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ANALYSIS

The role of ecosystem valuation in environmental decision making: Hydropower relicensing and dam removal on the Elwha River

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Abstract

A primary, but rarely examined, justification for ecosystem valuation studies is that monetization of environmental amenities and services makes a needed contribution to environmental decision making. This paper systematically examines the role and contribution of economic analysis, and specifically ecosystem valuation, in a precedent-setting dam removal case. The removal of operating hydropower dams for the purpose of ecosystem restoration (as opposed for safety reasons) is rapidly gaining national attention. One of the first examples involved two dams on the Elwha River in the state of Washington. In this paper we describe the technical analysis that was employed and how such analysis contributed to that dam removal decision. Ecosystem valuation played a minor role in the decision to remove the Elwha dams and participants in hydropower relicensing decisions in general do not rely on valuation studies to decide levels of ecosystem enhancements.

Keywords: Ecosystem valuation; Dam removal; Hydropower relicensing

1. Introduction

On October 24, 1992, President George H.W. Bush signed the Elwha River Ecosystem and Fisheries Restoration Act (Public Law 102-495). The Act represented a dramatic, and largely unprecedented, intervention by Congress into the hydropower relicensing proceedings of the Federal Energy Regulatory Commission (FERC). Just 7 years prior, the relicensing decision for the two Elwha River (Washington State, USA) dams was organized around incremental mitigation of existing dam operations. At that time, the idea of removing an operating hydroelectric dam for the purpose of ecosystem restoration (rather than for safety reasons) was considered a heretical idea by FERC, Congress, federal resource agencies, and most mainstream environmental groups. In a few short years, a precedent setting battle formed over dam removal for ecosystem restoration. Today, dam

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removal is a high profile, mainstream environmental issue (Reisner, 1998; McPhee, 1999; Murr, 1999; Born et al., 1998; Heinz Center, 2002; Lowry, 2003; Doyle et al., 2003). The Elwha case also foreshadowed many new pressures to reform the hydro relicensing process in the US.

The expression of support and commitment to restoring the ecological functioning of the Elwha River to pre-dam conditions was accomplished in the face of considerable costs, technical uncertainties, and legal challenges. During the course of the decision process a study was commissioned to monetize the value of removing the Elwha dams to restore the river to its natural state and to improve native salmon populations (Loomis, 1996). The literature describing that monetization work implies that this valuation study made an instrumental contribution to the decision to remove the dams (Loomis, 1996, 1997, 1998, 2000). Yet, while an ecosystem valuation study was conducted, it was done so only after the decision to remove the dams had been made.

More generally, ecosystem valuation studies are an extensive line of research within ecological economics (Faber et al., 2002) and the case is often made that such monetization is essential for balancing environmental gains against costs. The stated rationale for this work is that monetization is necessary because otherwise policy participants will place too little weight on environmental protection. Costanza et al (1997, p. 253) justify their study of the monetary value of world ecosystem services by stating that "because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions". Proponents sometimes claim that monetizing environmental change assists decision participants in weighing the social gains and losses by avoiding "apples and oranges" comparisons (Loomis and Feldman, 1995, p. 97). The implication is often that ecosystem services will be overlooked without monetization (Moore et al., 2001). But is the assertion that ecosystem valuation is necessary for making informed decisions regarding ecosystem services justified?

The valuation literature is most often concerned with developing techniques to monetize changes in the level of ecosystem services or amenities. Within the economics literature this usually involves making estimates of people's willingness to pay for different levels of different environmental end states (Faber et al., 2002). While the application and refinement of ecosystem valuation techniques continue to grow, remarkably little attention is devoted to examining the assertion that without such valuation ecosystem services are neglected by decision makers. In the case of the Elwha, the decision could not have relied on the ecosystem valuation analysis because the analysis was not competed until the Congress made the dam removal decision Instead, decision participants were able to discover, argue, and then make a commitment to restoring a free flowing Elwha River without such valuation studies. This paper provides a detailed historical account of how participants expressed and argued for ecosystem services in a landmark case without monetizing ecosystem services. We then argue that the Elwha is not a special case, but rather reflective of many subsequent changes in the hydropower relicensing process, and in environmental decision making more broadly. Specifically, ecosystem valuation rarely will be employed when making the case for ecosystem-enhancing measures.

2. The Elwha dam removal decision

A pattern modeling approach is used to identify the role and contribution of ecosystem valuation in the Elwha case. Pattern modeling is a structured approach to understanding complex decision-making processes (Wilber and Harrison, 1978). The product of pattern modeling is, unapologetically, a narrative (a story). The data come from diverse sources including published literature, administrative records, personal observation, interviews, and analyses of quantitative data. Of special note is that pattern modeling puts a premium on incorporating details of the legal, contextual, social, and organizational setting and minimizes the use of simplified assumptions about behavioral motivations of organizations and individuals. For this reason, an important qualification of the pattern modeler is familiarity with the situation being modeled. The construction of a narrative begins with a conceptual model of the system of interest. The narrative is developed over time and the story is tested against newly acquired evidence. The modeler can "...be reasonably certain the explanation is a correct

one if new data and different kinds of evidence fall into place in the pattern." (Wilber and Harrison, 1978). That certainty is secured by seeking an affirmation of its accuracy from decision participants. This is accomplished by asking for explicit corroboration of the most significant conclusions drawn from the story. In this case the conclusions about the role played by non-market valuation and by other analysis were tested by securing a review of significant arguments in the story as the pattern model was developed.

The Elwha pattern model began by first assembling a historical timeline of decisions from the official administrative record. All major analytical reports, administrative correspondence, and legal briefs were then catalogued and placed within the decision timeline. The major analytical justifications, methods, and outcomes from the various reports were noted and analyzed. This evidence formed the basis of a tentative model that established causal linkages between the types of technical analysis produced and the positions and choices of decision participants. The development of the tentative model was greatly facilitated by the specific contextual knowledge of one co-author. Charles Gowan was a staff biologist for the major contractor for the dam owner (James River) between 1986 and 1991. As a participant observer, Gowan was intimately familiar with the technical analysis, dam owner perspectives, and the issues dominating the negotiations. The tentative pattern model was verified, refined, or modified based on interviews and other communications with participants in the decision process.[1] The interviews were conducted at several times during the study and were structured to gain a better understanding of the basis for particular choices and for the rationale and consequences of pursuing certain technical analyses.

2.1. Historical background

The Elwha River is located in northwest Washington (USA) near Port Angeles. Historically, the river produced large runs of 10 different species and races of salmon (DOI, 1994). This situation changed in 1913 with completion of Elwha Dam 4.9 miles from the river's mouth. No accommodations were made to move salmon past the dam, and so about 105 km of high-quality salmon spawning habitat were lost (James River, 1988a). The second hydroelectric project, Glines Canyon Dam (Glines Dam hereafter), was built in 1926 about 14 km upstream from Elwha Dam. No fish passage measures were installed at Glines Dam because fish could not ascend past Elwha Dam. In 1938, Congress established Olympic National Park (ONP) on lands surrounding the Glines project. The dam and reservoir remained within a "Special Use Zone" in the ONP that allowed continued operation of the project (FERC, 1991). Elwha Dam and its reservoir remained outside Park boundaries. Today, run sizes of all wild (naturally spawning) salmon are severely depressed, with the only significant runs of fish being those artificially spawned in two hatcheries located below the dams (FERC, 1991).

Through the 1970s and 1980s, both projects were privately owned and operated by the James River Corporation. James River used the two projects to generate about 40% of the energy needed to run the company's paper and pulp mills (DOI, 1995). The primary benefit of these two projects was low cost electricity which could be produced at less than half the rate charged by the local utility (purchased power=24.1 US$/MW h in 1989 dollars; FERC, 1991 at pp. 2–35).

All privately operated hydropower dams must be licensed by FERC. The license establishes dam operating conditions including requirements for minimum downstream flows, upstream and downstream fish passage (for example fish ladders and screens), and provision of resource and recreational enhancements (for example, stockings and hatcheries). Once an original license expires, FERC is also authorized to issue a new license for the project (relicensing). Historically, FERC, an independent commission, has been

[1] The people interviewed for this study and their position at the time of the Elwha case were: Brian Winter biologist, National Marine Fisheries Service; Lori Bodi, counsel for the National Oceanic and Atmospheric Administration detailed to the National Marine Fisheries Service; Ron McKitrick, FERC staff; Fred Watts, University of Idaho Professor; Steve Ralph, fisheries habitat biologist for the Point No Point Treaty Council; Robert Wunderlich, fisheries biologist with U.S. Fish and Wildlife Service; Russ Busch, Evergreen Legal Services; Shawn Cantrell, Friends of the Earth; Robert Mohn, deputy project manager for Ebasco (the consulting firm contracted by FERC to help produce the Elwha EIS); Charles M. Prewitt, manager for Ebasco. While those interviewed were immensely helpful to this study, all opinions and conclusions expressed in this paper are only the authors. Any errors are our responsibility.

granted significant discretion to determine license conditions (Spence, 1999). As such, FERC is provided with broad authorities to determine the public interest in licensing decisions. The Federal Power Act instructs FERC to strike a balance between hydropower development, navigation, recreation, fishery resources, and other competing uses. Yet, FERC's authority to determine license conditions is not absolute. Federal and state agencies have significant input into the relicensing process, specifically with respect to resources under the trusteeship of the federal government and fish passage issues. Other organizations, such as environmental and local interest groups, can request formal recognition to comment and participate in the process as an "intervener" but have little authority to influence a licensing proceeding beyond the power of persuasion. Thus, the traditional relicensing process is a relatively-closed administrative proceeding focused on negotiation among the licensee, FERC and resource agencies (Stephenson, 2000).

2.2. The transformation of the debate: 1985–1988

When relicensing proceedings for the two dams began in earnest in the mid 1980s, removing the dams to restore wild anadromous fish runs was not considered by any major decision participant as a possible alternative (see next paragraph). At this time FERC had never ordered the removal of a functioning dam against the wishes of the dam operator. FERC did not consider the FPA's requirement to balance hydropower and ecosystem benefits to extend to dam removal. FERC begins relicensing proceedings by developing and evaluating mitigation alternatives assuming the dam remains in place (e.g., see FERC, 1987).

Initially, the state and federal resource agencies, primarily the Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), National Park Service (NPS), and the Washington Department of Natural Resources (WDNR) approached the relicensing with a similar premise. At the request of ONP, the Fisheries Assistance Office (FAO) of the U.S. Fish and Wildlife Service produced a technical analysis just before FERC began its active review of the application. The FAO report was prepared in response to new Park management policies, adopted in 1983, that favored restoration of wild (not hatchery) anadromous fish to the Park's rivers (FERC, 1991). Similar to FERC, the report focused on evaluating alternative ways to pass adult and juvenile salmonids around the existing dams rather than removing the dams altogether. Seven salmon species were mentioned as potentially benefiting from installing fish passage: summer/fall chinook, spring chinook, coho, winter steelhead, summer steelhead, pink salmon, and sea-run cutthroat trout (FAO, 1985).

The way in which FAO evaluated and selected fish passage alternatives was conceptually similar to the approach used by FERC (Fargo, 1991). Fish passage recommendations were first evaluated based on two basic criteria: (1) the probability of successfully passing different species of salmon, and (2) the costs of each passage alternative.[2] The final fish passage recommendations identified in the FAO report reflected an informal balancing between the capital cost of the alternatives and the probability of successfully restoring the salmon species. Fish passage was not simply selected to maximize fish passage success. Some potentially successful fish passage options were not selected for cost affordability reasons, but in striking a balance between fish restoration and costs, no monetization of the value of restoring salmon was undertaken.

The final report recommended trap and haul facilities for upstream fish passage and a combination of spill and fish screens for downstream fish passage. Dam removal was never mentioned or evaluated in the report. The FAO report was circulated by ONP for review by the WDNR, NMFS, the Washington Department of Fisheries (WDF), James River, a regional council of native American tribes (the Point No Point Treaty Council), and the local member of the council, the Elwha Klallam Tribe. In their comments, the federal and state agencies and tribes were not optimistic about the prospects for restoring fish above the dams (James River, 1988a). In addition, Park officials seemed reluctant to support expensive fish passage alternatives because of potential adverse impact of the Park's activities on the local economy. The general conclusion reached by all commenting

[2] The cost calculations in the FAO report only included estimates of capital costs of fish passage alternatives. The costs of operation and foregone power production were not calculated in the FAO report, but would have been in a FERC analysis.

parties was that the idea of fully restoring wild salmon runs was appealing but impractical in terms of engineering feasibility, cost, and, conflicts with existing management objectives. The agencies appeared resigned to accept a modest fish passage alternative. For example, NMFS (1985, p. 3) stated that restoration of seven races "would be very difficult to manage successfully and [so NMFS] recommends a reduction in the number of species/races for consideration. For example, we question whether pink salmon would be worth the expense and effort since they run only in odd years and are of lower economic value than other species."

The first calls for dam removal did not come from the federal and state agencies with statutory standing in the relicensing process, but rather from outside "interveners". The first group to formally advocate dam removal was the Elwha Tribe in its January 1986 Motion for Intervention in the FERC process. The Elwha Tribe's support for dam removal conflicted with the official policy of the Point No Point Treaty Council. Some elements of the Council were concerned primarily with protecting the harvestable fish produced by the two hatcheries (Point No Point Treaty Council's comments in the FAO report). Elements of the Elwha Klallam Tribe, however, became increasingly vocal about their support for dam removal. Particularly for elder members of the Tribe (some of whom remembered the river prior to the dams), the river meant more than a source of harvestable fish. The Elwha River formed an integral part of their spiritual heritage and the Tribe considered the construction of the dams a profound injustice (personal communication, Steve Ralph). The proponents of dam removal within the Elwha Tribe also professed a basic belief that the salmon would return if the dams were removed. A second call for dam removal came a few months later from a coalition of environmental groups consisting of the Seattle Audubon Society, Friends of the Earth, Olympic Park Associates, and the Sierra Club. The coalition filed for intervener status in May 1986, stating that dam removal was their preferred alternative.

Support for dam removal by the Elwha Tribe and the environmental groups was not based on any technical analyses. No such analysis had been conducted, including the technical feasibility of removing the dams, ecological values of restoration, or the costs of removal. The commitment to dam removal was based solely on deeply-held cultural values and personal beliefs (personal communication, Steve Ralph). For these groups, dam removal was an ethical issue and technical and cost barriers warranted little concern.

The dam removal option, however, would not be advanced in the relicensing process without support and commitment by the federal and state resource agencies and in 1986 and 1987 that support did not exist. Most importantly, profound uncertainty surrounded the technical feasibility of dam removal and state and federal agency staff would not publicly endorse a proposal without some supporting analytical evidence (personal communication Brian Winter and Steve Ralph). Therefore, although some agency staff may have felt that dam removal could be consistent with the emerging regional goal of producing wild fish, there was concern that pushing the idea without a sound technical foundation would brand the agencies as too radical and undermine their credibility with FERC and the public in the relicensing process. The agencies tended to view FERC as a conservative agency, at times seemingly indifferent to environmental concerns and more willing to side with hydropower interests in licensing conflicts. Making what would be perceived as unprecedented and technically ill advised licensing demands would be counter productive in advancing agency interests in the Elwha negotiations and perhaps in other licensing cases (personal communication Brian Winter and Steve Ralph).

Against this background, FERC held a series of public meetings in December 1986 for the purpose of identifying outstanding issues surrounding licensing of the projects, and in anticipation of producing a "Request for Additional Information" (RAI) directing James River to develop the analysis FERC needed to reach a final licensing decision. Shortly after, the Washington Department of Game, Elwha Tribe, Point-No-Point Treaty Council, Department of the Interior, and National Marine Fisheries Service recognized the value of coordinating their efforts and officially formed a group known as the Joint Fisheries and Wildlife Agencies (JFWA). From the remainder of the relicensing process, the JFWA would be the primary entity representing the collective interests of the agencies, Tribe and Council.

Early 1987, the JFWA petitioned FERC to order a number of analyses including studies related to the

potential for the river above the dams to produce seven species of salmon (Fisheries Agencies, 1987). Also included in the JFWA petitions were "proposals to mitigate and compensate for all. . .impacts including (1) design of upstream and downstream fishways; . . .and (5) a proposed plan for dam removal." While mentioned in the JFWA petition, the dam removal request was a minor component of the overall JFWA petition and was included primarily in deference to the Tribe (personal communication, Steve Ralph).

In May 1987, FERC issued its information request to James River. The request included essentially all the analysis and information requested by JFWA with the key exception being the dam removal study. If salmon were to be restored above the dams, clearly FERC considered fish passage facilities as the only way to achieve it.

For the next year consultants working for James River produced a number of biological, engineering and financial analyses. From James River's perspective, the primary analytical task was to quantify the gains from various fish passage alternatives in terms of numbers of fish and to estimate the costs of the various passage alternatives. Cost included primarily forgone power benefits (difference between the cost to produce power by the current dams and the cost of power under the next best available source) and fish passage construction costs (spillway modifications, fish screens, and fish ladders). No monetization of ecosystem services was conducted. Based on this analysis James River sought a passage alternative that could successfully pass fish at what James River considered a reasonable cost.

To evaluate the ecological response from various fish passage alternatives, James River used a life-cycle model to estimate the fish production potential of the Elwha watershed (James River, 1988a). The first step was to estimate the number of juveniles that could be produced in the upper watershed, based on the availability of suitable habitat. These juveniles would then migrate downstream past the dams, with a specified percentage killed due to predation in the reservoirs and imperfect dam passage measures. Once past both dams, juveniles entered the ocean and grew to adulthood. The number of adults produced was estimated based on the juvenile-to-adult ocean survival rate, a combination of natural and fishing morality. Adults returning to the river migrated past the dams, again with a specified percentage killed due to the passage facilities. The remaining adults (the "run size") were available to spawn naturally above Elwha Dam. In order for a fish population to be self-sustaining, an adequate number of adults must successfully return to the river each year to spawn. This number is called the "escapement goal", because it is the number that must escape death in the ocean. If the predicted run size equaled or exceeded the escapement goal, the species in question was considered restorable. If the run size was less than the escapement goal, successful restoration of the species was judged doubtful.

The results of this analytical effort were surprising to James River and altered their approach to the relicensing. Although the habitat survey confirmed the presence of a substantial amount of highly-productive habitat above the dams, James River came to the conclusion that restoration was feasible for only three species: chinook, coho and steelhead. The other species were either simply not physically capable of successfully moving around the dams and impoundments even with the aid of substantial fish passage facilities, or there was too little information to make a reliable prediction. Moreover, restoration of chinook and coho was judged doubtful because, in James River's view, ocean harvest rates were too high to allow restoration of wild fish. James River believed that it would be difficult or impossible for the management agencies to alter these policies because that would involve, among other things, renegotiating international treaties. In its final analysis, James River concluded that dam passage facilities would realistically restore only one species, steelhead, and that the total number of fish would be less that 5000 (James River, 1988a).

The poor prospect for restoration was more pessimistic than James River anticipated and the dim prospect for restoration placed them in a difficult position. They were concerned about proposing expensive passage facilities only to have ocean overharvest undermine restoration. When fish did not come back to Elwha, James River feared the resource agencies, and the general public, would seek alternative mitigation. Thus, James River would be exposed to continued demand for additional mitigation measures and ever-increasing costs. On the other hand, failure to propose some restoration alternative was

going to be unacceptable to agencies increasingly focused on wild fish, to the public, and possibly to FERC.

In May, 1988 James River submitted its technical analyses to FERC and the JFWA, concluding that restoration was doubtful for all species except steelhead, but proposing the investment in fish passage anyway. The fish passage plan was similar to the 1985 FAO study with some modest revisions. At the same time, James River felt that the dim prospects for recovery presented another, more favorable, option. James River suggested that a hatchery should be considered as an alternative to expensive fish passage alternatives. The James River report (James River, 1988a, p. VII-47) concluded "very difficult choices will have to be made regarding what is considered to be most important: catching [hatchery-produced] fish in Puget Sound, or knowing anadromous fish are once again in the upper reaches of the Elwha River." James River's hope was that the analysis of restoration potential would convince FERC and the agencies that providing fish passage was a costly and ineffective option, and that they would instead opt for a new hatchery. The possibility that the grim prospects for restoration would advance the argument for dam removal was not considered because dam removal was not viewed as even a remote possibility.

Unknown and unanticipated by James River, by 1988, many in JFWA were coming to an opposite conclusion. James River's habitat surveys showed that at least 33 miles of mainstem river, plus many more miles of tributaries, were accessible to salmon. Based on these data, the JFWA biologists undertook an analysis of pristine production potential (JFWA, 1988). The overall goal of the JFWA was to estimate the number of adult fish of each species that the river produced prior to construction of the dams. In broad terms, the JFWA used similar analytical methods as James River in that data from other rivers were used to estimate how many fish could be produced per unit length or area of habitat, and then an estimate of production potential for the Elwha generated based on the amount of habitat available. The primary differences in the analysis related to the agencies' assumptions of (1) no dam passage mortality, (2) no harvest, and (3) pristine habitat conditions leading to maximum fish production per unit of habitat. Strikingly, the analysis indicated that the river had the potential to produce possibly 220,000 fish representing 10 different species and races (JFWA, 1988). The magnitude of the pristine production potential estimate was important in helping persuade the agency staff focused on fish harvest that dam removal might be an option worth promoting (personal communication, Brian Winter).

These technical analyses were aligned with an emerging professional perspective among fishery bioloists. By the 1980s, biologists in the region were beginning to seriously question the efficacy of hatchery production in favor of restoration of wild fish (Walton and Houston, 1984). The revision of the ONP management objectives in 1983 reflected the change in perspective. An increasing emphasis was being placed on restoring the processes in natural ecosystems that support the life cycle of fish rather than simply producing certain numbers of fish (see NRC, 1996 for one expression of this view). This changing professional understanding ultimately influenced the willingness of JFWA staff to ask questions and investigate alternatives not considered under the more traditional views of fishery management.

In August 1988, JFWA provided formal comments on the James River analysis and proposal. The first paragraph of JFWA comments (JFWA, 1988, p. 4) states:

Our goal for the Elwha River is restoration of the ecosystem or full recompense for losses. All alternatives regarding the disposition of the Elwha River dams, including dam removal, need to be evaluated.

The agencies statement that their goal for the Elwha is "restoration of the ecosystem" marked a fundamental departure from their 1985 position. The unequivocal commitment to the full restoration of the Elwha system was the first public indication that the agencies were prepared to argue forcibly for consideration of the dam removal alternative.

While the technical analysis contributed to JFWA's commitment to advancing the ecosystem restoration objective, estimates of the monetized value of ecosystem restoration did not. The interest in restoring the Elwha to a more natural state was an outcome not expressed or understood in market metrics. This emerging understanding was in turn being supported by conventional engineering and biological studies that suggested a practical expression of the restoration

ideal. Engineering studies helped convince agency staff that conventional fish passage measures would fail in the confines of the high-canyon environment surrounding the dams and the biological analysis quantified the large amount of highly-productive habitat above the dams (personal communication, Brian Winter).

Participants in the decision process were involved in a process of discovery: coming to understand the alternatives available to them. At this point, no ecosystem valuation study could have answered whether ecosystem restoration was worth the expense or not because members of JFWA themselves were only beginning to form opinions about the practical as well as intrinsic value of ecological restoration and nothing about this emerging perspective required participants to think in monetary terms. The economic studies conducted during this period were exclusively related to costs of fish passage and foregone power. Yet, if full restoration of the Elwha was to occur, JFWA would need more evidence that dam removal was technically feasible and then convince FERC of the merits of dam removal (Brian Winter, personal communication).

2.3. Escalating conflict, entrenchment, and resolution 1988–1992

Given the JFWA's emerging position on dam removal and a growing concern that FERC considered JFWA's arguments legitimate, James River responded in two ways. First, James River developed arguments that portrayed conventional fish passage mitigation in a more favorable light, realizing that a hatchery plan was clearly unacceptable to JFWA and possibly FERC. James River was still concerned that expensive fish passage facilities might be considered a failure when adult fish did not return due to high harvest rates. To protect themselves from being drawn into an endless loop of mitigation requirements, James River sought to define their mitigation responsibilities in terms of juvenile fish protection and not adult fish returns. In its December 1988 response to JFWA, James River emphasized that their analysis did show a restoration potential for steelhead, coho and Chinook provided that adult fish were afforded adequate protection from ocean harvest James River (1988b).

Second, James River commissioned its own dam removal study in late 1988 (Simons, Li and Associates, 1989). The report evaluated a dam removal option of simultaneously removing both dams and allowing the unmanaged release of the accumulated sediment. Based on hydrological and sediment transport modeling, Simons, Li and Associates (1989) predicted severe impacts on the lower Elwha River for a period of probably 20 years. Channel aggradation would significantly increase flooding potential along the lower river. Other dam removal options for managing the sediment were evaluated, including the potential to stabilize the sediment in place as water levels were lowered, or excavating it. Regarding sediment stabilization or excavation, Simons, Li and Associates (1989) concluded that either option could reduce impacts significantly, allowing the river to return to natural conditions within 5–10 years. However, they expressed doubt that these options would be technically feasible because of the wet, unconsolidated nature of the material. No costs were estimated for any option. Although the work was very preliminary, the report correctly identified all major dam removal options.

James River believed the analysis of the sediment problem would quickly dampen talk of dam removal. JFWA, however, was coming to an opposite conclusion (personal communication, Brian Winter and Lori Bodi). The Elwha Tribe was able to fund a small contract with Fred Watts from the University of Idaho to provide a preliminary analysis of the sediment transport issue. Using relatively simple models of sediment fate and transport, Watts concluded that the current system was "sediment poor" and thus capable of transporting much more sediment than it was presently carrying. Further, Watts concluded that the sediment could be flushed from the system in just 5 or 10 years without extensive stabilization (personal communication Fred Watts). This analysis provided credible analytical support to JFWA that ecosystem recovery would occur fairly quickly. Many technical issues were not answered (costs of removal, how specifically the dams could be removed, mitigation of negative impacts during and after removal), but the Watts analysis helped convince JFWA that a key technical obstacle to the removal process could be overcome (personal communication, Brian Winter).

The technical feasibility of dam removal coupled with knowledge of the potential ecological productivity of the system solidified JFWA's commitment to

pursue dam removal. This cumulative evidence was summarized at the time by a biologist for the U.S. Fish and Wildlife Service in a one-page document that was simply referred to as the "prospects document" (personal communication, Robert Wunderlich). The basic content of the document is shown in Table 1. Although the table greatly simplified many technical issues, it was very persuasive to many JFWA members who were still uncertain as to the efficacy of dam removal (personal communications, Brian Winter, Lori Bodi, Steve Ralph, and Russ Busch). The "Prospects" document was cited by all JFWA members interviewed as a pivotal point in the process because it provided an easy-to-grasp summary of the benefits of dam removal compared to dam retention.

JFWA's commitment was having an effect within FERC. In August 1989, FERC reversed its 1987 decision and ordered James River to produce analyses of dam removal plans, including an analysis of sediment disposal options and methods to mitigate environmental impacts of removal. Two days later, FERC issued a notice of its intent to prepare an Environmental Impact Statement (EIS). For the first time, FERC signaled that it was serious about evaluating dam removal as a mitigation alternative.

Four months later, James River provided the information requested by FERC (James River, 1989). James River focused on dam removal options that involved physically removing the sediment, rather than letting it erode downstream. James River identified two options. The first would draw down the reservoir in stages, with the exposed sediment trucked out after it had dried. The second would remove the sediment with the dams still in place by dredge and slurry via pipes to the coast. James River noted that removal process would disrupt downstream water supplies, the local economy, two salmon hatcheries, and the ONP. The costs of dam deconstruction and sediment removal alone were estimated to be US$137 to US$413 million. James River also questioned who would pay for the removal and whether FERC had the authority to order it.

Table 1
Salmon restoration potential for the Elwha River (JFWA, 1990)

Species	Alternative	
	Dam removal	Dam retention
Chinook salmon		
Spring	fair	poor/unknown
Summer/fall	good	poor/unknown
Coho salmon	good	fair
Steelhead		
Winter	good	fair
Summer	good	fair
Pink	good	none
Chum	good	none
Sockeye	fair	none
Cutthroat	good	unknown
Dolly Varden	good	unknown

By the close of 1989, both James River and JFWA clearly knew what each other did and did not want. The focus turned to developing the arguments that would convince FERC of the merits of their respective positions. Throughout 1990, both sides produced a series of technical analyses and comments intended to influence FERC's EIS. Because JFWA believed the chances were slim that FERC would order dam removal, JFWA used this time to establish an administrative record for dam removal in a possible future court case (personal communication, Lori Bodi). To do this, JFWA (1990, p. 1) publicly asserted that their goal "is restoration of the ecosystem of the Elwha River drainage . . .One of the most important steps in meeting this goal is the restoration of all anadromous fish species and stocks. . .." This statement represented another important shift in emphasis. Previously, this goal was qualified with the statement "or full recompense for losses" (JFWA, 1988, p. 4). Now, JFWA was advocating that FERC adopt a standard for mitigation that could only be met via dam removal.

To build their case, JFWA's technical analysis focused on fishery models and dam removal options. JFWA used a salmon life-cycle analysis to show that fish passage around the dams would fail. Moreover, the JFWA specifically recommended that FERC not examine ocean survival rates in its analysis due the large bands of uncertainty around the parameters and model predictions (JFWA, 1990). In contrast, James River advocated that much attention be paid to ocean survival rates because James River believed that harvest was the key problem in restoring salmon (James River, 1990). Clearly, both sides were attempting to persuade FERC to structure its analysis in ways that would support their respective positions.

To build support for dam removal, JFWA hired consultants (paid for with funds from the Elwha

Tribe) to investigate more effective approaches to removing the dams (personal communication, Brian Winter). Based on this analysis, JFWA did not propose large-scale removal of the existing sediment, but rather produced two detailed conceptual plans (JFWA, 1990) based on stabilizing the sediment in place as the dams were removed.

The type of technical analysis JFWA used build its case is instructive in that at this point in a far-from-resolved debate there still was no interest in using monetized benefits as a policy argument. Instead, JFWA evaluated what dam removal would do to the ecosystem in physical terms, but did not attempt to quantify in monetary terms the value of ecosystem restoration. JFWA and their supporters simply asserted that their whole river restoration goal was an appropriate goal in this situation. JFWA used their limited resources to show that the goal was technically and financially attainable, and not that it was in some sense justified by a benefit cost calculation.

In February 1991, FERC produced a draft of their Environmental Impact Statement (FERC, 1991). FERC identified and evaluated the two major alternatives: dam retention or dam removal. The dam retention alternative included the best available measures to pass fish at each dam at an estimated total cost exceeding US$20 million. Analysis of the dam removal alternative focused on methods to handle sediment. FERC evaluated three options for handling sediment: allowing it to erode downstream, removing it all before the dams were removed, and stabilizing it in place. FERC, like James River and the JFWA, rejected the first option as too environmentally-damaging and the second as too costly. FERC's preferred option was similar to that proposed by the JFWA-redistribution of sediment into stable terraces located along the valleys formerly occupied by the reservoirs. The initial cost of dam removal was estimated at US$64 million (1990 dollars), including expenses for river diversion during dam removal, sediment stabilization, demolition and removal of the structures, revegetation, and construction of fish hatcheries necessary to support the initial fish restoration program. In addition, annual costs for replacement power were estimated at US$16.5 million.

A major component of FERC's dam removal analysis also included the effects on fish. FERC developed its own novel approach using four main elements that it thought were central to determining feasibility of restoration: (1) dam passage, (2) fishery harvest, (3) habitat, and (4) availability of a native stock of fish for a restoration program. Upstream and downstream passage success was an obvious criterion because dam passage survival rates directly affected restoration success. Against the advice of the JFWA (1990); FERC (1991) determined that fishery harvest was also a critical issue in evaluating restoration, judging that if harvest rates could not be lowered, restoration would not be successful. Habitat was judged important because habitat conditions changed depending on the alternative considered. Availability of a native stock was judged important because a native Elwha stock would be uniquely adapted to conditions in the river. If fish had to be transplanted from other watersheds, the potential for success would be lower. FERC staff then evaluated the potential for successful restoration for ten salmon species by each of these four feasibility criteria. FERC (1991) concluded that under the dam retention alternative prospects for restoration were "good" for only 1 of 10 species, but the chances for restoration under dam removal were "good" or "excellent" for 9 of 10 species.

While the DEIS represented a careful and in some ways novel comparison of alternatives, it was not conceptually different from most FERC analysis or previous analyses in the Elwha case. The FERC staff evaluated alternatives based costs and the physical ecosystem response of the mitigation options. Although FERC understood and carefully analyzed the trade-offs, no effort was made to make or decide these trade-offs using a quantitative, analytical procedure. FERC's fundamental conclusion was that the choice of a preferred alternative could not be made on a technical basis, but was instead rooted in societal values (FERC, 1991). When asked why FERC did not try to monetize ecosystem benefits to compare against costs, FERC staff recalled that staff believed such information could not resolve or reduce the conflict among firmly-entrenched positions and perhaps would make matters worse by adding more heat than light to the debate (personal communication, Ron McKitrick).

In a highly unusual decision, FERC staff did not identify a preferred alternative in the DEIS. Deferral of the decision further heightened anxiety on both

sides and, by this time, a court challenge seemed inevitable, regardless of FERC's final decision. However, FERC was never forced to choose. In an extraordinary turn of events for a FERC relicensing case, Congress intervened. The story behind Congressional involvement is complex and fascinating but beyond the scope of this paper (for one interpretation see Lowry, 2003). What is relevant, however, is that Congress essentially selected the dam removal option when it passed the "Elwha River Ecosystem and Fisheries Restoration Act" (Public Law 102-495). The Act called for "full restoration of the Elwha River ecosystem and the native anadromous fisheries" and directed the Secretary of the Interior to prepare a report (the "Elwha Report") to evaluate alternatives for fish and ecosystem restoration including a "definite plan for removal" of the dams. Although the Elwha Act never explicitly called for the dams to be removed, the adoption of the JFWA language of "full restoration" was pivotal, because it was well understood by everyone involved that dam removal was the only way to achieve full restoration. Congress also removed the liability of removing the dams from James River, agreed to pay James River US$29.5 million for the dams themselves and guaranteed replacement power from Bonneville Power Administration. Congress used no new analysis in reaching its decision.

2.4. The analysis of dam removal: 1992–present

Passage of the Elwha Act led to three more detailed analyses of the dam removal issue: the Congressionally directed "Elwha Report" and two formal Environmental Impact Statements. The 1994 Elwha Report (DOI, 1994) was prepared largely based on information generated during the FERC process. No monetization of ecosystem services was conducted. The document closely followed the FERC draft EIS, but with more emphasis and detail on the technical feasibility and methods of sediment control. The analysis concluded: "The information developed for this report demonstrates that it is feasible to remove the dams, protect existing water users, and fully restore the ecosystem and native anadromous fisheries" (DOI, 1994, p. xiv). The release of the Elwha Report satisfied the statutory requirements of the Elwha Act.

Although providing extensive analysis of fish and ecosystem restoration, the Elwha Report did not satisfy the legal requirements of an EIS under the National Environmental Policy Act (NEPA). NEPA requires an EIS for major federal actions that impact the environment, but does not contain any legal authority to halt these actions.[3] The Secretary of the Interior determined that two additional analyses would be conducted. The first EIS was to provide yet another analysis of the dam retention versus dam removal alternatives. This report, called the "Programmatic" EIS, would confirm under NEPA that it was necessary to remove the dams in order to achieve the objectives specified in the Elwha Act, and would examine the alternatives for safely removing the dams but not select a preferred one. The second EIS, called the "Implementation EIS", would identify the preferred dam removal option. The National Park Service would spend US$6.2 million to complete these studies (personal communication, Brian Winter).

The Programmatic EIS (DOI, 1995) provided another analytical justification for dam removal. The National Park Service and other federal agencies were primarily responsible for the engineering and fish passage studies. The Elwha Tribe, using funds provided by the Park Service, managed the development of the social, cultural, and economic analyses for the EIS. It was in the programmatic EIS that a monetized benefit analysis was included to complement the cost analysis. The benefit analysis included traditional market-oriented benefit estimates associated with improvements in the commercial and recreational salmon fishery. However, the significant costs of dam removal were larger than these direct, readily monetized benefits.

Against this backdrop a contract was made for an ecosystem valuation study (Loomis, 1996). That study would insure that the monetized net benefits exceeded removal costs (personal communication, Brian Winter). A contingent valuation study was conducted to estimate citizen's willingness to pay at the local, state, and national levels to remove the two dams and return the Elwha River to its natural condition and restore wild salmon runs through dam removal. As stated, people's stated willingness to pay could include both potential future use values (recreational fishing) as well as nonuse or "intrinsic" values associated with

[3] The NEPA is simply a study requirement and is sometimes referred to as a "stop and think" legislation.

a free flowing stream (DOI, 1996; Loomis, 1996). The study, which was peered reviewed and published in the academic literature, concluded that the monetized benefits of the nation were between US$3.47 and US$6.275 billion (Loomis, 1996).

Why was such an analysis conducted when the decision to remove the dams was already made? Some participants working with the Tribe on the economic portion of the EIS felt that a positive net benefit estimate was important to maintain Congressional support for the project (personal communication, Brian Winter). Although Congress authorized the removal of the dams through the Elwha Act, no funds had been appropriated for actual removal. At the time, there was Congressional pressure to withhold appropriations for the project (Lowry, 2003). Other EIS study leaders were not convinced the study was necessary, but in the end, the Tribe elected to fund the study (personal communication, Brian Winter). The EIS study leader stated that this effort was the first large-scale and most expensive EIS most members had ever been involved in, and there was a strong desire to be as comprehensive as possible (personal communication, Brian Winter). The tribe had access to an adequate budget and given the desire to avoid a possible criticism, the decision was made to fund the study.

Was the contingent-valuation study instrumental in altering the course of the decision? While it is obviously impossible to know what decisions would have occurred in absence of the study, the likely answer seems to be "no". Congress had stated that full restoration was the objective and the Elwha Report confirmed removal was the only way to achieve the objective. It is difficult to imagine how the dam removal decision would have been reversed if the EIS produced a benefit cost ratio less than one, but with a qualitative discussion of the benefits and an acknowledgement that some benefits were not monetized. A more plausible argument could be made that a positive net benefit estimate facilitated building Congressional support for funding dam removal. Yet, a positive net benefit result did not appear to spur Congress into action and fully fund dam removal. Congress did not initiate funding for the purchase of the dams until 2001 (personal communication, Brian Winter). Sufficient funds have yet to be appropriated to remove the dams now owned by federal government. To date, the dams remain in place.

The Implementation EIS (DOI, 1996) concluded by identifying a dam removal option not seriously considered in any prior analysis. The Implementation EIS showed that rather than attempting to stabilize or remove the sediment, the most feasible and least costly alternative would be natural erosion. While this option was explicitly rejected by both JFWA and James River in the FERC process, new technical analysis and modeling showed that some sediment downstream was actually beneficial because the stream reach below the dams was gravel poor. Gravel is important for spawning salmon. Moreover, Bureau of Reclamation modeling showed that much of the sediment would be naturally stabilized without active management. The total estimated cost under the preferred dam removal alternative was US$312.5 million, including measures to protect downstream users and ecological services during removal (DOI, 1996).

3. Discussion: the role of ecosystem valuation in hydropower relicensing

The Elwha dam removal deliberations progressed in three distinct phases: discovery, conflict, and resolution. Ecosystem valuation did not play a role in the two phases of the decision where analysis helped form and influence societal preferences for the dam removal option. During the discovery phase, the perspective of what was at stake and what level of ecosystem enhancement was possible changed radically. In the mid-1980s, professional agency staff struggled to reconcile an emerging desire for ecosystem restoration with what they understood as their choice of alternatives. At this stage, no one could conceive the question of what is the value of ecosystem restoration because they were struggling to even understand what ecosystem restoration meant to them. As positions of both the licensee and the resource agencies solidified and became entrenched, the deliberations entered the conflict phase. The positions of JFWA and James River were well-defined and the focus of the participants was directed at convincing uncommitted parties, primarily FERC and possibly future courts, of the wisdom of their position. Obviously, ecosystem values were not neglected or ignored in this phase, but neither side argued or

expressed their positions in monetary terms. Finally, after Congress intervened, the process entered the resolution phase. The dominant activity during this phase was to determine the most feasible and cost effective way to remove the dams. It was during the resolution phase that an ecosystem valuation study was conducted, primarily to legitimize a decision that had been made earlier.

The Elwha case represents an early example of how perceptions about ecosystem values were formed and expressed not just in the practical matters relating to the methods of dam removal but also in an emerging understanding of future approaches to water-resource management. Our detailed examination of the Elwha case found little evidence that monetizing ecosystem values was necessary for participants to support ecosystem restoration.

Since the Elwha dam removal decision, evidence supports the finding that monetization of ecosystem values continues to play a minimal role in FERC dam removal and relicensing decisions. Five years after Congress passed the Elwha Act, FERC itself ordered its first dam removal (Edwards dam) on the Kennebec River in Maine (Lowry, 2003; Heinz Center, 2002; McPhee, 1999). The Edward dam at the mouth of the Kennebec River blocked the migration of nine anadromous fish species, including endangered species (shortnose sturgeon) and recreational sport fishes (stripped bass, Atlantic salmon, rainbow smelt) (FERC, 1997). Like the Elwha, arguments for ecological enhancement centered around cost and effectiveness of fishery restoration. Analytical efforts focused on comparative cost analysis of dam removal and fish passage and the evaluating the fishery response to fish passage/dam removal alternatives (FERC, 1997). The analyses that were instrumental in the decision making showed that constructing fish passage facilities was more expensive than simply removing the dams and that power from Edwards could be produced at a lower cost at other sources (FERC, 1997; American Rivers et al., 1999). In addition, no fish passage alternative could successfully pass 4 target species (shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt) and thus failing to meet the stated restoration goals of the state of Maine (FERC, 1997). Monetization of ecosystem enhancements was limited to conventional estimates of the improvements in recreational fishing and these quantitative estimates were not used to reach or justify the dam removal decision (FERC, 1997).[4]

In the FERC relicensing process, the Elwha and Edwards removal cases are but a part of the growing pressure for more ecosystem restoration within the hydropower relicensing process. In deciding the operations of existing dams, groups sympathetic to the ecosystem-restoration ethic believe FERC has historically been too willing to side with the licensee in relicensing decisions. Consequently, FERC has come under increasing scrutiny and criticism and the licensing process has become more costly and contentious as result (Stephenson, 2000). How FERC has responded to these pressures for change, however, is instructive for purposes of this paper. FERC has not responded to pressure to place more weight on ecosystem enhancement by adopting new analytical approaches to monetize the value of ecosystem services (Moore et al., 2001; Stephenson and Shabman, 2001). Instead, FERC continues to compare dollar estimates of the costs of mitigation options (construction and foregone power costs) with the likely biological and physical changes in ecosystem function.

Nonetheless, FERC has responded to its critics, particularly in terms of how decisions are made. FERC recently revised the licensing rule making to place more emphasis on negotiation between decision participants. The licensee now has the option to pursue a new license under "alternative" and "integrated" licensing processes, rather than the conventional FERC licensing process (Swiger and Grant, 2004). These processes involve a structured negotiation with agency and environmental interests and the dam operator over terms of the license. The presumption is that if all interested parties to the negotiation can agree on a mutually-satisfactory license, FERC will

[4] While beyond the scope of this study, ecosystem valuation studies do not appear to be widely used in dam removal cases outside the FERC process. Economic analysis used in the decision to remove small (often abandoned dams) tends to focus around the comparative costs of removal versus remediation (Born et al., 1998). Similarly, larger dam removal studies outside the FERC context (the decision to remove the Matilija dam by the Corps of Engineers, Heinz Center, 2002) also report the use of economic cost studies, but not studies that monetize the ecosystem benefits of removal.

write these conditions into the license. The dam operator is encouraged to work with this selected group of stakeholders to identify the relevant studies, mitigation alternatives, and operating conditions (Stephenson, 2000). Conceptually, it is the participants who must develop common understandings about what is at stake, what issues are most important to them and which ones they are willing to negotiate in order to reach an agreement. The alternative process seeks to downplay the role of FERC analysis and judgment in deciding the appropriate balance between market and environmental services. Instead, this responsibility is in the hands of the participants of the negotiation process (Stephenson, 2000).

Experience with the new licensing processes suggests that participants are not using ecosystem valuation studies to make tradeoffs or to argue for higher levels of ecosystem protection and restoration. Participants in these collaborative decision processes continue to rely on conventional cost, hydrologic, and biological-response analysis (Stephenson and Shabman, 2001; Nature Conservancy, 2003). Monetization of ecosystem services presumes to weigh the environmental consequences for the participants. Yet, the decision participants wish to retain their authority to weigh the environmental gains against the opportunity costs of mitigation and make judgments as to the worth of a mitigation option.

Public statements of support for the new licensing processes come from a diverse set of groups, including the hydropower industry, environmental groups, and resource agencies (Groves and Liimatainen, 1999; Keil, 2002; Wilson, 2000; Richter et al., 2003). Such statements of support are additional evidence that participants are willing and able to weigh ecosystem services against market outcomes (for example) in a mutually satisfactory way without the aid of ecosystem valuation. This said, supporters of monetization do claim that such analysis should not be used as the sole criterion to decide among alternatives, but rather be used to facilitate negotiations and participant understanding. Perhaps this is the case, but similar to those who participated in the Elwha case, participants in the current FERC licensing processes are making little use of monetization, even though they are fully aware of the possibility of doing such studies.

4. Conclusions

Valuing ecosystem services is inherently a social valuation process and there is very little evidence that public policy participants require monetization of nature's services to make tradeoffs and choices in either precedent-setting or ordinary hydropower-relicensing cases. These conclusions suggest that ecological economists might look to other analytical contributions beyond monetization studies that might be more influential in ensuring that "appropriate weight" be given to ecosystem services. For example, ecological economists should pay closer attention to analyses that are important and credible to the respondents themselves (Shabman and Stephenson, 1996). Quantifying the costs of different licensing alternatives is clearly valuable because it illuminates the element of the choice confronting decision participants in clear, familiar, and understandable terms. FERC's cost analysis tends to be based on engineering models, but more refined cost analysis could incorporate standard microeconomic demand theory (price elasticities or consumer response to conservation programs). Such conventional analysis could be instrumental in showing that the cost (in terms of foregone power) of a particular licensing alternative may less than originally thought. Second, acknowledgement of the social and discovery-oriented nature of the public policy debates might also prompt more professional and analytical attention to the study of the decision-process itself. The way decision processes are structured and organized–the rules for making decisions, approaches to conflict management, etc.–can have a direct and profound influence on how preferences for ecosystem services are expressed and evaluated. Ways to create inclusive, deliberative decision-making forums in the hydropower relicensing process have proven to be more important avenues to enhance ecosystem protection than ecosystem valuation.

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