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Total Economic Valuation of Stream Restoration Using Internet and Mail Surveys

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ABSTRACT

The economic value of restoring Deckers Creek in Monongalia and Preston Counties of West Virginia was determined from mail, internet and personal interview surveys. Multi-attribute, choice experiments were conducted and nested logit models were estimated to derive the economic values of full restoration for three attributes of this creek: aquatic life, swimming, and scenic quality. The relative economic values of attributes were: aquatic life > scenic quality ≈ swimming. These economic values imply that respondents had the highest value for aquatic life when fully restoring Deckers Creek to a sustainable fishery rather than "put and take" fishery that can not sustain a fish population (defined as moderate restoration for aquatic life).

The consumer surplus estimates for full restoration of all three attributes ranged between $12 and $16 per month per household. Potential stream users (anglers) had the largest consumer surplus gain from restoration while non-angler respondents had the lowest. When the consumer surplus estimates were aggregated up to the entire watershed population, the benefit from restoration of Deckers Creek was estimated to be about $1.9 million annually. This benefit does not account for any economic values from partial stream restoration.

Based upon log likelihood tests of the nested logit models, two sub-samples of the survey population (the general population and stream users) were found to be from the same population. Thus, restoration choices by stream users may be representative of the watershed population, although the sample size of stream users was small in this study.

INTRODUCTION

Acidification is a major water quality problem in the Appalachian region of the U.S. This particular region suffers the lowest average annual rainfall pH in the U.S. and is second in the world in total acid deposition. The bulk of acidification (98%) is a result of coal mining in the eastern United States (U.S. EPA, 2002). Acid mine drainage (AMD), primarily from abandoned mine lands, alone degrades almost 90% of the over 5000 stream miles that are impacted by acidification. Problems associated with AMD are the contamination of public drinking water and industrial water supplies, disrupted growth and reproduction of aquatic plants and animals, decline in valued recreational fish species such as trout, restricted stream use for recreation, and corroding effects on parts of infrastructure on bridges.

Given this need for restoration of AMD impacted streams, state and federal agency officials are struggling with issues of how to: (a) justify stream restoration within a cost-benefit framework; (b) prioritize restoration projects among the numerous degraded streams given limited budgets; (c) demonstrate the economic importance of preserving stream quality where degradation has not occurred; and (d) devise a cost efficient method of data collection for economic valuations. These concerns were expressed by representatives from the Natural Resource Conservation Service (NRCS), the West Virginia Soil Conservation Agency, the West Virginia Division of Environmental Protection (WV-DEP), the Canaan Valley Institute, and the Rivers Coalition at a Stream Valuation Workshop held in October of 2000 at West Virginia University. Since minimal research has been conducted on the total valuation of stream restoration (Farber and Griner, 2000), this research provides important information by designing and testing a combination internet and mail survey for total valuation of stream restoration.

Given these considerations, the objectives of this research were to:

- Create a survey device that allows for effective primary valuation data collection within an AMD impacted watershed;
- Determine economic values for different levels of stream restoration; and
- Estimate economic values over varying populations of users and non-users of streams in this watershed.

Stream use and non-use values from restoration were estimated using multi-attribute, choice experiments (Louviere et al., 2000). Multi-attribute choice research has been applied to other water resource situations to examine valuations of water quality (Smith and Desvousges, 1986), watershed improvement (Farber and Griner, 2000), and groundwater protection (Stevens, Barrett and Willis, 1997). With the choice and survey data acquired in this research, nested logit models were estimated and log likelihood tests were used to compare two sub-samples of the survey population: the general population and stream users represented by stream restoration activists and rail-trail respondents. Welfare estimation followed methods in Blamey et al. (2000).

STUDY AREA DESCRIPTION

This research project was conducted on the Deckers Creek watershed in Monongalia and Preston Counties of West Virginia. This 23.7 mile creek flows into the Monongahela River at Morgantown, WV. Deckers Creek has a number of contamination problems that are typical of rural Appalachia - trash in the creek, sewage, and AMD contamination. The entire length of Deckers Creek is on the 303d list established by the WV-DEP. Highly acidic conditions eliminate almost all aquatic life in the creek. In addition, there are elevated levels of sulfates, iron, aluminum, and manganese throughout the creek[1]. A $10 million restoration plan has been drafted by state and federal agencies, although funding has not yet been secured to complete this restoration.

Local interest in restoring Deckers Creek is high. There exists an active watershed association called Friends of Deckers Creek (FODC) dedicated to restoration of the stream. A recently established rail-trail along the creek provides recreational access to the creek and creates a high level of awareness about the creek among local citizens using the rail-trail. Thus, stream restoration could have significant impacts on direct use of the stream (fishing, kayaking, etc.) as well as indirect effects on the value of rail-trail recreational experiences.

To determine citizen attitudes and values about Deckers Creek restoration, three focus groups were conducted with local citizens and members of FODC during the fall of 2001. Guidelines from Krueger (1994) were utilized in conducting focus groups. From these focus groups, three important attributes of stream restoration on Deckers Creek were identified – aquatic life, swimming/wading, and scenic quality. There are linkages between restorations of each attribute. For example, correction of AMD problems would restore aquatic life and also would improve some aspects of swimming/wading. However, restoration of one attribute in Deckers Creek does not necessarily improve the other two. Correction of AMD restores aquatic life, but would not eliminate trash problems (scenic quality) and increasing the pH actually makes bacteriological problems from sewage worse for swimming/wading as a low pH inhibits bacteria growth.

RANDOM UTILITY MODELING

The estimation of economic values using a choice modeling approach was based on random utility theory (Blamey et al., 1999; Louviere et al., 2000). Based on this theory, the h^{th} respondent was assumed to receive utility U_{ih} from the i^{th} option within a restoration choice set C. Utility derived from any given choice was assumed to be a function of the stream restoration attributes of the options in the presented choice set Z_{ih}, and characteristics of the respondent S_h. U_{ih} was assumed to have a systematic, measurable component V and a random component ε_{ih}.

(1) $$U_{ih} = V(Z_{ih}, S_h) + \varepsilon_{ih}$$

In the current context, each individual h was assumed to maximize his or her utility U, by choosing the restoration option i such that the utility associated with i is greater than or equal to the level of utility achieved with any other j option in the choice set C. The probability of choosing the i^{th} option becomes:

(2) $$P(i \mid C_h) = \Pr(U_{ih} \geq U_{jh}) \qquad \forall j \in C_h$$

However, given that U was not directly observable, substituting (1) into (2) leads to:

(3) $$P(i \mid C_h) = \Pr[(V_{ih} + \varepsilon_{ih}) \geq (V_{jh} + \varepsilon_{jh})].$$

Equation (3) was interpreted to mean that the probability a respondent will choose option i is the probability that the indirect utility from i (plus some error) is greater than the utility derived from j (plus some error). If the error components ε are assumed to be identically and independently distributed (IID) as a Type I extreme value distribution, then the probability of choosing option *i* can be estimated by a multinomial logit:

$$\text{(4)} \qquad \Pr(i) = \frac{e^{V_i}}{\sum_{j \in C_h} e^{V_j}} .$$

The multinomial logit model is characterized by the property of Independence of Irrelevant Alternatives (IIA). IIA implies that the ratio of choice probabilities will be unaffected by adding or removing other alternatives. Therefore, the assumption of IID in a multinomial logit model is a direct reflection of the IIA property. In many cases IID is too restrictive of an assumption in that it does not reflect consumer behavior very well.

One way to circumvent the IIA assumption is to estimate a nested logit model (Blamey et al., 2000). Nested logit models, although more complex than multinomial logit models, allow for correlations among error terms within certain alternatives. Nested logit models also correspond better to consumer decision-making (Louviere et al., 2000). For example, the restoration alternatives are likely more similar (or correlated) to each other relative to a do nothing alternative. Therefore, utility could be decomposed into two (or more) components: (1) utility associated with not restoring versus restoring the creek; and (2) utility associated with different types of restoration alternatives conditional on choosing to restore the resource.

A two-level nested logit model was assumed in this study where a respondent initially chooses one of two branches: either restoration or no restoration. At the second choice level, respondents who have selected restoration choose between one of two options presented where restoration of stream attributes ranged from moderate to full restoration. The probability of an individual respondent choosing the i^{th} option after selecting restoration (r) was represented as:

(5) $\mathrm{P}_{ir} = \mathrm{P(i/r)\,P(r)}$

P (i/r) is the conditional probability of an individual choosing the i^{th} option after selecting to restore and P(r) is the probability that a respondent chooses restoration. Following Kling and Thomson (1996):

(6) $$\mathrm{P}\left(i/r\right) = \frac{e^{V_{ir}/\alpha_r}}{e^{I_r}}.$$

(7) $$\mathrm{P} = \frac{e^{\alpha_r I_r}}{\sum_{k=1}^{R} e^{\alpha_k I_k}}.$$

where

(8) $$I_r = \log\left[\sum_{i=1}^{2} e^{V_{ir}/\alpha_r}\right]$$

I_r is called the inclusive value and measures the maximum expected utility from the two options associated with restoration and V_{ir} is the utility of the i^{th} option from restoration. The inclusive value coefficient (α_r) measures substitutability or the degree of correlation between alternatives within a restoration branch of the nested logit tree (Blamey et al., 2000).

Based upon a general formula from Hanemann (1984), welfare estimates as compensating variation can be obtained when choice models are reduced to a single before and after policy option:

(9) $$W = -\frac{1}{\mu}\left[\ln(e^{V_{i0}}) - \ln(e^{V_{i1}})\right] = -\frac{1}{\mu}\left[V_{i0} - V_{i1}\right]$$

where μ is the marginal utility of income and V_{i0} and V_{i1} represent the indirect observable utility associated with a moderate level versus full restoration of the stream. For a single change from the Z set of attributes (z), Equation (9) reduces to $-1^* \beta_z / \mu$ when a linear in attributes and characteristics parameters utility function was estimated for V_i.

METHODS

Electronic and paper copy survey instruments were developed and pre-tested with FODC members, the general public and students at West Virginia University. Design of the electronic survey followed recommendations from Dillman (2000). Survey questions included respondent recreation behavior related to public waterways and parks, attitudes about stream restoration in general, knowledge about Deckers Creek, and the usual demographic characteristics. In the final survey instrument, four choice questions were presented to each respondent. The electronic survey was made available to access code holders at www.nrac.wvu.edu/survey/ . A copy of this survey is available upon request.

The restoration choice options provided in this survey included three options, each with three stream quality attributes and a cost attribute (represented as an increase in monthly utility bills). Based upon focus group responses and the current conditions of the targeted resource (Deckers Creek), a status quo option was provided in each choice question. This status quo option represents the current conditions of the stream where all three stream quality attributes were at low quality levels and a zero additional cost for monthly utility bills. In the other two options, stream restoration attributes were randomly assigned two levels – moderate or full.

Full restoration included creation of enhanced fishery habitat for naturally producing populations (aquatic life), the entire creek length exceeds the water quality standards for bacteria and is safe (swimming and wading), and regular removal of all trash from the stream and creek banks plus beautification of stream bank development (scenic quality). For moderate restoration, the water quality would be sufficient enough to support stocking of fish, the creek meets the water quality standards for bacteria, and there is regular removal of all trash from the stream and creek banks.

A complete factorial for the four attribute levels in the choice set results in a 2^3 x 5^1 design, or 40 possible combinations of the attribute levels. Given the relatively small size of this factorial, we did not reduce it through a fractional factorial design. All possible combinations of the attribute levels were formed and then randomized. The random combinations of alternative were screened for redundancies and inconsistencies in the choices.

Given the relatively small size of Deckers Creek, the populations most impacted by its restoration were assumed to be people living within the watershed and users of the creek and rail-trail. Within the Deckers Creek watershed, the general population was contacted via telephone and asked to participate in either a mail or an internet survey. A stratified random sample of residential telephone numbers was obtained from Survey Sampling, Inc. Calling was done by five West Virginia University students during October and November of 2002 and then in February and March of 2003. At least three attempts were made to contact each phone number. If respondents agreed to participate, a survey was either mailed to them or they were e-mailed the web site address of the internet survey[2].

To compare activist/users with the general population, additional survey data were obtained from users of the creek and rail-trail: (1) recreational users of the rail-trail along Deckers Creek; and (2) citizens committed to watershed improvements who were FODC members. Throughout July and August 2003, personal interviews of rail trail users were conducted. This survey was conducted at two locations along the rail trail. For FODC members, a solicitation email was sent during May 2003 asking them to participate in the survey. Interested respondents who replied had the internet survey information sent to them via e-mail.

Individual level data obtained from the choice modeling portion of the survey instrument were modeled using the NLOGIT 3.0 component of LIMDEP 8.0 (Greene, 2002). An alternative specific constant (ASC) variable was created to capture the mean effect of unobserved factors in the error terms for the branched equations. In particular, an ASC variable was created such that 1 = restoration alternative and 0 = no restoration alternative. ASC variables also enabled the inclusion of socio-demographic and attitudinal variables in the models through an interaction with the ASC variables. These variables also were included in the models through intersecting them with the attribute-level variables. The model explaining responses to the level of restoration differentiated potential users of the restored stream (respondents who identified themselves as anglers) from all other respondents.

Choice responses were compared for two sub-samples: (1) the general population (GP) sub-sample consisting of internet and mail surveys; and (2) the user population (UP) sub-sample from rail-trail users and FODC members[3]. Comparisons were made with a Log-Likelihood Ratio (LLR) test of whether the two sub-samples were from the same population and, therefore, could be pooled. The LLR test statistic used was $2(LLR_U - LLR_R)$ with a χ^2 distribution with degrees of freedom equal to the number of restrictions imposed in the null hypothesis. LLR_U was the log-likelihood ratio for the unrestricted model and was computed as the sum of the individual LLR's from each –sub-sample model. LLR_R was the log-likelihood ratio for the restricted model based on the pooled model. The null and alternative hypotheses for the estimated coefficients were:

H_0: $\beta_{GP} = \beta_{UP}$ (restricted model)

H_1: $\beta_{GP} \neq \beta_{UP}$ (unrestricted model)

Using the estimated coefficients from the nested logit model, welfare improvement from stream restoration was estimated following Blamey et al. (2000). Dollar value estimates were derived for the marginal utility improvement of full restoration for each attribute separately along with consumer surplus estimates for full restoration of all three attributes. These dollar value estimates were based upon an environmental improvement from moderate to full stream restoration. Consumer surplus estimates were aggregated up to the entire watershed population using U.S. Census data from 2000.

RESULTS

Surveys

For the watershed population, a total of 1716 phone numbers were called, of which 1371 were residential numbers. A sample of 584 households completed the telephone portion of the survey. A total of 387 respondents agreed over the phone to complete a survey, either mail or internet. The overall response rate for completed stream valuation surveys was 53%, slightly higher for mail surveys (55%) compared to internet surveys (51%).

A total of 50 rail-trail users and members of FODC responded to the survey. The initial plan was for all of these surveys to be completed electronically. However, all rail-trail users ultimately completed paper copies due to difficulties in using a laptop computer along the trail. Of the FODC members, only two completed the surveys electronically. The other nine respondents completed paper copies due to the server support system for the survey being "hacked" and down for a couple of weeks.

With the exception of education, all respondents had similar socio-demographics to the watershed population (Table 1). There were differences between the two sample populations: general population versus users. The majority of general population sample was female (60%) compared to only 40% of the user sample. Major differences in age were found as 73% of the users were 45 years or younger compared to 47% of the general population. Education attainment was higher for the user sample compared to the general population (67% vs. 53% with a college degree) and both were much higher than the watershed (36%). Income-wise, however, both sample populations had similar household averages between $43,000 and $44,000 annually. This average was very close to the 2000 U.S. census average of $41,000.

Responses to knowledge and attitude questions about stream restoration are presented in Table 2. The vast majority of respondents (77%) were familiar with at least the lower portion of Deckers Creek (Table 2). Overall, relatively few users (13%) were completely unfamiliar with Deckers Creek. Three-fourths of all respondents stated that there were environmental problems with Deckers Creek. Very few respondents (3%) thought that there were not environmental problems with Deckers Creek, although 22% of respondents stated they did not know of any environmental problems associated with

Deckers Creek. As expected, the user sample was more familiar with Deckers Creek environmental problems. Respondents stated the top three environmental problems associated with Deckers Creek were trash, unnatural colors, and lack of aquatic life (Table 2). Respondents perceived that the most widespread stream pollution problems in West Virginia streams were related to visual aspects (trash followed by acid and minerals) rather than mainly water quality degradation from sewage.

Nested Logit Choice Model

The variables utilized to represent the choice set Z and respondent characteristics S are shown in Table 3. Respondent characteristics included the usual socio-demographics of age, education, gender and income. Knowledge and attitude variables included respondents' perceptions of the choice questions, knowledge of environmental problems on Deckers Creek and stated importance of stream attributes to the respondents. The three stream restoration attributes were set at either moderate or full restoration and were interacted with anglers as a distinct potential user group upon restoration.

Each respondent was presented with four choice sets. Given missing values, the nested logit model had 180 respondents from the general population sub-sample and 41 respondents from the rail-trail users and FODC members for a total of 884 responses to choice questions. Ten percent of responses selected no restoration, while aquatic life had the highest percentage choices with full restoration (Table 4). Less than half of the responses selected full restoration for the swimming and scenic quality attributes (Table 4).

Table 5 presents the coefficient estimates for the nested logit model. All coefficients had their expected signs and the χ^2 statistic was statistically significant. For the first level choice, the attitudinal questions concerning the need for more information (INFORMATION) or the respondent should not have to pay for restoration (PAY) were statistically significant. The negative signs indicate that respondents who felt more information was needed or should not have to pay for restoration were more likely to choose the status quo, or do nothing, option. The socio-demographic variables of AGE, INCOME and EDUCATION were statistically significant. Individuals who are older and have higher annual incomes were less likely to choose a restoration option, while more educated individuals were more likely to choose a restoration option.   These income and education results correspond with previous research on socio-demographic impacts on watershed restoration in West Virginia through formation and activities of watershed associations (Cline and Collins, 2003).

The second level choice had statistically significant, positive coefficients for each of the stream restoration attribute variables. When an option included full restoration for any of the three attributes, respondents were more likely to select that option. In addition, the large positive, statistically significant coefficient for the AQUATIC*ANGLER interactive variable meant that respondents who were anglers were much more likely to select full restoration of aquatic habitat. The SWIM*ANGLER interactive variable shows anglers are less likely to select full restoration for swimming safety. The utility bill had its expected negative impact on restoration choice.

The inclusive value coefficients (α_r) for the nested logit model were 1.000 for the "do nothing" choice and 0.382 for the restoration choice. Given that "do nothing" was a degenerative branch (only one option which is perfectly correlated with itself), the inclusive value parameter is restricted to unity. As Blamey et al. (2000) note, the α_r

measures substitutability across options. When substitutability is greater within options rather than between choices, $0<\alpha_r<1$. In this case, the inclusive value coefficient for the restoration choice shows that respondents who chose restoration will more readily choose from within the restoration options than substitute out to a "do nothing" choice.

To examine differences between sub-samples, a log-likelihood ratio test involved comparing the pooled model of the general and user populations (GP + UP) with the unpooled models of GP and UP. The log-likelihood results were -626.33 for pooled (GP + UP), -507.50 for GP and -109.39 for UP. The test statistic was $\chi^2 = 18.88$ ($\chi^2_{0.05,13} = 22.36$) so that the null hypothesis was accepted. The acceptance of the null hypothesis means that the equality of coefficients between β_{GP} and β_{UP} could not be rejected. Thus, users of Deckers Creek consisting of rail-trail and FODC members were no different from the general population in terms of the independent variables explanation of restoration choices.

Welfare Interpretation

The estimated coefficients in the second choice level provided an approximation of the marginal utility contribution to respondents from a change of moderate to full restoration of each attribute separately. These approximations were based upon the marginal rates of substitution between the marginal utility for full restoration of each stream attribute and the marginal utility for the money attribute:

$$(10) \qquad -1 * \beta_z / \mu$$

where β_z is equal to the stream restoration attribute coefficient in the second level choice and μ is the coefficient for the utility bill attribute.

Of the three attributes, restoration of aquatic habitat had the largest marginal utility contribution with scenic quality and swimming having roughly the same, lower contribution (Table 6). When respondents were anglers, the marginal utility contribution for full restoration of aquatic habitat was more than doubled (from $5.09 to $12.16 per month increase), but swimming quality restoration was essentially reduced to zero (from $3.55 to $0.21 per month).

Calculation of the welfare improvement when moving from moderate to full restoration of all three attributes simultaneously involved holding the first choice level equation variables constant at their mean values. Three welfare improvement scenarios were examined based upon treatment of anglers:

Scenario A – the effects of anglers were held constant (set at mean value)
Scenario B – the effects of anglers were removed (set effect to 0)
Scenario C – the effects of anglers were fully enforced (set effect to 1)

Welfare improvement was measured as the mean compensating variation from increasing restoration from moderate to full. From Equation (9), the gain in welfare generated from full restoration was equal to $(-1 / \mu) * \{ V_{i0} - V_{i1} \}$ where μ was the utility bill coefficient. V_{i0} represented a base case where a moderate level of restoration was achieved for all attributes and was computed by adding the first choice level constant to the CONSTANT coefficient from the second level choice model. V_{i1} was computed based upon all three attributes being fully restored and the angler effects included in three scenarios as shown above. This value was computed by adding the first choice level constant to the attribute coefficients from the second level choice model.

Compensating variation measure of the welfare gain under scenario (A) was estimated to be $12.88 per respondent per month (Table 6). This was interpreted as the mean welfare improvement for all respondents under the full restoration option. For scenario (B), non-anglers had a welfare improvement of $12.35 per respondent per month while anglers were about 33% higher at $16.06 per respondent per month (Table 6). These substantial welfare improvements were interpreted to mean that respondents perceived restoration of Deckers Creek to be much more valuable when fully restored compared to a moderate level of restoration. As an example, the aquatic life attribute improved respondents' welfare dramatically when the stream resource could be restored to a self-sustaining aquatic habitat compared to restoration that was dependent upon fish stocking programs (as a moderate level of restoration would achieve).

Aggregate welfare for full restoration was estimated for the entire watershed using the following assumptions:

- The monthly household welfare estimates were taken from scenario (B) for anglers and (C) for non-anglers. The percentages of angler (38%) versus non-angler (62%) populations in the watershed were estimated from survey data of the general population sub-sample.

- Those respondents who declined to respond to the survey were assigned a zero value from restoration. Based on the number survey responses divided by surveys sent out plus "no" responses over the phone, welfare estimates on a per household basis were applied to 35.4% of angler and non-angler households in the watershed. The household welfare estimates were adjusted downward to account for no restoration choices among respondent households (an 8.5% reduction for non-anglers and a 13% reduction for anglers).

- The total number of households in the watershed (35,719) was based on data from seven zip code areas which overlap parts of the watershed.

Using these assumptions, aggregate welfare over the entire watershed population from full restoration of aquatic life, swimming, and scenic quality on Deckers Creek was computed to be just under $1.9 million annually ($1,870,000).

CONCLUSIONS

The economic value of restoring Deckers Creek in Monongalia and Preston Counties of West Virginia was determined from mail, internet and personal interview surveys. Most survey respondents were familiar with Deckers Creek and its environmental problems. Respondents identified trash most often as a stream problem and a stream's ability to support aquatic life was the leading reason why streams should be restored.

Nested logit models were estimated to derive the economic values of restoring three attributes of this creek: aquatic life, swimming, and scenic quality. When evaluated individually, stream restoration for aquatic life had the largest marginal utility contribution. At full restoration, the relative economic values of attributes were: aquatic life > scenic quality ≈ swimming. This higher value for aquatic life implied that respondents had stronger preferences for full restoration of this attribute than the two other attributes. Thus, restoring Deckers Creek to a sustainable fishery rather than to a "put and take" fishery that can not sustain a fish population (defined as a moderate level of restoration for aquatic life) was more valued than full versus moderate restoration comparisons for the swimming and scenic quality attributes.

Welfare estimates for improvements from moderate to full restoration of all three attributes ranged between $12 and $16 per month per household. Angler respondents had the largest welfare gain and non-angler respondents had the lowest. These estimates were regarded as reasonable given that they represent about 25% to 35% of the average water and sewer utility bills for a Morgantown household in Monongalia County. When the welfare estimates were aggregated up to the entire watershed population, the benefit from restoration of Deckers Creek was estimated to be about $1.9 million annually with only an estimated 1/3 of households placing a positive value on restoration. This benefit estimate probably underestimates the entire gain from restoration because it does not include any welfare improvements that may be derived from partially restoring Deckers Creek to a moderate level of restoration. Welfare estimates of improvements from low to moderate could not be derived in this research.

This research effort examined two sample populations – the general population and stream users represented by rail-trail users plus members of the Friends of Deckers Creek (FODC), a local watershed association. Based upon log-likelihood tests, the two sample populations were statistically from the same population. Deckers Creek users/activists were found not to be different from the general population in terms of their restoration choice responses. Thus, restoration choice surveys using only users and activists may be representative of the watershed population. This result, however, must be viewed with some caution due to the small sample size of rail-trail users plus FODC members.

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Table 1. Socio-demographics of the Survey Sub-Samples and the Watershed Population

SOCIO-DEMOGRAPHIC CHARACTERISTIC	GENERAL POPULATION SAMPLE (N=207)	USER SAMPLE (N=50)	ALL RESPONDENTS (N=257)	2000 CENSUS DATA FROM THE WATERSHED[a]
Gender				
Female	60%	40%	56%	50%
Adult Population Age				
18 to 45	47%	73%	52%	62%
46 and over	53%	27%	48%	38%
Education				
College degree	53%	67%	56%	36%
Household Income – Average ($000)	43	44	43	41

[a] Based upon a population weighted average of census data from zip codes located in the Deckers Creek watershed.

Table 2. Respondent Knowledge about Deckers Creek and West Virginia Stream Water Quality

QUESTION	GENERAL POPULATION SAMPLE (N=207)	USER SAMPLE (N=50)	ALL RESPONDENTS (N=257)
What portion(s) of Deckers Creek are you familiar with?			
Lower portion	75%	83%	77%
Middle portion	44%	54%	46%
Upper portion	19%	33%	21%
None	14%	13%	13%
Do you think there are environment Deckers Creek?			
Yes	73%	84%	75%
No	3%	2%	3%
Don't know	23%	14%	22%
What do you think are the main environmental problems with Deckers Creek?			
Unnatural colors	71%	77%	72%
Odor	54%	58%	55%
Lack of aquatic life	69%	77%	71%
Trash	84%	79%	83%
Unsafe to swim	56%	51%	55%
Unsightly development	39%	40%	39%
High levels of acid	66%	72%	67%
Very widespread pollution problems in WV streams.			
Sewage	26%	35%	28%
Acid and minerals	43%	39%	42%
Trash	44%	43%	44%

Table 3. Variable Definitions

VARIABLE	DESCRIPTION	CODING	MEAN
Demographics			
AGE	Age of respondent	Years	28.618
EDUCATION	Education of respondent	Years of school	15.706
GENDER	Gender of respondent	1=Female, 0=Male	0.376
INCOME	Household income	1=under $10k, 2=$10k-$20k, 3=$20k-$30k, 4=$30k - $40k,5=$40k-$50k, 6= $50k-$60k, 7=$60k-$70k, 8=$70k-$80k, 9=$80k-$90k, 10= $90k -$100k, 11=Over 100k	2.937
Knowledge and Attitudes			
DIFFICULT	Response to statement: "I thought it was difficult to choose from among the options provided."	1=strongly agree, 0=otherwise	0.063
ENVPROBLEM	Knowledge of environmental problems on Deckers Creek	1=yes, 0=no or don't know	0.504
INFORMATION	Response to statement: "I didn't have enough information to decide which option to choose."	1=strongly agree, 0=otherwise	0.045
PAY	Response to statement: "I don't think I should have to pay for restoration of Deckers Creek."	1=strongly agree, 0=otherwise	0.078
VIAQUATIC	Respondent attitude that aquatic life attribute is very important	1=very important, 0=somewhat or not important	0.446
VISCENIC	Respondent attitude that scenic quality attribute is very important	1=very important, 0=somewhat or not important	0.365
VISWIM	Respondent attitude that swimming quality attribute is very important	1=very important, 0=somewhat or not important	0.510
Stream Restoration Attributes			
AQUATIC	Aquatic life improvement	1=full restoration, 0=moderate	0.344
AQUATIC*ANGLER	Aquatic life improvement * Angler	1=full restoration for angler respondent, 0=all others	0.137
BILL	Utility payment increase for restoration	0, 1, 2, 4, 8, or 16 per month increase	4.10
SCENIC	Scenic quality improvement	1=full restoration, 0=moderate	0.327
SWIM	Swimming quality improvement	1=full restoration, 0=moderate	0.335
SWIM*ANGLER	Swimming quality improvement * Angler	1=full restoration for angler respondent, 0=all others	0.128
CONSTANT	Attribute Specific Constant (ASC)	1=restoration alternative; 0=no restoration alternative	0.667

Table 4. Restoration Responses by Stream Attribute (n=884)

	LEVEL OF RESTORATION		
STREAM ATTRIBUTE	LOW[a]	MODERATE	FULL
Aquatic Life	10%	36%	54%
Swimming Quality	10%	43%	47%
Scenic Quality	10%	41%	49%

[a] No restoration level.

Table 5. Coefficient Estimates for the Nested Logit Model

FIRST LEVEL CHOICE: RESTORE OR NOT		
VARIABLE	COEFFICIENT	STANDARD ERROR
CONSTANT	-1.571	1.112
ENVPROBLEM	0.025	0.342
DIFFICULT	-0.477	0.427
INFORMATION	-1.885***	0.522
PAY	-1.802***	0.348
GENDER	-0.023	0.293
AGE	-0.020**	0.009
INCOME	-0.121**	0.052
EDUCATION	0.372***	0.062
VIAQUATIC	-0.113	0.337
VISWIM	0.016	0.348
VISCENIC	0.542	0.361

SECOND LEVEL CHOICE: MODERATE OR FULL RESTORATION

VARIABLE	COEFFICIENT	STANDARD ERROR
AQUATIC	0.645***	0.154
AQUATIC*ANGLER	0.897***	0.304
SCENIC	0.472***	0.125
SWIM	0.451***	0.147
SWIM*ANGLER	-0.425*	0.262
BILL	-0.127***	0.013

INCLUSIVE VALUES	
FIRST LEVEL	1.000
SECOND LEVEL	0.382
χ^2_{20}	909.01
Number Of Observations	884

*, **,*** statistically significant at the 10%, 5%, and 1% level, respectively.

Table 6. Welfare Measures for Partial (by attribute) and Full Restoration (all three attributes) of Deckers Creek.

PARTIAL RESTORATION BY ATTRIBUTE	MARGINAL UTILITY ESTIMATES ($/household/month)
AQUATIC	$5.09 (2.70 – 7.46)[a]
SCENIC	$3.72 (1.79 – 5.64)
SWIM	$3.56 (1.28 – 5.82)
AQUATIC*ANGLER	$7.07 (2.37 – 11.76)
SWIM*ANGLER	-$3.35 (-7.39 – 0.70)
FULL RESTORATION	COMPENSATING VARIATION ($/household/month)
(A) Anglers at mean level	$12.88
(B) Anglers set at zero	$12.35
(B) Anglers set at one	$16.06

[a]95% confidence interval holding marginal utility of income constant.

ENDNOTES

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[1] Deckers Creek is not used for drinking water so that these contaminants do not present hazards to human health.

[2] In a few cases, the web address was sent to them through the mail, or the web address and appropriate access code was give to them over the phone.

[3] Sub-samples of internet and mail survey respondents also were examined (Collins, Rosenberger, and Fletcher, 2003). Restoration choice responses were found to be statistically different between internet and mail surveys. Thus, a combination of internet and paper survey instruments is required in order to develop a general population sample that is representative of the broader watershed population.