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Rights to the River: Implementing A Social Cost-Benefit Analysis in the United States Hydropower Relicensing Process

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RIGHTS TO THE RIVER:
IMPLEMENTING A SOCIAL COST-BENEFIT ANALYSIS IN THE UNITED STATES HYDROPOWER RELICENSING PROCESS

by

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INTRODUCTION

There are over 250,000 thousand rivers and 3,500,000 miles of riparian channels cutting through the United States landscape. The intricate network of waterways snakes across the country and provides a host of resources. Cultural and social values are tied to the constant, reliable flows they provide. Rivers provide tangible and intangible benefits that are unique to their ecosystems and the communities that surround them. Congress intended the benefits of riparian ecosystems to be distributed equally amongst citizens, and common law has traditionally designated rivers as a public resource. Rivers are often referred to as the waters of the United States – they belong to the people. The era of hydropower production changed that. The potential for power generation superceded other potential river benefits. Once public and private hydropower projects began channeling river flows towards energy production, the economic value of rivers began to overshadow the natural value.

River flows were harnessed to produce hydropower, which became a widespread industry leading into the 20th century. Private parties began to reap the benefits of rivers and their potential for electricity production. River ecosystem benefits were traded for electricity benefits that boosted economic and industry growth. The country had to find a way to regulate and manage the use of rivers that often cross state boundaries and jurisdictions. The Rivers and Harbors Act of 1899 was the first federal law to coordinate this sort of regulation (Kosnik 2010). Originally, the Department of War was delegated to manage hydropower development, but as the enterprise expanded the Federal Energy Regulatory Commission (FERC) assumed the responsibilities of energy regulation, which included hydropower.

The FERC has jurisdiction over private, municipal and state projects, which comprise two thirds of the hydropower infrastructure in the country (Black et al 1998). The Committee currently oversees 1,700 hydroelectric dams in the United States (*FERC – Hydropower, General Information*). The FERC is responsible for evaluating those projects through a cost-benefit analysis performed in the best interest of the public. They compare the developmental and non-developmental values associated with dams and their respective ecosystems.

The Federal Power Act of 1920 outlines the duties of the Commission and authorizes the FERC to license projects that produce hydropower. The committee's responsibility is to "make investigations and to collect and record data concerning the utilization of the water resources of any region to be developed…and whether the power of Government dams can be advantageously used by the United States for its public purposes, and what is a fair value of such a power…" (16 U.S. Code § 797 - General Powers of Commission). The FERC must also "determine the actual legitimate original cost of and net investment in a licensed project" (16 U.S. Code § 797 - General Powers of Commission). In addition to hydropower, the FERC regulates oil, electricity and natural gas in the United States. The agency has expertise in power, energy production and regulation, and relicensing and inspecting hydropower projects comprises a small sliver of their responsibilities.

The momentum of hydropower production was paralleled by industry growth, and both reflected a market-centered society. That perspective is incorporated into the hydropower licensing process. Private hydropower construction capitalizes on the wealth of riparian natural resources. Most hydroelectric dams in the United States were built

before 1980 and the construction of new projects has plummeted since then (Kosnik 2010). Public environmental attitudes have evolved since the enactment of the Federal Power Act and initial expansion of hydropower. Ecosystem services and the value of natural capital hold more weight in decision-making processes (Alexander et al 2016).

Hydropower operators control the majority of the relicensing process. Most of the participation is limited to the owners and the FERC. The structure of the Federal Power Act primes the FERC to implicitly assume the rights of the rivers belong to private hydropower operators rather than the public. Without public input, the rights to the river are reversed and local values do not have fair weight in the process. Navigable rivers, traditionally a public resource, are treated as private property (Stimmel Law 2018).

The lack of public involvement prevents changes in how values are weighed in the cost-benefit analysis. The regulations in the Federal Power Act set up a high discount rate that undervalues ecosystem services, and post-removal studies on environmental benefits have confirmed their worth. Relicensing only considers proposals from operators in evaluations, and dam removal is usually not included. The unpredictability of ecosystem response following larger dam removals also feeds into a reluctance to consider dam removal as an option. Market analyses grounded in concrete and predictable outcomes are preferred (Kotchen et al 2006). There is a dearth of knowledge on the value ecosystem services and ecological restoration. Without those values the FERC is incapable of determining the legitimate costs and investments of projects as the Federal Power Act originally asks.

The Federal Power Act outlines a hydropower relicensing process that favors the development of power supply and reflects the values of a profit centered society. Very

few significant amendments have been made since Congress penned it in 1920. Environmental attitudes have undergone a dramatic shift, especially with the rise of the environmentalist movement in the 1960's and 1970's. Relicensing is determined by an outdated set of guidelines that do not incorporate local environmental values or ecosystem services.

The current process more closely resembles a financial cost-benefit analysis instead of a social one. As a public resource, the most beneficial use of the river should be determined by the public. Instead, the burden of proof is on the public to include their voice in the process, which diminishes the value of environmental benefits. Local populations are offered few opportunities to participate in the process. Hydropower is a crucial energy resource for the United States, but projects need to be evaluated in a way that reflects public values and fairly weighs energy and environmental costs and benefits.

With such long license periods at stake, the Committee should be making the most informed decision possible. Proposed changes to the Federal Power Act to incorporate social cost-benefit analysis will begin with suggestions that address broader structural issues and narrow down to the specific steps in the relicensing process. The recommendations will provide the FERC more structure and guidance to make socially efficient relicensing decisions that reflect the values of the public.

By examining the FERC's relicensing process for three separate hydropower projects, this thesis will explore the necessary elements of a successful cost-benefit analysis, including local and state participation and a more explicit inclusion of ecosystem values. The regulation guidelines poise the Commission to assume the operators have rights to the river, and their economic methodology reinforces that

assumption. Operators do not have to prove the net worth of their project, and the public has to fight for their preferred use of the river if it does not coincide with relicensing. A social cost-benefit framework may re-establish rivers as a public resource and yield a socially efficient outcome that balances energy production and environmental values. By examining the discrepancies in each relicensing decision, a policy recommendation to implement a social cost-benefit analysis will be made.

CHAPTER 1: THE FERC LICENSING PROCESS

The application for a renewed hydropower operation license is rather tedious and takes many years. Operators may choose one of three avenues to relicense their hydropower project. There is the Traditional Licensing Process (TLP), the Alternative Licensing Process (ALP) and the Integrated Licensing Process (ILP) (Kosnik 2010). The FERC defaults to the Integrated Licensing Process. If operators choose the Alternative or Traditional Processes, they require pre-approval from the agency. The ILP paves the least contentious path, and the FERC is heavily involved throughout the process. The Alternative Licensing Procedure is a largely collaborative process between hydropower operators, outside stakeholders and interests and agencies but it lacks the structure and deadlines of the TLP. The groups involved work together to develop deadlines, study plans and resolve disputes, and the FERC only steps in when necessary. The ILP is preferred because it combines the structure of the traditional process and the early stage negotiations of the alternative process, and the FERC is involved from the initial filing step (Kosnik 2010). The differences between the procedures are laid out in Figure 1 (FERC 2017).

	Integrated Licensing Process (ILP)	Traditional Licensing Process (TLP)	Alternative Licensing Process (ALP)
Consultation w/ Resource Agencies and Indian Tribes	- Integrated	- Paper-driven	- Collaborative
FERC Staff Involvement	- Pre-filing [beginning at filing of Notice of Intent (NOI)] - Early and throughout process	- Post filing (after the application has been filed) - Available for education and guidance	- Pre-filing (beginning at filing the NOI) - Early involvement for National Environmental Policy Act (NEPA) scoping as requested
Deadlines	- Defined deadlines for all participants (including FERC) throughout the process	- Pre-filing: some deadlines for participants - Post-filing: defined deadlines for participants	- Pre-filing: deadlines defined by collaborative group - Post-filing: defined deadlines for participants
Study Plan Development	- Developed through study plan meetings with all stakeholders - Plan approved by FERC	- Developed by applicant based on early stakeholder recommendations - No FERC involvement	- Developed by collaborative group - FERC staff assist as resources allow
Study Dispute Resolution	- Informal dispute resolution available to all participants - Formal dispute resolution available to agencies with mandatory conditioning authority - Three-member panel provides technical recommendation on study dispute - OEP Director opinion binding on applicant	- FERC study dispute resolution available upon request to agencies and affected tribes - Office of Energy Projects (OEP) Director issues advisory opinion	- FERC study dispute resolution available upon request to agencies and affected tribes - OEP Director issues advisory opinion
Application	- Preliminary licensing proposal or draft application and final application include Exhibit E (environmental report) with form and contents of an EA	- Draft and final application include Exhibit E	- Draft and final application with applicant-prepared environmental assessment or third-party environmental impact statement
Additional Information Requests	- Available to participants before application filing - No additional information requests after application filing	- Available to participants after filing of application	- Available to participants primarily before application filing - Post-filing requests available but should be limited due to collaborative approach
Timing of Resource Agency Terms and Conditions	- Preliminary terms and conditions filed 60 days after Ready for Environmental Analysis (REA) notice - Modified terms and conditions filed 60 days after comments on draft NEPA	- Preliminary terms and conditions filed 60 days after REA notice - Schedule for final terms and conditions	- Preliminary terms and conditions filed 60 days after REA notice - Schedule for final terms and conditions

Figure 1. Matrix comparing Integrated Licensing Process, Traditional Licensing Process and Alternative Licensing Process.

The Traditional Licensing Procedure begins five and a half years before a hydropower license is due to expire. This portion of the process is self-selective – if hydropower operators choose to relicense, they assume that continued operation is to their benefit. The hydropower operator notifies the FERC that they will reapply for a license, and the FERC passes that information onto the public and the relevant agencies. The Commission collects preliminary information on the current construction and operation procedures of the dam, safety and structural adequacy, fish and wildlife resources, energy conservation, recreation and land use (Black et al 1998).

In the second step of the process, federal and state agencies determine if there are any necessary studies or mitigation requirements. The area surrounding the dam is mapped and proposed changes to operation or construction are made. The agencies also determine the extent of environmental impact the dam has on present resources and what environmental protections are already in place. Flow regime information and any additional studies are also included in this step of the process (Black et al 1998).

Applicants carry out any recommended studies after consulting the appropriate agencies. Depending on the scale and area of the project, this could include recreational studies, fish and wildlife impacts, water quality, impact on resources, power needs, and project economics (Black et al 1998). A draft application is submitted to the FERC once the studies are completed and sent to resource agencies for review. If any part of the application is rejected, the respective agencies are consulted to reach an agreement (Black et al 1998).

This is where the National Environmental Policy Act kicks in, and FERC specialists review the application to ensure compliance and determine if there are

significant impacts on the human environment. After the draft application is approved, the official application is filed with all studies, consultation efforts, Clean Water Act certification, project compliance and public comments. Hydropower operators, resource agencies, and relevant Tribes, negotiate a compromise on operation procedures. Potential courses of action are evaluated through Environmental Impact Statements and Assessments. The goal is to find a proposed use of the waterway that is in the best public interest (FERC 1995). The application is then opened up for public comment, and at this point interest groups may get involved and voice their concerns. At the end of the period, comments are reviewed to determine if any additional agency recommendations, data or analyses need to be provided (Black et al 1998).

The Commission performs cost-benefit analysis that considers hydroelectric potential of the site, the potential benefits to interstate and foreign commerce, the mitigation measures taken to protect fish and wildlife, and public uses including "energy conservation, irrigation, flood control, water supply, recreational opportunities, and other aspects of environmental quality" (16 U.S. Code § 797 - General Powers of Commission). FERC's area of expertise is grounded in energy, but their staff is responsible for the Environmental Impact Statements and Environmental Assessments that determine the environmental conditions of a license (*FERC: Hydropower – General Information* 2019). They rely on input from the Fish and Wildlife Service and the National Park Service to inform the environmental requirements issued with the license, but the Commission determines what the final conditions will be. In the final license, the FERC addresses their decision to honor or exclude suggested requirements or conditions.

Once all these steps are successfully completed, the FERC issues their decision and either extends the hydropower license for either 30 or 50 years, decommissions the dam, or the federal government purchases the project and takes over operations (Kosnik 2010). Hydropower operators can appeal the decision if it is not satisfactory.

FERC Economic Methodology

The agency performs a cost-benefit analysis on all proposed courses of action in the official application in the hopes of reaching a socially beneficial outcome. It involves a comparison of both developmental and non-developmental values, and according to the FERC

> The basic purpose of the [FERC's] economic analysis is to provide a general estimate of the potential power benefits and the costs of a project, and reasonable alternatives to project power. The analysis helps to support an informed decision concerning what is in the public interest with respect to a proposed license. (FERC 1995).

The economics become more difficult when the FERC is faced with quantitative and qualitative values – namely power benefits and more intrinsic values like recreation and ecosystem services. In this comparison,

> [the FERC] must deal with both (1) resource effects [they] can quantify, often expressed in dollars, and (2) aspects [they] must describe qualitatively, sometimes based on expert opinion. In proceedings with qualitative aspects, [they] usually look at the economic value of the proposals first. Then [they] see whether the best qualitative proposal differs from the best economic proposal. (FERC 1993).

This approach automatically favors quantifiable benefits and diminishes the values of qualitative resources.

The FERC assesses six different values in their cost-benefit assessment: annual gross power benefits, annual costs of operation, annual benefits of project services, annual costs of mitigation measures and annual benefits that result from those measures (Black et al 1998). Mitigation measures are meant to minimize environmental impact during operation. The environmental benefits of complete removal are not considered unless that is a proposed option. The costs of operation and environmental measures are compared to the quantitative and qualitative power, project and environmental benefits.

The FERC compares the results of the economic analysis with their determined baseline. It is normally the current operating conditions of the dam under the existing license, or the "no action" proposal. The baseline affects what qualifies as an environmental impact and the types of mitigation measures that are proposed (Black et al 1998). Instead of the original ecosystem conditions, the baseline is the environment already altered by the construction of the dam.

The FERC consistently applies a ten percent discount rate over a thirty-year period (Black et al 1998). The high discount rate overestimates the environmental mitigation costs and does not reflect the true private discount rate (Moore et al 2001). A higher rate puts more weight on short-term benefits and diminishes the values of long-term benefits, which negatively affects potential environmental benefits. Environmental responses and recovery can take longer than thirty years to fully manifest, especially in the case of dam removal and ecosystem restoration (Black et al 1998). The costs of mitigation measures are inflated as well.

Annual power benefits, annual costs of operation and annual costs of environmental measures can be quantified and put into monetary values. Non-developmental resources are more difficult to quantify and are either excluded from net benefit calculations or very roughly estimated. The value of avoided pollution from hydropower production is equated to the cost of pollution control from the most likely alternative source, which varies by location. Pollution control costs for natural gas are much different than those of coal, which means every analysis weighs avoided pollution benefits differently. The value of project services such as flood control, water supply and irrigation are only formally assessed if dam removal is included as a potential course of action.

Although local economic impacts are estimated, considered costs are limited to mitigation and construction costs borne by the operator and do not address externalities. Cost of removal is also not included. Benefits are considered to be the market value of the power produced by the dam. The local population have limited opportunities to include their values and weigh in on the final decision. Interest groups have the power to influence decisions and have been shown to affect the number of environmental conditions issued with a license, but the clout and structure of the group are more important than than the issues they are advocating in the FERC's final decision (Kosnik 2010).

If a license requires new environmental measures, the resulting benefits only are quantified if the cost of implementing the measures equals at least ten percent of annual power benefits produced by the dam (Black et al 1998). Measures that cost less than ten

percent of annual power benefits are considered minor and the environmental benefits they produce often go unquantified and are left out of the final cost-benefit analysis.

The FERC relies on qualitative estimates drawn from general use surveys in their analysis. These estimates are based on recreational use, and do not account for potential changes in the future if alternatives to relicensing are chosen. Because of the difficulties associated with quantifying ecosystem services and environmental benefits, they take secondary priority in FERC economic analysis. Resource agencies estimate the impact the submitted proposals on local fish populations and conduct recreational surveys, but nothing is discretely valued or put into qualitative terms. They are not required to consider a removal option. Estimates of socioeconomic impacts are anthropogenically focused and limited to the effects of relicensing on local economy and employment. The economic effects on tourism, recreation or fishing industries are secondary considerations (Black et al 1998).

The FERC combines qualitative and quantitative methods to estimate social and environmental benefits in their cost-benefit analysis. There are no finite standards to abide by, and standards for ecosystem valuation varies with each project. The requirements of the CWA, ESA and NEPA provide structure, but still offer no concrete instructions. The loose guidelines set by the Federal Power lay out a broad map for the FERC to follow, but without explicit direction the FERC is left to decide how to best apply the economic methodology.

CHAPTER II: INFLUENCES ON RELICENSING DECISIONS

Most viable power production sites have been capitalized, and there has been very little hydropower construction since the 1980's. Environmental constraints limit potential development in areas that remain untapped. Development has essentially stalled, and potential increases in energy production will likely be a result of improved technology rather than new construction (Kosnik 2010).

With few new construction projects, the FERC is primarily responsible for determining renewed license conditions rather than issuing new ones. Between 1998 and 2010, over a third of the non-federal dams in the United States came up for relicensing, and the FERC expects nearly 50 applications between 2017 and 2032 (FERC 2017). The Commission has a history of approving almost every renewal application (Kosnik 2010). The organization only denied one license application against the wishes of the operator with the Edwards Dam on the Kennebec River in Maine in 1997 (Crane 2009, Manahan and Verville 2005).

As more and more dams approach their relicensing deadlines, it is crucial that the FERC makes decisions that accurately reflect the true economic impacts of hydropower production. This includes the consideration of ecosystem services and their values. The Committee is also responsible for insuring that the dam is still the best public use of the waterway, which necessitates a social cost-benefit analysis and the inclusion of public values.

The FERC tackles the responsibility of evaluating environmental impacts against energy needs, which is difficult to do as environmental values evolve and the demand for renewables continues to grow (Kosnik 2010). Several federal laws attempt to mold

relicensing into a more balanced process that fairly considers market and non-market benefits. The National Environmental Policy Act (NEPA) of 1970 changed the outlook on dam relicensing. NEPA was the product of a shift towards environmentally conscious legislation in the 1960's and 1970's and reflected the values of a nation concerned with environmental protection and preservation (Kosnik 2010). The FERC had to include Environmental Impact Statements with every application and consider ecosystem protection alongside hydropower production (Kosnik 2010). NEPA increases the attention directed towards mitigation requirements but it rarely stops a relicensing.

Despite a shift towards environmental awareness, the FERC still held a narrow evaluative outlook on potential river uses. The 1986 Electric Consumers Protection Act (EPCA) expanded the scope to include river uses beyond hydropower production (Moore et al 2001). The Act required the FERC to consider hydropower impacts on fish, wildlife and environmental quality (Black et al 1998). The FERC looked at relicense applications with "equal consideration of developmental and non-developmental values" (Black et al 1998).

Until the EPCA was passed in 1986, the FERC did not consider much beyond the potential production capacity of dams (Kosnik 2010). The Act mandated that hydropower production and environmental protection be balanced through environmental conditions attached to the license. Energy production is often sacrificed for environmental mitigation conditions, which reinforces the notion that environmental protection and energy production are a trade-off (Kosnik 2010).

The Act ushered the consideration of both market and non-market values into the FERC's decision-making process; most notably, it required including ecosystem service

values and non-traditional valuation methods. Ecosystem services are undervalued and provide positive externalities that often go unaccounted for in a traditional market setting (Goulder and Kennedy 2011). The EPCA was an attempt to breach the gap between economic and environmental interests.

The EPCA introduced other sweeping changes to the responsibilities of the FERC, and arguably had the greatest impact on final relicensing decisions issued by the committee. Beyond the equal consideration clause, federal land managers were authorized to "impose mandatory conditions on a FERC license for hydropower projects located on federal lands" (Black et al 1998). The agency also had to consider recommendations from resource agencies to include developmental and non-developmental resources in plans, protect fish and wildlife resources according to the Fish and Wildlife Coordination Act, and include upstream and downstream fish passage in license conditions (Black et al 1998).

The Energy Policy Act of 2005 redirected the FERC towards energy and consumer interests. The most recent strategic plan, released in 2018, states a mission to provide "Economically Efficient, Safe, Reliable, and Secure Energy for Consumers" (Department of Energy 2018). The Commission's primary goal was refocused towards energy production.

Relicensing decisions are also affected by internal and external factors (Moore et al 2001). There are several studies investigating what influences the FERC licensing process, their final decisions, and how many environmental mandates are included in each license. Public welfare, ideological agendas, Congressional and political influence, the application procedure, interest groups and historical precedents all play a role in the

process. The composition of the Commission varies between administrations, and relicensing decisions normally reflect the values of the current party.

The physical location of a project affects the number of mitigation conditions in a license. Dams situated on polluted rivers or in areas with lower water quality are subject to more environmental regulations, which implies that ecosystem values are accounted for to some degree even if they are not explicitly quantified (Kosnik 2010). The size and production capacity of a project are also factors. The FERC is more likely to reject environmental recommendations from participating agencies for larger hydropower projects, especially if they affect power production capacity (Moore et al 2001).

The hydroelectric dam industry is extremely lucrative. After the initial construction costs, yearly upkeep and maintenance costs are relatively minimal compared to the profits generated by energy production. Removal costs are not considered, which increases the net present value of the project. The cost-effective nature of hydroelectricity makes it even more appealing in the face of rising energy prices, and increased electricity prices lower the number of environmental regulations (Kosnik 2010).
Between 1983 and 2005, 498 hydropower licenses were issued with an average of ten environmental conditions each (Kosnik 2010). Dams with high hydroelectric potential received fewer regulations. Established dams applying for renewed licenses were grandfathered in and had fewer environmental conditions than new projects (Kosnik 2010).

The outlined economic methodology influences cost-benefit calculations and favors easily quantified market values. A study by Moore *et al* found that in 593 relicensing recommendations issued by the FERC, benefit estimates for fish and wildlife

resources were not included in a single one. Cost estimates were included in 168 (Moore et al 2001). The costs of environmental mitigation measures were also inflated and tended to be higher than private costs, which reduced their likelihood of being included in the license (Moore et al 2001).

Public interest and values vary between populations and regions. Although public involvement has not been found to affect the number of recommendations issued with a license, they can influence the final decision (Moore et al 2001). Interest group involvement often results in more environmental conditions (Kosnik 2010). Intervenors reflect the values of the populations that they are representing, which influences the final license conditions. Communities that value cheaper electricity and employment advocate for hydropower production and fewer environmental regulations, and communities that value environmental services will push for environmental regulations (Kosnik 2010). The Federal Power Act currently assumes that continued operation is in the best public interest unless the public says otherwise (Doyle et al 2003).

Economic models examining impact of different variables of the FERC's licensing conditions found the passage of the EPCA and administrative ideology were the two major factors influencing final license conditions (Moore et al 2001). After the EPCA, licenses had more environmental regulations. The Clinton administration had a similar impact on licensing conditions (Moore et al 2001).

The Federal Power Act, the EPCA amendment and NEPA provide the legislative framework for the FERC to carry out their licensing decisions. Those decisions are affected by a myriad of environmental statutes, including the Clean Water Act, the Endangered Species Act, the Clean Water Act, the Wild and Scenic Rivers Act, the Fish

and Wildlife Coordination Act, the Coastal Zone Management Act, and the National Historic Preservation Act (Black et al 1998). The statutes allow federal agencies to consult to FERC as they craft the license.

Although the FERC receives recommendations from state and federal resource agencies on fish and wildlife conditions and mitigation strategies, they exercise full discretion to determine conditions that affect those resources. The agency must include conditions in the license that comply with federal environmental regulations like NEPA and the Clean Water Act to protect public land use and water quality. However, the recommendations made by agencies regarding fish and wildlife protection measures are merely that – recommendations. Section 10 of the Federal Power Act only requires that the FERC consider the recommendations of environmental agencies, not treat them as mandates. Ultimately, it is up to the FERC to decide what to include or omit in the final license conditions. The FERC cost-benefit analysis can be swayed by a number of different factors. The weight of market and non-market values in the process is inconsistent and a social cost-benefit analysis is not a guarantee.

CHAPTER III: COMPONENTS OF A SOCIAL COST-BENEFIT ANALYSIS

The decision to renew a dam license directly affects the environmental resources the river provides. Renewal benefits can include electricity, flood control, water supply, reservoir recreation opportunities, and navigational services (Whitelaw and Macmullen 2002). The costs of hydropower are generally manifested in the disruption of ecological services and environmental disturbances, which are harder to quantify as non-market costs. Most economic estimates involving environmental factors emphasize mitigation costs because they have market value (Whitelaw and Macmullen 2002). There are also ripple effects that fan out to impact the surrounding population, employment, cultural and historical value, and the local economy.

If a hydropower operator chooses to relicense their project, they are expecting economic gains from continued operation and private benefits from power production. They are not responsible for the environmental damages, which are a public cost. The impact of hydropower on fish populations demonstrate this concept well.

Migratory fish populations suffer from dam construction as their spawning habitats are blockaded or destroyed, and their migratory patterns disrupted. Hydropower operators not feel the consequences of declining fish populations, and that cost is disproportionately placed on the public. This is especially true with the Elwha Dam, where native anadromous fish played a pivotal role in the relicensing decision. For communities that rely on fish for subsistence and economic profit, dwindling fish populations are detrimental. Fish are also associated with strong cultural and historical value, and that loss is also a public cost (Crane 2011). Angling and recreation activities

associated with fish populations suffer as well. Analyses that exclude or diminish these effects will not adequately capture the full costs of operation.

The FERC needs to consider both market and non-market values equally and accurately to determine if hydropower projects are still the best public use of a waterway. There are several different methods to quantify non-market ecosystem services. They are a step towards quantifying indirect and non-use values and produce discrete values that may be incorporated into cost benefit analyses.

Willingness to pay and contingent valuation have been established as methods to determine the public value of ecosystems. Both were used following the Elwha and Edwards Dam removals to assess the non-market benefits of ecosystem restoration (Loomis 1996, Lewis 2008). The benefits were not included in the FERC's original assessment and the studies were conducted after the FERC issued their decision.

In addition to the social cost-benefit analysis, another nuance in the relicensing process is the timing. It is a crucial part of a cost-benefit analysis, because optimal timing results in the optimal net benefit. The relicensing process dictates the timing of dam removal, which may not coincide with the optimal time for removal. During the thirty or fifty years of operation under a license, the costs of operation may outweigh the environmental benefits well before the project is due for renewal.

According to the FERC, the time to renew a license is dictated by the expiration date of the old one. Cost-benefit analyses laid out for investments presents a different strategy. A hydropower dam is an investment. A significant amount of resources is poured into the construction of the dam but once the dam is operational, upkeep, maintenance and operational costs are relatively minimal (Kosnik 2010).

The optimal time to remove a dam depends on the scale of the project, the components of the dam – such as the fish passages, the natural flow of the river, the parts of the structure – and the net present value (Jenkins et al 2011). The net present value is the relationship between the costs and benefits of the project, making finding the conjunction between timing and an accurate benefit cost analysis crucial. Environmental values are also a function of time, and the benefits of ecosystem restoration increase as the environment recuperates. If a dam surpasses its beneficial operational life, it operates at a net loss because the time for environmental benefits to restore themselves is lost.

The FERC recognizes dams as structures with multiple parts, because license conditions generally target one component of the operation like fish passage or flow rates. Although the FERC has never ordered the partial removal of a dam, it has been a strategy used by non-FERC regulated dams. It is uncommon, but partial dam removal may be the best option for a river system in some cases. Retaining part of the structure prevents the risk of flooding, sediment deposition, preserves historical value and avoids the costs of complete removal (ICF Consulting 2005). Complete removal is rarely presented an option, and in the Elwha and Edwards case studies it was pushed by outside interest groups. A complete social cost-benefit analysis considers all the possible outcomes.

The scale of a project is directly related to the costs (Jenkins et al 2011). The larger a project, the greater the expense. The costs are not limited to initial construction, either. Mitigation costs or additional infrastructure are more expensive as the size of the project is scaled up. Conversely, the larger the dam is, the more expensive it is to take it

down. Operators do not account for the costs of removal their projections, which increases their net present benefit.

Project scale functions in a variety of ways when it comes to hydropower. The size of a hydropower project is favored in the profitability approach, because larger projects generally correlated with improved power production capacity. From an environmental perspective, however, size becomes a cost. Larger dams have greater adverse environmental impacts compared to their smaller counterparts and have more potential to alter their environments.

Once the scale of a project and the costs associated with that scale – both maintenance and mitigation costs and the less easily quantified environmental and social costs – exceed the net present value of the project, it ceases to be profitable (Jenkins et al 2011). The tipping of the cost-benefit scale signals the point when hydropower is no longer a profitable investment. An economically viable hydropower project provides greater power benefits compared to the potential environmental benefits of ecosystem restoration.

If a dam passes that cost-benefit tipping point before renewal, it may operate at a net loss until relicensing does occur, which could happen several years later. This was exactly the case on the Elwha River. The potential environmental benefits of ecosystem restoration and a revived salmon population were brought to light years before the relicensing process began. The dams continued to operate at a loss until they were fully removed. A myriad of factors could tip the scale including structural or safety issues, decreased power production, or a shift in environmental attitudes that values ecosystem services more (Hammersley et al 2018).

There is some uncertainty associated with ecosystem restoration and potential responses cannot always be predicted. The Elwha is the only major dam removal that can be referenced as evidence of large-scale ecosystem restoration. Those environmental benefits were forgone in the period between the tipping point and relicensing. Operators will benefit from the electricity produced during this period of net loss, but the burden of sacrificed environmental benefits is unfairly distributed onto society.

The FERC incorporates some of this methodology into their cost-benefit analysis. Their evaluation is limited to a finite period of time to fairly evaluate the costs and benefits during the period of licensing, and they select the proposal with the greatest benefits and fewest costs. Not all options are considered, and dam removal is usually omitted. There are inconsistencies with how market and non-market values are included, and in some cases, they are not included at all. Without a complete social-cost benefit analysis, the FERC cannot make a socially efficient decision.

CHAPTER V: THE ELWHA AND GLINES CANYON DAMS

There have been successful dam removals in the past, and two recent major dam removals occupy both sides of the relicensing spectrum. One details a failed relicensing process while the other was a success. Both were messy and contentious, both had heavy public participation, and in both cases public values outweighed private interests. The Elwha and Glines Canyon Dam removals in Washington State tell the story of a failed relicensing process, but ultimately resulted in a successful and socially beneficial dam removal. The Edwards Dam removal on the Kennebec River in Maine had the same fate but followed a much more contentious path. But rather than being the rule, these dam removals are the exception. Both demonstrate the prolonged, complicated process of contesting a private hydropower license and removing a dam against the wishes of the operators.

The Elwha and Glines Canyon Dams highlight the problems of license timing, the underestimation of ecosystem benefits and restoration, the misallocation of river rights and the lack of public participation. The dams caused serious environmental damage and locals opposed them for years leading up to their relicensing. Local and tribal interests fought to restore the river and its ecosystem to its original state, and only succeeded with Congressional intervention.

The Construction of the Dam

The history of the Elwha River in Washington State winds its way through the 20th and 21st centuries to tell a story of ecosystem degradation, environmental policy, and agency conflict. It provides a case study for future dam relicensing and ecosystem restoration strategies. Over the course of a century the river was dammed in two

locations, underwent drawn out relicensing proceedings with the Federal Energy Regulatory Commission (FERC), and after decades of argument over the fate of the river, both dams were decommissioned in a decision that seemed to weigh environmental interests and removed to fully restore the ecosystem.

The Elwha River basin is tucked into the northwest corner of Washington State on the Olympic Peninsula. The convergence of the Elwha Basin Range, the Bailey Range and the Olympus Range feed the river and the glacial melt rushes through the peninsula and into the Strait of Juan de Fuca 45 miles below. Most of the 321 square mile watershed lies within the Olympic National Park, making the basin a nearly pristine ecosystem. Although there have only been two disturbances to the river, they were major ones. The construction of the Elwha Dam in 1913 and the Glines Canyon Dam in 1927 altered the course of the river for the entire 20th century.

Like many rivers utilized for hydropower, the Elwha is home to ten different species of anadromous trout and salmon (United States Department of Interior 1994). Salmon are an iconic species in the Pacific Northwest and occupy a role of deep biological and cultural significance. The Lower Elwha K'llalam tribe has lived on the Olympic Peninsula for centuries, and "salmon were the most important resource…at the very heart of [their] economy even as they constituted the vital core of the Elwha river ecosystem" (Crane 2011). Salmon were a cornerstone of their culture and livelihood. That slowly started to slip away in 1855, when the K'llalam Tribe ceded much of their land in exchange for cash and goods and agreed to relocate to a nearby reservation as part of the Point No Point Treaty. They still clung tight to their fishing rights, but the treaty was only the beginning of a long battle for the rights to the river.

In 1890, Thomas Aldwell landed on the Olympic Peninsula with a hunger for success and a specific vision for how the land should be used. Hydroelectricity was the key to his plan, and he spent twelve years acquiring the necessary land for the first dam 4.9 miles from the mouth of the river. Aldwell foresaw an economic boom in Port Angeles powered by hydroelectricity. His outlook on natural resources was in stark contrast to the one held by the Lower Elwha K'llalam Tribe. The Elwha Dam was built in 1912, during the throes of capitalism and in an era of extraction, and the rivers teeming with silvery salmon fostered a belief in a seemingly unlimited resource (Crane 2011).

The construction interrupted migratory patterns and prevented spawning in the upper 70 miles of the river, which decimated the fish populations (Loomis 1996). The Lower Elwha K'llalam Tribe was cut off from their most important resource, which was both a violation of the Point No Point Treaty and a harsh cultural and economic blow. The Elwha Dam failed to comply with an 1893 Washington State law requiring fish passageways and little consideration was given to the potential implications of construction on fish populations, and they were not able to rebound. Hatcheries were constructed below the dams in an attempt to compensate for the dwindling fish counts, but poor management and weak hatchery regulation laws led to their abandonment in 1923. The threat was compounded with overfishing, unabated resource use, water pollution and rapid industrialization, all of which put the future of salmon population in severe jeopardy. Salmon and steelhead population numbers nosedived from 400,000 to 3,000 over the course of the century (Crane 2003).

The Federal Power Act was enacted after the Elwha Dam was constructed, which exempted it from any of the licensing conditions required by the FERC (Crane 2003). An

official license application was not submitted until 1968 (Department of Interior 1994). The Elwha Dam only generated enough power to support one lumber mill in Port Angeles and failed to power the peninsular metropolis that Thomas Aldwell envisioned. In 1919, the dam was sold to the Crown Zellerbach Corporation. Although the Elwha Dam did not live up to its expectations, the spirit of capitalism persisted and plans to construct a second dam 8.5 miles upriver were put into motion.

The state of the art Glines Canyon Dam truncated the flow of the river even further and reinforced the reputation of the Elwha as an industrial river. The Corporation did not attempt to manage the river sustainably or in a way that would benefit salmon populations. The ecosystem itself suffered from the effects of construction. Downstream portions of the river eroded away as sediment piled up in the reservoirs, river channels meandered from their original courses, and vegetation died off (Crane 2011). The post-dam Elwha was a river characterized by low aquatic productivity, depleted nutrient levels, and starved of sediment, the effects of which were beginning to manifest on the Ediz Hook spit of Port Angeles.

The Glines Canyon Dam received a fifty-year license from the FERC upon its construction in 1927. Calls to restore salmon populations began shortly after construction was complete in 1930. Lower Elwha S'Klallam Tribe who continued to associate deep economic, cultural and social values with the fish, were primary opposers (United States Department of Interior 1994). The environmental concerns of Washingtonians were overshadowed by a focus on economic growth and production, and state fish and wildlife agencies had little power due to weak legislature.

In 1938, the Olympic National Park was created and added another layer to the story of the Elwha. The park enveloped 60 miles of the Elwha River within its boundaries. This put the river within the jurisdictions of National Park Service and the Department of the Interior. The park later received recognition as an International Biosphere Reserve in 1976 and World Heritage Site in 1981 (United States Department of Interior 1981).

The majority of the Elwha River basin lies within the park and was in relatively pristine condition, undisturbed by logging or other commercial activity (Loomis 1996). The Park was crucial in determining the final outcome of the river. The National Park Service strives to "restore natural aquatic habitats and the natural abundance and distribution of native aquatic species, including fish, together with the associated terrestrial habitats and species" (United States Department of Interior 1994). The damage the dams inflicted on the anadromous fish populations was at odds with NPS policy goals.

The FERC determines the license conditions of private hydropower projects, but the presence of the Olympic National Park and local interests complicated the relicensing decision. The National Environmental Protection Act mandates the agency to consider all possible options while performing a cost-benefit analysis of hydropower development, navigation, fishery resources, recreation, and other various uses of the river. The Commission also considers the input of local, state and federal agencies, interest groups, and the dam owners and operators. With the Elwha River, the committee was tasked with balancing multiple competing interests.

The Glines Canyon Dam, which was located within the boundaries of the Olympic National Park, directly contradicted the National Park Service policy goals. Both dams were altered the water quality and flow of the rivers and blocked migratory patterns, preventing the realization of the NPS restoration goals (Pess et al 2008). There were no fish passage facilities, and even the suggested improvements would not successfully restore natural fish populations. Although it is a mitigation required by the EPCA, fish passage facilities have not been proven to improve fish mortality rates as they attempt to migrate through dams (Yale E360 2013).

Glines Canyon Dam and the Elwha Dam trapped sediment critical to fish habitats, limited marine derived nutrients, raised water temperature, increased the risk of diseased or physiologically stressed fish, and inundated riverine and terrestrial habitats of the Elwha River which stymied fish population recovery (U.S. Department of Interior 1994).

Concerns over fish populations continued to mount through the decades as the social, ecological and economic values of the state residents shifted, which highlights the importance of license timing and duration (Abbe 2004). Residents were beginning to value the environmental benefits of the river over the power benefits, and most of their concern focused on salmon recovery.

The Washington State Department of Fisheries independently investigated the Elwha's restoration potential as a fish producing river in 1971, and they found the value of restoring the fish populations to be huge (WDF 1971). Recuperating just one single species, the chinook salmon, was valued at $370,000 a year (WDF 1971). The costs of implementing mitigation measures and constructing fish passage facilities for the aging structures came out to $550,000, with an additional $32,000 of associated yearly

maintenance costs (Crane 2011). The estimated environmental benefits outweighed the mitigation costs. The preliminary study was conducted several years before the relicensing process began. It was an early acknowledgement of the value of salmon in the ecosystem and indicated a burgeoning interest in fishery restoration.

The Relicensing Process

The Crown Zellerbach Corporation acquired the dams from the James Paper Company and privately owned both projects at the time of relicensing. The dams supplied 40% of the power for the local paper mill in Port Angeles (Winter and Crain 2008, Gowan et al 2006). The Corporation filed separate relicensing applications for each dam – first the Elwha Dam in 1968, followed by the Glines Canyon Dam in 1973 (Winter and Crain 2008). The FERC determined the projects were "hydraulically, electrically and operationally connected" and combined the applications to assess their cumulative impacts on the ecosystem in 1979 (Winter and Crain 2008).

The licensing process followed the traditional route. Although local interest groups and environmental organizations did not have formal authority or input, they requested to comment on the proceedings and decisions to voice their desire to restore the ecosystem (Gowan et al 2006). The Elwha was subject to unique outside pressures that influenced the end outcome, and the importance of salmon restoration was a large part of that. The relicensing process for the Elwha truly began in the 1980s as a negotiation between the FERC, the Fish and Wildlife Service, the National Marine Fisheries Service, the Washington Department of Natural Resources, the local population and the James Paper Company (Gowan et al 2006).

The Lower Elwha K'llalam Tribe filed as official petitioners to block the relicensing of the two dams once the Crown Zellerbach Corporation filed intent for renewal and proceedings were underway. They are credited with beginning the movement that advocated for complete dam removal and total ecosystem restoration (Crane 2011). During the negotiations, the FERC did not seriously consider the proposal remove the dams and restore salmon populations, which conflicted with public interests (Winter and Crain 2008). Their precedent to renew licenses reinforced that course of action, and pressure to remove the dams continued to mount. The Lower Elwha K'llalam tribe had experienced the once abundant runs of salmon and steelhead and knew the river's potential to sustain year-round fishing (*The Elwha Report* 1994). Local politicians, recognizing the economic potential of complete restoration, supported removal of both dams as well (Crane 2011). The Crown Zellerbach Corporation was not interested in removing either of their dams, and local and regional political battle ensued.

In an effort to reduce conflict and reach a decision that would benefit both the public and private parties, Crown Zellerbach and the Lower Elwha tribe were invited to collaborate throughout the relicensing process. Each wanted the opposite of the other. Congressional intervention finally sealed the fate of the dam in 1992, 24 years after the initial applications were submitted. The dam still continued to operate for over two decades after the public made explicit their interest in ecosystem restoration.

The Elwha River Ecosystem and Fisheries Restoration Act mandated the complete restoration of the Elwha River ecosystem and its native anadromous fisheries. The Secretary of the Interior was authorized to purchase both dams and undertake the necessary measures to achieve this goal (U.S. Department of Interior 1994). The FERC

evaluated four options: retaining both dams with fishery mitigation measures, removing the Elwha and retaining Glines Canyon, retaining the Elwha and removing Glines Canyon, and removing both dams. All the proposals were evaluated against the goal of the Ecosystem Restoration Act in the final Environmental Impact Statement.

Removing the Dams

The Crown Zellerbach Corporation fought to keep their dams, and proposed fish mitigation options as a compromise. The fish passage facilities were economically feasible, but mortality rates were high (Winter and Crain 2008). The economic potential of the dams would be sacrificed for salmon restoration efforts and the additional mitigation measures would significantly reduce power production.

The Elwha Report and initial Environmental Impact Statement carried out by the FERC were supplemented with additional studies from the Department of the Interior, the Washington

Department of Fish and Wildlife and private parties. The analyses performed by the FERC did not quantify non-market cultural benefits, which diminished the weight of the K'llalam people's values. The final Environmental Impact Statement by the National Parks Service included cost-benefit analyses for all four proposals, and the only option where benefits exceeded costs was removing both dams (Figure 2, United States Department of Interior 1994).

The Elwha Report predicted a total expenditure of between $75 and $101 million to remove and restore the Elwha River ecosystem, and that included the cost of acquisition for both dams (Hahn 1995). The acquisition of the two dams by the Department of the Interior set a harmful decommissioning precedent that relieves private

	ALTERNATIVES				
	No Action	**Dam Retention**	**Glines Dam Removal**	**Elwha Dam Removal**	**Proposed Action**
SAFETY					
ability to withstand maximum probable flood	safe	safe	precautions needed during dam removal	precautions needed during dam removal	precautions needed during dam removal
earthquake	Glines safe, Elwha unknown	Glines safe, Elwha unknown	Elwha unknown	Glines safe	N/A
localized floods	occur now	same frequency and impact as now	may be more frequent	may be slightly more frequent	may be more frequent
ECOSYSTEM					
biomass (1,000 lbs. of salmon/trout)	0	109	284	312	818
nitrogen & phosphorous (pounds)	0	1,800	4,770	5,200	13,000
number of runs with "good" or better restoration potential	0	0	2 to 5	0	0
river ecology	nutrients & debris blocked, flow regime altered	nutrients & debris blocked, flow regime altered	nutrients & debris blocked to RM 4.9, flow regime natural to RM 4.9	nutrients & debris blocked, flow regime altered	nutrients & debris transported along entire river, flow regime restored
CULTURAL					
tribal	tribal river focus lost	tribal river focus lost	tribal river focus lost	tribal river focus lost	tribal river focus restored
cultural properties	inundated and inaccessible	inundated and inaccessible	some inaccessible	some uncovered and accessible	all uncovered and accessible
historic structures	dams in place and on National Register of Historic Places	dams modified and potentially ineligible for National Register of Historic Places	one dam removed and the other potentially ineligible for National Register of Historic Places	one dam removed and the other potentially ineligible for National Register of Historic Places	both dams removed but fully inventoried. Potential loss of historic structures
SOCIOECONOMIC					
property taxes	$231,000 (1994)	large increase	small increase	moderate decrease	none
construction jobs	0 (now)	32 person years	172 person years	84 person years	228 - 1,542* person years
operations jobs	10 (now)	14 person years	7 person years	7 person years	1 person year
tribal fishery restoration potential	no restoration	poor or fair for most runs	poor to good for most runs	poor or fair for most runs	9 or 10 runs good or excellent for most runs
FERC cost estimates	$0	$17M - $34M	$66M - $72M	$44M - $50M	$76M
Base year (1997) local real cost replacement power (millions of dollars)*	$2.1	$6.2	$5.6	$8.4	$4.8

Figure 2. Cost-benefit estimates for all proposed courses of action in Elwha Final Environmental Impact Statement

hydropower operators of the responsibility to remove the dam (Pyle 1995). The public has to cover removal expenses with government acquisition, which thrusts another cost back onto local population.

The costs of removal were compared to the cultural, socioeconomic and ecological benefits. The recreation and tourism industries were predicted to grow by $133 million over 100 years of project life, and commercial fishermen netting $3.5 million each year. Up to 1067 jobs would be generated by the removal, spurring a $21 to $29 million increase in personal income and $40 to $55 million boost in the local economy. Sales taxes were predicted to increase by $260,000 each year. A private cost-benefit analysis estimated and additional $28.5 million in spending throughout Clallam County each year as a result of additional tourism activity (Meyer et al 1995).

The net present value of the Elwha Restoration throughout the project life was estimated to be $163.6 million in FERC's Final Environmental Impact Statement (Hahn 1995). Market benefits included commercial fisheries, sport fishing, the restoration of the Ediz Hook sand spit, recreation and tourism. The report acknowledged the exclusion of non-market benefits, citing the lack of reliability as the reason for omission.

The owners continued to point out the loss of recreational and biological value in the reservoirs behind the dams, the uncertainty of silt deposition after removal, and lost aesthetic value as reasons to retain the dams (Crane 2011). Those costs did not compare to the removal benefits. Any other option besides complete removal brought at most $11.6 million in benefits, nearly $150 million less than the complete restoration strategy (Hahn 1995). The proponents of removal won their decades long battle, and three

decades after the dams went up for relicensing the removal process finally began. The United States Department of Interior purchased both dams, and the Elwha was dismantled between 2011 and 2012, with Glines Canyon following suit in 2014.

Post-Removal Effects

One of the biggest environmental uncertainties of removal was the release of sediment stored in the reservoirs. 30 million cubic yards of sediment sat waiting to rush downstream, and the effects of such a large flux of sand, silt and clay were unknown. A carefully planned adaptive management strategy slowly released the sediment, and the river immediately adjusted with more efficient nominal flows (River Restoration Network, Randle and Bountry 2015). The rapid recovery took months instead of the predicted years and outpaced all expectations. The continual monitoring of the ecosystem recovery also provides valuable information to reference for future dam removals and ecosystem responses.

The Elwha decision was unconventional for its time. It struck a balance between economic and environmental that accurately reflected the interests of the population. As the largest dam removal to date in the United States it serves as both a case study for future policy reform and the environmental impacts of large-scale dam removals. The process to decide whether or not to remove a dam, and consequently restoring the ecosystem, requires a series of cost-benefit trade-offs and intense public, private, state and federal collaboration.

Close monitoring of ecosystem restoration in the years since removal yields promising results. The Elwha River, nutrient-starved for over 100 years, experienced an influx of marine derived nutrients just months after both dams were removed (Tonra et al

2015). Salmon were quick to repopulate their lost river. 4,000 salmon were counted in the upper reaches of the river just one season after removal, the highest fish populations had been in 30 years (*The Seattle Times* 2016). The rapid return of nutrients does not translate to complete ecosystem recovery but has positive implications for ecosystem health and the rate of restoration.

The non-market benefits were calculated in an independent study following the release of the Environmental Impact Statement. Contingent valuation and travel cost are methods approved by many government agencies as means to quantify recreation and non-market environmental benefits and could have been included in the original estimates (Swanson and Loomis 1996).

The study asked Clallam County residents, Washington State residents, and national residents their willingness to pay to fund dam removal and restoration.

The benefits of removal for both the ecosystem and the native fish populations were made clear to all participants, and the willingness to pay averaged at $59 per household in Clallam County, $73 per household for Washington State residents and $68 per household for the rest of the country (Loomis 1996). Loomis suggested that Clallam County residents responded with a lower willingness to pay because they weighed the net benefits against the costs of removal. Their community would be directly affected by the loss of energy production and the economic impacts, while other Washington residents and the rest of the country would only reap the benefits of restoration.

Based off the contingent valuation estimates, local restoration benefits ranged from $94 to $138 million annually, and the national benefits from $3.47 billion to $6.275 billion (Loomis 1996). These benefits were not captured in the FERC's original analyses.

The huge benefits also highlight the value of non-market services. The results confirmed removal as the right decision, and the methodology can be applied to future dam relicensing assessments to better incorporate public opinion.

A social cost-benefit analysis makes it clear that the outcome of the Elwha River represented what was best for the public interest. Local interests, especially those of the K'llalam people, had a heavy hand in determining the fate of the river. They pushed for the dam removal. The ecosystem restoration and the return of the salmon to both River and the K'llalam people as a result of the decommissioning and removal of the Elwha and Glines Canyon Dams make it a success story.

The ecological victory also showcases several flaws in the FERC licensing process. The issue of timing arose when then dams continued to operate for decades after calls for removal were made. Dam removal was the socially beneficial, but at the onset it was not even considered. It arose as an option because of intervenors when it should have been a possible scenario from the start. The FERC was leaning towards license renewal, which prioritized private interests and was not in the best public interest. It was only Congressional and public intervention that steered them in a different direction. The Olympic National Park and its policy goals led to the passage of the Elwha Restoration act, which mandated complete fish population restoration and ecosystem recovery. Environmental and ecosystem values were underestimated, and the benefits were far greater than expected. It was a successful social cost-benefit analysis, but it was not the result of a successful FERC relicense procedure. External pressures determined the final outcome, and it is unclear whether the Commission would have chosen the same option.

Had Congress not taken over, it is possible that both dams may have continued to damage the Elwha ecosystem for another 30 to 50 years.

CHAPTER V: THE EDWARDS DAM

The Edwards Dam on the Kennebec River in Maine parallels the trials of the Elwha in many ways. Local interests and private hydropower interests clashed, and restoration efforts were also at the center of the removal debate with the Edwards Dam. The ecosystem conditions and the political climate were very different, and so was route that the FERC took to reach their final relicensing decision.

The Edwards Dam wreaked environmental havoc on the Kennebec River since it's construction in 1837. The structure limited available habitat for the anadromous fish populations, worsened water quality and created hypoxic conditions along the river, making it inhabitable for most organisms (Crane 2009). That, combined with a period of intense economic and industrial growth, contributed to the pollution of the Kennebec. Few homes dotted the shores of the tainted river, and the ones that did held low property values.

Banning log drives and the Clean Water Act revived some of the river's ecological integrity, and by 1990 the river was much healthier compared to its conditions in 1972. With a glimmer of complete river restoration in sight, local advocates, interest groups and the state government began to push for the complete removal of the Edwards Dam.

The movement began with the intention to reach a community consensus, but negotiations crumbled when the owners of the dam, the Edwards Manufacturing Company (EMC) filed to relicense with the FERC in 1990. Although there are several dams along the Kennebec, the Edwards Dam was the most ecologically injurious to the

river and the fish populations (Crane 2009). The owners refused to comply with state fish restoration efforts, preventing that possibility.

Restoration advocates and the state of Maine officially opposed the relicensing, and a nine-year battle over the use of the river began. The EMC acknowledged FERC's historical tendencies when they decided to push forward with their license. They expected the agency would adhere to their precedent to renew existing licenses. The EMC proposed increased power production and improved fish passage facilities in their license as a compromise to complete removal.

Fractured political and economic interests in Maine led to a contentious relicensing process (Crane 2009). The state of Maine and the city of Augusta butted heads, with the state supporting removal and the city supporting the EMC. Sportsmen coalitions and restoration groups were on the side of removal. Even with conflicting goals, all parties expected the FERC to renew the license. Removal proponents recognized that attempting to decommission the dam through the FERC process was a long shot (Crane 2009).

Restoration advocates appealed to the cost-benefit methodology of the FERC and used both economic and environmental arguments to back their position. Past dam breaches, safety and stability issues, and poor environmental quality were all public costs. Most of the benefits were funneled to the privately-owned EMC as profits from the power produced by the dam (Crane 2009). The EMC was steadfast in their protection of their economic interests and their investment in the dam and were not going to relinquish those benefits easily.

When the FERC chose not to renew the license in a 2 to 1 decision, it was a shock to both the EMC and the community. The FERC cited that their decision to raze the dam was aided by a "balanced view of environmental as well as social and economic considerations" (Crane 2009). That view was informed by intense public participation. The draft Environmental Impact Statement by the FERC only called for fish passage facilities and did not include a removal option. It spurred groups pushing for removal to hire consultants that developed sound technical arguments that supported the option (Crane 2009). They were able to prove that dam removal would not cause erosion or downstream flushing, nor would it be excessively expensive; this countered some of the major arguments posed by owners of the Edwards Dam (Crane 2009).

Their efforts paid off, and in the final cost-benefit analysis the FERC recognized the benefits of power production were negligible compared to the environmental benefits. The Edwards only produced 3.5 megawatts of power, and most of those benefits were concentrated to the dam owners (Crane 2009). The public wanted to receive the environmental benefits of ecosystem restoration, which would be more equitably distributed.

The decision marked a shift in the way the government viewed the environment. It was celebrated as an instance where "'federal officials listened to the evidence and struck the right balance in their decision'" (Crane 2009). The agency conducted a successful social cost-benefit analysis that compared environmental and economic costs and benefits. They gave fair weight to public input and included their values in the analysis.

The EMC appealed the decision and demanded compensation from the FERC, attempting to invoke the precedent set by the acquisition of the Elwha and Glines Canyon Dams. Other hydropower operators joined in to echo the demand, concerned they would also be faced with the costs of removal if their dams were decommissioned in the future (Crane 2009). the Edwards removal was covered by Bath Iron Works, a local shipyard, and the Kennebec Hydro Developers Group (Lohan 2019). The EMC was not responsible for the decommissioning.

The dam came down in 1999, and anadromous fish populations, benthic aquatic organisms and riparian recreation thrived as a result (Lewis et al 2008). Additional removal effects aside from environmental improvements were studied via a hedonic property value analysis of homes in the area (Lewis et al 2008). Before the removal, properties faced a penalty for their proximity to the river, likely due to the poor water quality and limited recreational opportunities. Homeowners were willing to pay $2,000 more for each additional half mile between their homes from the dam (Lewis et al 2008). The penalty decline coincided with the removal of Edwards Dam and restoration of the river. Following the removal, the willingness to pay shrank to $134, signaling a huge shift in homeowner's desire to be distanced from the river (Lewis et al 2008). The subsidence reflected the benefits of removal, long term trends in water quality and improved aesthetic value of properties near the river (Lewis et al 2008). The Kennebec is subject to other sources of pollution that degrade the quality of the river besides the Edwards Dam, and that continued pollution was reflected in the persistence of the penalty (Lewis et al 2008).

The study provides a method to evaluate economic climates before and after dam removals and ecosystem restoration. Homeowner willingness to pay for a property situated further away from river served as a proxy for the value Maine residents placed on the environment. The Edwards Dam removal had a clear positive impact on fishery restoration and recreational value and changed property values in the area (Lewis et al 2008).

The Edwards Dam exemplifies a successful FERC relicensing process. Even though local and state interests clashed, it is still a strong argument for increased state involvement in the licensing process. It was the state's advocacy and the local investment in studies and strategies for dam removal that gave it footing in the process. The FERC would not have considered removal without that involvement. The state of Maine made it clear throughout the relicensing process that while they supported hydropower as a form of clean energy, their mission was to evaluate the environmental impacts and economic benefits of each dam on a case-by-case basis (Crane 2009). The state approach more accurately represented the local values, but they were not part of the official process and had to petition the FERC.

Public and state participation were crucial in the removal of the Edwards Dam. The FERC's decision in Maine reflected the power of the intervenor and the importance of local participation in the relicensing process. It was local involvement and action that thrust the removal option onto the table, and their continual commitment kept it there. The FERC's refusal to renew the license was completely their own after careful consideration of the environmental costs and benefits.

Despite the successes on the Elwha and the Kennebec, FERC decisions on dam relicensing still fluctuate on a case by case basis. Both the removals in Maine and Washington were socially positive outcomes, but that balance is not always found. A license issued to the Coosa River Project in Alabama was revoked in 2018 after opponents of the license took the decision to court.

CHAPTER VI: COOSA RIVER PROJECT

Located on the Coosa River in Alabama, the Coosa River Project is comprised of seven different hydropower projects operating under a single license issued to Alabama Power Company. The Coosa River is characterized by high levels of biodiversity, with nearly 150 species of fish, mollusks, mussels and snails (Chitwood 2016). The dams sectioned the river off into several reservoir regions and altered the riparian landscape.

The public was concerned with the recreational, environmental and aesthetic values of the river (Chitwood 2016). The hydropower operators were concerned with the river's power production potential. The pollution that resulted from the Coosa River Project threatened endangered species and affected public use (Chitwood 2016). The tensions between the conflicting interests played out in court after the project was relicensed.

The entire Coosa Project generates 960.9 megawatts of power, making it a significant source of electricity for the region. The project received its first operational license from the FERC in 1957 and filed intent for renewal in 2005. In 2013, the Coosa River Project received a 30-year license to continue operations.

As soon as the license was filed, the Alabama Power Company and recreational users of the waterways were at odds. The Alabama Department of Conservation and Natural Resources, Georgia Department of Natural Resources, the Environmental Protection Division, the U.S. Department of Interior, the Alabama Rivers Alliance and American Rivers, the Atlanta Regional Commission, American Whitewater, Coosa River Paddling and World Wildlife Fund all filed motions to intervene (Molloy 2013).

The license covered three peaking projects and four run-of-river projects. Each dam had individual operating conditions based on the biological opinions of the Fish and Wildlife Service and environmental assessments. The new license conditions included installing aeration systems to manage dissolved oxygen levels and plans to monitor water quality conditions, improving existing systems, adaptive management plans for minimum flow requirements, environmental measures to protect and enhance water quality, fish and wildlife, recreational, and cultural resources (Molloy 2013).

As part of the relicensing process, federal agencies are required to determine whether the project will "jeopardize the continued existence of federally listed threatened and endangered species or result in the destruction of their designated critical habitat" (Molloy 2013). The Coosa River is home to 14 species listed as threatened or endangered, and 12 designated critical habitat units (Molloy 2013). The original biological assessment by the Fish and Wildlife Service deemed five plants safe. The red cockaded woodpecker, two mussel species, four snail species, mussel critical habitat units, rocksnail habitat units, rough hornsnail habitat units, Georgia pigtoe habitat units, and 20 species that were to be reintroduced into the area, were all at risk (Molloy 2013).

The official biological opinion issued by the Fish and Wildlife Service stated that once the recommended incidental take conditions and conservation measures were included, the project would not adversely affect the continued existence of any species. The Alabama Power Company and conservation groups reacted to these recommendations very differently.

The Alabama Power Company resisted several terms of the license, including the baseline measures used in the biological opinion. They wanted more lenient conditions.

They commented on the FERC's heavy reliance on the recommendations, and the FERC responded by stressing that the "FPA does not require that the Commission have perfect information before taking a licensing action or that all environmental concerns be definitively resolved before issuing a license" (Molloy 2013). The FERC abided by the responsibilities laid out by the Federal Power Act and shaped the license using the recommendations of the Fish and Wildlife Service. The agency does not have environmental expertise and they must rely on the opinion of the Fish and Wildlife Service.

Conservation groups took an opposing stance. Instead of viewing the environmental mitigation measures as too stringent, they found the environmental assessment too lax. Their concerns were plenty. They took issue with the 4.0 mg/L dissolved oxygen level minimum in the license and argued that any levels below 5.0 mg/L had the potential to harm aquatic species (Molloy 2013). All dams lacked fish passages, and while the FERC acknowledged they would be a beneficial addition, they decided fish populations were relatively unharmed without them (Molloy 2013).

Opponents of the license also attempted to invoke NEPA and called for an Environmental Impact Statement. Conservation groups thought continued operations would have a significant impact on the human environment, and the environmental assessment did not adequately encompass all the potential effects. They wanted specific data that would better predict the specific impacts on wildlife for each proposed option. The FERC disagreed, again stating that they were not required to obtain perfect environmental information before issuing the license and post-license amendments could be made.

The baseline that Alabama Power Company disagreed with was also a sticking point for conservation groups. The assessments were made using current river conditions as a baseline, but conservationists wanted the baseline to be the original ecosystem conditions. They called for more precise estimates of ecosystem impacts, which the FERC again refuted. They insisted all alternatives were thoroughly considered. It was "not possible…to precisely identify and quantify how the new license will impact specific project resources over the next several decades" (Molloy 2013). The difficulties associated with quantifying environmental impacts prevented them from being included in the environmental assessment.

The FERC also refuted the NEPA violations the conservation groups accused them of. NEPA only requires they take a "hard look" at the environmental consequences of the projects, but the overriding rule is the "rule of reason" (Molloy 2013). The agency is allowed to use their discretion. They found no significant impacts and no need for a formal Environmental Impact Statement. They dropped the concerns of conservationists, stating that mere opposition by groups or individuals is not enough controversy necessary to spark an EIS. The original studies did not prove significant impact on the human environment. Conservationists continued fight for the studies and insisted that original conditions be used as a baseline for environmental assessments as well.

The economic benefits estimated by comparing costs of operation to the benefits of power production; environmental costs and benefits were not included. The annual cost of operation of $65.9 million was subtracted from total value of power production of $299.1 million to yield total benefits of $233.2 million. Even with mitigation costs, continued operation would cost $219.3 million less than the next available power

alternative. Public benefits were limited to system stability and a reliable supply of electricity. The benefits the dams provided were significant, and it would take enormous environmental benefits to offset the costs.

Sections 4(e) and 10(a)(1) of the Federal Power Act ask the Commission to equally consider "power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality" (Molloy 2013). Under those guidelines, the FERC staff conducted an independent review of all the information presented in the environmental assessment and biological opinion and concluded the Coosa River Project would not significantly affect the human environment (Molloy 2013).

The FERC kept the original mitigation and construction requirements of the license despite the protests of the Alabama Power Company. The mitigations would offer adequate environmental protection, and other environmental costs were balanced by a source of "efficient and reliable electric service in the future" (Malloy 2013). The public was "invited to participate in meetings and provide comments at each phase of the process" and Alabama Power Company was responsive to those comments (Malloy 2013). The FERC found the Alabama Power Company's efforts to include public opinion were sufficient (Malloy 2013).

A 30-year license was issued to the Alabama Power Company. The FERC determined that the new license, with the additional terms, conditions, and mitigation measurements, was the best course of action to improve and develop the Coosa River. The license secured a dependable, inexpensive source of electric energy for the future,

"the required environmental measures will protect and enhance fish and wildlife resources, water quality, recreational resources and historic properties" and the 960.9 megawatts of total energy do not contribute to atmospheric pollution (Molloy 2013).

Conservation groups sought a rehearing with the FERC to address the potential impacts of continued operation on dissolved oxygen levels and the endangered and threatened species of the Coosa River, stating that both would impact their recreational use and enjoyment of the river. The FERC denied their request. The Alabama Power Company also applied for a rehearing, but for opposite reasons. They felt the license conditions were too stringent and wanted more flexibility with their operations. The FERC granted Alabama Power Company their request and clarified that the water quality standards only applied when power was being generated, which absolves the Alabama Power Company of their responsibility to consistently monitor the water quality (No. 16-1195, U.S. Court of Appeals D.C Circuit). Conservation groups immediately requested a rehearing in response to the lowered water quality requirements and were denied again.

The FERC was sure in their reasoning, their cost-benefit analysis, their evaluation of environmental impacts and ultimately, the license renewal. Their decision did not hold, however, in the 2018 court decision. After failing to make any progress with the FERC, the conservation groups took the license to court. Members of the groups claimed they would be injured by the license; it would negatively affect their recreational use and enjoyment of the river and its biodiversity (No. 16-1195, U.S. Court of Appeals D.C Circuit). The Alabama Power Company asserted that the renewed license and their continued operation would benefit the river, and conservation groups referred to their arguments made in the original license comments.

Both the original environmental assessment and biological opinion submitted to the FERC recognized that the fluctuating flow regimes, potential poor water quality conditions and periodically low dissolved oxygen levels could harm aquatic species in the Coosa River (No. 16-1195, U.S. Court of Appeals D.C Circuit). The petitioners once again invoked NEPA, arguing that the FERC failed to carry out an Environmental Impact Statement despite their claims that continued dam operations would harm the human environment.

The court determined that the FERC failed to abide by the NEPA requirements on two counts. The petitioners argued the "Commission failed to reasonably consider and address multiple indicators that the project could have a significant effect on the environment…that would normally compel the preparation of and Environmental Impact Statement" (No. 16-1195, U.S. Court of Appeals D.C Circuit). The second strike was their failure to accurately assess the cumulative environmental impacts.

The impacts on fish populations served as the main evidence for the incomplete assessments. The new license conditions did not require fish passages, and fish survival rate estimates were based on outdated survey information supplied by Alabama Power Company, who demonstrated interest in both relicensing and more lenient mitigation conditions. The Commission did not demonstrate the "analytical rigor" that NEPA required by relying on the estimates provided by the operators themselves instead of gathering recent and site-specific data (No. 16-1195, U.S. Court of Appeals D.C Circuit).

The license conditions requiring minimum dissolved oxygen levels during operation times were also systematically violated. Five of the seven dams failed to achieve adequate dissolved oxygen levels outside of operational periods (No. 16-1195,

U.S. Court of Appeals D.C Circuit). There was no additional information in the license regarding when or how the aeration systems meant to mitigate these damages were to be installed, and no concrete plan to resolve the dissolved oxygen levels. The license lacked clear mitigation requirements.

The statement concludes by stating the FERC

> Relicensed the Coosa Project despite known violations of minimum dissolved oxygen levels based on its sight-unseen acceptance of the Alabama Power's anticipated-but-unidentified mitigation measures, the specifics of which did not even have to be submitted for examination until six months after the license issued, or installed for eighteen months (No. 16-1195, U.S. Court of Appeals D.C Circuit).

The biological opinion and the environmental assessment were "arbitrary and capricious, insufficiently reasoned, and unsupported by substantial evidence" (No. 16-1195, U.S. Court of Appeals D.C Circuit). The decision to renew the license was a violation of the Federal Power Act and NEPA, and the court found bias towards the Alabama Power Company in the FERC's license decision.

The Court of Appeals agreed with the petitioners, and in 2018 they moved to vacate the license issued to the Alabama Power Company. The license issued by the FERC illuminates the holes in the process relicensing process. The court found the FERC favored power production, failed to reasonably consider the environmental impacts, and did not enforce appropriate measures to mitigate those impacts. The FERC ignored public concerns throughout the relicensing process.

The public had to resort to litigation to include their values into the relicensing process, and their rights to river use were only returned through the court's decision. The license assumed the Alabama Power Company had rights to the river, and the license amendments reflected that. A successful license should balance the energy benefits generated by the Coosa River Project with the environmental impacts and include environmental measures that address public concerns. The river was not treated as a public resource, and public concerns were not given fair weight. The burden was on the public to fight for a license that benefitted their use of the river. Hydropower operators do not have to prove their use of the river is the most beneficial.

CHAPTER VII: POLICY RECOMMENDATION

Incorporating a Social Cost-Benefit Analysis

The standard cost-benefit analysis utilized by the FERC is not a complete social cost-benefit analysis. Failure to quantify environmental benefits and ecosystem services, an insufficient incorporation of the local population into the process, the widespread responsibilities, and lack of expertise of the FERC all contribute to inaccurate analyses and inefficient decisions. The standard cost-benefit analysis utilized by the FERC does not include non-market values. The private market that hydropower operates in does not leave sufficient room to protect or consider ecosystem services (Goulder and Kennedy 2011). A complete social cost-benefit analysis includes the social value of a riparian environment and its ecosystem services.

FERC cost-benefit analyses have demonstrated tendency to weigh private costs and benefits more than public ones (Moore et al 2001). In the general powers authorized to the FERC in 16 U.S. Code § 797, the Committee is instructed to analyze the power production potential of sites and the fair value of the power by prioritizing the economic arguments of each proposal first. Rivers are evaluated as a marketable economic resource, and the environmental costs and benefits are considered second.

An effective cost-benefit analysis has two primary components (Whitelaw and Macmullen 2002). It considers all costs and benefits, which includes the value of ecosystem services. Secondary to that is the distribution of the consequences and fairness of final decision, the resulting economic and ecological effects, and the unique social and economic climate (Whitelaw and Macmullen 2002). These components emphasize the importance of weighing environment and economic impacts and public participation. In a

relicensing decision, the two primary parties are the private hydropower operator and the FERC.

Economic and ecological values occupy an enormous spectrum based on location, and relicensing decisions that are appropriate in some areas will not work in others. The decision to remove or keep a dam needs to reflect local values. Some populations favor the power production and jobs generated by the existing structure, while others place more weight on the environmental values of an ecosystem.

Operators carry out their own cost-benefit analysis to determine whether it is economically viable for them to continue producing hydropower and self-select whether they would like to renew their license. In all three cases studies, the operators wanted to continue operations because it was to their benefit and they were expecting economic gains from continued operation. If operators do choose to apply for renewal, FERC precedent almost guarantees that it will be granted which makes the current process not a question of whether the hydropower project will continue to exist but rather what environmental regulations ride the new license. The complete range of options are not considered.

Hydropower operators do not experience the negative environmental consequences of operation, and that cost is disproportionately placed on the public. The external costs fall to public. Implicit environmental costs are a significant portion of total hydropower development costs and need to be considered (Carlsen et al 1993). This was especially true with the Elwha Dam. The dwindling fish populations were detrimental for communities that relied on fish for subsistence and economic profit,. The fish are also associated with strong cultural and historical values, and the decline in fish populations

was another cost that fell onto the public (Crane 2011). Angling and recreation activities suffered as well.

Changes to the Federal Power Act

The three case studies highlight the importance of timing, local and state participation, timing, and fair weight of environmental costs and benefits in a successful social cost-benefit analysis. The Federal Power Act authorizes the FERC to relicense hydropower projects but offers little technical guidance beyond the instruction to determine the best public use of waterways. The FERC needs more a more detailed economic methodology that clearly outlines the valuation of market and non-market, the inclusion of local and state interests, the advice of environmental experts, and complete information.

Environmental conditions and attitudes towards the environment are constantly in flux. The 30 to 50-year timeline in the current relicensing process is too rigid and cannot be adapted to reflect those changes. Attitudes towards a dam may change throughout the duration of a single license, or a dam may outlive its beneficial operational lifetime during the license. With the Elwha Dam, opposition emerged before the relicensing process formally began and the dam operated at a net loss for decades before it was taken down. There is a balance between the loss of ecosystem services and environmental values and power production. A dam should not be relicensed if the benefits of power production do not outweigh the environmental costs.

License duration can either be shortened or hydropower projects can be periodically evaluated to ensure they are still operating at a benefit to mitigate this problem. Shortening licenses, however, comes with its own difficulties. The relicensing

process is long, cumbersome, expensive, and it takes several years to gather the appropriate studies and input to submit to the FERC. Requiring operators to frequently undergo the process would deter them from relicensing altogether. While some dams are not beneficial and do not merit a license renewal, others are still well within their operational lives and provide power benefits.

The FERC would also have to shoulder an additional burden of reviewing license applications more often. It would not behoove the FERC or hydropower operators to make the process more complicated or strenuous than it already is. When hydropower is correctly managed, existing projects generate clean energy and inflict less environmental damage than alternative sources of energy. An unnecessarily complicated relicensing process would deter current dam owners from applying for a renewal and put those benefits at risk.

If the environmental losses are blatant, citizens have the option to file a citizen suit to halt operations. This places another unfair cost on the local population and forces them through the long and expensive litigation process to prove they are not benefitting from the current use of the river. Operating at a social net benefit for 30 or 50 years is not a guarantee. License terms can include conditions to evaluate dam operations on a periodic basis, perhaps every five to ten years rather than every 30 to 50 years. Surveys, environmental assessments, and biological opinions should be carried out to determine the value of environmental services and dam impacts on the natural environment throughout its operation. Licenses can also be amended to provide an avenue for citizen action in between the periods of renewal. If the local population feels that continued

operations results in more harm than good, they may petition to reopen the license for reevaluation by the FERC.

The government acquisition of the Elwha and Glines Canyon Dams set a precedent absolves dam owners of the responsibility and costs of removal. A federal takeover passes those costs onto tax payers, further tipping the cost-benefit imbalance. Dam owners do not consider the costs of removal in their initial projections. Outside sources covered to costs of the major dams that have been removed, not the operators. Hydropower operators are private parties utilizing public resources and turning a profit from it without considering the external costs. Most operators only consider the initial construction costs and annual maintenance costs of the structure, and they are not required to consider any other costs. They should be responsible for the project throughout its entire lifetime, from construction to removal.

The FERC has continually demonstrated a tendency to relicense existing projects. If a license is not going to be renewed, it is most likely the choice of the operator. Options in the license are limited to what is proposed by the operator. The FERC evaluates operation proposals submitted by the operator against their proposal that includes terms and conditions based on agency recommendations. Dam removal is not considered as an option and is advocated by outside interests. The original applications for both the Elwha and Edwards decisions did not include dam removal. Mitigation measures are limited to operational changes, structural updates and ecosystem impact monitoring.

A more adaptive outlook is necessary. Although it requires additional analysis, the relicensing procedure should evaluate every possible option before reaching a

decision. This should include the proposal by the operators and the FERC, as well as partial and complete removal options to ensure that the costs and benefits of all scenarios are fairly considered. This includes all market and non-market benefits, and environmental costs and benefits should be quantified through non-market valuation methods.

The most socially beneficial option may not be included in application submitted by the operator and should not be skirted over just because it is not an option presented by the FERC or the dam operator. Alternatives to the established options arise after intervenor involvement, which is not always guaranteed and depends on the public attitude.

Relicensing is limited to two parties: the operators applying for license renewal and the FERC. This approach implicitly assumes that the current use of the river is the socially beneficial one. The public is not able to comment on licenses until the relicensing process is well underway, which favors owner interests. Even with public input and agency recommendations, the decision is left to the FERC. State authorities and regulations, aside from state water laws, have no teeth in the process. A national agency has the authority to determine the result of a very local decisions.

Local and state-level agencies have a better understanding of individual ecosystems and can apply their knowledge on a local scale. The Fish and Wildlife Service and the National Park Service, which are often involved in FERC relicensing recommendations, are also better qualified to carry out ecosystem evaluations. Delegating more responsibility to state agencies is still not a panacea for completely efficient

decisions. One third of all states do not have any statutes regarding dam removal procedures (Doyle et al 2003).

There are benefits to having the federal government spearhead relicensing procedures. It ensures a relatively consistent process with uniform standards for hydropower operations across every state. Federal regulation is necessary because rivers cross states boundaries and multiple states may utilize the natural resources they provide. However, the overarching responsibility of the federal government should be married with state and local authorities to craft a relicensing process that is unique to each community to better incorporate their values. State and local agencies are more attuned to public perspective, and local communities also have more opportunities for representation. The interests of local and state governments in Maine aligned with local values in the Edwards Dam removal and provides a successful example of local and state collaboration. The clout and resources of the government provided a platform for the interests of the local population and makes a case for increased state participation and hydropower regulation.

The responsibilities of relicensing process, and the final decision, need to be distributed more equally between federal, state and local parties. Each party offers its own strength. Federal authority provides structure and uniformity across state boundaries. State and local participation bring expertise on public attitude and an intimate knowledge of ecosystem impacts. State Fish and Wildlife Services currently only give recommendations in their biological assessments. They are the environmental experts and their opinions should hold more weight licensing process to adequately assess environmental values. Incorporating parties beyond energy producers diversifies the

potential uses of the rivers. It also hedges against the political biases that have permeated the relicensing process in the past, seen with the influence of presidential administrations and political climate on the composition and decisions of the Committee (Moore et al 2001).

The licensing process is inching its way towards collaboration, but only if hydropower operators choose to do so. The Integrated and Alternative Licensing Processes imply that operators should include stakeholders from the outset, but it is not an explicit requirement. A mandate to include all stakeholders, rather than leaving the license open for comments for a short period of time, would improve collaboration efforts and reduce conflict between power and environmental interests that may arise after the license is issued. Incorporating the suggested amendments to the Federal Power Act and making them part of the relicensing process will address the problems would address issues with timing, local participation, and environmental values.

CONCLUSION

Hydropower provides clean, renewable energy and will continue to be a vital resource throughout the United States. Managing the use of the intricate network of waterways that snakes around the country is a trying task, and the responsibility falls onto the Federal Energy Regulatory Commission, who abides by their duties outlined in the Federal Power Act to determine the best public use of the waterway.

When hydropower development peaked in the United States, it reflected the values of a profit-driven society. Ecosystems could be commodified, and natural processes could be harnessed for benefit. In a post-World War United States, job creation and economic growth were top priorities and a resulting surge in hydropower production was the response. Economic, social and environmental values have evolved, and the dam relicensing process should reflect that evolution (Abbe 2004).

With 85% of dams due to reach the end of their predicted operational life by 2020, the FERC needs to perform accurate social cost-benefit analyses to determine the best public use of the river for the next thirty to fifty years (Hammersley et al 2018). The decision should incorporate the interests of the public, fairly weigh the costs and the benefits, and ultimately find the public use of the waterway. The FERC seeks to maximize the utility of a project by balancing hydropower production and environmental protection (Kosnik 2010). That scale can be tipped either way by historical precedent, congressional input, interest group involvement and agency discretion (Kosnik 2010).

The FERC is a federal agency that has the power to make a very concentrated, local impact. Their major focus is power production and regulation, not environmental protection. Their expertise is not centered in cost-benefit analyses, especially not

environmental or social ones. Yet the agency is saddled with the responsibility to determinine whether the economic, environmental and social costs and benefits of hydropower projects are fairly balanced.

Constants have surfaced through decades of FERC license decisions. Keeping official license negotiations between the FERC and the hydropower operators assumes the burden of proof is on the public to prove their use of the river. Factoring local input into the process as recommendations to be considered instead of as an official participant diminishes public rights and lessens their weight. The environmental, cultural, social and non-market values of rivers held by local communities are not fairly evaluated against the profit generated by hydropower energy production.

The FERC does not conduct a complete social cost-benefit analysis. The economic framework compares quantitative and qualitative resources but favors the economic values of proposals. FERC applies this framework and bases their decisions on the results on a systematic basis, which has produced socially costly outcomes (Moore et al 2001). With the Elwha and the Edwards, the public had to shoulder an additional burden to prove their most beneficial use of the river. The Coosa River was resolved through expensive litigation.

The Federal Power Act steers the FERC towards a financial cost-benefit analysis rather than a social one. As a public resource, river use should be evaluated through a social cost-benefit analysis. The exclusion of public values, the failure to incorporate environmental and ecosystem benefits into their calculations, the lack of environmental expertise, all contribute to this. The Elwha, the Edwards and the Coosa River Project relicensing processes all highlight different weak points in the FERC's process.

The failure to adequately incorporate public values and interests caused the majority of the conflict. With the Elwha, the Edwards and the Coosa River, each local community had to battle for their rights to the river. A social cost-benefit analyses is contingent upon including social values alongside the interests of the hydropower operators. The best public use of the waterway cannot be determined without public input.

The Elwha River showcased a failed relicensing process that was solved by federal intervention. Consistent public opposition against license renewal, a community passionate about environmental and cultural resources, and a Congressional mandate allowed for a socially beneficial outcome. The Edwards Dam is the Elwha's counterpart and highlights the relicensing process at its best. Again, a determined local population pushed against the hydropower operators and fought to include their values in the process. The Elwha proves the importance of timing and both cases exemplify the importance of local and state input for a successful social-cost benefit analysis.

Once removal was underway, the environmental benefits that were held back for so long sprang forth. The Elwha ecosystem underwent rapid recovery and restoration, and the benefits became apparent almost immediately. Although the Kennebec recuperated more slowly after the Edwards Dam was removed, positive signs of ecosystem recovery were visible after just one year. Economic benefits flowed in the form of tourism and recreation, social, cultural and existence values and were made clear through hedonic pricing and willingness to pay surveys.

The Coosa River Project did not have such a positive outcome. The project will have to undergo the relicensing process yet again to determine adequate license

conditions after the license was revoked. The Alabama Power Company proves the importance of public input and shows how expensive ignoring it can be. The first license took years to complete, only to cost the FERC and the Alabama Power Company additional legal fees. Conservationists along the river attempted to voice their concerns over the terms of the license and the potential ecosystem impacts multiple times, both throughout the licensing process and again in court. The revocation of the license validated their concerns and affirmed the FERC's failure to perform a true social cost-benefit analysis and fairly consider environmental impacts.

Hydropower will continue to utilize river flows for clean energy at the cost of ecosystem disruption. Including public input in relicensing decisions returns the rights of the river back to the public by weighing their interests fairly. It allows the public to evaluate the benefits of power production against environmental costs through a social cost-benefit analysis and determine the best public use of the river. Relicensing should be a discussion between local and private interests, with expert opinions informing the environmental consequences of continued operation or removal. As many projects approach the end of their license and prepare for renewal, the problems the FERC faces should be rectified sooner than later. The most beneficial use of the river can be determined, and the relicensing process can be remodeled to achieve that goal.

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