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DEMOLISH IT AND THEY WILL COME: ESTIMATING THE ECONOMIC IMPACTS OF RESTORING A RECREATIONAL FISHERY[1]

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ABSTRACT: This paper presents the results of an *ex post* survey of recreational anglers for the lower Kennebec River, post-Edwards Dam removal. To the best of our knowledge, this study represents one of the first *ex post* analyses of fisheries restoration from dam removal. We find significant benefits have accrued to anglers using the restored fishery. Specifically, anglers are spending more to visit the fishery, a direct indication of the increased value anglers place on the improved fishery. Anglers are also willing to pay for increased angling opportunities on the river. These findings have policy implications for other privately owned dams that are currently undergoing relicensing and/or dam removal considerations. Our findings may also hold implications for fisheries that have deteriorated due to historic dam construction.

(KEY TERMS: water resource economics; environmental impacts; watershed management; water policy; planning; dam removal; fisheries.)

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INTRODUCTION

After blocking anadromous fish migration for more than 160 years, Edwards Dam was removed from the Kennebec River in Maine in 1999. In June 2006, four Atlantic salmon entered the brand new fish lift at the Lockwood Dam, 22 miles above the former Edwards Dam site. This marked the first time in 162 years that Atlantic salmon reached the upper Kennebec (Maine Department of Marine Resources, 2006). This was called a "landmark event" for the river (Greg Ponte, Trout Unlimited, personal communication, June 30, 2006). By the end of the 2006 spawning season, thousands of anadromous fish had used the new up-river passage at the Lockwood lift and at Ft. Halifax Dam, now the first two dams upstream from the former Edwards Dam site. Other dams around the country are also coming down. Two dams in the Sandy River Basin in Oregon are in the process of being demolished to restore migratory fish habitat (*The Oregonian*, May 23, 2007). Sappi Fine Paper has recently agreed to remove a dam on the Presumpscot River (*Portland Press Herald*, July 11, 2007) in Maine for migrating fish and the Penobscot River Restoration agreement allows for two dams to be removed on that river and a fish bypass built around a third dam. As more and more dams are being evaluated and river restoration is gaining attention, evidence about the success or

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failure of past projects becomes increasingly important.

The Federal Energy Regulatory Commission (FERC) requires economic analysis as part of the application process for the renewal of any hydropower license for privately owned dams. However, rarely is economic cost-benefit analysis used after a dam removal or even after a license renewal. In other words, the important *ex post* economic analysis is rarely performed. In fact, we are unaware of any other *ex post* economic analysis for a dam removal related to fisheries. The Aspen Institute's (2002) report on dam removal recommends a complete economic analysis that includes all benefits and costs and not just the ones that are easily monitored. The Heinz Center (2002) panel on dam removal also recommends "improved economics evaluation tools to enable the assignment of monetary values for outcomes of dam removal" (p. 13). The Maine State Planning Office issued a Draft River Restoration Guide in 2004 that emphasizes the need for a "comprehensive, accurate method for evaluating the beneficial and adverse impacts of a dam removal." This report includes a section highlighting the need for socioeconomic valuation. In 2002, the Department of Interior commissioned the Water, Science and Technology Board (WSTB) to undertake an assessment of water resources research funded by federal dollars. Henry Vaux, Chairman of the WSTB Committee, presented a keynote talk on the findings in 2005. According to Vaux, one of the priority needs is for *ex post* analysis of projects and for continued monitoring of current projects; social science research is also lacking. These shortcomings will become increasingly apparent as more and more dams outlive their useful lives and come up for relicensing, both in Maine and across the nation.

This paper presents the results of an *ex post* survey of recreational anglers for the lower Kennebec River, post-Edwards Dam removal. We find significant benefits have accrued to anglers using the restored fishery. Specifically, anglers are spending more to visit the fishery, a direct indication of the increased value anglers place on the improved fishery. Anglers are also willing to pay for increased services related to the fishery. To the best of our knowledge, this study represents one of the first *ex post* analyses of fisheries restoration from dam removal. Given that an *a priori* survey of angler values also found significant anticipated benefits, these findings support that analysis and have policy implications for the many other privately owned dams that are currently undergoing relicensing and/or dam removal considerations. Our findings may also hold implications for fisheries that have deteriorated due to historic dam construction. As dam removal for river restoration gains national attention, this study may help inform decisions for other rivers.

The Kennebec River and Edwards Dam

The Kennebec River is one of Maine's largest river systems. Extending 132 miles from Moosehead Lake in Greenville, Maine, all the way to the ocean in Phippsburg, the river has been a source of recreational and economic opportunities for hundreds of years. In 1837, despite opposition from Maine citizens fearing detrimental impacts to the river's fishery, Edwards Dam was built by the Kennebec River Dam Co. Twenty-four feet in height and 917 feet in length, the dam was intended to facilitate upstream navigation, and also provide power to nearby saw mills (American Rivers *et al.*, 1999). Between the years of 1842 and 1846, the dam powered seven saw mills, a grist mill, and a machine shop (http://www.americanrivers.org). However, construction of the dam also resulted in an immediate loss of seventeen miles of spawning habitat for migratory fish species. These species include the shortnose sturgeon, Atlantic sturgeon, Atlantic salmon, Striped Bass, Shad, alewives, and several species of River Herring. Just two years after the dam was built, fish stocks began to plummet. Figure 1 illustrates the Kennebec River with current dams and the former Edwards Dam site marked.

Valuation as Part of the Relicensing Process

The FERC, established in 1977, is an independent agency responsible for the regulation of interstate transmission of electricity, natural gas, and oil. FERC also reviews and licenses (or denies licensing) of hydropower projects (http://www.ferc.gov). When the license to operate Edwards Dam expired in 1993, FERC was responsible for determining whether or not the dam would continue to generate electricity. An application for renewal of the Edwards Dam license was submitted by its owners, and review began by FERC in 1995.

The National Environmental Policy Act, originally created in 1969, requires that FERC complete an environmental impact statement (EIS) as part of the dam relicensing process. The EIS is then used by federal agencies in their decision-making processes by incorporating environmental values and potential environmental impacts of proposed actions, as well as alternatives to those actions (http://www.epa.gov). The Draft EIS (DEIS) for the Edwards Dam project was completed in January 1996.

This DEIS included a partial benefit-cost analysis of the dam removal project. From this benefit-cost

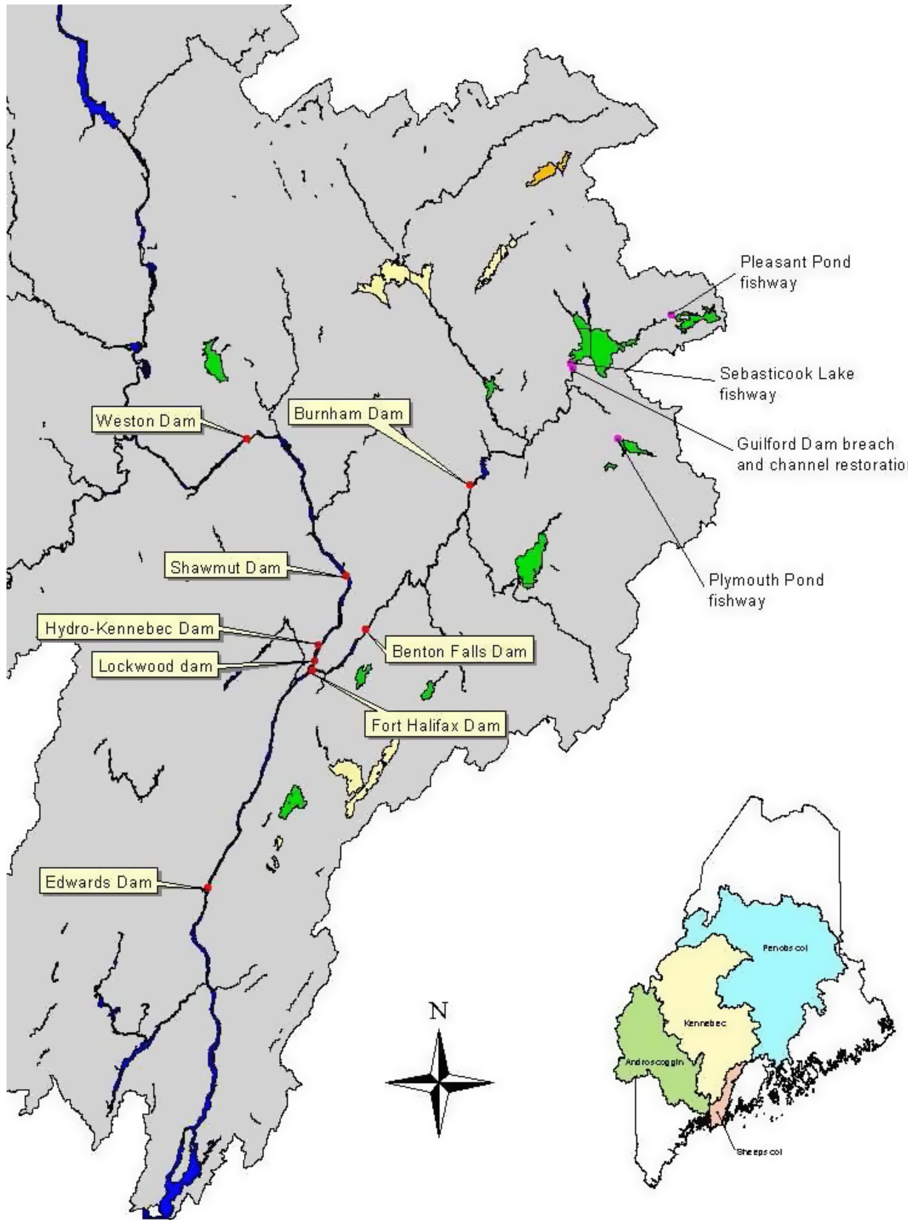

FIGURE 1. Kennebec River Dam Sites (www.maine.gov/dmr/searunfish/kennebec/map.htm).

analysis, the DEIS recommended the relicensing of Edwards Dam, but with construction of fish passage. One study which contributed to the recommendation of this DEIS was written by Boyle *et al.* (1991). Their report concluded that the construction of fish passage at Edwards Dam would yield comparable recreational fishing benefits to a scenario with full dam removal. However, the DEIS did not include the nonpower benefits that dam removal would yield.

In a report submitted to FERC prior to the decision to remove Edwards Dam, Freeman (1996) reviewed and critiqued FERC's benefit-cost analysis for the Edwards Dam project. In this report, Freeman emphasized why nonpower values must be included in benefit-cost analysis. FERC did not include any nonpower values in its study. (Typically, these values are excluded from FERC analyses due to the difficulty of estimation.) As Freeman states, "this is a fatal methodological flaw" (Freeman, 1996, p. 5). By ignoring and excluding these nonpower values in its benefit-cost methodology, FERC made it "impossible for the dam removal alternative to ever show a net economic benefit to society" (Freeman, 1996, p. 5). Freeman (1996) estimated the present value of benefits to recreational anglers alone would be at least US$36.2-48.2 million in 1995 dollars. This estimate was based on data collected from a study by Boyle *et al.* (1991). This is, of course, a lower bound as it does not include other potential recreational economic benefits. For example, whitewater boating opportunities were also expected to increase with removal. Additionally, there are other nonmarket benefits and costs, such as habitat enhancements and overall water quality improvements that were not estimated. Evidence to date suggests that these numbers were, in fact, underestimates.

The FERC released a final Environmental Impact Statement for the Edwards Dam project in 1997 which reversed their initial decision, and recommended dam decommissioning and removal of Edwards Dam (Costenbader, 1998). A settlement was then made between the State of Maine and Edwards Manufacturing Co. (dam owners at the time), and ownership of the dam was transferred to the State of Maine on January 1, 1999 (http://www.americanrivers.org).

Edwards Dam was breached in the summer of 1999. By the fall of 1999, the dam was completely removed allowing anadromous fish species to reach spawning habitat that had been unavailable for the previous 160 years.

Interestingly, many outcomes of dam removal are not captured by market values and may be at odds with one another. Naeser and Smith (1995), for example, examine the conflicts between different instream flow users including anglers and rafters. River-based recreation is not necessarily improved by leaving more water in the river. Many times the timing and volume of flows are important to recreational users, in which case the effects of dam removal would be different for different users.

The difficulty of nonmarket valuation is well established in the literature and much has been written on methods for nonmarket valuation (Freeman, 2003 and Mitchell and Carson, 1989, for example).

Few studies have attempted to estimate the total nonmarket value of a dam removal. Loomis (1996) finds significant willingness-to-pay to remove dams in the Pacific Northwest in order to restore salmon and steelhead runs. He uses a contingent valuation survey to obtain estimates of willingness-to-pay for removal of dams on the Elwha River. His results suggest that total nonmarket benefits to all U.S. households of these dam removals fall in the range of US$3-6 billion. He suggests that this type of "valuation information should be used by FERC in relicensing decisions on the east and west coast" (Loomis, p. 446). Loomis (1999) used a survey of households in the Pacific Northwest and California to estimate benefits of the potential removal of four Lower Snake River dams. In this study, travel cost models were estimated for anglers and nonanglers. He finds that if the salmon population increases sufficiently to allow for angling opportunities, its value would increase from US$98.3 to 206 million while nonangler benefits would range from US$190 to 548 million once the river is restored. Benefits transfer was used to estimate passive use values ranging from US$56 million to 2.9 billion annually.

Gonzalez-Caban and Loomis (1997) examine willingness-to-pay to avoid a dam on the Rio Fajardo in Puerto Rico. They find an annual willingness-to-pay of US$28 per household or US$13.09 million when expanded to the one million households in Puerto Rico. They also estimate willingness-to-pay to preserve instream flows for Rio Mameyes and find an annual household willingness-to-pay of US$27 (US$11.33 million).

The above studies used survey methods including contingent valuation and travel cost surveys. Most recently, Lewis *et al.* (2008) and Provencher *et al.* (2008) have both estimated the effects of dams and dam removal on property values adjacent to the rivers and near the dam sites.

Valuation Methodology

Freeman's (1996) analysis relied heavily on the results of a mail survey conducted by Boyle *et al.* (1991). That survey used a combination of travel cost and contingent valuation (willingness-to-pay) questions and was sent to a sample of Maine Inland Fisheries and Wildlife license holders.

The survey by Boyle *et al.* was sent to adjacent, nonadjacent, and nonresident anglers. About 270 surveys were sent to each sample for a total of 810 surveys. The authors acknowledge the sampling issues they had due to the difficulty of developing a sampling methodology.

In the State of Maine, a fishing license is required to fish above the head of tide, but not to fish below the head of tide (or in any tidal or saltwater). Edwards Dam was located at the head of tide mark on the Kennebec River. Developing an appropriate sample for anglers both above and below the dam would have been prohibitively expensive. Thus, their survey results do not provide any information on individuals who exclusively fished the tidal portions of the Kennebec River. They also could not use their data to infer how individuals who did not fish in Maine at the time of the survey might respond to improved conditions (Boyle *et al.* acknowledge these sampling difficulties in their report). Freeman (1995, 1996), in his reports to FERC, criticized the sampling methods of this study and emphasized that the methods used "served to underestimate – potentially significantly – the nonpower recreational fishing value for dam removal" (Freeman, 1996, p. 11). In particular, Freeman notes that the population sampled does not include those who fish the tidal waters of Maine and who would likely place a high value on dam removal (Freeman 1995).

In order to compare the *ex ante* estimates of the value of a restored fishery to the benefits as seen through the current state of the fishery, ideally we would have drawn a sample from the same population as did Boyle *et al.* However, given the flaws in their sampling methodology as outlined by their own report and again by Freeman (1995), as well as our interest in capturing the saltwater angler values, we chose to sample from a different population – one that included nonlicense holders. (Additionally, we were unable to obtain permission for the Maine Fishing License holders data.)

Since Boyle *et al.*'s survey was sent only to license holders and our intention was to also collect data from anglers we knew were fishing in saltwater or below the head of tide, we are thus unable to make direct comparisons to the *ex ante* results. However, our survey data still provides valuable information on the *ex post* fisheries expenditures and benefits. Simply estimating *ex post* project costs and benefits provides useful information. We also believe there is likely significant overlap between the *a priori* and *ex post* populations sampled. This paper presents one of the first (to our knowledge) *ex post* analyses on the economic impact of dam removal on recreational fisheries.

Survey and Survey Design

Although we are unable to directly compare to their results, we used the *ex ante* survey (Boyle *et al.*, 1991) as a starting point when designing our survey of *ex post* economic impacts. By mimicking as closely as possible, the original survey and analysis, we believe we can potentially capture similar recreational benefits, *albeit* for a different, but overlapping population. As in the *ex ante* angler survey, our survey contained both travel cost and willingness-to-pay questions in order to collect data on fishing activity and economic benefits arising from use of the lower Kennebec River fishery.

In January 2006, a mail survey entitled "Kennebec River Survey" was sent out to 1,530 households – all recipients were members of Maine Trout Unlimited (TU) and/or the Maine Coastal Conservation Association (CCA). (A copy of this survey is available upon request from the authors.) We chose to survey members of both groups in order to capture both freshwater and saltwater anglers (CCA members), the latter of whom do not need a license. 1,530 surveys were sent in total: 450 to CCA members, and 1,080 to TU members (47.99% of CCA members returned the survey, as did 37.38% of TU members resulting in a total response rate of 40.51%). Response statistics for the mailing lists are provided in Table 1. Since we did not use multiple mailings given budgetary constraints, we feel these response rates are quite good for a mail survey.

The cover page of the survey shows a map of the lower Kennebec River, portraying (from South to North) the city of Bath, Chops Point, Merrymeeting Bay, Gardiner, the Transmission Line Crossing (former Edwards Dam site), Augusta, Lockwood Dam, Waterville, Maine, and finally the Sebasticook and Sandy Rivers (see Figure 2). The transmission line crossing (former dam site) is also the line above which a Maine inland fishing license is required to fish on the Kennebec River.

The first part of the survey was aimed at general fishing activity in Maine. Respondents were asked to report the first year they fished a freshwater fishery

TABLE 1. *Ex post* Survey Response Rates.

Mailing List	**CCA**	**TU**	**Total**
Surveys sent	450	1080	1530
Failed surveys	2	10	12
Returned	215	400	615
Response rate	47.99%	37.38%	40.51%

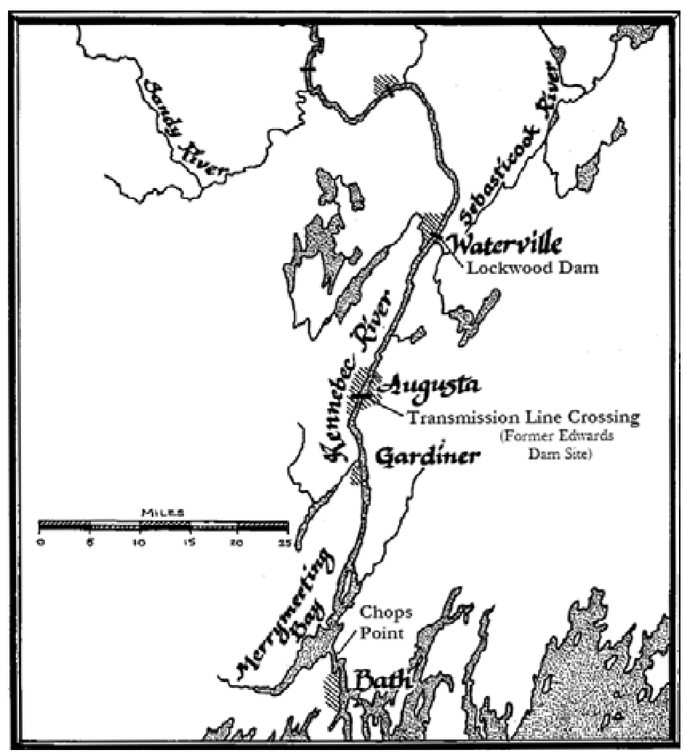

FIGURE 2. Kennebec River Survey Map (with permission from Boyle *et al.*, 1991).

TABLE 2. Most Targeted Fish Species.

TU	n = 380	CCA	n = 213	Total	n = 593
Brook trout	97.63	Striped bass	98.12	Brook trout	89.71
Landlocked salmon	85.79	Bluefish	82.63	Landlocked salmon	80.10
Brown trout	78.68	Brook trout	75.59	Striped bass	79.09
Striped bass	68.42	Mackerel	69.95	Brown trout	73.02
Smallmouth bass	63.68	Landlocked salmon	69.01	Smallmouth bass	62.39

Note: Values are given in percent.

in Maine, the first year they fished a saltwater fishery in Maine, and approximately how many days per year they fish different types of fisheries in Maine.

We then asked respondents to indicate the types of fish species they have targeted while fishing in Maine. In total, 28 fish species were listed, with a space for other species to be handwritten in. The percentages of the five fish species most targeted by respondents in each mailing list are shown in Table 2.

Respondents were then asked about their perceptions of the post-Edwards Dam Kennebec River, such as whether or not they thought removal of the dam was beneficial; how they felt water quality had changed since removal; how they felt the amount of wildlife had changed since removal; and finally, how they felt the numbers and types of fish had changed since removal.

Responses suggest that most respondents held positive perceptions of the dam removal decision. Removal was indeed beneficial according to 83.53% of respondents, 59.91% of respondents felt that water quality had improved since removal with only 10.57% indicating they felt it had remained the same or worsened. Respondents who felt that the amount of wildlife surrounding the river had increased numbered 48.71%, whereas 13.72% indicated they felt the amount wildlife had remained the same or decreased, and 65.84% of all respondents reported that they felt the numbers and types of fish in the river had increased since removal of Edwards Dam; only 8.56% of respondents felt these numbers had decreased or remained the same.

Although these questions give us little information on actual values of the post-Edwards Dam fishery, they do provide interesting information on the post-dam perceptions of anglers. Responses to these perception questions are shown in Figures 3-5.

Respondents were then asked about their fishing activity in the freshwater section of the Kennebec River, from the transmission line crossing to the Lockwood Dam in Waterville. This section included questions concerning respondents' willingness-to-pay for a full-day guided freshwater fishing trip and also a freshwater travel-cost question. Respondents were

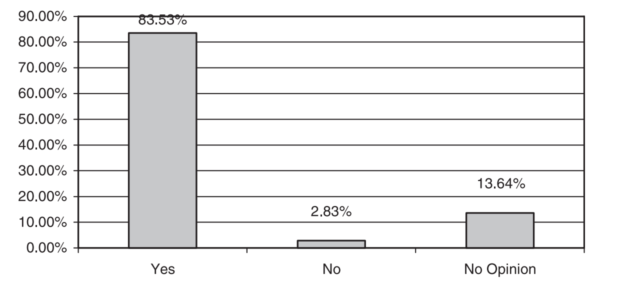

FIGURE 3. Do You Think Removal of Edwards Dam Has Been Beneficial?

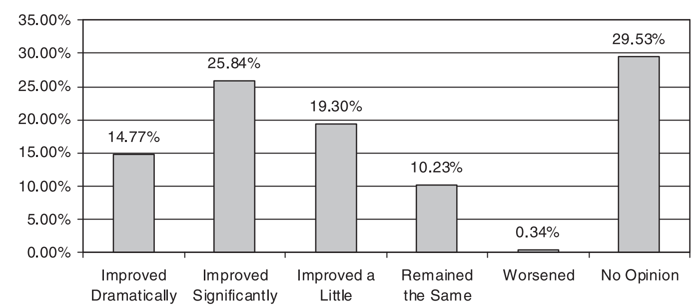

FIGURE 4. Since Removal, How Has Water Quality Changed?

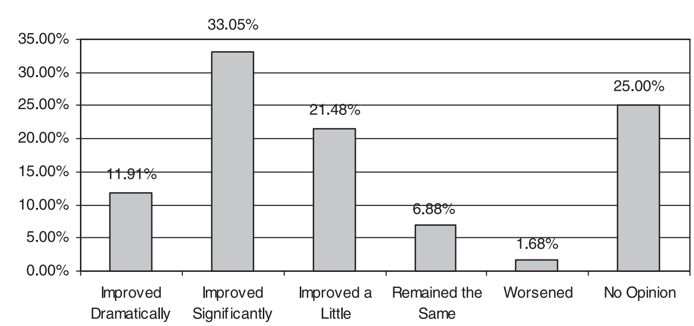

FIGURE 5. Since Removal, How Have the Numbers and Types of Fish Changed?

also asked to report the approximate costs they paid on a "typical one-day freshwater fishing trip to the Kennebec River," based upon the last time they fished the freshwater section of the river. A similar set of questions followed for tidal water fishing. Also included in this section was a question that asked respondents whether or not they would purchase a saltwater fishing license, and if so, what is the most they would pay for it (currently, there is no requirement for a saltwater fishing license in Maine). The final section of the survey collected demographical information of the respondents.

Table 3 illustrates the sample's general fishing activity. Unlike the earlier study, we also targeted saltwater fishers using the CCA membership list.

Ex post *Economic Analysis*

We calculate the average direct economic impact per angler per trip, the annual direct economic impact per angler, and the total annual economic impact. Each value is determined for both the freshwater and tidal water section of the Kennebec River. Table 4 provides a summary of the economic impacts.

To find the direct economic impact per angler (Calculation A in Table 4), Boyle *et al.* (1991) found the sum of the per person expenditures reported on their travel cost question. Average economic impact per angler per trip (Calculation B) was found by dividing the sum of all direct economic impacts per angler by the total number of anglers who responded to the question. We do the same here because even though we cannot directly compare the results, we feel there is enough overlap in the populations sampled that the information is still interesting. The annual direct economic impact per angler was found by multiplying the average per person direct economic impact by the average number of trips taken to each stretch of the Kennebec per year. Finally, because Boyle *et al.* (1991) used data only from adjacent anglers for these economic impact estimates, the estimate for the total annual economic impact was determined by multiplying the annual direct economic impact per angler by an estimate of the total number of adjacent anglers in Maine fishing each section of the river. Boyle *et al.* used estimates of 1,539 and 2,898 adjacent anglers fishing the fresh and tidal water sections, respectively. In one calculation (Calculation C) of the total annual economic impact, we use these estimates for the numbers of anglers fishing each section. In the other (Calculation D), we use a ten-year average of total Maine fishing licenses sold, multiplied by the percentages of our respondents who have fished each section (29.82% of respondents fished the freshwater section and 42.69% fished the tidal water section). For potential comparison, we make this calculation using the total annual economic impact estimate from Boyle *et al.* (1991) as well. Maine fishing license statistics for 1993-2004 were provided by the Maine Department of Inland Fisheries and Wildlife. The ten-year average of Maine fishing licenses sold was 270,222. Table 4 details the results from these calculations; all amounts are in 2005 U.S. dollars, adjusted using the Consumer Price Index from the U.S. Bureau of Labor Statistics.

Tables 5 and 6 show the reported expenses by angler category (adjacent, nonadjacent, nonresident) for our sample for freshwater and tidal water,

TABLE 3. Respondent Historical Fishing Activity.

	***Ex post* Survey (%)**
Respondents who have ever fished salt or tidal water in Maine	41.79
Respondents who have ever fished freshwater in Maine	69.27
Respondents who fished tidal water sections of the Kennebec River last year	24.07
Respondents who fished freshwater sections of the Kennebec River last year	18.54

TABLE 4. Economic Impacts.

	2006 Study	
	Freshwater Section	**Tidal Water Section**
Average economic impact per angler, per trip (Calculation A)	US$55.00	US$59.00
Annual economic impact per angler (Calculation B)	US$342.00	US$379.00
Total annual economic impact (Calculation C)	US$ 526,700	US$1,098,200
Total annual economic impact (Calculation D)	US$27,575,200	US$37,589,600

TABLE 5. Average Freshwater Travel Costs.

	***Ex post* Survey**		
	A	**NA**	**NR**
Transportation	US$7.67	US$14.96	US$17.45
Public transportation	US$0.00	US$0.58	US$0.00
Food and beverage	US$6.75	US$9.70	US$5.00
Lodging	US$0.00	US$7.73	US$7.19
Guide fees	US$4.87	US$33.45	US$71.14
Bait	US$0.67	US$1.15	US$0.00
Boat rental	US$0.06	US$1.04	US$0.00
Shuttle service	US$0.00	US$0.64	US$0.00
Fuel	US$2.06	US$2.81	US$3.59
Other	US$2.09	US$2.17	US$0.00
Total	US$24.37	US$76.85	US$121.72
	n = 77	n = 99	n = 3

Notes: A, adjacent angler; NA, nonadjacent angler; NR, nonresident angler.

TABLE 6. Average Tidal Water Travel Costs.

	Ex post Survey		
	A	NA	NR
Transportation	US$6.78	US$15.08	US$33.46
Public transportation	US$0.05	US$0.15	US$14.10
Food and beverage	US$7.18	US$10.70	US$16.54
Lodging	US$0.33	US$4.24	US$0.00
Guide fees	US$8.67	US$25.48	US$103.77
Bait	US$1.93	US$1.64	US$0.00
Boat rental	US$0.01	US$0.55	US$0.00
Shuttle service	US$0.00	US$0.03	US$0.00
Fuel	US$8.02	US$6.27	US$10.91
Other	US$1.15	US$2.55	US$3.55
Total	US$32.08	US$69.58	US$206.60
	n = 98	n = 140	n = 5

Notes: A, adjacent angler; NA, nonadjacent angler; NR, nonresident angler.

respectively. When aggregated, we find the total annual economic expenditures (Calculation C in Table 4) to be US$526,700. Tidal water section estimates are significantly higher; we estimate the total annual economic impact to be US$1,098,200. This follows Freeman's logic that the *ex ante* estimates were likely significant underestimates, by not including this valuable stretch of the river. Using a ten-year average of Maine fishing licenses sold, we estimate the total annual economic impact accruing from recreational use between Milstar Dam in Waterville and the transmission line crossing in Augusta to be US$27,575,200 (Calculation D in Table 4). We estimate the total annual economic impact of the tidal water stretch, from the transmission line crossing to Chops Point on Merrymeeting Bay using the same methodology, but multiplying by the percentage of our sample who hold a Maine fishing license and also fish tidal water (86%). We find this impact to be US$37,589,600. (These numbers are rounded to the nearest US$100.)

These numbers are substantially greater than those estimated before removal and used to inform FERC's decision. The Boyle *et al.* (1991) study found economic impacts of US$159,595 and 395,787 for freshwater and tidal water, respectively, for Calculation C. Using our methodology and assumptions for Calculation D, their numbers would have shown impacts of US$8,355,019 and 13,551,104, respectively. While not directly comparable, it is interesting to note that Freeman (1995, 1996) suggested that the Boyle *et al.* study estimates were likely underestimates of the potential economic impacts from removal of Edwards Dam [respondents to our sample also reported higher travel costs than in the Boyle *et al.* (1991) survey sample in every category, but especially for transportation, food and beverage, lodging, guide fees, and boat fuel (Table 5)].

Of the three survey samples, the adjacent anglers would most likely have the least total travel costs, as they live in the communities closest to the fishery. It is logical to assume that nonadjacent and nonresident anglers would have higher travel costs, and thus a greater direct economic impact.

Willingness-to-Pay

The four willingness-to-pay (WTP) questions contained in the present Kennebec River Survey asked respondents to report their willingness-to-pay for an all-day guided fishing trip. In the freshwater section of the survey, respondents were asked to value two trips: one targeting brown trout and another targeting smallmouth bass. In the tidal water section, respondents were asked to value trips targeting striped bass and also Atlantic salmon. Since Atlantic salmon are currently endangered in eight Maine rivers, the question for the Atlantic salmon trip was described as a hypothetical situation. (The angling season for Atlantic salmon in Maine officially closed in 1999 and Atlantic salmon populations in eight Maine rivers were officially declared endangered in 2000.)

The willingness-to-pay question, for striped bass, reads as follows:

> Consider a full day (8 hour) guided fishing trip on the Kennebec River in the tidal area, between the transmission line crossing in Augusta and Chops Point on Merrymeeting Bay. All flies, lures, and/or bait would be provided as well as fishing rods and a lunch, snacks, and drinks for the trip. The trip would be run on the guide's fishing boat and would depart on the river at a location of your choice between Augusta and Merrymeeting Bay. If this trip targeted striped bass, what is the maximum amount that you would be willing to pay for this trip for yourself?

Similarly phrased questions were asked for the other species. Lastly, we asked for respondents' willingness-to-pay for a saltwater sport fishing license. (Currently, saltwater sport fishing in Maine does not require the purchase of a fishing license.)

We estimate the willingness-to-pay equation using a Tobit model. A Tobit is a censored regression model, with the censoring value in this case at zero. Thus, the observed values of the dependent variable are either zero or positive. This allows us to include the valid zero WTP numbers that respondents gave in this survey. Since anywhere between 10 and 34% (depending on the species) of our sample answered US$0 to the willingness-to-pay question, the Tobit model is the most appropriate model to use [(An Ordinary Least Squares (OLS) model would be inconsistent and biased toward zero (Greene, 2003). LIMDEP uses the OLS values as starting values for the Maximum Likelihood iterations).].

The results of the Tobit model for striped bass are presented in Table 7. The model suggests that willingness-to-pay is significantly affected by several variables: the number of years the respondent has fished in tidal water (NUMBSALT), the number of days per year the respondent fishes coastal or tidal waters (DYSCOAST), whether or not the respondent targets bluefish (BLUFISH), and also the respondents' age, years of education, and income. The coefficient on the number of years the respondent has fished in tidal waters (NUMBSALT) is negative, suggesting perhaps that anglers who have fished in tidal waters for many years feel more inclined to conduct such a trip on their own. This may also suggest that some anglers feel the quality of marine fisheries has declined; those anglers who have fished the longest place a lower value on the trip because they have the most experience on the river whereby they have been able to experience the decrease in quality.

The respondents' number of days fishing in coastal or tidal waters per year (DYSCOAST) has the opposite sign, suggesting that the more days anglers frequent coastal and tidal fisheries, the higher is their willingness-to-pay for a fishing day. This may initially seem to be at odds with the above result, but the survey question which gave our results for the DYSCOAST variable (number of days respondent fishes coastal or tidal waters), was asked in such a way that it captured respondents current fishing activity.

It is not surprising that those respondents who targeted bluefish placed a higher willingness-to-pay on the striped bass fishing day; bluefish and striped bass commonly inhabit the same marine areas, and are often sought after in a day trip along with striped bass.

The negative coefficient on AGE (respondent age) is consistent with our previous suggestion that those anglers who have fished in tidal waters for longer place a lower value on the fishing day because they have personally experienced the decline in fishing quality; the older the respondent, the longer they have potentially fished the fishery and the longer they have been able to observe declines (or increases) in fishery quality. While statistically significant, the coefficient on respondents' income (INCM) is close to zero. The variable (EEL) which represents whether or not respondents targeted American eels while fishing in Maine, is not significant. This variable was originally included in the regression with the thought that some striped bass anglers may also target American eels for use as bait. Our respondents' years of education (EDUC) is also statistically insignificant.

Willingness-to-pay for a full day Atlantic salmon trip is also effected by a number of variables (Table 8). It is interesting to note that the variables NOYEARS and NUMBSALT (the number of years the respondent has fished in fresh and saltwater in Maine,

TABLE 7. Tobit Model for Striped Bass.

Dependent Variable		WTP Striped Bass
Maximum likelihood estimates		
No. of observations		426
Log likelihood function		−2429.821
Threshold values for the model		
Lower 0.0000		Upper + Infinity
LM Test [df] for Tobit		20.999 [8]
ANOVA-based fit measure		0.126291
DECOMP-based fit measure		0.127949
Variable	**Coefficient**	**SE**
Constant	70.8529	54.1802
NUMBSALT	−1.2915	0.5011**
DYSCOAST	1.5609	0.3664**
EEL	8.2430	24.9478
BLUFISH	29.8330	15.5275*
AGE	−1.2959	0.6708*
EDUC	8.6240	3.0944**
INCM	0.0006	0.0003**

*Significant at 90% CI.
**Significant at 95% CI.

TABLE 8. Tobit Model for Atlantic Salmon.

Dependent Variable		WTP Atlantic Salmon
Maximum likelihood estimates		
No. of observations		409
Log likelihood function		−2404.792
Threshold values for the model		
Lower 0.0000		Upper + Infinity
LM Test [df] for Tobit		29.560 [11]
ANOVA-based fit measure		0.131453
DECOMP-based fit measure		0.133091
Variable	**Coefficient**	**SE**
Constant	104.1973	70.5411
NOYEARS	0.7243	0.6973
NUMBSALT	−1.8720	0.6774**
RIVERDYS	0.6563	0.394*
DYSCOAST	1.6073	0.3945**
BKTROUT	7.2742	31.1545
BNTROU	33.6020	20.9434
LANDSAL	−4.7688	22.4166
AGE	−1.8925	0.7891**
EDUC	8.4922	3.4201**
INC	0.0008	0.0003**

*Significant at 90% CI.
**Significant at 95% CI.

respectively) have coefficients with opposite signs. Our responses show that the number of years a respondent has fished in freshwater positively affects willingness-to-pay, while the opposite is true for the number of years the respondent has fished saltwater in Maine. Atlantic salmon is anadromous, living in saltwater but spawning in fresh and thus are a fish species targeted recreationally in freshwater. Therefore, it makes sense that anglers fishing longer in freshwater would, on average, hold higher values for the trip.

Both the variables RIVERDYS and DYSCOAST (days the respondent fishes rivers and coastal/marine waters per year) have positive, significant coefficients. It seems that anglers who fish generally more often, place a higher value on the theoretical Atlantic salmon fishing trip. This may be due to a number of factors, but we feel there is a great interest in the Atlantic salmon fishing trip. As of the date of this survey, there had not been a recreational fishing season for this species since 1999.

None of the three variables that represent whether or not respondents target brook trout, brown trout and landlocked salmon (BKTROUT, BNTROU, and LANDSAL, respectively) are statistically significant. Since the Atlantic salmon fishery has been closed since 1999, it may stand to reason that anglers' willingness-to-pay responses hold very little correlation to the salmanoid species they target currently.

The three demographic variables in this regression, age, years of education, and income (AGE, EDUC, and INCM, respectively) are all statistically significant at the 95% confidence interval. Most interestingly, we found respondents' age to be negatively correlated to Atlantic salmon willingness-to-pay. Again, since the opportunity to fish for Atlantic salmon has not existed for at least seven years, it may be that only the older anglers, who remember this experience, place a higher value on the trip than younger anglers.

Model results for a full-day brown trout fishing trip are presented in Table 9. Not surprisingly, the coefficient for the variable BNTROU (whether the respondent targets brown trout or not) is positive, great in magnitude, and also significant at a 95% confidence interval. However, the coefficient for the variable SMBASS (whether the respondent targets smallmouth bass or not) is not significant. It seems that respondents who target coldwater species (trout) may either not target warmwater species such as smallmouth bass or it could simply mean that targeting a warmwater species is not a determinant of willingness-to-pay for a coldwater species.

Another interesting observation from the brown trout estimate concerns the number of years respondents have fished fresh water in Maine, and also their age. It seems that respondents who have been fishing fresh water in Maine longer, and who are older place, on average, less value on the brown trout fishing trip; both variables (NOYEARS and AGE) have negative, significant coefficients. While it is hard to give an exact reason for this (perhaps respondents who have fished longer have less desire or need for a guide), the consistency in the data (anglers who are older have most likely fished longer) is evident (many respondents omitted the smallmouth base WTP question, so we have not presented those results here).

Finally, Table 10 presents the descriptive statistics for the willingness-to-pay for a saltwater license. Respondents were asked to report whether or not they would purchase a saltwater fishing license, were one to become necessary, and if so, how much they would be willing to pay for it. A number of respondents wrote comments with respect to this question, perhaps because they believed the survey may influence policy makers. While not currently the case, the comments do shed light on the strong feelings anglers

TABLE 9. Tobit Model for Brown Trout.

Dependent Variable		**WTP Brown Trout**
Maximum likelihood estimates		
No. of observations		528
Log likelihood function		−2798.131
Threshold values for the model		
Lower 0.0000		Upper + Infinity
LM test [df] for Tobit		23.325 [8]
ANOVA-based fit measure		0.074444
DECOMP-based fit measure		0.077501
Variable	**Coefficient**	**SE**
Constant	77.1271	56.7165
NOYEARS	−0.8313	0.4794*
RVRSTRMS	0.1772	0.3278
BNTROU	44.7974	16.2396**
SMBASS	5.1481	14.5739
AGE	−2.2833	0.6651**
EDUC	7.3277	3.0208**
INC	0.0009	0.0003**

*Significant at 90% CI.
**Significant at 95% CI.

TABLE 10. Willingness-to-Pay for a Saltwater Fishing License.

Respondent Willingness-to-Pay Statistics for Hypothetical Saltwater Fishing License	
n = 551	
Respondents would purchase	74.49%
Respondents would not purchase	24.51%
Average WTP	US$25.36
Max WTP	US$500.00
Min WTP	US$5.00
WTP SD	US$31.79

have with respect to the concept of a saltwater fishing license. Some respondents were so opposed to the idea that they were emphatic in their "No" responses, while other respondents were very much in favor of the idea. As such, we simply report the descriptive statistics here.

Approximately, three quarters of our sample said they would purchase the license. However, it should be noted that some of these "Yes" responses included comments indicating that the respondent would purchase the license only if it were made law. Average willingness-to-pay for the saltwater license was US$25.36, which is very close to the cost of a 2006 freshwater license (US$22.00).

DISCUSSION

The Edwards Dam on the Kennebec River, which was breached and removed in 1999, was the first major dam to be removed in Maine. Since removal of the dam, anadromous fish, including Atlantic salmon, have returned to the river above the dam site. Aquatic insect populations are growing dramatically. Recreation on the river in the form of fly fishing, canoeing, and kayaking has also grown. However, little has been done in the way of post-project research or monitoring. The project has been deemed successful by most observers, but without formal evaluation, few objective measures of "success" are possible.

Removal of the Edwards Dam is part of a long-term effort of restoration and recovery of Maine's rivers dating back to before the passage of the Federal Water Pollution Control Act in the early 1970s. Indeed, the benefits of dam removal or fish passage for the dams that remain support and are contingent on long-term improvements in river condition. Removal of Edwards Dam would not have led to significant fisheries improvement a generation ago, because water quality conditions in much of the Kennebec were unable to support a healthy fishery.

The need for better post-project monitoring and social-economic evaluation of aquatic restoration projects is becoming widely recognized. These shortcomings will become increasingly apparent as more and more dams outlive their useful lives and come up for relicensing, both in Maine and across the nation.

Our survey was partially designed as an *ex post* analysis to estimate the economic benefit of the post-Edwards Dam Kennebec River fishery. In addition, however, the results also yield significant information regarding the general angler activity in Maine, angler perceptions of the post-dam fishery, and fishing activity in the lower Kennebec River from the Milstar Dam in Waterville to Chops Point on Merrymeeting Bay. We find sizable positive economic impacts of this restored recreational fishery.

While we are unable to make direct comparisons to the *ex ante* results, our study still provides valuable information on the *ex post* fisheries expenditures and benefits. In fact, in some respects our results may suggest underestimates as this particular group rarely if ever hires guides to fish locally.

The results of this study support the work conducted prior to dam removal and offer policy implications for other areas considering relicensing or removal. As river restoration efforts gain national attention and more dams come up for relicensing, these types of analyses will be increasingly important. Interestingly, the Ft. Halifax Dam, on the Sebasticook River near its confluence with the Kennebec River (Figure 1), has been undergoing litigation on removal for 8 years. Ft. Halifax Dam was breached and removed in the summer of 2008. Two dams on the Penobscot River have the potential to be removed under the Penobscot River Restoration Agreement with a fish bypass built around a third dam (www.penobscotriver.org). The Penobscot Project, if successful, will free up 1,000 fish miles for anadromous species including the endangered Atlantic salmon, while maintaining 90% of the hydropower production on the river. Two dams on the Sandy River in Oregon are scheduled for demolition later this year. Estimation of the fisheries benefits are crucial to these types of agreements and will be the focus of future research. Additionally, *ex-post* monitoring should be a part of all project analysis.

Interestingly, while our survey captured use-values for anglers, these numbers can still be considered underestimates of the total benefits of the restored river. Estimation of the nonuse values of the fishery remains for future study.

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