well as the establishment of a decommissioning fund" (NPS & American Rivers, 1996), whether or not that authority is exercised is up to FERC. This means that, even if the license for a dam is not approved, the owner of the dam may not be required to pay for removal (Eddie, 2004). FERC, though, did order the Edwards dam removed at the owner's expense after denying relicensing (the first time FERC ever exercised that authority) (American Rivers, 2000). On the other hand, the federal government will pay for the removal of the Elwha dams.

> The Elwha River Ecosystem and Fisheries Restoration Act of 1992 (PL 102-495) authorizes the Secretary of the Interior to acquire and remove the Elwha and Glines Canyon dams on the Elwha River to fully restore the ecosystem and native anadromous fisheries. The National Park Service completed two Environmental Impact Statements (EIS). EIS-1 found that both dams must be removed to meet the goals of the Elwha Act. (NPS, 1998)

(See Appendix 4 for descriptions of Condit Dam and Bull Run Dam which relate to relicensing costs.)

It is important to note that the costs of deconstructing a dam are as much a part of the total or "life cycle cost" of the dam as are the costs of planning, construction, operation, and maintenance. The questions must be addressed as to who should pay for such costs and how?

If it were clear that the eventual cost of decommissioning dams that were being sold would have to be paid by the buyer of the dam, then the sale price would take into account this cost. If a dam does not change hands, a case could be made that any private benefits from operation of the dam are part of the excess of revenue over costs enjoyed by private owner of the dam, and consequently the private owner could pay for decommissioning out of these net revenues.

Another approach could be modeled on the Decommissioning Trust Fund established for the decommissioning of nuclear power plant facilities. Money for this fund is generated from a surcharge on electricity rate payers. A similar trust fund could be established for decommissioning of hydroelectric facilities. Such a fund could be based on estimates of when hydroelectric facilities would need to be decommissioned and the cost of doing so. A surcharge on rate payers could go into the fund and deconstruction costs be paid out of this fund. If the fund were not sufficient to pay for current decommissioning, bonds could be sold and retired using future payments into the fund.

Setting aside the immediate business considerations regarding PG&E's desire to sell its facility, the current FERC license for the PVP expires in 2022—18 years from the date of this writing. Five years before the license expires, the licensee files notice with FERC to seek a new license; this would be in 2017, only 13 years from now. In some cases where a hydroelectric facility is uneconomical, licensees have not even applied for relicensing, in an effort to avoid the often-substantial costs of preparing an EIR. Consequently in 13 years or sooner, it could be evident that relicensing might not occur. Since deconstruction planning itself takes several years, it is not too early to start considering deconstruction and financing of deconstruction.

B. Nature-based Tourism

Nature-based tourism benefits to Mendocino and Lake Counties, counting both rafting and increased fishing, are estimated to exceed $2,000,000 annually.

Economists measure the value of natured-based tourism in several different ways. The most direct and tangible measurement is in terms of the expenditures made by tourists on lodging, food, supplies, etc. But often data on this are not available, or the situation being studied is a proposed alternative rather than an existing situation. When direct data are not available, economists can use the “benefits transfer approach,” which applies the results of a study done elsewhere to the situation under examination. Other approaches estimate value indirectly, through surveys (such as the contingent valuation method, which measures people’s willingness to pay) or through the travel cost method, which is based on costs related to travel. (See Appendix 5 for a further discussion of valuing nature-based tourism and recreation.)

Many types of nature-based tourism or recreation are possible. The following shows the results of a survey of the Condit Dam deconstruction project area.

Exhibit 3-9

RECREATION PARTICIPATION IN THE CONDIT PROJECT AREA

Recreational Activity	% Participation*
Rafting the river	49
Fishing	33
Picnicking	24
Motorboating	11
Swimming	7
Hiking	7
Wildlife viewing	5
Nature study	3
Kayaking	3

* Numbers do not total 100 percent because individuals could participate in more than one activity.
Source: S. Allen, *Condit recreation use study*, Pacific Power and Light Company, 1990, as cited in FERC, Condit Hydroelectric Project, October 1996, p. 3-50.

Table 5: Recreation on the Condit Project Area
(From Industrial Economics, Inc., 1998)

Rafting opportunities below Cape Horn Dam would increase from deconstruction of the PVP dams. One debarkation point for rafting trips is near Dos Rios in Mendocino County. It is estimated that as many as 10 rafting parties could be started each day without congestion (CEED 2002). If so, for the 46-day period from May 1 to June 15, a maximum number of trips during this period that could be supplied without congestion would be 460. Assuming only half this amount, 230 25-person rafting trips would generate $2,300,000 in rafting trip revenue.

In addition, 230 rafting trips with 25 people per trip totals 5,750 people. Assuming an average of $100 per day on food, lodging, and other expenses, each person spending an additional day either before or after the rafting trip would collectively spend $575,000. Additional tourist expenditures before or after a rafting trip added to rafting trip revenue totals $2,875,000. Using a regional multiplier of 1.25 implies a total economic benefit of $3,593,750. The distribution of this benefit between the Eel River and Russian River basins would depend on where food and other supplies for the rafting trip are purchased and where people associated with the rafting party live and spend their money. If economic benefits were divided equally between the two regions, each would receive $1,796,875 annually.[5]

There is extensive literature on estimating the value of recreation, especially fishing. An excellent survey and summary of the literature is in *Economic Analysis for Hydropower Project Relicensing Guidance and Alternative Methods*, by Industrial Economics, Incorporated, of Cambridge, Massachusetts. This study compiles the results of dozens of studies into comparative tables and also describes particular studies in detail. For example, it notes that the average expenditures by Oregon recreational anglers per fishing day was estimated to be $42.15 (Industrial Economics Inc., 1998). This total is broken down into 9 subcategories (see Table 6).

Table 6: AVERAGE EXPENDITURES BY OREGON RECREATIONAL ANGLERS
(Industrial Economics Inc., 1998)

Category	Expenditures per fishing day
Transportation including gas	$10.54
Lodging	$3.30
Food/drink at stores	$10.04
Food/drink at restaurants	$4.02
Guide and charter fees	$2.55
Boat gas	$2.59
Equipment rental	$1.35
Supplies and misc.	$5.46
Other expenses	$2.30
TOTAL	$42.15

Source: Oregon Department of Fish and Wildlife, *Oregon Angler Survey and Economic Study*, June 1991.

This estimate was from a 1991 study. Adjusted for inflation this figure would be $55.72 in 2002 dollars. It is worth noting that this study shows only $3.30 for lodging, suggesting that most Oregon anglers camp or do not lodge away from home when fishing. Also, since guide and charter fees per person are many times higher than $2.55 per person, the study's $2.55 average implies that a relatively small percentage of angler days involve guides and charters. Lodging and use of guides and charters by anglers, who would use the restored portions of the Eel River after removal of the PVP dams, could differ from the average use of these categories by anglers in Oregon.

[5] Kayaking on the Salt River in Arizona is estimated as having a $28 per day value (1997) (Wash et al., 1980, cited in Industrial Economics. At this valuation, each 1,000 days of increased kayaking would be worth $28,000.

In the same study the economic impact of an increase in 1,000 fishing days was also estimated (Industrial Economics, 1998, p. 181). This figure was estimated to be $42,150 in direct expenditures, $96,945 in impact on total output, with an increase of 1.97 jobs. Adjusting for inflation, these amounts are $55,720 for direct expenditures and $128,156 in impact on total output, respectively (the employment impact would not change due to inflation).

Exhibit A-2

SUMMARY OF STATEWIDE ECONOMIC IMPACT OF INCREASED RECREATIONAL ANGLING IN OREGON

Increase in Fishing Days	Direct Expenditures	Impact on Total Output	Employment Effect (Jobs)
1,000	$42,150	$96,945	1.97

Source: IEc analysis using IMPLAN. Adapted from U.S. Environmental Protection Agency, *Costs and Benefits of Water Quality Improvements in Oregon's Willamette Valley*, prepared by Industrial Economics, Incorporated, December 1997.

Table 7: Economic Impact of Recreational Angling (From Industrial Economics, Inc., 1998)

To give some sense of the magnitude of sports fishing, consider that in 2002 there were 2,165,044 anglers in California. Nationally there are 29.5 million anglers who pay $500 million for fishing licenses. A study prepared for CalTrout found that:

> Of the 9.4 million people who participate in wildlife-related recreation each year in [California], 20% choose to fish mostly in freshwater streams, mostly (70 percent) for trout and mostly for wild trout (U.S. Department of the Interior, Fish and Wildlife Service/U.S. Department of Commerce, Bureau of the Census 1998; Anderson 1990)…Trip and equipment expenditures associated with freshwater fishing in California totaled $2.3 billion in 1996. Equipment represented…60 percent of expenditures, followed by lodging (16 percent), transportation (12 percent), and other items (12 percent). Each angler in California spent an average of $972 that year (U.S Department of the Interior, Fish and Wildlife Service/U.S. Department of Commerce, Bureau of the Census 1998). (Alkire, 2003.)

Another study, *Dam Removal: Science and Decision Making* (2002) by the Heinz Center, addresses the benefits of removing Matilija Dam in southern California and restoring the environment. It observes:

> Removing Matilija Dam would open up 30 miles of stream for anadromous species of fish, including 85 percent of the remaining habitat of endangered steelhead trout. The population of steelhead trout has been reduced to fewer than 200 from a historical run of at least 4,000 adult fish per year (Capelli, 1999). One study has shown that a single steelhead may be worth $75 to $300 because of increased sport fishing business revenues (e.g., from fishing and outdoor equipment, lodging, guide services, and restaurant meals). Increasing the sport catch in the Ventura River by 2,000 adult fish (about half of the historical run) could generate as much as $600,000 per year to those industries (Marx, 1996–1997).

Scott Dam is 12 miles upstream from Cape Horn Dam, so removing Cape Horn Dam would open up 12 miles of the main stem of the Eel River to unimpaired access by fish. In addition, 35 miles of spawning habitat was blocked from chinook salmon and over 55 miles of habitat lost to steelhead. The Department of Fish and Game estimates that “75 miles of spawning habitat in the Upper Eel River and its tributaries” is blocked by Scott Dam (this implies an overlap in the spawning habitat of chinook and steelhead). DFG states “The reduction in habitat resulted in the loss of 3,000 steelhead trout and 2,500 Chinook salmon” (Steiner 1998 in DFG 2001, p. 56).

For purposes of illustration, note that an increase of 1,000 adult fish caught would be valued at $300,000 a year using the valuation applied above in relation to the deconstruction of the Matilija Dam on the Ventura River. If this increase in adult fish caught were in the portion of the Eel River in Mendocino, the benefit would primarily accrue to Mendocino County. An increase of 2,000 adult fish caught, using the same valuation, would be associated with $600,000 a year.

The above does not address fish populations below Cape Horn Dam. “In the early 1900s, the Eel River supported runs of salmon and steelhead trout that were estimated to exceed one-half million fish” (Dept. Fish and Game, 2001, p. 57). “The most recent estimates…[in] the late 1980s…indicated steelhead trout had declined to 20,000 fish, Chinook to 10,000 fish, and Coho salmon to 1,000” (DFG 1997) for a total of 31,000 fish remaining. In general, the removal of dams that are not cost-effective, the return to natural water flow regimes, and restoration of habitat would all contribute toward improving both freshwater and ocean fish populations. Increases in ocean fish populations could help slow or reverse the decline of the commercial fishing industry. Benefits to the commercial fishing industry would, in turn, benefit coastal fishing towns including those of Mendocino County.

Not including commercial fishing impacts, counting both rafting and increased fishing, nature-based tourism benefits to Mendocino and Lake Counties would total more than $2,000,000 annually.

C. Commercial and Ocean Sport Fishing

Increases in ocean salmon fish populations would likely help slow and eventually reverse the decline of the commercial salmon fishing industry, which as recently as 1988 contributed more than $94 million in additional personal income to the Northern California economy and supported 4,000 commercial fishing-based jobs. Such increases could also benefit sport fishing-related businesses, which in 1988 provided $372 million in personal income impacts to the Northern California economy, supporting an additional 19,000 family-wage jobs in that industry. (The Economic Imperative of Protecting Riverine Habitat in the Pacific Northwest, Pacific Rivers Council, Jan. 1992.)

Such fishery-based economic benefits can arise directly and indirectly. It is obvious that when the population of a species of fish that can be harvested increases, both sport and commercial fishing economies directly benefit from increases in harvestable fish. However, there is a not-so-obvious indirect beneficial effect as well. Because both strong and weak fish populations intermingle in the ocean, to protect some depressed or weak salmon runs, restrictions have been placed on harvesting of runs that are otherwise plentiful (such as the California Central Valley hatchery-origin stock, which migrate north throughout Northern California in the millions), in order to reduce the chances of accidental overfishing on the weakest populations in these intermingling fisheries. This is referred to as "weak stock management," by which the weakest stock becomes the limiting factor in all intermingling fisheries, and is a conservation requirement of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 *et seq*.). Thus to save one very weak stock (and federally protected) Eel River coho might mean forgoing harvests on hundreds of otherwise abundant (hatchery-origin) chinook.

Even small increases in very weak-population species, such as coho salmon, could indirectly benefit sport and commercial fishing on chinook if they caused a relaxing of restrictions on the harvesting of some of these far more plentiful species, such as Central Valley hatchery-origin chinook. Thus small increases in Eel River salmonid populations could have large economic benefits to the commercial fishing industry and sport fishing business both directly and indirectly, potentially allowing harvest access to many more fish from these otherwise abundant stocks that are now off limits. These benefits would specifically include additional fishing opportunities (and thus additional fishing income and jobs) to coastal fishing towns including those along the Mendocino Coast. (Glen Spain, 2004, Institute for Fisheries Resources. Personal communication.)

Fort Bragg’s Noyo Harbor “is the only commercial port between San Francisco and Eureka” (Pacific Municipal Consultants, 2003) and was at one time “the leading salmon fishing port on the Pacific coast” (Coastal Conservancy, 2004).

In the 1920s “millions of pounds of salmon were caught and brought to market in Fort Bragg” (Griffin and Scharffenberger, 2003) and in 1979 Noyo Harbor was first in the state “for the total value of its salmon catch ($5,483,441), and second for total numbers, contributing about 20 percent of the state total catch” (County of Mendocino, 1981).

In 1976, 3.6 million pounds of coho were landed (Griffin and Scharffenberger, 2003). The Mendocino County General Plan states, “In 1976, the local salmon fishing and processing industry had total sales of $4.9 million, which contributed $15.6 million to the County's total sales through the local multiplier effect" (County of Mendocino, 1981). The Costal Commission (2004), however, points out "the commercial fishing activity in Noyo Harbor has declined 80 percent over the past 20 years (Z. Grader, IFR, 2003, pers. comm)," and in 1992 the amount of coho landed had declined to 11,000 pounds (Griffin and Scharffenberger, 2003). In 2003, "about 90 of its berths (40 percent) are taken up by commercial fishing boats – a major decline from five to seven years ago, when commercial boats occupied 75 percent or more of its berths" *(ibid).*

The Mendocino County General Plan states:

> The Eel River ranks second in the state for coho (silver) salmon and steelhead production, third in chinook (king) salmon production, and second in the North Coast for sport fishing. The value of the sport and commercial anadromous fishery in the Eel River alone is estimated to be about $12.3 million per year, according to a Humboldt County study. (For additional facts and figures on Fisheries in Mendocino County, see "Fisheries—State of the Resource" available in the Planning Department office.)

Also, it notes that,

> As the result of angler surveys, economists estimate that the net economic value of sport fishing is $47 per angler-day for river fishing and $113 per angler-day for ocean salmon fishing. These values do not, however, include the second- and third-level beneficiaries in support industries, such as equipment, boats, travel and tourist accommodations. Estimates have also been made of the commercial and sport value of each spawning anadromous fish: Chinook (king) salmon - $178; coho (silver) salmon - $160; and steelhead - $69. (See "The Economic Value of Anadromous Fisheries for Six Rivers National Forest" by Dean Smith, February, 1978.) (County of Mendocino, 1981.)

These figures imply significant potential economic benefit to the Mendocino County commercial fishing industry from the restoration of Eel River salmon, especially considering that Noyo Harbor is the only commercial fishing port between San Francisco and Eureka, and so most likely accounts for a considerable proportion of ocean-caught Eel River salmon.

D. Resources of Value to Native American Tribes

This report focuses on market values. Nonetheless, it recognizes the validity and importance of intrinsic or non-market values. Perhaps foremost of these are resources of value to Native American tribes.

California Indian Legal Services (CILS) stated in their 1999 comments to FERC that "The [Federal Energy Regulatory] Commission must protect resources of value to the [Round Valley] Tribes, such as the Eel River fishery on which the Tribe relies for the exercise of statutory and federally reserved fishing rights." The Round Valley Reservation, the largest in Mendocino County, is a discontinuous assemblage of at least 15 parcels, some of which extend into Humboldt County. The Round Valley Indian Tribes have stated that "FERC has already allowed PG&E to do tremendous damage to the Eel River fishery and has squandered the opportunity to help reverse that damaging trend by allowing PG&E to conduct a study to examine its own impact on the fishery" (comment on Draft Environmental Impact Statement).

CILS in their comments also argued that the "no-project" option or natural flow of the Eel River is the baseline for measuring the impact of the Potter Valley Project's diversion of water from the Eel. Native American opportunities for fishing have been greatly diminished, for example, by the above-mentioned loss of more than 35 miles of chinook salmon spawning habitat because of Scott Dam, and at least 55 miles of habitat lost to steelhead.

Economist Philip Meyer notes that "Indian elders link the survival of salmon with survival of their tribe as a people." Moreover, traditional elders value water, air, sun, and land as the four life-givers on which all living things depend—all humans, all plants, and all animals. (Meyer, 19991.) Although placing a dollar amount on resources of value to tribes (including spiritual values related to salmon and water) is inappropriate and inadequate, such resources are, nonetheless, real values that need to be fully recognized and acknowledged.

III. Water

There is abundant water supply in Mendocino County; annually an average of 1 million acre-feet of water falls in the Upper Russian River basin, which is in Mendocino County.

A. Supply Issues

1. Magnitude of water supply and demand in the Russian River basin portion of Mendocino County

The Russian River basin covers a total of 1,485 square miles "This drainage covers the lower elevation interior valleys, which include (north to south): Potter Valley, Redwood Valley, Ukiah Valley, and Sanel and McDowell Valleys near Hopland" (MCRCD, 2002). 563 square miles or 38% of the Russian River basin is in Mendocino County. Since there are 640 acres in a square mile, the Russian River basin comprises 360,320 acres of Mendocino County. This area is often referred to as the "Upper Russian River Basin." Since Mendocino County's area is 3,510 square miles, the Russian River basin portion constitutes 16% of Mendocino County.

Rainfall in Mendocino County averages between 35 and 80 inches a year (*ibid)*. Sommarstrom notes an average annual rainfall in the headwaters of Potter Valley of about 44 inches, in the city of Ukiah 36.2, at the Hopland Field Station of 37.4, and at 2900 feet near Hopland 46.6 inches—all in excess of 3 feet. Consequently, more than 1,000,000 acre-feet of rain falls in the Russian River basin portion of Mendocino County.

In an average year the natural flow into Lake Mendocino is around 110,000 acre-feet (FERC, 2000, pp. 3-60).

Annual water demanded in 2020 from water suppliers in Mendocino County is estimated at 31,600 to 36,200 acre-feet in the Russian River basin in Mendocino County, depending on growth rate assumptions (Sommarstrom, 1986).

Sommarstrom estimated water use in 1985 in the Upper Russian River Basin (excluding Potter Valley) to total 25,990 acre-ft. This estimate is divided into "Major and Small Water Purveyors" and "Individual Wells" and "Diversion." Furthermore, the estimate is divided among Residential, Commercial, Industrial, Municipal, and other categories. Sommarstrom uses urban growth rates of 1.2% to 2.2% to project water demands in 2020 to be between 31,554 acre-ft and 36,221 acre-ft for a normal year; between 34,512 and 38,013 in a dry year; and between 23,944 and 26,744 in a critically dry year.

The population of Mendocino County increased from 66,738 in 1980 to 86,265 in 2000. This is a 29% increase over 20 years, or a 1.46% average increase per year (less, when compounded growth is considered). Most of this growth occurred between 1980 and 1990 when the population reached 80,345 or a 20.4% increase, or a 2% average increase per year. From 1990 to 2000, Mendocino growth was only 7.37% or 0.74% average growth per year. These actual growth rates fall in the mid to lower ranges of Sommarstrom's projections.

The City of Ukiah during this same period went from 12,035 residents to 15,497, an increase of 29% or 1.44% average increase per year (again, less when compounded growth is taken into account). Assuming a growth rate over the entire 35-year period from 1985 to 2020 of 1.7% per year, the water demand according to Sommarstrom would be the midpoint of her low and high estimates, or 38,888 acre-feet for a normal year, 36,263 for a dry year, and 25,344 for a critically dry year.[6]

"Of the 70,000 acre-feet per annum (afa) water supply of Lake Mendocino, Mendocino County was granted 8,000 afa for its contribution of 11.3% of the project cost. The County's right is held and administered by the Mendocino County Russian River Flood Control and Water Conservation Improvement District (RRID)" (Sommarstrom 1986, p. 10). 2,500 afa of the 8,000 afa total is allocated to the Redwood Valley Community Water District.

Another notable constraint on water supply and demand is Decision 1610 of the State Water Resources Control Board, requiring the Sonoma County Water Agency (SCWA), in accordance with its water rights permits, to maintain minimum streamflows at various points on the Russian River and Dry Creek. One particular requirement is a minimum stream flow between Coyote Valley Dam and Dry Creek of 25 cfs. Other requirements of Decision 1610 are described in Appendix 6. When considering month periods, it is useful to note that 1 cfs equals 2 acre-ft a day; this 25 cfs requirement implies a minimum of 1,500 acre-ft per 30-day month.

From 1911 to 2000, the annual diversion from the Eel to the Russian River basin has averaged 113,352 acre-feet.

Table 8: Average Eel River Flows
1911-2000 (acre-feet)

	Unimpaired	Diverted	% Diverted
Oct	3038	2364	0.78
Nov	15360	7275	0.47
Dec	58528	16415	0.28
Jan	90540	5619	0.06
Feb	110544	22180	0.20
Mar	77066	11724	0.15
Apr	56640	22226	0.39
May	26412	14596	0.55
Jun	9180	7405	0.81
Jul	2604	2283	0.88
Aug	1054	724	0.69
Sep	840	541	0.64
Total	451806	113352	0.25

The diversion flows were increased in the 1950s. During the 1992 to 2001 water years, the average amount diverted annually from the Eel River to the East Fork of the Russian River was 136,325 acre-feet.

[6] Sommarstrom's agricultural projections assumed "90% of vineyards are irrigated, no significant acreage changes, and [a] "low" applied water use rate"; adjustment for conditions different from these assumptions is a topic for further research. It is recognized that revision of Sommarstrom's estimates with updated data would be very useful.

2. Water Needs of Salmon in the Russian River

An important question regarding water flow in the Russian River is the quantity needed for the Russian River's salmonid populations, which—like those of the Eel River—have been heavily affected by human alterations to the river system. Estimated salmon runs of 20,000 around the turn of the century have dwindled to 500 to 1,000 returning fish today (CDFG, 2002). Contributing to this decline is the dramatic alteration of river habitat that has occurred as the human population of the Russian River basin increased, including changes to the natural flow regime of the river that result from dams and the importation of Eel River water.

In regard to the alteration of natural flows of the Russian River, Entrix (2003) points out:

> The stream flows in the Russian River that have resulted from the flow requirements of D1610 and previous regulated flow regimes vary dramatically from the natural flow regime of the river. These changes have affected the magnitude, frequency, duration, timing and rate of change of the hydrological conditions in the river.
>
> In recent years there has been an increasing recognition that human alterations of river flow regimes, whether incidentally associated with other human activities or with the specific intent to "improve" the river ecosystem, change the established pattern of natural hydrologic variation, thereby altering habitat dynamics and creating new conditions to which the native biota may be poorly adapted (Poff *et al.* 1997).

Additionally, Steiner Environmental Consulting, as quoted by the California Department of Fish and Game (2002), states that "Changes in flow and temperature resulting from dams and diversions have significantly impacted Russian River salmonid populations. Regulated flow coupled with gravel extraction has caused channel incision, channelization, diminished gravel recruitment, riparian encroachment, and habitat simplification."

In the Potter Valley Project Biological Opinion (2002), NMFS explains that:

> A range of flows that follow the natural flow regime is most beneficial to protected native fishes (Poff *et al.* 1997). The unnaturally-high flows provided as a result of Project releases into the East Branch Russian River adversely affect rearing juveniles by increasing water temperatures through the mixing of stratified pools, which increases vulnerability to disease, and proliferation of predatory and competing introduced species. High flows also alter invertebrate communities, channel morphology, and geomorphologic function, as well as negatively affecting critical habitat by reducing riparian vegetation by 30 percent and altering sediment transport (SEC 1996b; Poff *et al.* 1997).

Due to the imperiled nature of anadromous fish populations in the Russian River and the significance of river flow conditions to fishery health, USACE, SCWA, and NMFS have developed a "Natural Flow Proposal" that would manage Russian River flows to better resemble natural river flow conditions (Entrix, 2003). This Proposal acknowledges the importance of sustainable resource use and the restoration of the Russian River. Furthermore, the removal of the Potter Valley Project, combined with improved water use practices, could additionally benefit Russian River salmonids through more natural flow conditions.

3. Russian River Hydrology

The average annual rainfall in the Russian River basin is 41 inches, with variation throughout the basin ranging from 22 to 80 inches (CDFG, 2002). However, since most of this rainfall is in the winter, the CDFG points out that "Approximately 95% of the basin's natural runoff occurs between November and April," and consequently, "Runoff is negligible between July and October, with many tributaries running dry in the lower reaches."

Before Coyote Valley Dam and the Potter Valley Project, summer flows in the Mainstem Russian River "often dropped to 20 cfs or less" (Entrix, 2004), and it has been estimated that "summer flows at Healdsburg were 10 to 15 cfs" (CDFG, 2002). In the East Fork Russian River, the PVP diversion and Coyote Valley Dam create high summer flows—from 1992 to 2001, average monthly flows below Coyote Valley Dam were 232 cfs in July, 247 cfs in August, and 251 cfs in September—when under natural conditions "the river would otherwise be dry, or nearly dry"(Entrix, 2002b). Even after the completion of Cape Horn Dam and the Diversion Tunnel, but before Scott and Coyote Dams, summer flows remained quite low—even with addition of some Eel River water, a "spot discharge of 6.6 cfs was recorded near Cloverdale in August 1910, and 17 cfs was recorded near Healdsburg in August 1911 (McGlashan and Dean, 1913)" (CDFG, 2002). It is historic, natural conditions—with very low summer flows—that the Russian River salmonids evolved under, and these are therefore the conditions to which it is likely they are best adapted.

In contrast to historic flows, current Russian River summer flows are extremely high and have been determined to be detrimental to anadromous fish populations. The CDFG comments that "Dam operations diminish flood peaks, redistribute winter flows, and increase summer flows above Healdsburg by as much as 200 cfs" (CDFG, 2002). During the ten water-years from 1992 to 2001, the average flow at Healdsburg for July, August, and September was 187 cfs, 178 cfs, 186 cfs, respectively (USGS).

Illustrating the negative impacts of these high summer flows, NMFS states:

> Currently, high summer flows (generally exceeding 125 cfs) result in an adverse effect to juvenile salmonid habitat in the Russian River. It has been determined that flows higher than 38 cfs are likely to eliminate or completely mix stratified pools containing cold water refugia that rearing juveniles may best use to over-summer (DWR 1976; Nielsen *et al.*, 1994; SEC 1996b). (NMFS, 2002.)

Similarly, Entrix (2003) has found that "Velocities in the upper mainstem of the Russian River are higher than optimum for salmonid rearing," and "Expanded warmwater habitat in the Middle and Lower Russian River favor fish species that prey on or compete with steelhead and salmon."

Additionally, excessive summer flows can disrupt the Russian River's estuary habitat:

> Augmented summer flows have increased the amount of water that flows to the Estuary, thereby altering it from historical conditions. Before construction of major water projects mainstem flows often dropped to 25 cfs or less, and at times ceased altogether. Under these conditions, the Estuary likely remained closed to the ocean for weeks or months at a time. (CDFG, 2002)

And according to Entrix (2003),

> Current operations result in frequent breaching of sandbar at the mouth of the Estuary during some parts of the year. This creates unstable conditions in the Estuary that are unsuitable for salmonids and their food base. Other estuaries in California appear to provide good rearing conditions for anadromous salmonids when closed during the summer. Estuary management is dependent on flows in the Russian River.

The average flow during the 1992-2001 period at Hacienda Bridge near Guerneville for July, August, and September was 210 cfs, 181 cfs, and 190 cfs, respectively (USGS). In contrast, the natural flows in a normal year for these months would be 80 cfs, 33 cfs, and 29 cfs, respectively (SCWA, 1991). Even in 1977 the average flows for these months were 32 cfs, 36.7 cfs, and 35.9 cfs, respectively—when the estimated natural flows would have been zero (USGS; SCWA, 1991). (See Table 9.) This means that the average September flow from 1992 to 2001 is 6.5 times greater than the average natural flow, and the minimum flow currently allowed in a "dry" August (not even under "critically" dry conditions) is 14 times greater than what the average natural flow would be under similar conditions.

Table 9: Mean Monthly Summer Flows in the Russian River at Hacienda Bridge near Guerneville (USGS; SCWA, 1991)

	July	August	September
		cfs	
Average flow, 1992-2001	210	181	190
Average flow in 1977	32	36.7	35.9
Current minimum flow, Normal conditions	125	125	125
Current minimum flow, Dry conditions	85	85	85
Current minimum flow, Critical conditions	35	35	35
Average natural flow*, Normal conditions	80	33	29
Average natural flow, Dry conditions	37	6	8
Average natural flow, Critical conditions	0	0	0

*"Average natural flows" are the average flows from 1923 to 1984 "which would have occurred without the influence of civilization" (SCWA, 1991).

4. The Russian River Without Eel River Water

While the Potter Valley Project diversion has a dramatic effect on the hydrology of the Russian River, it is important to note that the PVP is a hydroelectric project, and—with the exception of some water provided directly to the Potter Valley Irrigation District—is not operated for water supply purposes. Also, Entrix (2002) points out that "Presently, operation of the PVP is not coordinated with the operation of Coyote Valley Dam and is not subject to SCWA or USACE control." Since "the Project is not economic as a hydroelectric project" (SCWA), and decommissioning of the Project is a distinct possibility, it is important to consider the effect of the Project's removal on the Russian River.

According to SCWA (1991), "Without the PG&E diversion, minimum streamflows between Coyote Valley Dam and Dry Creek would have to be reduced to 25 cfs in all years." As illustrated above, even a minimum flow of 25 cfs in the summer months would be higher than what would exist under natural conditions.

SCWA goes on to say that "The current agricultural and urban demands could then be satisfied provided a 30 percent curtailment were taken in critically dry months," and "if there was no change in the lower Russian River streamflow requirements, the total annual urban demand downstream from Dry Creek which could be satisfied would be reduced by approximately 15 percent."

Regarding the water supply demands below Dry Creek, SCWA also states,

> [Though the loss of the Potter Valley Project] would reduce the total annual demand downstream from Dry Creek which could be satisfied provided there was no change in the lower Russian River streamflow requirements, it is not unreasonable to expect that a reduction in those requirements could be secured from the State Water Resources Control Board in such circumstances. The high lower Russian River minimum flows are closely associated, historically, with the Coyote Valley and Potter Valley Projects. In fact, the normal year 125 cfs minimum in the lower Russian River was established in 1959 solely in reliance on those projects. With such a dramatic change in the physical capacity of upper river projects, a good case could be made that the municipal water supply of Lake Sonoma should not be sacrificed to totally compensate for the loss of the upper river supply and that at least some, if not all, of the loss should be compensated for with streamflow reductions.

Additionally, Entrix (2003) point out that:

> During water supply operations, water is released from Lake Mendocino to meet water supply demands between Lake Mendocino and Healdsburg, and the required minimum flow at Healdsburg. No additional water is released from Lake Mendocino for diversions by SCWA or any other diverters below Dry Creek.

Considering that current high summer flows above Dry Creek are harmful to anadromous fish, and that Coyote Valley Dam is not intended to supply water to users below Dry Creek, it is reasonable that flows in the Russian River above Dry Creek should be based on Upper and Middle Russian water needs and the lower summer flows that would benefit fish populations.

Even though a minimum summer flow of 25 cfs may not be ideal for salmonids, if, for illustrative purposes, Russian River flows are modeled with that condition, recent water demands above Dry Creek could have been met without Eel River water and without dewatering Lake Mendocino.

Based on USGS river flow data and USACE reservoir storage records, the 1975 to 2001 water years can be modeled with the following conditions:

- Flow into Lake Mendocino is only what it would have been without Eel River water and after Potter Valley use.

- Coyote Valley Dam releases are based on maintaining a minimum flow at Healdsburg (USGS station 11464000) of 25 cfs under all conditions, while satisfying water use demands above that point, and maintaining a maximum storage in Lake Mendocino of 90,000 acre-feet.

- Coyote Valley Dam release rate that will satisfy water use demand and maintain the 25 cfs river flow is estimated by calculating the net gain of water between Coyote Valley Dam and Healdsburg. The "net gain" below the dam is the measured flow at Healdsburg minus the measured Coyote Valley Dam release—leaving the sum of all inflow (runoff, sub-surface flow into the channel, etc.) into the river minus all the losses (withdrawals, losses to groundwater, evaporation, etc.). This is a negative number in some months—that is, more water is released into the East Fork Russian River from Lake Mendocino than is left in the river at Healdsburg.

- Releases from Lake Mendocino are equal to the amount needed to maintain 25 cfs at Healdsburg, including compensation for negative net gains between the Dam and Healdsburg. If this release would result in Lake Mendocino exceeding 90,000 acre-feet of storage, the release is increased as much as needed to prevent Lake Mendocino from exceeding 90,000 acre-feet.

Using this method of estimation, between 1975 and 2001 it is possible to satisfy both the 25 cfs minimum flow at Healdsburg and the withdrawal demands of that period.

Under these conditions, even without Eel River water, the reduced release rate from Lake Mendocino allows for adequate reservoir storage levels. Visitation at Lake Mendocino increases as the amount of water in storage increases. FERC (2000) states that "Below 44,000 acre-feet storage, boat-based recreation is lost because launching ramps are unusable. Between 44,000 and 65,00 acre-feet storage, there is reduced visitation because lower lake levels reduce the quality of swimming, camping, and other experiences." Table 10 and Figure 3 show that reducing the minimum flow at Healdsburg to 25 cfs, even without Eel River water, actually results in fewer months when storage in Lake Mendocino is below ideal levels. Out of the 324 months of the 1975-2001 period, there were 19 months during which Lake Mendocino's storage level dropped below 44,000 acre-feet, whereas with a reduced minimum Russian River flow and no Eel River water there would have only been 10 months below 44,000 acre-feet.

Table 10. Monthly Storage Level in Lake Mendocino between 1975 and 2001 water years (324 months)—historically measured and estimated with 25 cfs minimum flow at Healdsburg and no Eel River water.

	Number of months:			
	<44,000 AF	<65,000 AF	>80,000 AF	>90,000 AF
Actual measured (USACE)	19	87	100	46
With 25 cfs minimum and without Eel River water	10	70	152	0

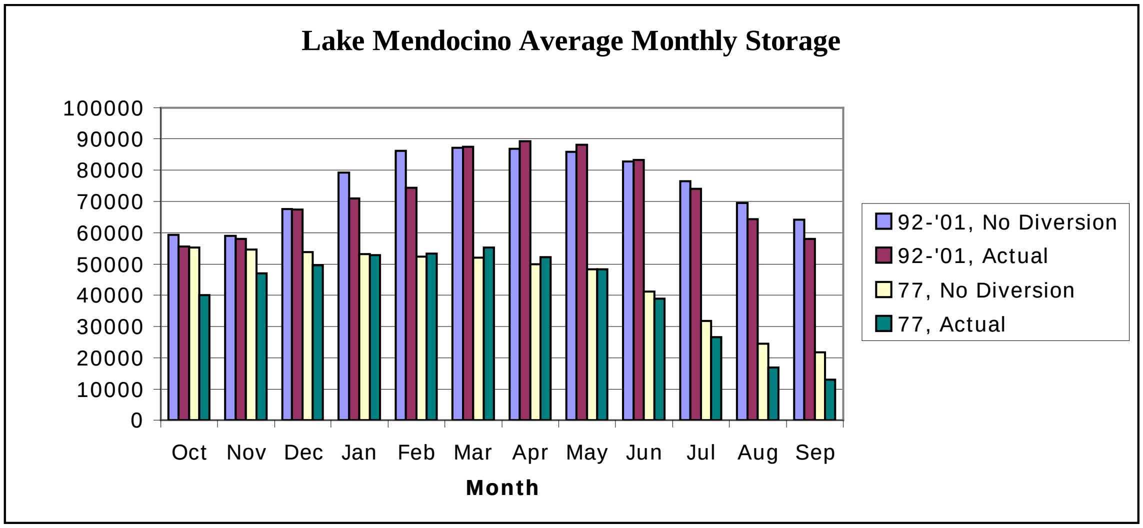

Figure 3

Using the average of the 1992 to 2001 period as an approximation of current normal conditions (since it is a recent period and does not include any major drought years), Figure 4 compares the average flow in the East Fork Russian River below Coyote Valley Dam for both actual historic flows and estimated flow without Eel River water and the reduced minimum flow. Also shown for comparison is the actual average flow for the period in the West Fork Russian River, since it is a basin somewhat of similar size, characteristics, and weather.

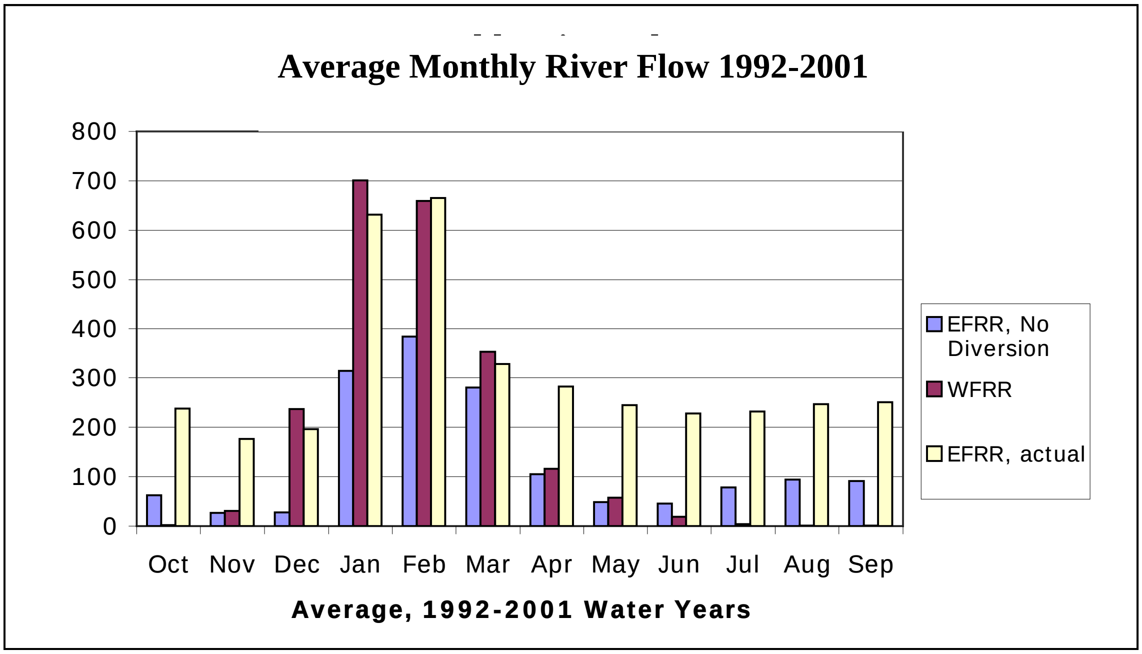

Figure 4

Figures 5 and 6 compare the average monthly flows at Healdsburg for the 1992-2001 period, and for the 1977 water year.

Figure 5

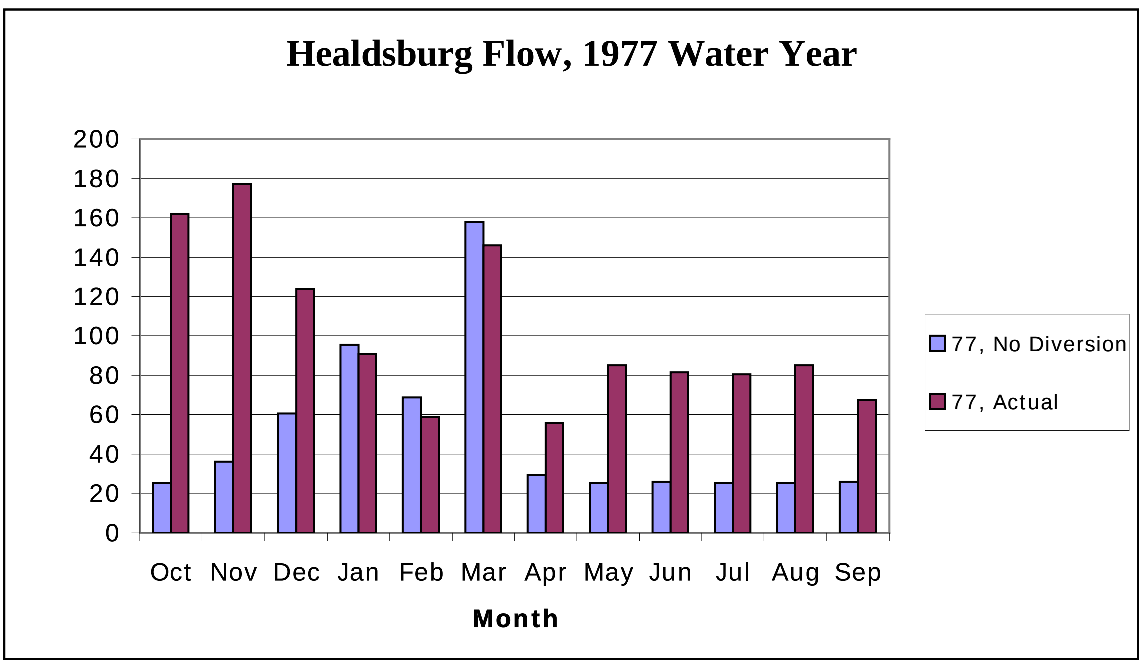

Figure 6

A few aspects of the model are worth addressing. This modeling approach is based on recent actual demands, not on predicted future demands. It does not take into account decreased storage capacity of Lake Mendocino due to sedimentation. However, cost effective improvements in water-use efficiency or development of alternative water sources, which are discussed in the following section, could more than satisfy future water demands and decreased Lake Mendocino storage capacity. In the model, between 1992 and 2001, without water imported from the Eel River, an annual average suggests a deficit of 7,919 acre-feet. However, this figure is based on an assumption of “business as usual” and does not address the possibility of alternative sources — such as increased groundwater use—or water-conserving practices and crop selection.

B. Demand Management and Improved Water Efficiency

The potential for improved water efficiency is great.

In regard to demand management, especially noteworthy is a comparison of Potter Valley and Redwood Valley agricultural water use. These two valleys are very similar, with Potter Valley receiving slightly more rainfall on average. Potter Valley, however, uses over six times as much water per irrigated acre of grapes, ten times as much water per irrigated acre of pears, and eight times as much water per irrigated acre of hay as Redwood Valley (Northwest Economic Associates, 1998).[7] If these crops were grown with the water-use rate of Redwood Valley, Potter Valley would need to use only 1,940 acre-feet of water compared to the current 14,600 acre-feet a year (1/7th as much water).

Table: 11: Potter Valley crops and acre-feet of water used at:
1) Potter Valley (PV) and 2) Redwood Valley (RV) use rates
(using Northwest Economic Associates figures)

Crop	Irrigated Acres	PV rate AF/acre	AF used PV rate	RV rate AF/acre	AF used RV rate
Grapes	3300	2	6600	.3	990
Pears	400	5	2000	.5	200
Hay	1500	4	6000	.5	750
Total			14,600		1,940

SCWA plans to reduce water use by 2015 by 6,600 acre-feet per year (from 107,100 to 100,500 acre-feet per year) by promoting conservation (Water Conservation Plan, SCWA, 1999). "If all conservation measures and urban water reuse were implemented, base demands could potentially reduce water consumption among the water contractors by more than 8,900AFY[acre-feet per year] by the year 2015." *(Ibid.)*

Sommarstrom has noted that for the Upper Russian River Basin:

> Average annual use for all of the services is approximately 198 to 202 gpcd [gallons per capita per day] … These local per capita water use rates should be compared to those found in other studies. During the 1971-1975 period, the Dept. of Water Resources calculated that three Ukiah area districts averaged 170 to 199 gpcd (CDWR, 1980). In other cities, recent urban water use averaged 147 gpcd in Santa Rosa, 124 gpcd in San Francisco, 171 gpcd in Los Angeles, and 291 in Sacramento (CDWR, 1983b). The Ukiah Valley's current usage rate, therefore, is in the range between that of Los Angeles and Sacramento (an unmetered city). (*Ibid.*, p. 29.)

[7] According to Northwest Economic Associates (1998), " Application rates [for the West Fork Russian River] are lower than for the rest of Mendocino County because water from the Russian River is used as a supplemental source to groundwater. Redwood Valley also has more efficient irrigation systems." The Upper and Middle Russian River sub-basins also use considerably less water per acre for all crop types *(ibid).*

C. Options for Improving Water Supply

Viable options for improving water supply in the Upper Russian River Basin exist.

1. Develop more groundwater sources

Hydrologist Robert Curry has testified that: "There are several groups of options for meeting the water demands in lieu of the Potter Valley diversions. The most promising solutions for upstream sites as well as some Middle Reach sites is increased use of groundwater" (Curry, 1999). Sommarstrom noted that "the location and depth of the wells would need to be carefully planned to ensure that groundwater and not river underflow was being pumped. According to a …study by the U.S. Geological Survey, more groundwater could be extracted in the Ukiah Valley without depleting the reservoir over the long-term" (Sommarstrom, 1986). To potential to increase groundwater use in Potter Valley should also be explored.

2. Use excess winter runoff to recharge the groundwater reservoir

Curry has also testified that:

> At present, nearly 1.1 million acre-feet of water in the Russian River system is untapped, and most of that passes to the sea in the winter. In the past, before the incision of the Russian River in Ukiah, Alexander Valley and Middle Reach areas, less water would have been "lost" from the system because more would have recharged groundwater during winter flood periods. Most of that water would still have passed to the ocean ultimately, but it would flow as base-flow in summer months rather than as flood flows in winter months. Today, winter flow peaks are higher than in the past due primarily to the inability of the River to access its flood plains to store winter water flows and to recharge groundwater. This creates great social cost to lower Russian River residents who are flooded far more than in the historic past, and to individual water users along the river valley throughout the watershed who have less groundwater that must be pumped from deeper levels with decreased water quality. All of this is due to a combination of instream gravel mining and trapping of sediment supply in Lakes Mendocino and Sonoma (Curry, 1999).
>
> Groundwater tables are lowered along the Russian River, recharge is greatly curtailed, and water storage is greatly reduced as the river cuts downward and abandons its flood plains. Russian River winter bankful discharge volumes no longer fill the channel and thus bank storage and overbank recharge is greatly diminished or eliminated altogether *(ibid.)*.
>
> Looking only at the volumes of groundwater that could be enhanced by reductions of winter flows through recharge along the main course of the Russian River from Lake Mendocino southward, I estimate that an added 492,000 acre-feet of water could be stored, of which 246,000 could be readily available annually to make up for the 160,000 ac-ft shortfall due to decommissioning. This estimate assumes that the Ukiah Valley area could store an added 57,600 ac-ft if the original flood-plain functions were restored, that the Alexander Valley reach between Cloverdale and Healdsburg could store an added

204,800 ac-ft, and that the lower Middle Reach between Healdsburg and the Wohler Bridge could store an added 230,400 ac-ft. *(ibid.)*.

3. Extend existing water supply through the use of reclaimed water

Sommarstrom noted that:

> With this option, groundwater pumpage would exceed annual replenishment, but the overdraft would be replaced with surplus winter surface water. Such conjunctive use of surface and groundwater is becoming an increasingly popular alternative in some areas and is expected to allow the Sonoma County Water Agency to extend its water supply by the year 2010. (Sommarstrom, 1986)

IV. Conclusions, Recommendations, and Suggestions for Further Research

A. Conclusions

PVP deconstruction costs are estimated to be $31 million. This includes deconstruction of the dams and other facilities and addressing sediment and restoration needs.

<u>A total of nearly 700 jobs will be directly and indirectly created during the dam deconstruction and habitat restoration period.</u> This includes 486 local temporary jobs[8] created by this deconstruction and restoration, 52 local jobs indirectly created in support industries to the project, and an additional 161 "induced" local jobs created from the increase in local spending from the above direct and indirect jobs.

The direct and indirect economic impact from the Project is estimated to total $45 million.

<u>Because of the timeline for applying for relicensing of hydroelectric facilities, now is not too early to consider deconstruction and financing of the deconstruction of the PVP dams.</u>

<u>Many sources of funding and means for financing deconstruction of the PVP are available.</u> As PG&E addresses issues related to its filing for bankruptcy and its efforts to sell by auction its hydroelectric facilities, questions of who pays for decommissioning and deconstructing hydroelectric facilities become increasingly important and timely. In addition, if the PVP cannot be sold, and if operation and maintenance costs exceed revenue, PG&E might decide to cease operating PVP, which would bring its current license into question.

Nature-based tourism benefits to Mendocino and Lake Counties, counting both rafting and increased fishing, are estimated to exceed $2,000,000 annually.

<u>There is abundant water supply in Mendocino County; annually an average of 1 million acre-feet of water falls in the Upper Russian River basin, which is in Mendocino County</u>. Annual water demand in Mendocino is very small compared to the water that is available.

In an average year the natural flow into Lake Mendocino (without diversion of water from the Eel River) is about 90,000 acre-feet.

<u>Even in critically dry years the water flow requirements of Lake Mendocino can be met without Eel River water.</u>

<u>Several options exist for matching water supply with water demand for the upper Russian River basin.</u> These options include:

1. Revise and improve water storage and release management of Lake Mendocino
2. Develop more groundwater sources
3. Use excess winter runoff to recharge the groundwater reservoir
4. Increase efficiency of water use

[8] "Job" is defined here as "one job for one year," i.e., the equivalent of one person employed full-time for a year. A local job is defined as a job in Mendocino and Lake Counties.

5. Extend existing water supply through the use of reclaimed water

Overall, water in the Upper Russian River basin is relatively abundant, not scarce. For the months of the year when there is no or little rainfall and during the years of exceptionally low rainfall, management of release of water from Lake Mendocino, increases in water supply, and improvements in water efficiency can match the water naturally available in the Upper Russian River basin to humans' social and economic needs.

B. Recommendations

Take steps to ensure that funds to finance decommissioning and deconstruction are available, either through making any new purchaser of a hydroelectric facility responsible for ultimate deconstruction costs, or making the current owner responsible, or legislating mechanisms for creating a Deconstruction Trust Fund for hydroelectric facilities, similar to the Deconstruction Trust Funds established for nuclear facilities.

Manage Lake Mendocino water storage and release so as to maintain higher storage levels in the spring; thus minimum release requirements can be met even during a series of critically dry years.

C. Suggestions for Further Research

Develop PVP-specific engineering cost estimates for deconstruction of the PVP dams and for management of the associated sediment.

Revise and improve the Sommarstrom projected demand estimates based on updated data.

Survey the interest of anglers, rafters and others, especially in the San Francisco Bay Area, for pursuing increased nature-based recreational activities arising from deconstruction of the PVP dams and restoration of the affected watershed.

Create operational plans for developing new groundwater supply and for recharging groundwater as outlined by Robert Curry.

In summary, removal of PVP dams not only benefits fish and fisheries in the Eel River ecosystem, but also benefits the Mendocino and Lake County economies through the jobs created by deconstruction and through the increase in nature-based tourism. Meanwhile local water needs are still satisfied, even without the contribution of Eel River water to the southern counties.

References

Alkire, Carolyn (2003). *Economic Value of Golden Trout Fishing in the Golden Trout Wilderness, California*. Report prepared for Cal Trout.

American Rivers (2000). *Paying for Dam Removal: A Guide to Selected Funding Sources.* American Rivers, Washington, D.C.

American Rivers, Friends of the Earth, Trout Unlimited (1999). *Dam Removal Success Stories*. American Rivers, Friends of the Earth, Trout Unlimited.

American Society of Civil Engineers (1997). *Guidelines for Retirement of Dams and Hydroelectric Facilities.* ASCE, New York, NY.

Babbitt, Bruce (August 4, 1998). Speech at the Ecological Society of America. Restore Hetch Hetchy, http://www.hetchhetchy.org/babbitt_on_dams_9_4-98.html.

Beck, R.W., Inc. (1998). *Condit Hydroelectric Project Removal: Summary Report, Engineering Considerations*.

California Department of Fish and Game (2001). *Draft Environmental Document Analyzing the California Fish and Game Commission's Special Order Relating to Incidental Take of Coho Salmon North of San Francisco During the Candidacy Period.* California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game (1997). *Eel River Salmon and Steelhead Restoration Action Plan*. California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

California Department of Fish and Game (2002*). 2002 Draft Russian River Basin Fisheries Restoration Plan*.

California Department of Water Resources (2004). *Data Exchange Center: Dam Database*. http://cdec.water.ca.gov/cgi-progs/damSearch

California State Costal Conservancy (2004). *Noyo River Plan*. California State Costal Conservancy.

Center for Environmental Economic Development (2002). *A River in the Balance: Benefits and Costs of Restoring Natural Water Flows to the Eel River*. Arcata, CA.

County of Mendocino (1981). Land Use Element of the Mendocino County General Plan: Fisheries. County of Mendocino, Ukiah, CA.

Curry, Robert (1999). Testimony prepared for Friends of the Eel River, Redway, CA.

ECONorthwest (1999). *An Economic Strategy for the Lower Snake River*. ECONorthwest, Eugene, OR.

Eddie, Sara (2004). *FERC Hydropower Relicensing*, Presentation and Discussion. 2004 Public Interest Environmental Law Conference, March 5, 2004, University of Oregon, Eugene, OR.

Entrix, Inc. (2002). *Russian River Biological Assessment, Interim Report 3: Flow-Related Habitat*. Entrix, Inc. Walnut Creek, CA.

Entrix, Inc. (2003). *Russian River Biological Assessment Flow Alternatives, Addendum to "Alternatives: Evaluation of Management Actions" dated September 13, 2002*. Entrix, Inc. Walnut Creek, CA.

Entrix, Inc. (2004). *Russian River Draft Biological Assessment*. Entrix, Inc. Walnut Creek, CA.

Federal Energy Regulatory Commission (1978). *Potter Valley Project: Draft Environmental Impact Statement*. FERC, Washington, D.C.

Federal Energy Regulatory Commission (2000). *Proposed Changes in Minimum Flow Requirements at the Potter Valley Project: Final Environmental Impact Statement*. FERC, Washington, D.C.

Griffin, Jenny, and Thomas Scharffenberger (2003). *Mendocino County Coastal Conservation Plan*. Mendocino Land Trust, Mendocino County, CA.

Hackett, Steven (2001). *Natural Resource and Environmental Economics: Theory, Policy, and the Sustainable Society*. M.E. Sharp, Armonk, NY.

The H. John Heinz III Center for Science, Economics and the Environment (2002). *Dam Removal: Science and Decision Making.* The Heinz Center, Washington, D.C.

Industrial Economics, Inc. (1998). *Economic Analysis for Hydropower Relicensing: Guidance and Alternative Methods*. Industrial Economics, Inc., Cambridge, MA.

Mendocino County Resource Conservation District (2002). *Mendocino County Resource Conservation District Long Range Plan 2001-2005*. http://www.carcd.org/wisp/mendocino/lr-plan.htm.

Meyer, Philip A. (1991). "What's a Salmon Worth" in Lufkin, Alan (ed.) *California's Salmon and Steelhead: The Struggle to Restore an Imperiled Resource*. University of California Press, Berkeley and Los Angeles, CA.

National Marine Fisheries Service, Southwest Region (2002). *Biological Opinion for the Proposed License Amendment for the Potter Valley Project*.

National Park Service (1995). *Elwha River Ecosystem Restoration: Final Environmental Impact Statement*. National Park Service, Denver Service Center, Denver, CO.

National Park Service (1998). *Elwha River*, Olympic News. http://www.nps.gov/olym/issues/isselwha2.htm.

National Park Service: Rivers, Trails, and Conservation Assistance Program, and American Rivers (1996). *River Renewal: Restoring Rivers Through Hydropower Dam Relicensing.* Washington, D.C.

Nguyen, Don D. (2003). *Feasibility Study of Matilija Dam Removal*. Available at www.matilijadam.org/alt-project.pdf.

Northwest Economic Associates (1998). *Analysis of the Socioeconomic Impacts of Changes in the Potter Valley Project Flow Release Schedule, Interim Report*. Sonoma County Water Agency, Santa Rosa, CA.

Pacific Municipal Consultants (2003). Background Report for the County of Mendocino General Plan Update. County of Mendocino, Ukiah, CA.

Pacific Gas and Electric Company (1968). *Report to the Federal Power Commission on the Potter Valley Hydroelectric Project.* PG&E, San Francisco, CA.

Spain, Glen, 2004. Personal communication.

Sones, Jacob (2002). Memorandum: Wyoming Economic Benefits Derived from Highway Construction Projects. http://wydotweb.state.wy.us/web/inside_wydot/dist5/construction_multipliers_overview.pdf

Sommarstrom, Sari (1986). *An Inventory of Water Use and Future Needs in the Russian River Basin of Mendocino County*. Mendocino County Flood Control and Water Conservation District, Ukiah, CA.

Sonoma County Water Agency (1991). *Water Sources and Supply Outlook, Including Firm Yeilds, and Frequency and Magnitude of Supply Deficiencies*. Sonoma County Water Agency, Santa Rosa, CA.

Sonoma County Water Agency (1999). *Water Conservation Plan*. Sonoma County Water Agency, Santa Rosa, CA.

University of Alaska (1997). Quoted in *Regional Port of Anchorage Master Plan, Appendix A: Economic Impact Overview*. http://www.ci.anchorage.ak.us/iceimages/port/APPDXA.pdf.

U.S. Geological Survey (2004). *Surface Water Data for California*. http://waterdata.usgs.gov/ca/nwis/sw.

Appendices

Appendix 1: OTHER DAMS

Table A-1: The Potter Valley Project dams compared to selected other dams removed or slated for removal

Dam	Height (ft)	Length (ft)	Impoundment	Status	Cost (actual or estimated)
Lewiston	45	1060		Removed	$633,428
Marmot	47	195	18 acres	Slated	$17,060,000
Bluebird	56	200		Removed	$1,500,000
Grangeville	56	440		Removed	
Mounds	58	430	57 acres	Removed	$170,000
Willow Falls	60	160	100 acres	Removed	$450,000
Cape Horn	63	520	700af		
Two-mile	85	720	500af	Removed	$3,200,000
Elwha	105	450	8,100af	Slated	$25,600,000
Condit	125	471		Slated	$13,650,000
Scott	130	805	73,000af		
Matilija	190	620	1,800af (7,018af)	Notched, slated	$53,795,553
Glines Canyon	210	270	30,000af	Slated	$40,300,000

Following are descriptions and discussion of other dams that have been removed or are the subject of proposals for removal.

<u>Lower Snake River Dams</u>

The Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams are all approximate 100 feet high and were all considered for removal in the 2002 U.S. Army Corps of Engineers' 2002 *Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement*.

Sediment (USACOE, 2002, Appendix F, F20-5)
Accumulated sediment behind the four dams:

	Millions of cubic meters	Acre-feet (high estimate)
Ice Harbor	16.1-21.4	17,342
Lower Monumental	2.3-3.1	2,512
Little Goose	11.5-15.3	12,399
Lower Granite	55.1-73.4	59,481

Studies estimated that "a significant portion of the channel sediment erosion will have occurred within about 2 to 5 years after dam breaching" (F25-1). (USACOE also cites the 1996 Elwha sediment report for erosion predictions.)

Total estimated cost of sediment monitoring before and after breaching of the four dams: $2,158,680, including surveys ($1,507,500), sediment transport monitoring, data analysis and reporting, etc. (USACOE, 2002 Appendix F, page F26-2).

Jobs and costs
American Rivers estimates: 23,639 short-term and at least 3,183 permanent jobs. 1,293 jobs removing earthen portion of dams.

The largest construction costs are for dam embankment removal and river channelization, which in combination exceed $70 million at each of the dams.

Recreation
"The estimated annualized present value of the economic benefits of restored river recreation exceed reservoir recreation activities by at least $28 million per year to as much as $306 million per year with a middle estimate of $66 million per year. The incremental passive use values for the increase in anadromous fish due to the dam breaching is about $1 billion for households in the Pacific Northwest and California." —*Lower Snake River Juvenile Salmon Migration Feasibility Study, Recreation and Tourism Analysis*, USACE, 1999.

Elwha River
From *Elwha River Restoration Project: Sediment Analysis and Modeling of the River Erosion Alternative*, DOI, BOR, 1996.
Summary
"Removal of two hydroelectric dams on the Elwha River of Washington's Olympic Peninsula is an alternative being considered to restore the ecosystem and native anadromous fisheries. Elwha and Glines Canyon Dams block anadromous fish passage to more than 70 miles of the Elwha River and its tributaries, limiting anadromous fish to the lower 4.9 river miles. Lake Aldwell, formed behind Elwha Dam in 1913, stores an estimated 4 million cubic yards (myd3) of sediment. Further upstream, Lake Mills was created in 1927 with the closure of Glines Canyon Dam and contains an estimated 14 myd3 of sediment."

Elwha River Dam Removal Cost and Jobs (from *Dam Politics*, William R. Lowery, 2003)

Removal of:	Cost	Jobs
Glines Canyon Dam	$86 million	172 person years
Elwha Dam	$65 million	84 person years
Both Dams	$75-$100 million	763-1,067 person years

Condit Dam
From Friends of the Earth*: http://www.foe.org/camps/reg/nw/river/whitesalmon.html*

The Condit Hydroelectric Project is a 14-megawatt project located on the White Salmon River in southwestern Washington. Owned by PacifiCorp, the dam is 471 feet long, 125 feet high, with a 125-foot spillway. The project was built in 1913 and is located three miles upstream from the confluence of the White Salmon and Columbia Rivers about 60 miles east of Portland, Oregon.

In September 1999, all parties reached a final settlement agreement. The agreement calls for the company to stop generating electricity at the project after seven years—October 2006—and for the dam and the water conveyance system to be removed.

During the seven-year period, funds generated by the project operations will go toward dam removal, engineering, permitting, a fisheries enhancement fund and a fund to enhance a traditional Indian fishing site at the mouth of the White Salmon River. The overall costs will not exceed $17.15 million. Of this:

$13.65 million will go for project removal costs;

$2.0 million will go for permitting and mitigation costs;

“$1 million will go for a Tribal Restoration Fund which will be administered by the Yakama Nation for enhancement and restoration of fishery resources in the White Salmon River; and

$500,000 will go for an enhancement fund for the traditional Indian fishing site to assist in dredging near the mouth of the White Salmon River.

From *Columbia River Inter-Tribal Fish Commission: 1997*
“Removal costs range from $14 million for natural river erosion to $16 million for pipeline slurry to Bonneville Dam Pool to $37 million for a dry excavation alternative.”

From *Condit Removal Plan Summary*
estimated “waste” from dam removal:
• Concrete - over 45,000 cubic yards (broken volume)
• Wood Pipe Staves - over 6,000 cubic yards stacked
• Steel - over 400 tons
• Woody Reservoir Debris - from drained reservoir area (unknown quantity)

Matilija Dam
Height: 190 ft (now 160 ft)
Length: 620 ft
Volume: 51,100 cubic yards of concrete
Impounds: 1,800 acre-feet of water
Removal cost: A 2000 Bureau of Reclamation study estimated that removing the dam would cost $21–$180 million.
Reservoir Capacity:
* Design: 7,018 acre-feet
* After notching: 3,800 acre-feet (excluding sedimentation losses)
* Current: Less than 500 acre-feet (combined notching and sedimentation losses)
* Projected: zero capacity by 2020
* Original reservoir area: 126.8 acres
* Drainage area of Matilija Creek above dam site: 55 square miles

Matilija Sediment Alternatives

Sediment management alternative	Approximate time	Estimated cost
1A upstream stabilization	2 years	$69.2 M
1B downstream transportation	4-5 years	$144.4 M
1BB slurry pipeline	4 years	$179.4 M
2 phased natural transport	25 years	$21.6 M
3 combination of alternatives 1 & 2	?	?

Source: Matilija Coalition (http://pages.sbcglobal.net/pjenkin/matilija/how_to.htm)

Matilija Coalition
"Over the past half century the capacity of the Matilija reservoir has been reduced by over 90% mainly due to the 6 million cubic yards of sediment trapped behind the dam. This has rendered it an obsolete structure that no longer serves a purpose for flood control or water storage." "The reservoir storage is predicted to be zero by 2020."

Matilija Dam Ecosystem Feasibility Study, Draft Main Report, and EIS/EIR Feasibility Study. 2003 (detail of alternatives on 9-11 = page 86)
"Alternative 2b is full dam removal in one phase. All the trapped sediment is allowed to be eroded downstream by storm events and natural fluvial processes. Alternative 3a is incremental removal of the dam. The dam demolition will be conducted in two phases. In Phase 1, the fine sediment in the area underlying the current lake is slurried downstream to a 94-acre disposal site, followed by the removal of the dam structure to elevation 1000. Phase 2 removal of the remaining portion of dam will begin once the sediment level in the reservoir has, by natural fluvial erosion, reached an equilibrium condition with the modified dam height resulting from Phase 1."

"Costs for the alternatives range from $51,400,000 to $88,900,000. From an incremental cost perspective, Alternative 2b has the lowest average annual cost per habitat unit. Alternative 2b is the tentatively recommended plan."

FEASIBILITY STUDY OF MATILIJA DAM REMOVAL
Prepared by: Don D. Nguyen 26-Jun-03

ALTERNATIVES TOTAL PROJECT COST	
1. Full Dam Removal/Mechanical Sediment Transport:	
Dispose Fines, Sell Aggregate	$65,507,919
2. Full Dam Removal/Natural Sediment Transport	
2a. Slurry "Reservoir Area" Fines Offsite	$67,200,861
2b. Natural Transport of "Reservoir Fines"	$53,795,553
3. Incremental Dam Removal/Natural Sediment Transport	
3a. Slurry "Reservoir Area" Fines Offsite	$71,216,545
3b. Natural Transport of "Reservoir Fines"	$55,692,766
4. Full Dam Removal/Sediment Stabilization on Site	
4a. Permanent Stabilization	$80,392,575
4b. Temporary Stabilization	Not evaluated

Hemlock Dam

Costing of the Options
From *Hemlock Dam Fish Passage Evaluation and Restoration*, Barber and Perkins, 1999.

Costs for each of the options follows the detailed description of each of the options. The tasks that need to be priced include building a new ladder, diverting part of the stream to the ladder, removing the old ladder, improving the irrigation system, improving the trap, cutting 7 feet from the dam, removing the dam, creating an off-channel pond, and restoring a stream channel. These tasks are broken down into items that could be priced.

Many construction costs are obtained using prices from the 1998 National Construction Estimator computer program developed by Kiley and Moselle (1998). Where equipment and labor costs are not split apart, Marshall and Swift's 1998 Dodge Heavy Construction Cost Book is used (Marshall and Swift, 1998). These prices are compared to costs that other similar projects estimated to gage the accuracy of the estimates. Adjustments are made where necessary. Several design elements are not detailed in these books so other sources are used. Examples of the unique costs are fishway design, the placement of large woody debris, and dam removal.

Examples of the evaluation of the costs by Kiley and Moselle (1998) can be seen for the revegetation of the lake and the dredging of the reservoir. In the evaluation of removing the Condit Dam (RW Beck, 1998), the estimated cost for revegetating a dried-up Northwestern Lake was $10,000 an acre. The costs are then evaluated using Kiley and Moselle by determining the average cost to seed a level area and lay down 4 inches of topsoil. This method resulted in a cost of roughly $12,000 per acre. This estimate is probably a little high because 4 inches of topsoil may not be necessary to get sufficient plant growth on the dried-up lake bed. This cost, therefore, is a conservative estimate.

For the cost of dredging the reservoir, two additional sources are used: The Guidelines for Retirement of Dams and Hydroelectric Facilities (ASCE, 1997) and Seesholtz (1986). In the ASCE report, it is reported that a lake in central Illinois was dredged to remove 280,000 cubic yards of sediment using a hydraulic dredging approach. This project cost $3 per cubic yard. Seesholtz (1986) estimated that it would cost $200,000 to dredge 45,000 cubic yards using a Mud Cat-type dredge. This results in a cost of $4.44 per cubic yard. Using a scraper-hauler approach, Kiley and Moselle's (1998) costs result in a cost of $3.76 per cubic yard.

In Charles Clay's Design of Fishways and Other Structures (1995), the fishway structure cost criteria is listed as $37 per cubic foot of volume encompassed by the structure. This estimate is used for the pricing of the new fishway structure and for a new fish trap. In this book, it also estimates that operation and maintenance charges average 1-2 percent of the capital cost of the fishway structure. The operation and maintenance cost is estimated at 1.5 percent for the new fishways designed.

For the removal of the dam itself, the cost estimate by R. W. Beck (1998) for the demolition and disposal of the Condit Dam in the nearby White Salmon drainage is estimated at being between $105.85 and 142.35 per cubic yard of the dam structure. The Condit Dam removal, however, would be a lot more complicated than removing Hemlock Dam. The Condit Dam removal is complicated by access problems, larger and deeper sediment load behind the dam, and larger summer flows. The dam removal costs for Hemlock Dam are estimated by determining the costs to blast the dam apart and for the removal of the debris. This resulted in a cost of $34.40 per cubic yard of the dam structure.

The large woody debris structure, spawning survey, and dam maintenance costs are estimated from previous costs at Trout Creek that were provided by Ken Wieman. Costs to meet OSHA requirements to provide safe access to the fish ladder for maintenance activities are not included for any of the options but could be a cost for each of the options with the exception of the Full Dam Removal.

R.W. Beck (1998) estimated contingencies to be an additional 25% of the direct construction cost, and engineering and permitting were estimated to be an additional 10%, and 3% of the total construction cost. These costs are added to each option.

Full Dam Removal Inflation-Adjusted Costs and Benefits

	1999 Dollars	2039 Dollars	2039 Dollars	2039 Dollars
		With 3% Inflation	With 4 % Inflation	With 5% Inflation
Initial Cost	$1,091,297.46			
40-year Cost	$240,000.00	$782,889.07	$1,152,244.95	$1,689,597.29
40-year Benefits	$4,562,250.00	$14,882,231.92	$21,903,456.36	$32,118,188.50
Benefit/Cost Ratio	3.43			

Bull Run Project: Marmot Dam (and 15.75-ft-high Little Sandy diversion dam)
Height: 47 ft
Length: 195 ft
Impoundment: 18-acre reservoir area
Decommissioning cost: $17.3 million (Bull Run FEIS) or $22 million (Heinz Report)
Generation: Loss of 111,000 MW per year (22 MW maximum capacity)
Sediment: 960,000 cubic yards

Two Tables from Bull Run Project FEIS:

Estimated Cost Associated with Project Decommissioning and Removal

Cost Estimate/ Component	Alternative 1	Alternative 2	Alternative 3
	Single season dam removal with minimal sediment removal (PGE's proposal)	**Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation**	**Remove the dam and the maximum amount of sediment possible during 1 in-water work period**
Marmot Dam Removal	$3,344,000	$12,418,,000	$10,054,000
Project Removal	$9,500,000	$18,574,000	$16,210,000
Total Project Decommissioning	$17,060,000	$26,134,000	$23,770,000

Comparison of Marmot dam removal alternatives.

Resources	Alternative 1 Single season dam removal with minimal sediment removal (PGE's proposal)	Alternative 2 Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation	Alternative 3 Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Sediment (Excavated)	20,000 to 30,000 cubic yards of sediment excavated from behind dam	340,000 cubic yards of primarily sand excavated	Removal of between 125,000 and 300,000 cubic yards of sediment
Sediment Transported Downstream)	950,000 to 960,000 cubic yards of sediment transported downstream	640,000 cubic yards of sediment transported downstream over 2-year period	680,000 to 855,000 cubic yards of sediment transported downstream
Water Quantity	Restoration of natural flows to approximately 10 miles of the Sandy River between Marmot Dam and the confluence of the Bull Run River	Same as alternative 1	Same as alternative 1
Water Quality—short-term	Short-term increases in suspended sediment loads as a result of dam removal activities and limited dredging	Greater short-term effects because of more dredging than under alternative 1	Greater short-term effects because of more dredging than under alternative 1
Water Quality—long-term	Reduction in water temperatures and increase in dissolved oxygen	Same as alternative 1	Same as alternative 1

<u>Other Dams</u>

Grangeville & Lewiston Dams, Idaho

Height: 56 ft & 45 ft
Length: 440 ft & 1060 ft
Built: 1903 & 1927
Generating capacity: 1 MW & 10 MW
Cost of removal: unknown & $633,428
Removed: 1963 & 1973
Removal method: explosives & dismantling

Willow Falls & Mounds Dam, Wisconsin

Height: 60 ft & 58 ft
Impoundment: 100 acres & 57 acres
Built: 1870 & 1926
Estimated cost of removal: $622,000 & $1.1 million
Cost of removal: $450,000 & $170,000
Removed: 1992 & 1998

Two-Mile Dam, New Mexico

Height: 85 ft
Length: 720 ft
Impoundment: 500 acre-feet
Built: 1894
Cost of removal: $3.2 million
Removed: 1994
Removal method: heavy construction equipment

Bluebird Dam, Colorado
Height: 56 ft
Length: 200 ft
Built: 1904
Cost of removal: $1.9 million to purchase water rights and easements (including two other dams); $1.5 million for physical removal of Bluebird Dam
Removed: 1989 - 1990
Removal method: heavy machinery, helicopters

Savage Rapids Dam, Rogue River, Oregon
Height: 39 ft
Length: 460 ft
Built in 1921 for agriculture diversion
BOR Study found that a salmon-friendly retrofit could cost as much as $21 million, while removing the dam and meeting local water supply needs with modern pumps was estimated to only cost $13 million. (Heinz Report, p. 142.)

Appendix 2: SEDIMENT MANAGEMENT

"…with an effective sediment management plan, releases of sediment in a controlled fashion can generate beneficial results such as releasing coarser-grained gravels, woody debris, nutrients, and other materials which can provide benefits to fish, wildlife, and aquatic communities. Increased braiding of a river course can create new spawning and rearing habitat for salmon and other fish species."

Also, "…the cost of a sediment management strategy can be a dominant part of the total retirement cost." (ASCE, Guidelines for Retirement of Dams and Hydroelectric Facilities, p. 74).

Natural River Erosion

Often, the dam is removed in stages to control rate of reservoir drawdown and sediment erosion. "Low breaching rates are likely to release less sediment during a given period than high breaching rates." (ASCE, p. 81.)

Mechanized Removal

Conventional excavation
Mechanical dredging
Hydraulic dredging
Sediment conveyance

"*Conventional excavation* requires lowering the reservoir or rerouting the river to excavate and remove dry sediment. When sediment is dry, bulldozers and front-end loaders remove the sediment, and trucks or conveyor belts transport it to an appropriate disposal site. Using this approach depends on the amount of time required to dry sediment, the available facilities, sediment volume, the flood and discharge characteristics of the river basin discharging into the reservoir, and the distance to the disposal site. Depending upon the sediment composition, the length of time for sediment to "dry" may be substantial (several months).

"At a shallow 4-hectare (10-acre) reservoir in northeastern Illinois, approximately 11,500 m^3 (15,000 cubic yards) of 'special waste' sediments were removed and disposed at a nearby landfill for total cost of $350,000 (1989). The unit cost was about $19 per cubic meter ($25 per cubic yard)." (ASCE, p. 82.)

Hydraulic dredging

"At a 73-hectare (180-acre) lake in central Illinois, 210,00 cubic meters (280,000 cubic yards) of sediment were hydraulically dredged and disposed from a facility constructed on the owner's adjacent property. The total cost was $900,000 (1989), with a unit cost of approximately $2.30 per cubic meter ($3 per cubic yard)." (ASCE, p. 83.)

Long-term disposal

"Distance from the reservoir is an important parameter in the selection of a disposal site as conveyance costs increase as the distance to the disposal site increases. If the disposed sediments contain high concentration of pollutants, a land disposal site may have to be lined to prevent groundwater contamination.

"Reservoir sediment volumes can be large and require sizable land areas for disposal. For example, studies showed that disposal of the estimated 14 million m^3 (18 million cubic yards) of sediment in two reservoirs on the Elwha River would require a 230-hectare (560-acre) site with sediment placed 6 meters (20 feet high)." (ASCE, p. 83)

In regard to the Elwha dams the following descriptions are relevant and useful to understand some of the issues and features of sediment management. From *Elwha River Restoration Project: Sediment Analysis and Modeling of the River Erosion Alternative*, DOI, BOR, 1996.

Removal of these dams requires development and analysis of alternative plans to manage the reservoir sediment and analysis of the effects of re-establishing the natural sediment supply to the Elwha River downstream of the dams. Removing the dams in controlled increments and allowing reservoir sediment to erode and be transported downstream through natural processes is the alternative evaluated in this report. The impacts of this alternative on the river's sediment concentration, riverbed aggradation, and corresponding increases in flood stage were predicted from results of reservoir drawdown testing at Lake Mills and a series of computer models.

Model results predicted that 15–35 percent of the coarse sediment (sand, gravel, and cobbles) and about half of the fine sediment (silt- and clay-size particles) would be eroded from the two reservoirs because of dam removal. The remaining sediment would be left behind along the reservoir margins as a series of terraces. Fine sediment concentrations released from the reservoirs would be high during periods of dam removal, typically 200–1,000 ppm but occasionally as high as 30,000–50,000 ppm. Release concentrations would be relatively low — less than 200 ppm — during periods of high lake inflow when dam removal activities and lake drawdown would stop. After the dams are removed, fine sediment concentrations would be low and near natural conditions during periods of low flow. Concentrations would be high during progressively higher floodflows as erosion channels widen in the reservoir areas. Within 2 to 5 years, concentrations would return to natural levels.

Coarse sediment would aggrade in river pools in the relatively steep reach between the two lakes and would increase 100-year-flood stages up to 0.5 feet. In the more mild slope reach below Elwha Dam, general riverbed aggradation would occur which would likely cause the river to migrate laterally, especially near the mouth. Over the short term (up to five years), this could potentially increase river stages during the 100-year flood 0–3 feet, depending on location, with an average increase of less than 1 foot. Over the long term (50 years), aggradation could continue and increase existing river stages during the 100-year flood 0–5 feet (depending on location) with an average increase of 2.5 feet. Coarse sediment would enlarge the delta at the river's mouth to a size and character similar to that of predam conditions.

With monitoring and mitigation, the 'river erosion alternative' constitutes a viable sediment management plan for the removal of Glines Canyon and Elwha Dams. Extensive monitoring and control of the dam removal rate are needed to manage or avoid problems with riverbed aggradation, flooding, and water quality."

Appendix 3: Financing Deconstruction and FERC Relicensing Costs

Condit Dam

After conducting an EIS of the Condit Dam Project, FERC made the installation of fish-passage measures a condition of relicensing. The cost of such measures would have made the project uneconomical, and after negotiations between the hydropower company (PacifiCorp), environmental and tribal groups, and federal and state fisheries agencies, all of the parties petitioned FERC to stop the licensing Proceedings. Eventually a settlement agreement was reached that included the removal of the dam, paid for by PacifiCorp, at a significantly lower cost than that of relicensing.[9]

Bull Run Hydroelctric Project

In this situation the utility, Portland General Electric Company (PGE), chose the "alternate" approach to relicensing, which is a more collaborative approach where stakeholders meet and develop a settlement agreement prior to license application. PGE determined that continued operation would be uneconomical based on the costs of relicensing, and so decided against applying for relicensing and instead applied to surrender the license and remove all structures.[10] This course of action saved PGE money by avoiding all the related costs of applying for relicensing (which they were able determine ahead of time would not have had an economically feasible result).[11]

[9] Friends of the Earth. http://www.foe.org/camps/reg/nw/river/whitesalmon.html
[10] *Final Environmental Impact Statement: Bull Run Project, Oregon.* Federal Energy Regulatory Commission. 2003.
[11] Brett Swift, American Rivers, Presentation on FERC Relicensing at University of Oregon, March 2004.

Appendix 4: Further Discussion of Valuing Nature-based Tourism and Recreation

There are two main approaches that have been used to determine the value of a steelhead. These are classified as economic impact and economic value approaches (Carter, 1999). The economic impact approach measures the money people spend to buy goods and services on their fishing trips. This usually results in a value per angler day. The economic value approach determines what a person is willing to pay to be able to fish and subtracts the value that the fisherman actually pays. This results in a value per fish caught. Both of these techniques, however, yield inconsistent and incomplete results for evaluating the value of Trout Creek steelhead. Carter (1999) compared 11 economic impact studies and found that the values of steelhead ranged from $21.87 to $66.58 per angler day in 1997 dollars. Carter (1999) lists two economic value approach studies performed by Olsen et al. (1990, 1994) which list the average value per fish caught in 1997 dollars as $76.36 for coastal steelhead, $91.49 for summer steelhead, and $49.31 for winter steelhead.

These valuation techniques, though, do not account for “passive use” values. “Passive use” values are the values attributed to knowing that a fish stock exists, to maintaining a species for future generations, and to ensuring the opportunity to fish in the future. The bulk of the short-term benefits of Trout Creek steelhead will be from this category because fishing is not allowed on Trout Creek and probably will not be until the stock is restored to a sustainable level. There are currently no “passive use” value studies on fish and the validity and repeatability of the data from these types of studies (contingent valuation) is still being debated (Diamond and Hausman, 1994; Hanneman, 1994).

From **Analysis of the Socioeconomic Impacts of Changes in the Potter Valley Project Flow Release Schedule, Northwest Economic Associates, 1998.**

Recreation

“Very limited recreational activities exist on the East Fork of the Russian River above Lake Mendocino due to limited access and the characteristics of water flows.” (p. 34)

“In 1981 recreation days peaked at 2,761,400 and have declined to around 1,500,000, due in part to the availability of Lake Sonoma.” . . . “ This is due not only to the availability of Lake Sonoma, but also because the facilities at Lake Mendocino are at or near capacity, especially during peak periods. Campers are regularly turned away during the summer months when campgrounds are full.” (p. 35)

“The Majority of visits occur between Memorial Day and Labor Day, with the months of June, July, and August accounting for 45.1 percent of all visitation. September, October, and November account for 15.3 percent; December, January, and February account for 11.2 percent; and March, April, and May account for 28.4 percent.

“Approximately 53 percent of the visitors to Lake Mendocino live within 25 miles of Lake Mendocino (i.e. Mendocino County). Another 21 percent live within 26 and 100 miles of the project, while the remaining 26 percent live more than 100 miles from Lake Mendocino.

“Approximately 83 percent of the visits to Lake Mendocino are for day use, and approximately 17 percent are for camping. Day use and camping visitors participate in picnicking (18%), boating (22%), water-skiing (13%), fishing from a boat (4%), fishing from shore (8%), swimming (35%), hunting (3%), and sightseeing (29%).”

Appendix 5: Decision 1610

From:

Krista Rector (1996). ***Sonoma County Water Agency White Paper*****. Sonoma County Environmental Center. http://www.envirocentersoco.org/SCWA/**

Decision 1610: Adopted on April 17, 1986. Approved the completion of construction projects by December 1, 1995 and the time to complete beneficial use of water extended to December 1, 1999. Maximum combined rate and quantity of direct diversion at the Wohler and Mirabel Park pumping facilities should be limited to 180 cfs and 75,000 afa. Stream flow requirements are 25 cfs in East Fork Coyote Dam to confluence of East Fork with Russian River. Flows in the Russian River between Dry Creek and the mouth will be a minimum of 125 cfs.

Appendix 6: Water Demand and Supply, Upper Russian River Basin

Summary of County Agricultural Commissioners' Reports 2000-2001. Leading Commodities for Gross Value of Agricultural Production in Mendocino County, 2001.

Crop	$1,000
1. Grapes	87,678
2. Pears, Bartlett	12,549
3. Cattle and Calves	7,750
4. Milk	4,703
5. Nursery	2,750
6. Pasture, Irrigated	1,807
7. Pears, Bosc	1,346
8. Pasture, Range	1,161
9. Vegetable Crops	1,112

Table: Agricultural Land Use in 1997 (1997 Census of Agriculture, U.S. Department of Agriculture, 1999)

	Mendocino	Lake	Sonoma
Acres in farms	638,566	138,482	570,804
Acres of total cropland	66,316	33,085	144,544
Acres of irrigated land	24,716	16,704	57,181
Acres of harvested cropland	30,425	16,704	80,771
Acres of hay-alfalfa, other tame, small grain, wild grass silage, green chop, etc.	10,062	5,100	26,565
Acres of vegetables harvested	556	45	2,001
Acres of land in orchards	19,272	14,795	50,301

Northwest Economic Associates, 1998

21,097 irrigated acres of crops in Russian River basin in Mendocino County.

USGS National Water-use Data files for 1995 (USGS, 1999)

	Russian River Basin	Mendocino County
Population	355260	84300
Domestic		
Ground water withdrawals AFY	3384	2622
Surface water withdrawals AFY	381	291
Total Withdrawals AFY	3765	2913
Deliveries from public suppliers	30389	7429
Total Withdrawals plus deliveries	34154	10343
Consumptive use	10477	2689
Per Capita Use self-supplied gpd	75.08	75.1
Per Capita Use, public supplied pgd	87.34	133.45
Commercial		
Consumptive Use	2264	381

Irrigation		
Groundwater Withdrawals AFY	19341	15060
Surface water withdrawals AFY	62628	25694
Total Withdrawals AFY	81968	40754
Consumptive use	81968	40553
Acres irrigated, sprinkler, in thousands	9.07	4.57
Acres irrigated, microirrigation, in thousands	15.6	5.79
Acres irrigated, surface, in thousands	30.27	13.24
Acres irrigated, total, in thousands	54.94	23.6
Industrial		
Groundwater Withdrawals AFY	5569	3743
Surface water withdrawals AFY	168	112
Total Withdrawals AFY	5737	3855
Consumptive use	1748	1244
Totals		
Total Groundwater Withdrawals	51243	30266
Total Surface water withdrawals	96390	28630
Total withdrawals	164497	58896
Total consumptive use	113198	45685

Analysis of the Socioeconomic Impacts of Changes in the Potter Valley Project Flow Release Schedule, Northwest Economic Associates, 1998.

Potter Valley Irrigation

"Many years ago, the farmers in the area primarily used flood irrigation. Currently, most of the flood irrigation has been replaced with sprinkler and drip irrigation systems. Virtually all Potter Valley vineyards have overhead sprinklers for frost protection and drip systems for summer irrigation. Many pear growers have converted from overhead sprinkler systems to micro-emitter under-tree systems. The only crop still utilizing flood irrigation is pasture. For pasture, flood irrigation is simple and very cost effective. There is very little reason for producers to convert to other systems. Concurrently, pasture is being converted to vineyards at a rapid pace." (p. 69)

"An estimate of the per-acre capital cost that the Potter Valley farmers may already have invested to improve their individual irrigation systems is in the range of $1,200 to $2,900 per acre for sprinkler systems, and $1,100 to $3,200 per acre for drip systems."(pp. 69-70)

Water Sources and Supply Outlook. . .   SCWA, 1991.

Forsythe Basin (Redwood Valley) 2010 demand is 4,447 AFA.

Coyote Basin 2010, 8,970 AFA normal year, 10,560 AFA dry year.

Upper Russian 2010 Urban demand, 7,670 AFA, Normal Agriculture 13,200AFA, Dry Agriculture 18,600 AFA

". . .the construction and maintenance of dams and reservoirs with the capacity to satisfy 100 percent of the demand during climatic conditions which occur only very rarely is not feasible. Planning assumptions vary from agency to agency, but a 15 percent deficiency is generally considered to be manageable, provided it only occurs infrequently." (p. 11)

Allocation of Russian River water in an Average Year under year 2010 Demand Conditions (p. 13):
Agriculture: 43,000 AF
Urban: 121,000 AF
Streamflow: 1,552,000 AF

The Russian River: An Assessment of its Condition and Governmental Oversight, Beach, SCWA 1996

Allocation of Russian River Water in Average Year, Under Year 2015 Demand Conditions (p. 1-I-16):
Agriculture: 50,000 AF
Urban: 117,000 AF
Streamflow: 1,442,000 AF

Water Action Plan for the Russian River Service Area, Dept of Water Resources, 1980.

"In the future an increase in irrigated agricultural land of about 35 percent or 6,600 hectares (16,000 acres) is predicted. About half would be due to conversion of dry farmed grapes to irrigation." (p. 6)

Mendocino County Russian River Flood Control and Water Conservation Improvement District. Progress Report, 2002.

Annual water consumption for crops:
Orchards: 3.89 AF/year per acre
Vineyards: 1.98 AF/year per acre
Pasture: 33.33 AF/year per acre
Unknown crop (average of vineyard and orchard): 2.89 AF/year per acre

Water distribution (AF/acre) from crops								
crop	Oct-Mar	Apr	May	Jun	Jul	Aug	Sept	Total
Orchard	0	14%	14%	18%	18%	18%	18%	3.98
[in AF]	0	0.557	0.557	0.716	0.716	0.716	0.716	
Vineyard	0	30%	30%	10%	10%	10%	10%	1.89
[in AF]	0	0.567	0.567	0.189	0.189	0.189	0.189	
Pasture	0	0	0	25%	25%	25%	25%	3.33
[in AF]	0	0	0	0.833	0.833	0.833	0.833	
Unknown	0	22%	22%	14%	14%	14%	14%	2.89
[in AF]	0	0.636	0.636	0.125	0.125	0.125	0.125	

Sommarstrom 1986

“Urban water demand in 1985 was estimated to be 10,354 acre-feet for the Russian River Basin in Mendocino County, excluding Potter Valley. Regional population was approximately 32,500 people.”

“Total agricultural demand was estimated to be 15,636 acre-feet in 1985.”

“Combined water demand for both urban and agricultural users amounted to 25,990 acre-feet. With the addition of 9,380 acre-feet used in Potter Valley, total water use in the Russian River Basin was 35,370 acre-feet.”

“Water use projections are based on three rates: 150, 200, and 250 gallons per capita per day (gpcd). Water conservation is required to reduce consumption to 150 gpcd.” (page v)

“Reducing urban consumption from 200 to 150 gpcd by the year 2020 can lead to water savings of from [sic] 3,600 to 4,800 acre-feet.”

“Average annual use for all of the services is approximately 198 to 202 gpcd.”

“These local per capita water use rates should be compared to those found in other studies. During the 1971-1975 period, the Dept. of Water Resources calculated that three Ukiah area districts averaged 170 to 199 gpcd (CDWR, 1980). In other cities, recent urban water use averaged 147 gpcd in Santa Rosa, 124 gpcd in San Francisco, 171 gpcd in Los Angeles, and 291 in Sacramento (CDWR, 1983b). The Ukiah Valley’s current usage rate, therefore, is in the range between that of Los Angeles and Sacramento (an unmetered city).” (p. 29).

Appendix 7:
Other Information Relevant to Opportunities for Improved Water Efficiency

For international comparisons:

Domestic use in cubic meters/p/yr	
U.S.	203 (1995)
Canada	157 (1990)
Japan	122 (1990)
Denmark	68 (1990)
Finland	56 (1994)
Germany	100 (1990)
Italy	138 1990)
Spain	100 (1994)
Switzerland	81 (1994)
United Kingdom	40 (1994)

Table: from Peter Gleick (1998). ***The World's Water, 1998-1999*****. Island Press, Covelo, CA**

Selections from Amy Vickers (2001). ***Handbook of Water Use and Conservation*****. WaterPlow Press, Amherst, MA.**

Average U.S. Residential Use: 101 gpcd. 31% outdoor use, 69% indoor use.

Average indoor use on a non-conserving home: 69.3 gpcd

Average indoor use in a conserving home: 45.2 gpcd

"Turf grass, planted on residential lawns as well as corporate, government, and roadside areas, covers an estimated 30 million to 50 million acres in the United States, an area larger than Pennsylvania and greater than the acreage used to grow any single U.S. agricultural crop."

"Also significant is the amount of lawn chemicals applied on residential properties; homeowners apply nearly 10 times more pesticide per acre on turf than farmers use on crops." (p. 145)

"Estimates indicated that potential water savings from improved agricultural water management and irrigation systems can be as much as 50%. Improvements can be achieved through the use of more efficient irrigation technology, such as drip and LEPA systems, as well as on-farm water management practices including water measurement (metering), soil-moisture monitoring, improved irrigation scheduling, tailwater reuse, conservation tillage, canal and conveyance system lining and management, laser leveling, and limited-irrigation, dry-land farming. In some cases, better irrigation management practices, not necessarily new technology, are the key to increased water-use efficiency and reduced drainage on farms. Finally, incentives—educational, financial, and regulatory—can play a role in encouraging farmers and irrigators to use water more efficiently." (p. 341)

Agriculture

"Water savings achieved through improved irrigation scheduling result primarily from better-timed applications and more precise identification of the amount of water needed by crops."

"When carefully applied, irrigation scheduling has been shown to save water, energy, labor, and fertilizer and to improve crop yields and quality. Farmers who use the U.S. Bureau of Reclamation's AgriMet Northwest Irrigation Network serving the Pacific Northwest typically achieve estimated water savings of 15 to 20%."

"In a 1995 survey of 55 growers representing 134,00 acres of irrigated agricultural land in California, the cooperative extension service at the University of California, Berkeley, found that an 8% increase in average annual crop yields could be attributed to use of the CIMIS weather information network. A 13% reduction in average volumes of applied water was also attributed to CIMIS data. The annual value of these water reductions and increased yields is estimated at $14.7 million."

"According to a 20-year study of irrigation scheduling equipment and techniques conducted by the USDA's Agricultural Research Service, two commercial, sprinkler-irrigated farms in Colorado and Oregon (encompassing a total of 15,000 acres) achieved average annual water savings of 30% from improved irrigation scheduling practices. In addition to saving water, the farms also reduced water pumping and energy requirements and lowered labor and fertilizer costs. The Oregon research site reduced water applications from its center pivot irrigation system by 30 to 50% and decreased its irrigation staff from 20 people to 10 by installing irrigation monitoring and control technology. The Colorado farm increased its corn yield by 25 bushels per acre in addition to its water savings." (p. 364)

"Drip-under-plastic irrigation produced a 60% higher yield of melons (cantaloupe and honeydew) than furrow irrigation in a side-by-side evaluation of the two methods conducted by the Texas Agricultural Extension Service. The higher production rate was attained with about 33% of the water and 50% of the fertilizer required by the furrow-irrigated field." (p. 382)