Using Willingness-to-Pay Surveys When Assessing Dam Removal: A New Hampshire Case Study

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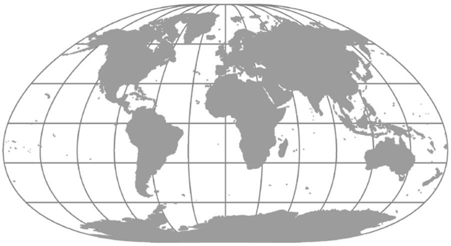

ABSTRACT

As dams in the United States age and become obsolete and river restoration emerges as a new priority, dam removals have increased. Feasibility studies serve to detail the costs and benefits of such proposed dam removals; however, most do not consider intangibles such as the benefits derived from reconnecting seasonal fish habitat or improving the biological diversity within a river. In this research, a willingness-to-pay survey was used to assign a monetary value to intangible goods associated with the proposed removal of an historic dam on the Ashuelot River in southwestern New Hampshire. Within the town where the dam is located, we administered an intercept survey in order to document environmental, historic, and existence values associated with the dam. Results indicated that the environmental benefits of removing the dam, such as improving water quality and restoring fish populations, were highly valued by surrounding community members, while historic and existence values associated with keeping the dam were significantly lower. The results from this analysis provide further support for removal of this dam.

Key Words: dam removal, New England, willingness-to-pay survey, cost-benefit analysis, New Hampshire

INTRODUCTION

The era of dam construction in the United States has effectively ended and has given way to a deconstruction movement in which an increasing number of dams across the county are being targeted. Following a century of dam construction which peaked in the late 1960s, dam owners and managers in the 1990s found themselves facing safety and related cost issues associated with maintaining aging structures. As these concerns surfaced, a collective call for river restoration from researchers, government resource agencies, and non-governmental organizations such as American Rivers, began in earnest. As a result, dam removal emerged as an acceptable river restoration technique in the late 1990s (Lowry 2003).

Across the country, dams are being removed, restoring hundreds of free-flowing miles in our rivers. Over 750 dams have been removed in the United States, over 200 of these since 1999 (American Rivers 2010). Since the highly-publicized and controversial removal of the Edwards Dam on Maine's Kennebec River in 1999, dam decommissioning and removal has become an increasingly viable option for those who wish to address the environmental damage associated with decades of structural alterations to our rivers. The Edwards Dam removal was a watershed event, the first notable relicensing decision in which the Federal Energy Regulatory Commission supported ecosystem values over limited hydroelectric power values (Grossman 2002).

As more dams have aged, they have clearly become less financially viable. Aging dams have escalating repair and maintenance costs, while at the same time becoming more limited in their ability to provide benefits such as hydropower, water supply and/or flood control. As the structures diminish in value to the owners, routine repair and maintenance activities are often discontinued. In the absence of such routine maintenance, some dams become safety hazards to surrounding communities. This has coincided with increased understanding and acknowledgement of the environmental harm created by these structures and the possible ecological benefits associated with their removal. While safety concerns propelled the majority of dam removals in the 1970 and 1980s, during the 1990s a shift occurred toward dam removals for environmental reasons. Indeed, during the 1990s, environmental rationales provided the primary support for 47 percent of the removals that occurred (Pohl 2002).

A growing body of research over the last decade has documented the ecological benefits of dam removal (Bednarek 2001; Gregory, Li, and Li 2002; Doyle, Harbor, and Stanley 2003; AASHTO 2005; Burdick and Hightower 2006). At the Waterworks Dam on the Baraboo River in Wisconsin, for example, native fish returned to the stream and expanded their numbers within two years of the dam's removal, while non-native fish decreased (Francisco 2004).

While initial reports are positive, much work remains when it comes to establishing a clear picture of all costs associated with the loss of a dam and the benefits generated by the restoration of a free-flowing river. Much less is known about perceptions of individuals who live in the area surrounding a dam regarding the impact of a removal, and how those perceptions translate into values that can be integrated into a routine cost/benefit analysis (Johnson and Graber 2002). When decisions are made to remove a dam, questions often surface regarding their continued value to society. What intangible values (such as the values derived from reconnecting seasonal fish habitat, improving the biological diversity or restoring the natural aesthetic conditions of the river) do individuals who live in the communities surrounding the dam hold that have little to do with the structure's utilitarian services? Likewise, are there costs or benefits that the surrounding communities will bear from allowing the dam to remain? Economic assessments guiding removal decisions should attempt to incorporate these intangible societal values, yet they rarely do (Heinz Center 2002; Whitelaw and MacMullan 2002). Both public and private organizations working to secure the removal of obsolete or ecologically damaging structures from our nation's waterways acknowledge the importance of securing public input when making decisions (Johnson and Graber 2002). While studies have highlighted the importance of the inclusion of societal perceptions, a larger question remains over the best techniques available to systematically incorporate these views into a cost/benefit analysis on a dam slated for removal. (Baish, David, and Graf 2002; Sarakinos and Johnson 2003). In short, how can we best quantify social values when conducting a cost-benefit analysis on a proposed removal?

This article examines and quantifies perceived community values, expressed through a willingness-to-pay survey, for the Homestead Woolen Mill Dam (HWMD) in the Ashuelot River located in the southwest corner of New Hampshire (Fig. 1). Like numerous dams in New England, the HWMD is old, small, and no longer produces hydropower benefits for its owner. Its removal was originally proposed in 1997 when a state inspection declared the structure to be in poor condition and a potential safety hazard. Additionally, the owner determined that the cost to repair the dam was larger than the cost of removal (NHDES 2008). Despite early state-level support for removal, the required state permit was placed on hold due to concerns expressed by individuals and local officials in the town surrounding the dam. In response to these concerns, the state hired an independent firm to produce a removal feasibility study. Within the feasibility study, the firm presented four plausible options for the dam to the local community for consideration. While the feasibility study accounted for numerous costs and benefits associated with the four outlined options, it did not include the costs and benefits perceived by local community members from these options. This article presents the results of a willingness-to-pay (WTP) survey designed to value and include intangible community benefits and losses resulting from the alternative proposed options outlined in the original feasibility study. By incorporating these values into the analysis, a more complete assessment of the true costs and benefits of this dam removal can be made.

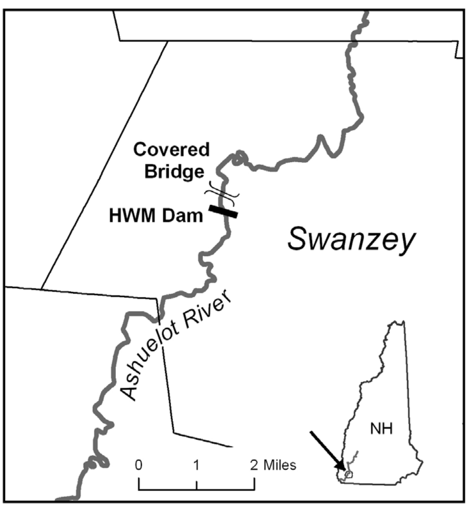

Figure 1. Map of the Homestead Woolen Mill Dam. Cartography by Chris Brehme, March 2010.

VALUING DAM REMOVAL INTANGIBLES USING THE CONTINGENT VALUATION METHOD

The cost of dismantling small dams has often proven to be lower than the cost to reconstruct and maintain these structures (Born et al. 1998; Trout Unlimited 2001). While most repair cost estimates for small dams are three to five times higher than the cost of removal, some have been more than ten times the costs of removal (Graber 2003). In an era when aging infrastructure has created public safety vulnerabilities, governments are also facing large declines in public fiscal resources. As a result, dam removal has emerged as an increasingly fiscally prudent choice. Rebuilding, repairing, and/or retrofitting dams have very high initial costs and are therefore often assumed by those involved with the decision to removal dams to be the least cost-effective option when a dam no longer produces benefits to society. However, would certain community values, if present and quantifiable, change the evaluation? For example, a dam that was constructed decades prior may also have historic and cultural value to the local population in the community surrounding the dam. Such values, if quantified and incorporated into a cost-benefit analysis, have the potential to affect final decision making.

Quantifying all the costs and benefits of a dam removal has proven to be difficult. Smith (2006) defined five challenges confronting economists attempting to place dollar values on the costs and benefits of a removal. These involve the uncertainty surrounding the changes in a river after a removal, the non-market nature of these changes, externalities that may be present (e.g. improvement of the river for whitewater recreation such as kayaking would represent a positive externality; a negative externality would be when property owners upstream of the dam are left with barren land when the reservoir is lost); the time frame for river recovery after the disturbance, and how best to structure the analysis to provide an overall evaluation.

Several valuation techniques have emerged in order to compute the value of community benefits, including travel cost analysis, unit day analysis, hedonic property valuation and the contingent valuation method (Walsh 1986). The travel cost method utilizes surveys to ascertain the amount of money people would pay to travel to the recreational area as a gauge for the value of the resource. The unit day method computes community benefits by defining the value per day of recreation and multiplying that value by the number of recreation days per year at a site. Another approach used to examine the value of various components of environmental quality and how those components relate to property values is the hedonic property valuation method (Leggett and Bockstael 2000; Poor, Pessagno, and Paul 2007). Hedonic analysis shows potential for computing costs and benefits of some removal decisions, specifically decisions that involve concerns over changing property values (Lewis, Bohlen, and Wilson 2008; Provencher, Sarakinos, and Meyer 2008).

Finally, the contingent valuation method is used to assess the value of defined intangible goods. A primary means of evaluating these intangibles is through a willingness-to-pay survey (WTP). First used by Davis (1963), a WTP survey allows the researcher to quantify respondents' stated preference for what they would be willing to pay to gain the benefits or avoid the costs of a specific outcome (Freeman 1993). One of the advantages of using the contingent valuation method is that it can be applied to many different intangible goods, such as recreational value, preservation value, resource quality improvement value, and existence value (benefits derived from simply knowing a resource exists). Indeed, contingent valuation is the only method that is capable of assigning benefits to so many somewhat intangible variables.

One of the most important considerations for a WTP survey is the need to make the hypothetical questions as real as possible to avoid inflated or deflated values (Carson and Mitchell 1993; Loomis 2006). Respondents need to feel that the situation proposed is reasonable, and that all other participants will be held to the same fair market rules so as not to encourage the 'free rider effect' of assuming a neighbor will pay for your enjoyment. To mitigate this effect, the survey questions need to explicitly state that the only way to gain the benefit of the resource is to pay, and failure to pay will result in a loss of the resource.

Selection of a payment vehicle is arguably another critical consideration in designing a WTP study. The payment vehicle is the method which respondents will be expected to pay for the resource, e.g. a tax, fund, or donation. This is a very sensitive portion of the survey, since people may be biased toward various payment vehicles and thus let their sentiments affect their stated WTP amounts. The use of a tax generally deflates WTP values due to a general negative perception of taxes among the public. Donations, on the other hand, sometimes inflate WTP values because people assume they can decrease or entirely cut off the donation at any time if they so choose. For these reasons, use of a community fund is generally favored to minimize payment vehicle bias among survey respondents.

THE HOMESTEAD WOOLEN MILLS DAM

New England has more dams per square mile than any other part of the country and is one of the leading regions in dam removal (Lindloff 2003). Dams in New England are particularly good candidates for removal since many are old (a number of which were originally constructed in the 1800s), small (less than 50 feet in height), and no longer produce significant utilitarian benefits (such as hydropower) demanded by the existing owners. These older and smaller dams are also better candidates since removal costs tend to be lower than repair or rebuilding costs. Likewise, dams that do not provide hydroelectric power or other utilitarian benefits, such as milling, irrigation, or provision of water supply, present a stronger case for removal since they no longer offer tangible benefits.

The Homestead Woolen Mill Dam (HWMD) in Swanzey, New Hampshire, is a small, privately-owned dam on the Ashuelot River (Fig. 2). The Ashuelot is a sizable tributary of the Connecticut River. The HWMD is approximately 167 feet long and 12 feet high. It has only a minor impact on the Ashuelot River's flow for approximately 3.5 miles upstream by creating a long, narrow impoundment with a storage capacity of 158 acre/feet and an average depth of 3.5 feet (VHB 2005). Forty-five acres on average are submerged by the dam's reservoir.

The HWMD is not a flood control facility, since the river's flow spills over the dam when the small impoundment behind the structure fills. Originally built as a timber-crib dam in the 1860s, it was rebuilt as a concrete structure in 1910 (Marcoux et al. 2007). In its early history, this facility provided hydropower to mills located along the Ashuelot River. Presently, it is not being used in this or any other utilitarian capacity and has been partially breached as a result of years of neglect. After a safety inspection in 1997, New Hampshire's Dam Bureau designated the HWMD as a low or "Class A" hazard, meaning that a failure would not normally result in loss of life but would result in minimal economic loss and damage to surround-

Figure 2. Photograph of Homestead Woolen Mill Dam. Photograph by Adam Marcoux, October 2006.

ing roads. This is the lowest of three hazard classes used for dams.

Following the failed safety inspection, the private owner petitioned the state for a removal permit. This proposal was, in turn, supported by several state and federal natural resource agencies as well as conservation groups such as the Connecticut River Watershed Council and American Rivers. The New Hampshire Fish and Game Department, in their 1998 Ashuelot River Restoration Plan designed to enhance habitat for native fish populations, fully supported this dam's removal. An environmental assessment conducted on the Ashuelot River found that the segment occupied by the HWMD provided suitable habitat for native American shad, blueback herring, and Atlantic salmon. Because the dam bisects suitable spawning and nursery habitat for these species, native fish restoration requires either dam removal or the construction of a suitable fish passage structure to allow fish migration between their hatching and rearing habitat and their adult habitat (VBH 2005). In sum, removal of the HWMD would restore access to 27 miles of stream for these species.

Despite potential ecosystem benefits, the initial proposal for removal of the HWMD did not stem from a desire to restore fish populations. As noted, the private owner of the dam petitioned for a removal permit in the late 1990s when a routine state inspection showed severe structural and potential safety problems that required repairs. When the initial repair costs were considered, removal became the least costly option for the owner. A number of community members, however, viewed the issue differently and began to voice opposition to the proposed removal (Marcoux et al. 2007). First, resistance to the removal centered on the perceived potential negative impact on the preservation of an historic covered bridge (built in 1832) located less than a mile upstream. The primary concern was that an increase in water velocity following the dam's removal would cause scouring of the Thompson Covered Bridge's substructure. Second, the community was concerned that the removal would lower groundwater levels and negatively affect four wells in the dam's reservoir riparian area. Another articulated concern was for the potential loss of species now occupying the floodplain and the shallow reservoir of the dam. Residents also expressed concerns over the potential loss of the dam's impoundment and thus the amount of water available in the community for both firefighting and recreation (VHB 2005).

Primarily for these reasons, a feasibility study was commissioned by the New Hampshire Department of Environmental Services, the National Oceanic and Atmospheric Administration, the town of Swanzey, the U.S. Fish and Wildlife Service, and the New Hampshire Fish and Game Department. They hired a private firm, Vanasse Hangen Brustlin (VHB), in 2003 to determine the possible associated costs and benefits resulting from the proposed removal. The firm, in collaboration with the New Hampshire Department of Environmental Services, held a series of community meetings to solicit public input. The feasibility study, completed in March 2005, outlined four alternative options and offered recommendations for the dam. While all options were considered, the analysis concluded that dam removal would be the most beneficial and least costly choice. Following a series of public informational meetings in 2005 and 2006, the dam owner in cooperation with the New Hampshire Department of Environmental Services Dam Bureau agreed to move forward with a design to remove the dam.

WILLINGNESS-TO-PAY SURVEY METHODOLOGY

In the case of the HWMD, the benefits from removal outlined in the feasibility study, were projected to be mainly non-recreational environmental benefits. This study found that in addition to eliminating the dam as a safety hazard, its removal could result in improved water quality and habitat for native fish species.

The contingent valuation method was selected for this research since it can be used to estimate both use and non-use values. The unit day and travel cost approaches were not applicable given that both rely on the recreational use value of a resource. We therefore designed a seventeen-question WTP survey to value social and environmental goods not previously considered in the feasibility study. Social and environmental goods valued in our study include the removal's impact on fish restoration, archaeological artifacts, water quality, hazard reduction, historical district status, and endangered species. These are key social values which emerged in the community forums during the completion of the original feasibility study.

To minimize confusion and ensure that each participant understood the survey guidelines, we administered the WTP surveys face-to-face. Intercept surveys were given outside a Swanzey polling booth on both the primary and final election days, and at the town recycling center in the fall of 2006. These locations were selected to specifically target residents of Swanzey, the focus community in this study.

We began each survey by providing the participant with background information on the Homestead Woolen Mills Dam and the proposal to remove the structure. We also described the payment vehicle, a community fund into which respondents would pay a certain amount yearly. After this information was given, we gathered the respondents' basic socioeconomic data. Next, we presented four detailed questions to determine participants' willingness to pay for: 1) reducing the safety risk associated with the dam; 2) improving fish passage; 3) improving river habitat; and 4) improving water quality. These were followed by a question which involved respondents' WTP for restoration of habitat for the federally-endangered dwarf wedge mussel. Participants were then questioned about their WTP for protecting archeological resources and for ensuring the town of Swanzey's continued historic district status. The last portion of the survey centered on the recommendations made by the feasibility study to remove the HWMD. Respondents were asked to indicate whether they supported dam removal or rebuilding the dam with a fish passage structure and to state their WTP for their preferred action. While two rebuilding schemes were presented in the feasibility study, both included alterations for fish passage. We decided it might prove difficult for respondents to differentiate between these two rebuilding schemes and, as a result, respondents were asked only to state WTP to rebuild the dam with fish passage.

When administering the survey, a complication emerged over the payment vehicle. It was clear that some respondents assumed the payment vehicle was a tax, even though they were informed it was a community fund. This perception may therefore have lowered stated WTP values. It was also noted that the reported household income for our survey respondents was significantly higher than for the average household income reported in the 2000 Census. This difference needs to be factored in when considering the WTP values in relation to average stated household income (as a percentage). If income was inflated, this means the respondents were willing to pay a higher percentage of their actual income for the resources evaluated in this study.

There were other obstacles that presented challenges to the study. The purpose of using this WTP survey was to monetize community benefits that were not included in the original feasibility study. However, an issue that was not addressed in this study was the potential impact of dam removal on the upstream historic covered bridge (Fig. 2). The Thompson Covered Bridge is a well-known historic structure in the local area (NHDES 2008). While originally considered to be threatened by the proposed dam removal, engineering studies undertaken prior to and as part of the feasibility study revealed that the center pier of the bridge was already structurally compromised (VBH 2005). While the feasibility study concluded that removal of the dam might speed up the scouring process around the pier, it also stated that the bridge required repairs regardless of the fate of the dam. Therefore, this issue was not included in our analysis. However, this is an issue that was mentioned by a few of the survey participants and may have impacted stated support for removal.

Another cost not captured in this study was the perceived threat to nearby wells. The feasibility study outlined four wells in the area around the dam's reservoir that could be negatively affected by the removal. Of these four wells, the state only found two to actually be vulnerable to a reservoir draw-down resulting from this dam's removal. Because very few community members would be affected by a change in these wells, this issue was not included in this analysis.

RESULTS

We administered 104 surveys but discarded 18 because of payment vehicle interference or because the participants were unwilling to complete the survey. This left a total of 88 surveys for analysis. We then totaled all of the WTP amounts and expressed them as a percentage of the respondents' income. The extreme outliers were then deleted, leaving 86 surveys for further analysis. It is not uncommon in WTP surveys for participants to make promises for exorbitant amounts since they are presented with a hypothetical situation and they do not intend to actually pay. While all effort was taken to create a realistic scenario for the survey participants, respondent bias and as well as their expression of inflated WTP amounts were two of the many challenges presented by using the contingent valuation method. Looking at the total WTP for each participant as a percentage of their household income helped to pinpoint these inflated WTP values so they would not cause error in the overall WTP analysis. After we omitted the two outliers (with values of 13.3 and 7.8 percent of given income), the remaining highest WTP value as a percentage of given income was 4.1 percent, and the lowest was 0 percent. The mean total WTP as a percentage of income for all 86 respondents was .59 percent.

The overall annual household income mean was $68,630, with the reported median household income for the survey participants being $62,500. This is significantly higher than the stated 2000 Census median household income of $44,800 for the town of Swanzey. It is possible that this survey captured more affluent Swanzey residents, especially since a large percent of the surveys were administered at a town polling booth. Studies generally find that those who vote tend to have higher average household incomes (Filer, Kenny, and Morton 1993). However, it is equally likely that people simply overstated their actual income. If true, the inflated incomes given make the WTP as a percentage of income appear smaller than it may actually be.

We then examined a series of independent variables for their influence on stated WTP amounts. These included respondents' socioeconomic variables, awareness of HMWD issues, attendance at the public HMWD forums, and use of the river and land surrounding the dam. A least-squares regression analysis was used to determine these independent variables' relationship to the WTP amount stated by the respondents (Table 1). For this regression, the mean for each independent variable was used. Results from this analysis indicated that the overall fit of the regression to the data was very poor, exemplified by an adjusted R-square value of .05 (this value should be equal to 1 in the best possible regression fit). This illustrates that in this case, socioeconomic variables and the respondents' knowledge about the proposal of the dam removal had little impact on expressed WTP values.

The t-statistic and P-value are also displayed in Table 1. The t-statistic is the estimated coefficient divided by its own standard error. It is a measure of how many standard deviations from zero the estimated coefficient is and thus is used to test that the value of the coefficient is non-zero, in order to confirm that the independent variable has a significant relationship to the dependent variable. When an independent variable's

Table 1.Willingness-to-Pay Regression Analysis

Regression Statistics	
Multiple R	0.36413933
R Square	0.13259745
Adjusted R Square	0.05475363
Standard Error	483.335899
Observations	86

	Coefficients	*Standard Error*	*t Statistic*	*P-value*
Intercept	147.11376	227.1602448	0.647621	0.519132
Gender	8.46292187	112.214939	0.075417	0.940076
Town of Residence	-36.259409	112.6738031	-0.32181	0.748458
Income	0.00455011	0.001639429	2.775423	0.006898
Age	-1.7327748	3.818062073	-0.45384	0.651207
Awareness of HWMD Issues	-26.440378	129.6013465	-0.20401	0.838875
Attendance at HWMD Meetings	-159.69522	201.0376383	-0.79435	0.429399
Use of area around HWMD	6.36535567	3.115941756	2.042835	0.044447

t-statistic is less than 2, it is only "accidentally" significant, and thus has no impact on WTP amounts stated by the respondents. A positive t-statistic over 2 indicates that the independent variable increases the total WTP amount (a negative coefficient shows that the variable decreases the total WTP amount).

All independent variables had t-values less than 2 except for income and current use of the area surrounding the dam. The analysis shows that income had a positive impact on stated WTP (the higher the income, the greater the stated WTP). Also, survey respondents who used the area around the dam were more likely to state a higher WTP. Respondents' household proximity to the dam, age, awareness of the proposal to remove the dam, and attendance at a public meeting where the dam removal was discussed all produced negative coefficients (decreased stated WTP), although these variables were not statistically significant. We initially assumed that awareness about the proposal to remove the dam and attendance at a meeting held where the HWMD issues were discussed would increase a respondent's stated WTP value. However, this was not the case as these variables were not significant in influencing expressed WTP amounts. While not explored in this study, tax increases to pay for the removal were discussed in the informational meetings and could have negatively colored opinions and WTP amounts.

Prior to running the regression analysis, we also expected that respondents who resided in the area surrounding the dam would result in higher expressed WTP values. This was not the case from data generated in the study as this variable was not significant in impacting WTP. Instead, it was the respondents who used the area, regardless of their resident proximity to the dam, who articulated statistically significant higher WTP values. Nevertheless, all the variables analyzed in Table 2 did little to explain expressed WTP values.

Once these factors were explored, we identified the highest and lowest resource categories (as stated by WTP). Table 2 shows the mean and median for each WTP category. These values are important because they help to determine which proposed option would be most cost-effective. Hazard reduction was the category with the largest mean WTP value. The average value respondents gave was $87.92 to reduce the dam-related safety hazard to the community. This was $8.59 more than the next valued category of support for water quality improvements ($79.33). The average WTP for funds to support fish restoration ($67.15) and dam rebuilding ($62.78) were the next two categories of highest value.

The median values, however, display a different ranking for the categories. The medians show hazard reduction ($20) to be significantly less in stated value than fish restoration ($50) and water quality ($40). The median WTP value for improving the habitat for the endangered dwarf wedge mussel was the lowest ($3) with archaeological resource and historic values only slightly higher ($5 each). Lockwood, Lomis, and DeLacy (1993) argue that while mean values are most suitable for use in CVM analysis from an economic efficiency standpoint, the median values are most appropriate when assisting in democratic decision-making around public goods. Given that our analysis is geared toward assisting a public decision-making process around a dam removal, we selected to use median values when calculating total WTP amounts for the options of: removing the dam, rebuilding the dam with fish passage or doing nothing and allowing the existing dam to remain.

We then totaled the appropriate median values for the options of: 1) removal; 2) rebuilding with a fish bypass structure; and 3) doing nothing and allowing the dam to remain. To determine the WTP for the removal option, the median values for hazard reduction, fish restoration, water quality, dwarf wedge mussel and archaeological resources were totaled. This translated to $118 per household per year for the removal option.

For the rebuilding option, the median values for hazard reduction, fish restoration, historic values and the additional median WTP amount of $10 respondents gave to rebuild totaled $85 per household per year. If a decision were made to 'do nothing' and simply allow the dam to remain, the benefits become more complicated. This option initially results in "historic" benefits. However, when (or if) the dam fails, then benefits will be eventually be accrued in the areas of water quality, fish restoration, dwarf wedge mussel habitat, and potentially uncovered archeological resources. The 2000 Census reported

Table 2.WTP Category Means and Median Values

	Hazard Reduction	Fish Restoration	Water Quality	Dwarf Wedge	Archaeological Resources	Historic	Rebuilding	Removal
mean	$87.92	$67.15	$79.33	$27.75	$37.55	$24.63	$62.78	$38.51
median	$20.00	$50.00	$40.00	$3.00	$5.00	$5.00	$10.00	$0.00

2,666 households in Swanzey; therefore, totaled value for each is multiplied by 2,666 to come up with the total WTP for the town of Swanzey for each option annually.

Table 3 exhibits the values economically discounted to bring them into present worth for each option: removing the dam; rebuilding the dam with fish bypass; or doing nothing with the resultant dam failure within a 5, 10, 20, 30 or 40-year period. The expiration year represents the number of years into the future the benefits are extended. The most cost-effective option, dam removal, does not change as we move into the future. Benefits of removal do, however, increase significantly the farther into the future we project. Calculating the values for the 'do nothing' option was complicated by the fact that more benefits will accrue after the dam fails. The feasibility study estimated that the dam is likely to fail within 5-10 years (VGH 2005). When the failure occurs, there would be a significant shift toward more benefits for the removal option and less cost. To account for the possibility that the dam might not fail in the estimated timeframe (5-10 years), values for dam failure in 20, 30, and 40 years are also included in this analysis. Looking 50 years out gives a good understanding of what option is the most cost effective, and we can see that the front runner does not change in future years.

Table 4 demonstrates the percent difference between the option of rebuilding with a fish bypass channel and the removal option for future years. Both initially and into the future, the analysis shows that removal is more cost-effective than rebuilding the dam with a fish passage structure. However, the difference between the cost comparison of the removal option and the option to rebuild diminishes as we move into the future.

CONCLUSIONS

This study, through the use of the contingent valuation method, incorporated several intangible values in a cost-benefit analysis of a proposed dam removal. After quantifying and including these values, removal of the Homestead Woolen Mills Dam produced the most cost-effective outcome. In this particular dam removal case study, adding previously ignored community values did not change the results of the earlier feasibility studies' cost-benefit analysis and recommendations. In fact, in this case the WTP values calculated strengthened the economic argument made for dam removal. Additionally, this finding held up regardless of the removal timeframe. This may not be the case for every dam removal decision. For example, if respondents' perceived values for rebuilding the dam or its

Table 3. Discounted Values for WTP Benefits accrued from Different Options or Dam Failure Scenarios

Years benefits are extended	Remove The Dam	Rebuild with Fish Bypass	Do nothing: 5 year failure	Do nothing: 10 year failure	Do nothing: 20 year failure	Do nothing: 30 year failure	Do nothing: 40 year failure
10 years	$2,636,944	$1,253,948	$1,120,914	($138,334)	$119,738	$119,738	$119,738
20 years	$4,955,096	$2,923,802	$3,439,065	$2,179,818	$6,256	$217,965	$217,965
30 years	$6,856,787	$4,293,665	$5,340,757	$4,081,509	$1,907,947	$124,870	$298,545
40 years	$8,416,837	$5,417,429	$6,900,806	$5,641,558	$3,467,997	$1,684,919	$222,175
50 years	$9,696,620	$6,339,307	$8,180,590	$6,921,342	$4,747,781	$2,964,703	$1,501,958

Table 4. Removal and Rebuilding Cost Comparison

Expiration Year	Remove	Rebuild	% Difference
10 years	$2,636,944	$1,253,948	110%
20 years	$4,955,096	$2,923,802	70%
30 years	$6,856,787	$4,293,665	60%
40 years	$8,416,837	$5,417,429	55%
50 years	$9,696,620	$6,339,307	53%

historic value were higher, then rebuilding a dam could prove to be the most cost-effective option.

The best way to produce an inclusive economic assessment is by examining all removal benefits and costs perceived by the community members for a specific proposed dam removal. Each case is inherently unique; therefore, the results of a cost-benefit analysis can never be assumed before taking a deeper look into the community's view toward the resources related to the dam and surrounding landscape. Using a WTP survey to assess the social values of the community prior to a removal decision is a way to more systematically incorporate these previously neglected intangible public views into the process. A feasibility study, in addition to a contingent valuation study, can yield additional costs surrounding a dam removal and ensure that the most cost-effective outcomes are defined. As explained in this study, some of the most important benefits of dam removal can be intangible, non-use values associated with river restoration and the recovery of endangered species. It is therefore of critical importance to pursue economic analysis that incorporates these hard-to-quantify benefits, thereby enhancing understanding of their value to society.

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