RESOURCES FOR THE FUTURE

Ecosystem Valuation and Hydropower Licensing Decisions: Lessons from the FERC Experience

Kurt Stephenson and Leonard Shabman

Working Paper 18-29
December 2018

About the Authors

Kurt Stephenson is a professor in the department of Agricultural and Applied Economics at Virginia Polytechnic Institute and State University. His research interests include market-based environmental policies, water resource economics and policy, and the role of economic analysis in public policy. Stephenson's current work focuses on nutrient credit trading, stormwater management, enhancing nutrient sink functions, and incentives to reduce agricultural nonpoint source nutrient runoff.
Email: kurts@vt.edu

Leonard Shabman is a senior fellow at RFF. Shabman's current work balances time spent in research with advisory activities in order to have a direct bearing on the design and execution of water and related resources policy. His ongoing work focuses on evaluation protocols for large-scale ecosystem restoration projects, with a special focus on the Everglades and coastal Louisiana, increased effectiveness of national flood risk management programs, and design of market-like programs for water quality and wetlands management.
Email: shabman@rff.org

Acknowledgments

The authors gratefully acknowledge Christian Myers and Kelly Casper's assistance in cataloging the studies conducted in the licensing cases and note that senior authorship is shared equally.

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Abstract

Monetary valuation of benefits and costs of public investments, or of issuing a permit, has been common practice for decades. However, not all benefits or costs have been reported in monetary terms, despite the fact that economists have developed methods for placing a monetary value on all ecosystem services. Advocates for use of these ecosystem valuation methods assert that extending monetary valuation to a comprehensive list of services fills a gap in the information policymakers can use when making investment or permitting decisions. This paper examines the use of ecosystem valuation methods by the Federal Energy Regulatory Commission (FERC) when permitting the operation of existing nonfederal hydropower dams in the United States. First, we report that when FERC reformed the hydropower licensing process it chose not to require specific types of analysis or analytical procedures, including ecosystem valuation for the permit applicant. We explain the logic for that decision. Second, we report on 17 major licensing cases where project operations would yield monetized hydropower benefits, but would also affect fish passage or recreational opportunities. We find that neither license applicants, nor those who commented on the license application, called for ecosystem valuation studies for comparison with monetary estimates of hydropower benefits. In lieu of having ecosystem valuation studies, FERC encouraged applicants to engage in a deliberative, decentralized negotiation process with a wide array of stakeholders. If that group agreed on project operations, FERC would expedite issuing the license. This reliance on a deliberative and decentralized process, in lieu of ecosystem valuation, for comparing and making tradeoffs among project-specific effects is consistent with the deliberative valuation processes supported by many ecological economists.

Key Words: ecosystem, valuation, hydropower, negotiation processes

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1. Introduction

Ecosystem services are provided by natural capital whether in a managed or unmanaged state. People have preferences for particular mixes of ecosystem services and governments consider those preferences when they choose investments or take regulatory actions to preserve or manage natural capital. Benefit-cost analysis considers and reports preferences using a monetary metric, where benefits are measured as the sum of individuals' willingness to pay (Cropper 2000; Turner et al 2003; NRC 2005; Mendelsohn and Olmstead 2009).

Reporting a monetary measure of benefits for services with close private good analogues or substitutes, such as flood risk reduction and navigation, has long history of application when making project specific investment and regulatory decisions. In recent decades economists have refined ecosystem valuation methods (EVM), also referred to as "non-market valuation", for services that lack a private good analogue. Using tools such as such as revealed and stated preference analysis allows non-consumptive aesthetic, preservation, or recreational uses to also be reported in monetary terms (Champ et al. 2017). Whether EVM should be used for decisionmaking is a subject of intense interest and debate (Shabman and Stephenson, 2000).

Underlying that debate is this core question: how should people's preferences for some types of ecosystem services be reported and considered for public decisionmaking? Advocates for use of EVM argue that calculating and reporting monetary measures of the benefits for a full suite of ecosystem services, and making the results part of a comprehensive accounting, will assure that decisionmakers choose the socially preferred alternative. However, not all agree with this assertion and they would rely on a structured deliberative process of representative stakeholders that is charged with identifying alternatives, debating the various mix of ecosystem and market services in consideration of costs, and letting their agreement be the basis for defining the socially preferred alternative (Zografos 2015; Zografos and Howarth 2010; O'Neill 2007; Splash 2008; Vatn 2009; Gowdy and Erickson 2005; Holland 1997).

These different perspectives reflect wholly different premises about people's preferences. The underlying premise of EVM advocates is that individuals have reasonably well formed and stable preferences for ecosystem services and they reveal those preferences when they make a purchase in a market or when they, for example, respond to a survey asking them their willingness to pay for a particular ecosystem service. Supporters of a deliberative process assert that ecosystem services are unfamiliar and may be difficult to understand. This means that preferences for ecosystem services must be discovered, not recalled, and a deliberative process

allows preferences to be revised, as influenced by experience, learning, and recognition of opportunity costs (Jacob 1997; Sagoff 2004; Bromley 2004; NRC 2005a; Gregory et al 2012; Slovic 1995). Bromley (2004, 92) notes that preference construction and formation means that "individuals (and groups) do not know precisely what they want until they work out what the can have."

Despite a voluminous literature on EVM, relatively little research exists evaluating if, and how, EVM is used in decisionmaking (Laurans et al 2013; Gowen et al. 1996). The lack of attention given to if and how EVM is used is striking given the assertion of EVM practitioners that such analyses provide critical and decision-relevant information (Costanza and King 1999; NRC 2005b; Laurans et al 2013).

In this paper we describe the rulemaking history and record of decisions on hydropower dam (re)licensing by the Federal Energy Regulatory Commission (FERC), highlighting how ecosystem services are incorporated into public decisionmaking. The FERC is responsible for overseeing the operation of all nonfederal dams in the United States. These nonfederal projects produce a little more than half of all hydropower in the U.S (FERC 2017). The FERC makes decisions about whether to grant a license to private and municipal entities to construct and operate a hydropower facility on public waters (licensing) and to reissue operating licenses on existing projects (relicensing).

The FERC hydropower licensing program offers a compelling policy setting to evaluate what analyses are most relevant to decisionmaking. First, hydropower licensing and relicensing must decide the mix between services such as provision of electric power that has a market value and aesthetics, aquatic life support and recreation services that have no market valuation. Second, the Federal Power Act's hydropower licensing process represents one of the few instances in US environmental law where a public agency is explicitly directed to balance a service that has a market value with nonmarket ecosystem services. Many environmental statutes, such as Clean Water Act, Clean Air Act, and Endangered Species Act explicitly prohibit explicitly such balancing. Finally, the FERC has been subject to intense criticism for failing to place adequate weight on non-market ecosystem services when making licensing decisions, and over the past three decades has undertaken extensive efforts to address the criticism.

We begin by reviewing a series of reforms to the rules surrounding the FERC hydroelectric dam licensing process. We show that during the reform process, the FERC had the opportunity to require use of EVM for considering all ecosystem services when making licensing decisions. However, the FERC did not require EVM, but rather responded to the criticisms by reforming the licensing process to expand the use of deliberative processes that increased the ability of interest groups concerned with the impact of hydropower operations on recreational and aquatic living resources to affect the terms of the final license. These reforms, however, did

not dictate what type of analyses participants used under the new deliberative licensing process. With this as context, the next section examines the types of ecosystem analysis that have been used in 17 major licensing cases decided under the new licensing rules. We find little evidence that decision participants need or use EVM in that process. Rather, participants in the deliberative process debate and decide levels of ecosystem services, and agreements on licensing decisions are reached without reliance on EVM.

2. Ecosystem Valuation and the FERC Hydropower Licensing Process

The 1920 Federal Power Act created FERC as an independent commission. The Commissioners were appointed by the President on staggered terms and were served by a staff of experts from the disciplines required for the commissioners to execute their responsibilities. As an independent commission, the FERC was to determine the public interest in dam licensing decisions based on the results from various technical studies. Even by standards of the day, the FERC was designed to be better insulated from public pressure than most water resource agencies (Spence 1999a). With a few exceptions, Congress granted the FERC broad authority to decide whether a nonfederal dam would be constructed and the conditions under which the dam should operate.

2.1. The FERC's Traditional Hydro Licensing Process

The FERC hydropower licensing process required license applicants to follow a formal licensing process intended to provide the FERC commissioners with the information they deemed necessary for making a decision that would serve the public interest. Prior to the recent reforms, FERC's "traditional" licensing process could be described as applicant driven and sequential. In general the licensing process was divided into two parts: pre-filing and post-filing (license) phase. In the pre-filing phase, the applicant (dam operator) notifies interested parties of its intent to file for a license (or relicense) and accepts comments and requests on study needs. The applicant then selects and funds the analytical studies. The applicant submits a draft license application to FERC that includes comments on the application from state and federal resource agencies as well as the license conditions recommended by the licensee. The post-filing phase begins when FERC accepts the application for review. FERC then requires additional studies to be conducted (funded by the applicant). The application process, conducted under the National Environmental Policy Act (NEPA) guidelines, formally recognizes all participants (federal and state agencies, ecosystem groups, Native American Tribes, etc) who wish to review and comment on the application. FERC accepts and reviews license proposals from these groups and may issue request for additional studies. FERC may also develop license alternatives of its own. FERC would evaluate and select among a number of license alternatives, including the preferred alternative of the applicant.

Throughout this process FERC was not required to, and would not, compare license alternatives with a benefit cost analysis that reported all project effects in monetary terms. Rather, in relicensing the FERC compared estimates of hydropower costs and revenues with a variety of qualitative and quantitative measures of the physical and biological changes of different dam operation alternatives (Marcus 1997; Moore et al., 2001; Stephenson and Shabman 2001). FERC calculates the financial costs (capital and annual operating and maintenance costs) to the license applicant of alternatives to the existing license including the applicant's preferred alternative. Costs also include foregone power revenues from any required change in operations from the existing license (typically measured as the cost for purchasing power from the next best available alternative). Financial outlays as well as forgone power typically result from requirements to mitigate adverse ecosystem effects from the different operation plans identified by state and federal resource agencies and other stakeholder groups.

In most cases, the majority of analytical attention and resources were directed toward the identifying ecosystem outcomes and evaluating alternatives to mitigate adverse outcomes. Mitigation measures might include specified schedules for downstream flow releases, maintenance of reservoir levels, sizes of fish screen and operating practices to minimize entrainment, passage facilities for upstream and downstream migration of fish, recreational use enhancements, and riparian zone and related wetlands restoration. The FERC staff calculated the reduction in the net financial position of the licensee (e.g. increased costs from the construction costs of a fish passage facility, recreational facility, or reduced power benefits due to foregone power production) for different mitigation options.

The incremental cost to the licensee of different mitigation options was then compared to different metrics for measuring ecosystem effects. These metrics might include changes in fish populations, acres of usable aquatic habitat, and increased number of recreational user days. These trade-offs were sometimes analyzed using incremental (knee-of-the curve) analyses. For example, the analyses might examine the incremental gains in usable fish habitat as different minimum instream flows were required associated with increases in the sum of the financial and power replacement costs (Fargo 1991). Some ecosystem effects might be expressed in dollar terms, for example as the replacement cost through hatchery production of juvenile fish lost to entrainment. However, these replacement costs were made to evaluate the financial burden on the applicant and were not proxies for willingness to pay measurement, the underlying conceptual foundation for EVM estimation.

Many economists have long criticized the FERC's approach to evaluating license alternatives. Proponents of EVM criticized the FERC for failure to monetize ecosystem and recreational outcomes of licensing alternatives using willingness to pay estimates (Moore et al 2001; Loomis and Feldman 1995; Kotchen et al 2006). Moore et al. (2001, 424) state:

> One result is clear from examination of the record: FERC does not explicitly weigh the social benefits and costs of relicensing decisions. It regularly considers only private hydropower revenues and costs in its decisions. The opportunity costs of hydropower operations—in terms of the benefits of whitewater recreation and sport fishing—are rarely quantified in the sample of licenses studied here.

Yet, FERC did explicitly weigh the monetary and nonmonetary outcomes of licensing decisions. FERC commissioners (and the staff that made recommendations) evaluated trade-offs of licensing alternatives and made decisions based on FERC's collective judgment about whether the mitigation options were "worth" the cost to the licensee. In effect the FERC commissioners' preferences, as legislatively assigned representatives of the public interest, weighed the tradeoffs involved in a (re)licensing decision.

2.2 FERC Hydro Licensing Reform, 1997-2005

Environmental and recreational interests have longed argued that the FERC placed too much weight on hydropower production in the traditional licensing process (Spence 1999b). This belief manifested itself in increasingly vocal criticism beginning in the 1960s, gathering broader public support as the river restoration movement emerging in the 1990s (NRC 1992). In the 1980s and 1990s, the Congress and courts added new requirements to consider the ecosystem consequences of hydro licensing decisions. For instance, the 1986 Electric Consumers Protection Act (ECPA) required the FERC give equal consideration to wildlife and recreational outcomes and to accept resource agencies' recommendations or to in writing explain why it was rejecting the recommendations (Tarlock 2012). The ECPA also created additional procedural requirements that created new opportunities to critique and challenge studies, information and decisions produced in the licensing process. The courts, meanwhile, expanded state water quality agencies' authority to specify downstream flow conditions under section 401 of the Clean Water Act, as well as expanding authority of the U.S Department of Interior to prescribe fish passage facilities on existing facilities (Sensiba 1999). Unlike FERC, however, state and federal agencies faced no statutory obligation to balance ecosystem effects against hydropower when exercising their licensing authorities. Instead, these agencies advocate for a single objective (ex. aquatic habitat) and performance measure (ex. Dissolved oxygen at X concentration).

Many of these developments increased the ability of resource agencies to assert their views in FERC deliberations and eroded FERC decisionmaking authority (Spence 1999a; Sensiba 1999; Kosnik 2010).

These changes only appeared to make the licensing process costlier and more conflict-ridden (Giovando 2000; Powell 1997). The time to process a relicense request increased fourfold between the early 1980s and the mid-1990s (Hunt and Hunt 1997). The hydropower industry became increasingly concerned about time and cost required to secure a license renewal. Even as legislation and court decision shifted the roles of participants in the process, federal and state resource agencies and environmental groups remained critical of the FERC's final licensing conditions. Federal/state agencies and nongovernmental groups kept resisting FERC decisions, and court challenges increased.

The widespread dissatisfaction with the licensing process occurred during a time period of rapidly expanding professional interest and development of EVM techniques. Economists interested in applying willingness to pay methods to value ecosystem amenities devoted considerable intellectual attention to refining and applying stated preference and revealed preference techniques in the 1980s and 1990s (Cropper 2000). Simultaneously, a significant component of the burgeoning field of ecological economics centered on the monetary valuation of ecosystem services, albeit not allows using accepted willingness to pay methods (Costanza et al. 1997). Unsurprisingly, the debate over hydropower licensing led to recommendations for more explicit use of EVM in evaluating licensing alternatives (Loomis and Feldman 1995; Marcus 1997; Loomis 2000).

In 1997 FERC itself made an initial effort to address the criticisms by developing and experimenting with an "alternative" licensing process (referred to as the ALP process) (18 C.F.R. § 4.24(i) 2000). The alternative licensing process retained the two stage pre-filing and post-filing licensing process as the traditional process, but front loads the pre-filing process with early negotiation and collaboration between the license applicant, the resource agencies and other intervening stakeholders (Powers 2004; Hill and Murphy 2003; Swant 2001; Bonham 1999; Groves and Liimatainen 1999; National Hydropower Association 1999).

Of special interest was the changing role of FERC under the ALP process. First, the licensee files a request to use the alternative process and before granting the request, the licensee must demonstrate to FERC satisfaction that the relevant stakeholders have been contacted, have agreed to participate in the process, and the must have an acceptable communications protocol (National Hydropower Association 1999). Second, if approved, the licensee must establish a collaborative process to investigate and discuss licensing alternatives among the stakeholders. The licensee and stakeholders decide what studies (engineering, biological, or economic) will be

conducted. In addition, the NEPA document preparation is moved into the pre-application phase so the applicant and stakeholders, not FERC, are largely responsible for preparing a draft NEPA report and a license application (National Hydropower Association 1999). Third, FERC staff are actively engaged in facilitating, but not directing, the pre-filing discussions (Hill and Murphy 2003). At the time the license renewal application is filed, FERC staff receives a draft NEPA document and license application submitted by the license applicant. FERC then produces a final EIS/EA and license recommendations.

The most significant change of the ALP process was the FERC's affirmation that if a consensus of interested parties to the negotiation agree on a mutually satisfactory license conditions, and such conditions are within the FERCs authority to confer, then the FERC will translate these conditions into a new license. The ALP process, however, does not require, but encourages agreement by all participating parties on license terms before the applicant files the license application. As a practical matter, the alternative process decentralizes decisionmaking by downplaying the role of the FERC staff and commissioners' preferences for judging whether the cost imposed by a license condition is "worth" the ecosystem/recreational enhancements (Stephenson 2000; Shabman and Stephenson 2007).

As the alternative licensing process was being tested in the late 1990s, FERC and a number of federal agencies (Departments of Commerce, Interior, Energy, and Agriculture, Environmental Protection Agency, and Council of Environmental Quality) voluntarily formed an interagency task force (ITF) to further reform the licensing process (DeWitt and Ebrahim 2001). It was in this setting that the possible expanded use of EVM was considered. A steering committee initially divided into four workgroups: Coordination of federal and state statutory and regulatory mandates; Review of ex parte regulations; Collaborative Process Issues; and Economic Analysis: Methods and Procedures.

The economic analysis work group was to review whether and how FERC's economic analyses methods could be changed to improve licensing decisions. The US Fish and Wildlife Service independently commissioned a study for advice on how economic analysis could be used to represent FWS concerns in FERC decisionmaking (Industrial Economics 1999; Loomis 2000). More than half of the report was devoted to explaining and advocating the use of EVM. A few years earlier, a coalition of environmental groups (called the Hydropower Reform Coalition) commissioned another study to review and critique FERC's economic analysis (Marcus 1997). That report also advocated for greater use of EV as a way to replace FERC's subjective valuation with an analytical assessment of preferences for ecosystem services. Academic economists were also arguing for increased used of EV for licensing decisions (Moore et al. 2001; Loomis and Feldman 1995).

Three years after forming, the Interagency Task Force released seven final reports (DeWitt and Ebrahim 2001).[1] The reports dealt almost exclusively with government agency coordination and licensing procedural issues. Notable by its absence were reports or recommendations on economic analysis in licensing. In addition, the activities of the economics workgroup were not mentioned in any of the final reports.

However, the economic analysis work group did meet, deliberate and develop initial work tasks in two phases (Heinz 2000). A Phase 1 report was descriptive in nature, cataloguing the type of economic analyses conducted by the different agencies and the types of methods that *could* be used to monetize the various market and nonmarket effects that might be involved hydropower licensing. Drafts of this report were produced, but not released as a final report. A Phase II report was intended to be a group consensus on what type of analyses *ought* to be done. No consensus could be reached on the Phase II report and no recommendations were made (Heinz 2000).

Even after the ITC reports were issued, investigations into further reforms to the licensing process continued. Two major efforts, the Interagency Hydropower Committee (IHC) and the National Review Group (NRG) ran in parallel. The IHC was comprised of the same agencies that formed the Interagency Hydropower Committee (IHC). Formed in July 2001, the goal of the IHC was to two-fold. First, the IHC would monitor the use of the ITF recommendations. Second, the IHC would investigate and make as necessary further recommendations for improvement (Hill and Murphy 2003, 40). The National Review Group (NRG) was led by the Energy Policy Research Institute. Made up of representatives from the hydro industry and conservation organizations the NRG aimed to investigate and report on voluntary practices that might improve the licensing process (Hill and Murphy 2003; DeWitt and Ebrahim 2001). Both the IHG and the NRG published reform proposals in 2002 (Hill and Murphy 2003, 40). Again, the type and use of economic analysis as a way to improve the licensing process was not a substantial part of these reports and none of the recommendations addressed the use of EVM.

The recommendations from each group were similar and tended toward procedural recommendations and modifications that built on the ITC recommendations (Hill and Murphy 2003; Swiger and Hill 2003). The reasons why analytical guidelines or recommendations were not included in these reforms, especially as related to the use of EV, are not part of the official record. However, during discussions with FERC staff, the following reasons for the failure to endorse EV were offered. Requiring the FERC staff to conduct a computational analysis to identify the best license could be viewed

[1] The seven reports were: Guidelines to Consider for Participating in the Alternative License Process Agency Recommendations; Conditions, Prescriptions under FPA; NEPA procedures in FERC relicensing; FERC Noticing Procedures; Improving the Studies Process in FERC Licensing; Improving Coordination of Endangered Species Act Section 7; Tracking and Enforcing License Conditions

as usurping the Congressionally delegated authority of the Commissioners to decide among alternatives. Supporting this concern was the perception that EV studies yield highly variable measurements of people's preferences and that different study techniques or methods of the same ecosystem service will not yield consistent or reliable estimates. In that case, debate over methods and corresponding results would further extend licensing decisions by creating an additional controversy among the various parties affected by the license without necessarily improving decisions (EPRI 2000). In effect, EV studies were not required as a practical or acceptable substitute for the statutory requirement that the FERC Commissioners exercise their judgment, or as a necessary input to reach consensus in the ALP. However, in neither licensing process was EV prohibited or officially discouraged.

The ongoing deliberations between the ITF, IHG, and NRG contributed to the development of a third licensing process in 2003, called the Integrated Licensing Process (ILP). Conceptually, the integrated licensing process merges aspects of the ALP and TLP processes (Swiger and Grant 2004). Like the ALP, the ILP stresses and supports collaboration early in the licensing process (pre-filing stage), but adds a number of schedules/timelines and formal dispute resolution provisions (Layman et al 2006). In 2005 the ILP process became the FERC's default hydropower licensing process (18 CFR Part 5). The TLP and ALP processes remain options, but license applicants must officially petition FERC to be allowed to use these processes.

The selection of studies to be conducted in a licensing case is illustrative of the ILP. Early in the process, stakeholders formally submit study requests. Stakeholder include federal and state resource agencies, tribes, nongovernmental organizations, and the general public. The license applicant negotiates with stakeholders in deciding which studies to fund and conduct. Rules contain a list of criteria designed to ensure that a nexus exists between a study request and licensing alternatives (FERC 2004; 18 CFR §5.11). Consistent with the FERC's approach to reform, the study criteria do not prescribe *what type* of study to conduct, leaving decision participants the option to fund any type of study the feel is needed to decide among licensing alternatives. FERC establishes deadlines for submitting a study plan and establishes a formal dispute resolution process, including the establishment of a third-party arbitration panel, in the event of a disagreement between the license applicant and environmental agencies/stakeholders over what studies to conduct (18 CFR §5.14).

In summary, the FERC did not pursue, and stakeholders did not demand, an analytical solution to the challenge of accounting for the public's preferences for the various ecosystem services at play in a hydropower (re) licensing decisions. The FERC responded to problems with the licensing process and the criticisms for failing to place adequate weight on ecosystem services by revising the licensing process itself to stress greater opportunity for cooperation and negotiation. While FERC retains the

ultimate authority to decide licensing conditions, the ALP and ILP devolve substantial decisionmaking responsibility to the license applicant and environmental stakeholders. Federal and state agencies and intervening stakeholders are granted additional opportunities to represent the interests of people concerned about the nonpower outcomes associated with hydropower dam operations. Far from failing to take account people's preferences, the nearly decade long reform effort illustrates the extensive efforts undertaken to grant greater opportunities of non-power interests to influence licensing decisions.

3. Use of Ecosystem Valuation Methods Under the Reformed Licensing Processes

Given that the FERC's reformed hydro licensing process stresses greater participation in deciding levels of ecosystem services, the question then becomes, what analyses do decision participants use in their deliberations over license conditions involving ecosystem services? Many economists have asserted that decision participants will want to use EVM information when assessing tradeoffs involving ecosystem services. Since FERC does not prescribe analyses, to what extent do decision participants request, produce, and use EVM in the ALP and ILP processes?

To address this question, we inventoried the technical analyses produced for major hydropower project licensed in the ALP and ILP processes between 2006 and 2016. A record of all hydropower project licenses issued after 2005 was obtained from FERC records. Since the number and sophistication of technical studies produced in a licensing case is expected to vary directly with the controversy and ecosystem impact of the hydro project, we focus on the cases that required an environmental impact statement (EIS). The National Environmental Policy Act (NEPA) requires all federal agencies to consider ecosystem impacts by producing either an EIS or an Environmental Assessment (EA). EAs are conducted under the findings of no significant impact.

Of the hydropower projects receiving a license between 2006-2016, 31 projects required an EIS. Of this total, 10 projects were settled using the ALP and 7 projects received licenses under the ILP. The other 14 projects were licensed under the traditional licensing process or a combination of the licensing processes (eg. a project may have begun under the TLP and finished under the ALP). Because the critics charge FERC as being unwilling to use EV under the traditional process, we conduct a detailed case analysis for the 17 cases settled under the ILP and ALP processes (See Table 1, below). These 17 projects represent 58 percent of the total generating capacity FERC licensed during this period.

Next, we identified all studies produced in a licensing case by examining the EIS, license order, and published study list. The decision to fund and conduct an analysis requires a judgment among decision participants about the value of information relative to the cost of the study. Studies conducted are classified into 5 general categories: hydropower analysis, incremental flow/aquatic habitat analysis, entrainment/fish passage analysis, recreational user day studies, and EV studies. In licensing cases, hydropower analysis typically is the estimated cost in terms of value

of the electric power forgone from the existing license baseline for ecosystem or recreational improvements. Incremental flow and aquatic habitat analysis constitutes a broad category of analytical efforts to estimate the change in aquatic habitat or biological functioning that would occur downstream of the dam or in the reservoir due to changes in the timing, duration, or magnitude of different flow releases. Fish passage analysis includes any attempts to evaluate fish mortality through the dam (e.g. fish loss due to entrainment/impingement) and technical studies to evaluate success of passing fish around the dam. Studies falling under the recreational user day classification were confined to efforts to either estimate the current or future use of recreational amenities at the project site or the estimate the cost to provide or enhance an amenity. For purposes here, recreational user studies do not include any attempts to monetize the value of the recreational amenity. EVM includes any monetization of preferences for recreational or aquatic service enhancements.

Table 1: Case Study Hydro Projects Settled Under the FERC's ALP and ILP Processes

FERC Project Number	License Process	Date License Issued	License Type	Project Type	Authorized Capacity (kW)
P-935	ALP	June 2008	Relicense	Peaking	136,000
P-2071	ALP	June 2008	Relicense	Peaking	134,000
P-2111	ALP	June 2008	Relicense	Peaking	240,000
P-2145	ALP	Feb 2009	Relicense	Run of River	865,760
P-2150	ALP	Oct 2008	Relicense	Peaking	170,030
P-2195	ALP	Dec 2010	Relicense	Peaking	137,645
P-2213	ALP	June 2008	Relicense	Peaking	66,800
P-2216	ALP	March 2007	Relicense	Peaking	2,755,550
P-2545 & 12606	ALP	June 2009	Relicense	Run of River/Peak	137,500
P-13563	ALP	Sept 2016	New	Peaking	19,800
P-349	ILP	Dec 2015	Relicense	Peaking	182,500
P-1888	ILP	Dec 2015	Relicense	Run of River	19,620
P-2144	ILP	March 2013	Relicense	Peaking	1,003,253
P-2149	ILP	Nov 2012	Relicense	Run of River	774,250
P-2210	ILP	Dec 2009	Relicense	Pump Storage	636,000
P-2305	ILP	Aug 2014	Relicense	Peaking	82,300
P-2355	ILP	Dec 2015	Relicense	Pump Storage	828,000

We recognize that the absence of an EVM study does not necessarily mean that some decision participants might not find EVM useful in decisionmaking. For instance, some decision participants may demand such analyses, but face opposition to funding the study. To investigate evidence for latent, unmet demand for EVM, the record of decision was searched to determine whether an EV study was requested by a decision participant, but not approved/funded. As described earlier, the ILP process includes a

formal study solicitation and approval process. Denial of a study request must include a written justification explaining the reasons for the denial. Furthermore, decision participants who persist with a denied study request can appeal to a third-party arbitration to decide or not to fund the study. ALP cases, by design, are decided in more collaborative, less structured way. For ALP cases, FERC records of official correspondence was searched for any evidence of denial of study requests or study disputes, particularly during the "scoping" part of the licensing process. Since the ALP study determination process is not as formalized as the ILP, search for evidence requires sorting through hundreds of entries for each licensing case. In addition, records of minutes and progress reports posted online by licensees were also obtained and searched for discussion of requested studies.

Table 2: Analyses Produced under FERC Alternative and Integrated Licensing Processes

FERC Project Number	Hydro Power Analysis	Incremental Flow Studies/Habitat Analysis	Recreational User Day Data/Studies	Entrainment/ Fish Passage Analysis	Nonmarket Valuation
P-935	X	X	X	X	
P-2071	X	X	X	X	
P-2111	X	X	X	X	
P-2145	X	X	X	X	
P-2150	X	X	X	X	
P-2195	X	X	X	X	
P-2213	X	X	X	X	
P-2216	X	X	X	X	
P-2545, 12606	X	X	X	X	
P-13563	X	X	X		
P-349	X	X	X	X	
P-1888	X	X	X	X	
P-2144	X	X	X	X	
P-2149	X	X	X	X	
P-2210	X	X	X	X	
P-2305	X	X	X		
P-2355	X	X	X	X	
Summary	*17/17*	*17/17*	*17/17*	*15/17*	*0/17*

A summary of the types of studies produced in the 17 settled cases are shown in Table 2 (above). In no case did decision participants devote any analytical resources to an EV study. Participants in the ILP and ALP processes devoted the vast majority of analytical resources to studies that helped them understand the relationship between existing dam operations on the biological and physical system. Incremental stream flow and fish response studies were conducted for every project and most projects also examined some aspect of the effectiveness of fish passage structures (see Table 2). No attempts to monetize ecosystem service change was found. For every project,

some assessment of recreational use was conducted. The studies typically estimated either user days associated with a specific recreational facility or activity, assessed how user days might change under different licensing conditions, or evaluated user attitudes of different attributes of a recreational amenity (for an illustration see, Shelby et al. 2004). One project (P-349) asked landowners how shoreline property values might change with different seasonal lake levels (Southwick Associates 2010). No evidence was found of monetizing recreational benefits in terms of willingness to pay or estimating the change in use or value from a recreational enhancement alternative. In addition, many licensing processes also generated regional economic impact studies that estimated employment, local revenue, etc., from the existing hydropower project.

Monetizing of outcomes was limited to financial cost analyses. Some type of financial cost analysis of the foregone power costs of licensing alternatives was conducted for every project. Most project licensing processes produced cost estimates of various modifications to the existing project, including recreational enhancements and the cost of fish passage alternatives. Expert judgment was often used to assess the effectiveness of such enhancements and collective judgment to decide whether the enhancements justified the cost. The types of analyses produced under the ILP and ALP processed do not appear to differ in any general way from the types of analyses produced under the traditional licensing process or under early applications of the ALP process (Shabman and Stephenson 2007; Stephenson and Shabman 2001).

However, the question remains: did some decision participants request EV analysis to aid the deliberation process? The examination of the study request process finds little evidence of substantial unmet demand for EV analysis. For the 7 cases with a formal study request process (ILP), no individual EV study was requested. In one case (P-1888), two interveners jointly asked for an analysis of costs and benefits, but without reference to specifics for how the study would be performed. The requesting language indicated a general desire to consider gains and losses rather than an EV approach to quantifying benefits and costs. Another case (P-2305) requested a "recreational supply and demand study". As is common in sorting through study requests, similar study requests were folded together in a single study listed in the final study plan. One licensing case approved a recreational study plan (P-2144) that included a questionnaire that included asking visitors questions about their willingness to pay to visit the site, but these questions did not appear in the final project report. In no case did the requester challenge a final study plan, directly or indirectly, related to the failure to conduct and use EVM in making the decision. The study disputes that did occur in these ILP cases related to disagreements on the necessity for, and design of, physical and biological studies (hydrologic studies, inventories of terrestrial species, invasive plants, etc.).

Between 2006-16, FERC records indicate that ten projects filed formal requests for study dispute resolutions (arbitration with third party panel). None of these requests were seeking an EVM study (FERC 2018). The cases overwhelmingly involved disagreements on the need for specific physical and biological studies (instream flow, hydrologic studies, fish passage issues, and terrestrial and aquatic species)

In the 10 ALP cases, no evidence of EVM related requests could be located for 9 of 10 cases. Like the ILP, participants study requests overwhelmingly focused on studies of aquatic and terrestrial living resources and hydrologic consequences. Disputes over studies tended to focus on the extent to which project operations reasonably could be expected connected to those outcomes. In the one case (P-2545), two comments on the draft license proposal suggested that the recreational benefits of river-based recreation and nonpower benefits of a waterfall be monetized (Avista 2005). Note that, these comments were two from among over 900 comments provided by 42 stakeholders on the draft license proposal.

4. The FERC Experience: Ecosystem Valuation as a Process

The decades' long effort by FERC to reform its licensing process to account for non-power services parallels the development of now well established EVM by professional economists. Today, after many years of opportunity, FERC has not required EVM analyses in support of license decisionmaking. Rather, FERC reformed the licensing process itself trusting the deliberative ALP and ILP processes to decide the mix of ecosystem services when a license is granted. The permit applicant, cooperating resource agencies, and interested stakeholders are free to seek such analyses as an aid to decisionmaking. However, the record reviewed in this paper found that neither FERC nor participants in the deliberative processes required or requested EVM results for making decisions.

The FERC experience provides counter evidence to several claims made by EVM proponents about the policy need for EVM. Proponents of EVM might argue that monetization of ecosystem services would lead to more expeditious, different, "better" choices being made. EVM practitioners often assert that by expressing outcomes in a single dollar metric, the results expedite decisionmaking by simplify the task of comparing outcomes of different policy alternatives (Arrow et al 1996; Moore et al. 2001; Loomis 1998; NRC 2005b; Mendelson and Olmstead 2009). However, when the FERC carefully considered reforms to its process one reason for not requiring EVM was that such studies would themselves become a focus of disagreement, adding to the cost of studies and delaying the time to reach agreement. The absence of EVM studies in the deliberative process suggests that participants did not feel EVM would simplify decisionmaking.

Even if use of EVM might not expedite decisionmaking, EVM advocates assert that without monetization of preferences for ecosystem services will be ignored when decisions are made (Costanza et al. 1997; Loomis et al. 2000; Atkinson et al 2012). A National Academies National Research Council report echoed the same idea as "use of the (imperfect) information about these values is preferable to not incorporating any information about ecosystem values into decisionmaking (i.e. ignoring them), since the latter effectively assigns a value of zero to all ecosystem services" (NRC 2005b, 242). However, the FERC deliberative valuation process does not ignore ecosystem services, or treat their value as zero. In fact by requiring the inclusion of advocates for those values in the processes, the ecosystem services are given a "voice" they may not have had in the traditional process.

The FERC process relied on more inclusive and deliberative processes to better account for emerging preferences for ecosystem services. A considerable literature focuses on deliberative processes for water resources planning and decisionmaking, beyond the FERC experience reported here (Palmer et al 2013; Rivera and Sheer 2013; Gregory et al 2012; Stephenson and Shabman 2011; Sheer and Dehoff 2009). That literature reports that agreement on quantitative bio-physical metrics (acres of wetlands, fish abundance, etc) become the centerpiece of these deliberative processes. Of course the metrics useful to decision participants will differ depending on the specific context. Such "place-based" decision contexts require detailed and unique knowledge of the local physical and economic system (Sagoff 2011). In FERC licensing the resource agencies, as well as nongovernmental groups such as property owner associations around a reservoir, whitewater boating groups, and ecosystem groups, and the dam owner focus on how specific and readily identifiable metrics that represent their interests are affected by different operational regimes. The participants are acutely aware that their negotiation is about the "value" of different levels of different services, but participants do not find monetizing ecosystem services particularly useful a (Ruckelshaus et al. 2015; Sagoff 2011; O'Neill 2007; Failings et al 2007).

Participants in FERC's deliberative processes relied on bio-physical and behavioral response information about ecosystem services, rather than EVM derived value estimates, for reaching agreement on the hydropower operational rules that should be included in a license. Participants in hydropower decisionmaking in other contexts and countries report a similar lack of EVM studies (Morlan 1999; Failings et al. 2007). Failings, Gregory and Harstone (2007, 57) were involved in a planning process for 22 Canadian hydro facilities and concluded that:

> The WUP (water use planning) experience, and also common sense, suggests that abstract exercises such as willingness to pay surveys are at best meaningless and at worst offensive and divisive to participants, including but not limited to local and aboriginal people. Such elicitations have little role to play in usefully exploring value judgments in a participatory evaluation process.

We recognize that the FERC deliberative process, as a means for ecosystem services valuation, could be critiqued based on process criteria (Shabman and Stephenson 2011). Such criteria might include representativeness (are participants responsive/reflective of the constituents' interests), inclusiveness (participants bearing the costs and benefits are represented in the process) and consequentiality (nexus between deliberation and final decision) (Zografos 2015).

That said, the deliberative decision processes have been widely viewed as an improvement for recognizing and accommodating a full range of ecosystem services when compared with the traditional process. Public statements of support come from a diverse set of groups, including the hydropower industry, ecosystem groups, and resource agencies (Groves and Liimatainen 1999, Swant 2001; Keil 2002, Wilson 2000, Richter et al. 2003; Richter et al 2005; Pearsall et al. 2005). Ulibarri (2015) found that FERC licensing cases that were more collaborative considered a greater range of ecosystem outcomes and produced more agreement among participants. FERCs own assessment of the process also confirms that the time, cost, and level of conflict has diminished under the alternative licensing process and that ecosystem agencies and NGOs prefer the reformed licensing processes over the TLP (FERC 2001, 2011). Note, however, that the licensing reforms have not eliminated all licensing issues. The licensing processes existing within a specific statutory framework and the duration of the licensing process and mandatory conditioning authorities remain a focus of ongoing public debate (US. House of Representatives 2017).

More work is warranted evaluating the contribution of EVM to policymaking (Laurens et al 2014). Identifying how analysis is used in policy, however, is challenging (Rich 1997). Many decisions are being made all the time and proponents of EVM analysts often point to the fact that EVM estimates have been prepared, (often in national rule-making) as part of that decisionmaking. Few make an effort to isolate influence of those studies on the final decision (Loomis 2000; Smith 2000; McCollum 2003, Griffiths et al 2012; Loomis 2005). In the few cases where there is an effort to isolate the influence of EVM results, the conclusion is that such studies were not included in a formal and quantitative analysis that in turn was used to direct the decision that was made (Gowan, et al 2006; Nelson 2006). Bergstrom and Loomis (2017) review of 30 river restoration valuation studies found that only a fraction have played, based on authors' own judgments, an instrumental role in restoration decisions. Rogers et al (2015) note that EVM has had limited instrumental application in policy.

If the FREC experience raises doubt about the use and contribution EVM calculations in project specific decisionmaking, and if deliberative processes can be understood as a process of valuation, what is the job of economic analysts? Economists can dedicate their theoretical and empirical knowledge to the design and evaluation of decisionmaking processes and institutions (Sagoff 2004; Bromley 2006). Economists would be interested in how the structure of deliberative choice processes that influence the creation of mutually beneficial agreements. For instance, a fundamental argument made by economists is opportunities to shift costs to unrepresented parties can undermine the achievement of efficient outcomes. Game theory and experimental research into actual choice behavior offer multiple avenues of insight into the analysis

of incentives and the design of collective choice processes. Comparative institutional analysis can also facilitate the identification of factors that lead to decision participants to successfully negotiate and reach agreement.

Economists have much to contribute by actively participating *within* deliberative policy process. Negotiation processes require sound analyses that help decision participants form their preferences and that enrich the collective understanding about acceptable tradeoffs (Stern 2005). For example, costs are always an integral part of policy deliberations (including FERC) and economists often bring a conceptual framework and empirical tools to more clearly estimate the marginal opportunity cost of decisions. Economists possess an impressive array of skills to estimate and forecast behavioral responses to different conditions and incentives. Identifying causal relationships between reservoir levels or downstream releases on levels of recreational activities is a frequent request within FERC hydro license cases.

This study examined the instrumental use of analysis in decisionmaking. Others have noted the variety of ways decision participants use analysis other than as a necessary input into making a decision (McKenzie et al 2014; Laurens and Mermet 2014). For instance, Marre et al 2015 reports that EVM analyses are primarily used as general information or awareness raising. While not being used in making the specific decision at hand, EVM analysis may lead to additional insight into the consequences of a decision, background knowledge about the system, or broaden the scope of the deliberation to recognize the preferences of previously unknown or unconsidered groups (Primmer et al 2018; Laurans and Mermet 2014; Atkinson et al. 2012; McCollum 2003; Loomis 2000). Still another use of EVM could be ex post justification that bolsters political support for controversial decisions that have already been made. For instance, Bergstrom and Loomis (2017) note that EV methods may be used to justify expensive project decisions. Different decision-contexts produce different analytical uses and needs (Laurens and Mermet 2014).

The lesson from this experience is that policy economists should be attentive to the demand for the different kinds of work they might do in support of decisionmaking in different contexts (National Research Council 2005). Rather than start from the premise of the instrumental need for EVM, a deliberative approach starts with a broader question: What information is useful to decision participants in a deliberative process in discovering, evaluating, and weighing tradeoffs involving ecosystem services? Economists have long been critical of prescriptive approaches to environmental policy. Perhaps economists can be more effective by being less prescriptive of the types of analysis we feel decision participants need in considering and evaluating changes in the level of ecosystem services. Accepting that public negotiation processes are themselves a valuation process, the policy economist would be then be more sensitive to what type of analyses are most effective and useful.

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