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Meta-Analytic Benefit Transfer of Outdoor Recreation Economic Values: Testing Out-of-Sample Convergent Validity

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Abstract. A benefit transfer approach to recreation economic valuation using meta-analysis is examined. Since the meta- regression model takes into account some of the study specific effects on willingness to pay (WTP) estimates, benefit transfer using meta-analysis could yield a valid WTP estimate of unstudied recreation resources. The convergent validity of the meta-analytic benefit transfer is tested using out-of-sample original studies from the U.S. The analyses are performed using percentage difference, paired t-test, regression and correlation tests. The tests reveal mixed results on convergence between estimated WTP using meta-analytic benefit transfer function (BTF) and out-of-sample original WTP values. There is a fairly high percentage difference between the estimated and original WTP values (80–88%), and the mean differences are statistically significant as shown by paired t-tests. However, correlation and regression results consistently show significant positive relationships between national BTF estimated and original WTP values indicating some level of convergence. The results show that the national BTF outperform the regional BTF indicating a potential of the national BTF for recreation benefit transfer when a "first best" primary valuation study is not affordable.

Key words: benefit transfer function, meta-analysis, outdoor recreation, out-of-sample test

JEL classification: Q26, Q21

1. Introduction

Benefit transfer approach utilizes non-market valuation information from existing studies to value natural resources or site (Smith 1992; McConnell 1992; Brookshire and Neill 1992; Desvousges et al. 1998). The place where the existing study is conducted is defined as the "study site" and the location for which the new benefit value is estimated as the "policy site" (Desvousges et al. 1992). The advantage that the analyst could estimate benefit value using existing information has made the benefit transfer approach a practical tool for decision makers and resource managers when a "first best" empirical non-market valuation study is not feasible due to limited time or resources.

Some forms of economic value transfer often take place in legal proceedings and government policy analysis (Boyle and Bergstrom 1992; Desvousges et al. 1998).[1] Krupnick (1993) discusses some of the earlier applications of benefit transfer in the U.S. Federal regulatory decisions. The U.S. Environmental Protection Agency (EPA) suggests that "off-the-shelf" benefit transfer methodology should be used where possible (Desvousges et al. 1992; Freeman 1984). The high cost, extended time requirement, and funding uncertainty for empirical studies to estimate non-market values are primary factors that often lead analysts to transfer benefits. Freeman (1984) highlights the application of benefit transfer in a broader framework of benefit-cost analysis as required by President Reagan's 1981 Executive Order 12291.

In this study we investigate a meta-analysis approach to benefit transfer.[2] The literature often suggests that the use of a meta-regression model to estimate benefit values for a new policy site would allow the analyst to control for various site, method, or study specific effects on benefit estimates, thus it would generate an estimate that is closer to the original willingness to pay (WTP) value of the resource. In particular, the meta-regression model is an aggregated valuation function estimated from the underlying empirical non-market valuation functions reported in the existing studies. Given that a meta-regression function fully represents the empirical valuation functions or the random sample of those functions across the sites and resources, it is plausible in theory that the value of the new site or the resource could be uncovered using the meta-regression model. In recreation literature, meta-analysis and benefit transfer studies are often conducted independently, though suggestions are made that meta-analysis would serve as an improved technique to benefit transfer (Sturtevant et al. 1998; Smith and Kaoru 1990).

Performing benefit transfer using meta-analysis has several advantages. First, information is utilized from a number of studies providing rigorous measures of central tendency. Second, methodological differences in the original studies can be controlled for when calculating a value from the meta-regression equation. Third, by setting the explanatory variables specific to the policy site, the analyst can potentially account for differences between the study site and the policy site characteristics. Finally, the benefit estimate using meta-analysis is likely to be a better approximation of the value of the resource at a new policy site.

The objective of this study is to provide a more rigorous analysis of the potential application of meta-analytic benefit transfer to recreation economic valuation. We examine the validity of our meta-regression model to be used as a benefit transfer function (BTF) in estimating benefit values. First, we estimate meta-regression models or BTFs using recreation valuation studies conducted in the U.S. for the past 30 years. Second, we use BTFs to estimate benefit transfer values. Finally, we test for the convergent validity of BTFs estimated WTP values against the original WTP estimates reported in the out-of-sample studies.

2. Meta-Econometric Model Specification

In this study, we apply a meta-regression technique to estimate the benefit transfer function using existing WTP per day values from contingent valuation and travel cost methods. Data used for meta-analyses are often characterizes as panel data with multiple estimates from many studies. Thus, a generic specification of the benefit transfer function in terms of the meta-regression model can be written as

$$WTP_{mn} = \alpha + \sum_{k=1}^{K} \beta_k x_{k,mn} + e_{mn} + u_n \quad (1)$$

where, m is number of candidate studies (m = 1, ..., M), and n is number of WTP estimates reported in each study. The total number of estimates is $N = \sum_{m=1}^{M} N_m$. The variations in WTP_{mn} are to be explained by a vector of explanatory variables k = 1, ..., K, denoted by $x_{k,mn}$. Important explanatory variables include resource attributes, valuation methods, recreation activity, and socioeconomic characteristics. The estimates within the study may share, in part or whole, several explanatory variables, whereas the estimates across studies may differ in many of those exogenous variables. The fact that the estimates are not independent within a study leads to a nested error structure, i.e. decomposed error variance at the study level e_{mn} and error at the estimation level u_n, which are assumed to be normally distributed with zero mean and constant variances $\sigma_e{}^2$ and $\sigma_u{}^2$, respectively (Bijmolt and Pieters, 2001). In Equation (1), α is the intercept term and β_k is a vector of slope parameters of the benefit transfer function.

Multiple value estimates can result in some systematic effects that are not accounted for in the specification of a classical regression model. In the case where each study (m) provides a single estimate (n), then m = n and e_{mn} collapses into u_n. But, when each study (m) provides one or more estimates (n), we need to account for the common error across estimates (u_n) and the group-specific or panel error within a study (e_{mn}). A random or fixed effect specification can be used to address this issue or multi-level modeling (Bateman and Jones, forthcoming). Studies on recreational fishing (Sturtevant et al. 1998) and the health effect of air pollution (Desvousges et al. 1998) used panel estimators. However, previous testing for our dataset found that random effects were rejected in favor of fixed effect specification, which in turn rejected in favor of equal effects (no panel effects) suggesting our data did not discern panel effects (Rosenberger and Loomis 2000; Loomis et al. 1999). Therefore, with the assumption of independent and identically distributed (iid) error terms, we use a classical ordinary least squares (OLS) technique to estimate our meta-regression models for benefit transfer.

3. Benefit Transfer Validity Test Statistics

The estimated meta-regression models are used as BTFs to estimate WTP values. The validity of the BTF in estimating the benefit values can be analyzed using

Table I. Test statistics for convergent validity

	Objective	Hypothesis	Test Statistics
1.	Analyze similarity of BTF estimated and original WTP values	$[(WTP_{estimated} - WTP_{original})/WTP_{original}]^{*}100 = \lambda^{c}$	Percentage difference.
2.	Test for equality of BTF estimated and original mean WTP values	H_o: $\mu_D = 0$ H_a: $\mu_D \neq 0$	Paired t-test.
3.	Test for variability between BTF estimated and original WTP values	H_o: $\beta_0 = 0$, $\beta_1 = 1$ H_a: $\beta_0 \neq 0$, $\beta_1 \neq 1$	OLS regression.
4.	Test for correlation between BTF estimated and original WTP values	H_o: r = 0 H_a: r $\neq$ 0	Pearson's Correlation.

[c] A relatively smaller λ (% difference) indicates convergence.

various test statistics (Brouwer and Spaninks 1999; Horowitz and Louviere 1993; Valdes 1995). The performance of the model could also be measured in terms of its success in estimating the values of a holdout sample, much like a bootstrap process or Monte Carlo method (Loomis 1992). In our analysis, we use out-of-sample benefit transfer validity tests, which require two estimates of values – (1) comparable original WTP value obtained from the out-of-sample studies, and (2) BTF estimated WTP values adjusted for relevant out-of-sample study characteristics. Thus, the BTF estimated values are calculated incorporating the policy site explanatory variables. Then, the testable hypothesis is whether the BTF estimated WTP values are statistically different from the original WTP values reported in the out-of-sample studies. We used relatively simple test statistics to examine the validity of our BTFs.

First, we analyze the convergence between original and estimated WTP values for individual out-of-sample studies using percentage difference (Table I, #1). A smaller percentage difference between BTF estimated and out-of-sample original WTP values for each study indicates convergence (Loomis 1992). Second, convergence of BTF estimated and original WTP values are tested using a paired t-test for equality of means (Sirkin 1995). Valdes (1995) used paired t-test for benefit transfer analysis of CVM studies in recreation sports fishing. Brouwer and Spaninks (1999) refers to Bergland et al. (1995) in developing similar test statistics, and tested equality of average WTP estimates from different studies. In paired t-test, statistical significance of the t-value indicates rejection of the null hypothesis of $\mu_D = 0$, where μ_D is the mean difference between BTF estimated and out-of-sample original WTP values (Table I, #2). The convergent validity of the BTF requires that the null hypothesis is not rejected.

Third, it is plausible that the variance in each difference tested in the paired t-test is not constant as the test assumes. To account for the variance component, we test the hypothesis formulated in Table I, #3 with a regression analysis of the form, $WTP_{original} = \beta_0 + \beta_1 WTP_{estimated} + \eta$ (Horowitz and Louviere 1993). Here, β_0 is a constant term, β_1 is regression coefficient, and η is a random error term. A failure to reject the null hypothesis $\beta_0 = 0$ and $\beta_1 = 1$ would support the convergent validity of our benefit transfer.

Fourth, we analyze correlation coefficients that measure the direction and degree of association between the estimated and original WTP values. Carson et al. (1996) use a correlation coefficient in testing the validity of non-market valuation estimates. The Pearson's correlation coefficients (r) between estimated and original WTP values are evaluated using the hypotheses stated in Table I, #4. The rejection of the H_o: r = 0 implies significant correlation between the estimated and original WTP values showing a consistency in our benefit transfer.

4. Data Collection for Meta-Analysis

All past recreation valuation studies of the U.S. are the candidates for our meta-analysis. In the meta-analysis dataset, we updated the literature review by Walsh et al. (1989, 1992) with additional valuation studies available up to 1998. The data for years prior to 1993 were obtained from the MacNair (1993) database that also coded Walsh et al. (1989, 1992). We obtained a few additional details directly from the Walsh et al. (1989, 1992). Thus, our database contains data from Walsh et al. (1989, 1992), MacNair (1993), and our current literature search. We performed meta-analysis on the full dataset that spans from 1967 to 1998.

We searched recreation valuation studies using electronic databases including the American Economic Association's EconLit, First Search Databases, the University of Michigan-Dissertation and Thesis Abstracts, National Technical Information Service (NTIS) database and the Water Resources Abstract Index. We also used unpublished or gray literature including western regional research publication (W133) from 1987 to 1996. Inclusion of gray literature reduces a potential publication bias in meta-analysis (Stanley 2001). The Carson et al. (1994) CVM bibliography and second author's own collection of working papers and conference papers were major sources of gray literature. Recreational fishing studies were not emphasized in our meta-analysis as they were assessed in previous literature reviews (Sturtevant et al. 1998; Markowski et al. 1997). However, fishing studies included in Walsh et al. (1989, 1992) and McNair (1993) were used.

Among the observations recorded, 682 contained enough information to fully code for each of the variables listed in Table II. These observations were obtained from 131 recreation valuation studies of the U.S. Inclusion of candidate studies in the dataset was restricted to the studies that reported WTP value per unit of use. Primary valuation studies included in our meta-analysis use both CVM and TCM. Using WTP estimates from CVM and TCM studies to estimate a meta-regression raises concern about inconsistencies between Marshallian and Hicksian welfare measures (Willig 1976; Hanemann 1991). CVM WTP estimates are derived from a Hicksian demand function, while the TCM WTP estimates are derived from a

Marshallian one. For a rise in price toward the choke price to calculate consumer surplus, the Hicksian measure would be larger than the Marshallian even when there is no measurement error. Smith et al. (2002) provide insights in calibrating the value estimates elicited from different valuation methodologies. Our meta-analyses accounts for these conceptual differences in WTP and overall method through a *METHOD-MEASURE* dummy variable. Generally, we expect method to dominate the measure effect because an income variable is either absent in many TCM demand studies or has such a small coefficient that there is little difference between Hicksian and Marshallian measures (Creel and Loomis 1991). In terms of the METHOD part of the METHOD/MEASURE variable, the omitted category is Hedonic TCM. The Hedonic TCM, while strictly speaking is a revealed preference method, is quite different than most other variants of TCM and was rarely applied, making it an ideal candidate for the omitted category.

5. Meta-Analysis Results

We estimated the meta-regression models as specified in Table II. Initially, a fully specified meta-regression model was estimated. Then, to use the meta-regression models for benefit transfer the reduced models or the BTFs were estimated retaining only the variables significant at $p \leq 0.20$ (Greene 1997). Thus, many variables including socioeconomic variables dropped out of the model. While it is important to account for socioeconomic factors in a BTF the information reported in the original studies on socioeconomic variables representing study specific measures was incomplete, thus we tried state level economic and demographic variables instead. Possibly due to aggregation effect of our state level data there was no statistically significant socioeconomic variable in the BTFs. Smith and Huang (1995) used city level income data in their hedonic meta-analysis. However, our meta-analysis uses TCM and CVM estimates, thus making it difficult to connect between state level secondary information and empirical WTP estimates. The national model results reported in Appendix A indicate that the sign and significance of the coefficients remain largely unchanged across the models with full specifications. The *INCOME* variable reveals a positive sign but remains insignificant in both linear and linear-log specifications.

Five BTFs were estimated, one for each of the four geographic regions represented by U.S. Census Regions (CR) and one for the national model. The regional BTFs are CR1 (northeastern states), CR2 (southeastern states), CR3 (intermountain west), and CR45 (Pacific coast states and Alaska). CR45 is a combination of two census regions. Because of lack of degrees of freedom for CR5 (Alaska), we tested coefficient equality using a Chow test (Greene 1997) and found that we could combine CR5 with CR4 (Pacific coast states). However, testing the four regions against one another yielded an F statistic of 3.66, suggesting at the 0.01 level at least one of the regional intercept terms or slope coefficients differs from one of the others. This means that there is lack of equality of regional coefficients

Table II. Variables tested in meta-regression models – benefit transfer functions

Variables	Expected Sign	Description
Dependent variable:		
WTP		Consumer surplus per person day (1996 dollars).
Method variables:		
METHOD/ MEASURE	–/+	1 if stated preference (SP) valuation approach used (Hicksian measure), 0 if revealed preference (RP) approach used (Marshallian measure).
DCCVM	+	1 if dichotomous choice elicitation technique in SP was used, 0 otherwise.
OE	–	1 if SP and open ended elicitation technique was used, 0 otherwise.
PAYCARD	–	1 if SP and payment card elicitation technique was used, 0 otherwise.
ITBID	±	1 if SP and payment card elicitation technique was used, 0 otherwise.
RPSP	–	1 if SP and RP was used in combination, 0 otherwise.
INDIVID	+	1 if RP approach was an individual model, 0 otherwise.
ZONAL	±	1 if RP and zonal travel cost model was used, 0 otherwise.
RUM	–	1 if RP was a random utility model, 0 otherwise.
SUBS	–	1 if demand model incorporated substitute sites, 0 otherwise.
TTIME	±	1 if RP model included travel time variable, 0 otherwise.
MAIL	–	1 if survey type was mail, 0 otherwise.
PHONE	–	1 if survey type was phone, 0 otherwise.
INPERSON	±	1 if survey type was in person, 0 otherwise.
LOGLIN	±	1 if regression function was estimated as a log dependent variable and linear independent variable, 0 otherwise.
LOGLOG	±	1 if regression function was estimated as a log of both the dependent variable and the independent variable, 0 otherwise.
LINLIN	±	1 if function form was linear on both dependent and independent variables, 0 otherwise.
VALUNIT	–	1 if consumer surplus was orginally estimated as per day, 0 otherwise.
TREND	+	Year when WTP estimate was recorded, coded as 1967 = 1, 1968 = 2, . . ., 1996 = 30.
Site Variables:		
FSADMIN	–	1 if study sites were USDA Forest Service National Forests, 0 otherwise.
R1, R2, R3, R4, R5, R6, R8, R9, R10	±	1 if study sites were in the respective USFS Region; 0 otherwise: R1 = Montana or North Dakota, R2 = Colorado, Kansas, Nebraska, South Dakota or Wyoming, R3 = Arizona or New Mexico, R4 = Idaho, Nevada or Utah, R5 = California or Hawaii, R6 = Oregon or Washington, R8 = Southeast states, R9 = Northeast states, R10 = Alaska (Note: R7 does not exist).
LAKE	–	1 if the recreation site was a lake, 0 otherwise.
RIVER	+	1 if the recreation site was river, 0 otherwise.
NATL	±	1 if the recreation site was the entire U.S., 0 otherwise.
FOREST	±	1 if the recreation site was a forest, 0 otherwise.

Table II. Continued

Variables	Expected Sign	Description
PUBLIC	+	1 if ownership of the recreation site was public, 0 otherwise.
DEVELOP	±	1 if a recreation site had developed facilities, e.g. picnic tables, campgrounds, restrooms, boat ramps, ski lifts, 0 otherwise.
NUMACT	+	Number of different recreation activities the site offers.
Recreation activity variables:		
CAMP ... GENREC	±	1 if the relevant recreation activity was studied; 0 otherwise: CAMP is camping, PICNIC is picnicking, SWIM is swimming, SISEE is sightseeing, NONMTRBT is non-motorized boating, MTRBOAT is motorized boating, OFFRD is off-road driving, HIKE is hiking, BIKE is biking, DHSKI is downhill skiing, XSKI is cross country skiing, SNOWMOB is snowmobiling, BGHUNT is big game hunting, SMHUNT is small game hunting, WATFOWL is waterfowl hunting, FISH is fishing, WLVIEW is wildlife viewing, ROCKCL is rock climbing, HORSE is horseback riding, and GENREC is general recreation.
Socioeconomic variables:		
INCOME ... POPUL	±	Socioeconomic variables are measured in state level aggregate figures, where INCOME is per capita income in $1000, AGE is percent of population over 65 years, EDU is percent of population holding at least bachelor degree, BLACK is percent of African American population, HISPAN is percent of Hispanic population, POPUL is population size.

and that separate models should be estimated for each census region. Thus, we estimated four regional BTFs including a combined model for CR45 (Table III). Model specifications were based in part on Walsh et al. (1989, 1992) and Smith and Kaoru (1990). The explanatory power of the national BTF shown by adjusted R^2 is 0.27, slightly below that of Walsh et al. (1989, 1992) for their combined TCM/CVM Model. The regional BTFs had greater explanatory power, ranging from 0.28 for CR1, 0.33 for CR45, 0.36 for CR3, to 0.66 for CR2.

The signs and significance of the variables in the BTFs are consistent with expectations and congruent with past recreation valuation studies. *METHOD/MEASURE* is negative indicating CVM studies produce lower estimates of WTP than do TCM, a result consistent with Carson et al. (1996), Walsh et al. (1989, 1992) and a recent review of CVM study by Carson et al. (2001). Thus, differences between Hicksian compensating measures common with CVM and Marshallian consumer surplus common with TCM, appear swamped by empirical differences between CVM and TCM. That is, if this coefficient primarily reflected differences in welfare measure it should have had a positive sign. However, it had a negative sign more consistent with past differences between TCM and CVM.

Table III. Estimated benefit transfer function using meta-regression models

Variable	NATIONAL	CR1	CR2	CR3	CR45
CONSTANT	19.159* (10.20)		26.541[a] (24.89)	66.234* (15.19)	10.044[a] (10.65)
METHOD-MEASURE	–17.598* (6.81)			–34.381* (12.17)	
DCCVM				27.066* (13.63)	
OE	–7.468* (3.82)				
RPSP	–38.170* (10.73)	na	na		na
PAYCARD	–28.333 (19.72)	na	na		na
INDIVID		38.927* (14.40)	52.653* (14.21)		
RUM		63.278* (29.500)		–28.392* (16.12)	30.445* (14.65)
SUBS	–20.277* (5.08)			–33.481* (17.75)	–18.851* (12.67)
MAIL			19.309 (12.01)		
PHONE	–18.626* (4.24)				
LOGLIN					22.642** (11.84)
LOGLOG		24.305* (12.11)			
VALUNIT	–5.820 (4.12)	–18.426* (9.00)		–10.023* (5.85)	
TREND	1.613* (0.38)				
FSADMIN	–20.056* (3.929)		–18.471 (11.36)	–14.595* (8.74)	
R2	–6.581 (5.077)	na	na	–8.791 (5.57)	na
R5	–10.448 (6.96)	na	na	na	
R6	–14.218* (4.55)	na	na	na	

Table III. Continued

Variable	NATIONAL	CR1	CR2	CR3	CR45
R8	–8.756* (3.74)	na	pc	na	na
R9	–7.124* (3.83)	pc	na	na	na
R10	–14.980* (8.50)	na	na	na	
LAKE	–16.803* (6.61)	–30.097* (15.26)			
RIVER	17.747* (8.05)		–73.951* (26.40)	40.462* (26.84)	
FOREST			17.792* (3.87)	–18.358* (10.29)	
PUBLIC	21.655* (5.66)	29.652* (6.18)	48.940* (27.78)		pc
DEVELOP			–65.216* (24.30)		
NUMACT				2.267* (0.72)	
CAMP					107.59* (33.30)
PICNIC			–25.683* (12.30)	–45.120 (15.82)	60.118* (33.37)
SISEE		78.925* (16.56)	–50.590* (27.36)		36.809* (10.05)
OFFRD	–7.898 (5.08)	na	na	na	19.803 (10.05)
BIKE	–13.569* (7.63)	–58.772 (19.11)	–25.962* (15.92)		na
DHSKI		na	na	40.033 (17.10)	
XSKI		14.005 (8.20)	na		na
SNOWMOB	–20.299* (9.74)	na	na	20.026 (12.38)	na
BGHUNT	12.478* (3.42)	21.70* (13.94)	–48.391* (23.82)	19.070* (11.68)	34.536* (22.25)
WATFOWL	10.161* (4.25)	14.479* (8.24)	–57.781* (23.49)		17.827* (8.57)

Table III. Continued

Variable	NATIONAL	CR1	CR2	CR3	CR45
FISH	9.057*		–61.378		19.419*
	(4.12)		(25.07)		(7.81)
WLVIEW			–49.923		30.304*
			(23.42)		(15.94)
ROCKCL	39.738*		na	28.222	na
	(12.59)			(13.5557)	
HORSE	–11.841*	na	na	na	na
	(5.11)				
GENREC					24.721*
					(13.74)
Adjusted R^2	0.26	0.28	0.66	0.36	0.33
F-STAT	9.98*	8.89*	16.14*	10.08*	4.48*
	[25, 656]	[10, 195]	[14, 97]	[15, 222]	[12, 82]
N	682	206	112	238	95

* is $p < 0.10$; (all variables are $p = 0.20$); a is intercept term dropped in CR1 ($p > 0.9$), but CR2 ($p = 0.29$) & CR45 ($p = 0.34$) retained; na is no observation, pc is perfectly correlated. Numbers in parentheses indicate standard errors (corrected for heteroscedasticity & serial correlation using Newey-West version of White correction).

In our meta-analysis, only the big game hunting activity variable (*BGHUNT*) was consistently significant across national and all regional BTFs. Other activity variables have different influences across the BTFs. The discussion on BTF results is not elaborated here since our intent is to use these results for benefit transfer analysis.

6. Out-of-sample Benefit Estimation

Before we could perform convergent validity tests on the BTFs, we had to obtain the BTF estimated WTP and out-of-sample original WTP values with necessary adjustments. To obtain out-of-sample original WTP values, recreation valuation studies of the U.S., that became available after the estimation of our BTFs, were acquired. The characteristics of our out-of-sample studies are reported in Table IV. From the out-of-sample studies the information including original WTP values were coded. If the original WTP values were not reported as per day, they were converted to WTP per day. In some cases, further information had to be sought from the author to calculate per day original WTP value. All original WTP values were adjusted to 1996 U.S. dollars using an implicit price deflator. With inflationary adjustments the original WTP values are comparable to estimated WTP values.

Table IV. Out-of-sample study characteristics and WTP comparison

Study	Recreation good valued	Study site	Valuation method	No. of estimate	Original WTP	Estimated WTP		λ (% difference)	
						National	Regional	National	Regional
AEI et al. 1998	Reservoir recreation	Lower Snake River, WA	TCM-ID	1	$35.02	$68.25	$57.41	94.87	63.90
Boyle et al. 1998	Fishing	National study, U.S.A.	CVM-DC	7	16.29 (1.97–26.65)	42.22 (16.40–49.46)	32.31 (12.12–40.59)	159.21	97.51
	Deer, Elk, and Moose hunting,	National study, U.S.A.	CVM-DC	7	37.68 (22.70–68.11)	49.84 (44.81–51.94)	48.66 (40.94–57.20)	32.30	35.30
	Wildlife viewing	National study, U.S.A.	CVM-DC	11	17.77 (8.88–30.60)	30.67 (6.40–38.92)	36.22 (21.87–44.58)	72.63	87.72
Chakraborty and Keith 2000	Biking	Moab, UT	TCM-ID	1	116.78	82.09	68.50	–29.70	–41.34
Cooper 2000	Waterfowl hunting	San Joaquin Valley, CA	TCM-ID	3	32.60 (29.23–37.91)	39.57	42.97 (27.87–50.51)	21.37	31.80
Coupal et al. 1998	Snow-mobiling	WY	TCM-ID	1	42.92	35.37	67.57	–17.58	57.43
Hackett 1999	Wilderness	Trinity Alps, CA	TCM-ZN	1	31.21	43.27	13.81	38.65	–55.67
Hansen et al. 1999	Pheasant hunting	Mid-west	TCM-ZN	2	26.00	58.03	43.49 (12.51–74.47)	123.20	67.29

Table IV. Continued

Study	Recreation good valued	Study site	Valuation method	No. of estimate	Original WTP	Estimated WTP		λ (% difference)	
						National	Regional	National	Regional
Hilger 1998	Hiking	Snow Lake, Stuart/ Colchuck, WA	TCM-ZN	2	26.53 (21.77–31.29)	52.34	32.69	97.29	23.20
Leeworthy and Bowker 1997	Nature-based recreation	Florida Keys, FL	TCM-ID	1	85.88	62.72	34.82	–26.97	–59.45
Loomis et al. 2000	Whale watching CA	California coast,	TCM-ID	1	46.62	30.22	62.99	–35.17	35.12
Loomis 2001	Rafting	Along the Snake River	CVM-DC	2	57.56 (45.88–69.24)	64.74	33.93	12.48	–41.06
	Hiking	Along the Snake River	CVM-DC	1	21.10	64.74	33.93	206.81	60.78
Moeltner 1998	Wilderness recreation	Alpine Lake, WA	TCM-ZN	1	7.15	36.52	32.69	411.08	357.44
Piper 1998	River recreation	Missouri and other 5 rivers, ND	TCM-ID	1	32.44	62.35	84.55	92.21	160.65
Roach et al. 1999	Rafting	Dead River, ME	CVM-DC	1	113.57	79.01	29.57	–30.43	–73.89

Note: CVM-DC = Dichotomous Choice CVM; TCM-ID = Individual TCM; TCM-ZN = Zonal TCM; CA = California; FL = Florida; ME = Maine; ND = North Dakota; UT = Utah; WA = Washington state; WY = Wyoming; National is national meta-regression model used; Regional is regional models used; Estimated is model estimated WTP values, and Original is out-of-sample original values. Mean value of WTP estimates are used to compute λ (% difference) for studies with multiple estimates. Numbers in parentheses are range of multiple estimates.

Second, we calculated BTF estimated WTP values incorporating out-of-sample study characteristics. In doing so, relevant variables in the BTFs were set according to the original out-of-sample study (e.g. recreation activity, lake, stream, region), and if unavailable from the study, were set at zero or at the mean as applicable. Our out-of-sample test approach has the advantage of including the effects of the variables on the out-of-sample original studies. This is usually not possible in real world benefit transfer when the transfer has to be performed without a pre-existing valuation study of a new policy site. In such cases, analysts will have to set explanatory variables of BTF to zero, one or the mean based on prior experience or as is appropriate to the policy site characteristics.

When calculating estimated WTP values all BTFs were used. Thus, there are multiple estimates of WTP values using the national BTF as well as relevant regional BTFs for the same original study. In some cases there are values estimated using more than one regional BTF because of the original WTP values given for multiple states.

7. Benefit Transfer Test Results and Discussion

To test the validity of national and regional BTFs we evaluated the convergence between the BTF estimated and original out-of-sample WTP values. The convergent validity of the BTFs was analyzed using the percentage difference, paired t-test, regression analysis, and correlation test. Because of the relatively small sample of estimated WTP values for each of the four regional BTFs, the estimated WTP values for regional BTFs were aggregated. The difference in the number of observations between the national and aggregated regional BTFs is due to the multiple values for some of the out-of-sample studies using regional BTFs. While computing λ for studies with multiple estimates an average value is used (Table IV, last two columns). We computed λ by recreation activity, thus providing multiple estimates of percentage difference if the out-of-sample studies reported WTP for multiple activities.

Interestingly, the percentage differences between original and estimated WTP values show consistent results using either national or regional BTFs. The λ values reveal exactly the same number of positive and negative estimates, implying that there is an equal probability that WTP values estimated by both national and regional BTFs can be larger or smaller than the original WTP estimates. The national and regional BTFs under-estimated 5 out of 17 estimates of out-of-sample studies (see Table IV). However, the signs for national and regional BTFs estimated λ values are reversed in four of the studies. The national BTF estimated values for Coupal et al. (1998) and Loomis et al. (2000) are lower than the original estimates, whereas the estimated values are higher using regional BTFs. Similarly, national BTF estimated values for Hackett (1999) and Loomis (2001) are higher, but they are lower while using regional BTFs. Overall, absolute values of the mean λ between original and estimated WTP estimates are about 88% and 80% with

Table V. Paired t-test, correlation, and regression results

Measurement	National	Regional
Original out-of-sample mean WTP	\$34.04	\$32.48
BTF estimated mean WTP	\$47.10	\$40.91
t-statistics	3.832**	2.10*
Pearson correlation coefficient	0.651**	0.191
Regression coefficient β_0	–17.778	20.048
	(-1.643)	(1.902)
Regression coefficient β_1	1.108	0.304*
	(0.494)	(–2.827)
Adjusted R^2	0.407	0.013
N	37	44

** is significance at $p \leq 0.01$, * is significant at $p \leq 0.05$, and numbers in parentheses are t-statistics. National is national meta-regression model used, Regional is regional models used.

ranges 12.48–411.08% and 23.20–357.44%, respectively, when using national and regional BTFs.

The results of paired t-test reported in Table V show that the t-statistics are significant at or below probability value of 0.05 in both national and regional BTFs, implying the H_o must be rejected. In other words, there is a statistically significant difference between the benefit function estimated and original WTP values, thus the benefit transfer estimates do not converge based on the paired t-test.

It is also evident from the results that the mean estimated WTP values of \$47.10 and \$40.91 using national and regional BTFs, respectively, are higher than the mean WTP estimates of the corresponding \$34.40 and \$32.48 from the original studies. This result indicates that on average our BTFs over-estimate WTP values. The mean estimated value obtained from our national BTF is 37 percent larger, and that of aggregated regional BTF is 26 percent larger than the mean WTP estimates reported in original studies (Table V). The aggregated regional BTF has a relatively smaller mean estimation error, but this would not necessarily provide assurance about the validity of the model if the associated variance is large.

A test to account for the variability in each difference between original and estimated WTP values was conducted using simple OLS regression. For the national BTF, we do not reject the null hypotheses of $\beta_0 = 0$ and $\beta_1 = 1$ at $p \leq 0.05$ (t = –1.643 and 0.4659, Adjusted R^2 0.407) suggesting a reasonable fit of the data and a direct linear relationship between the estimates. However, in the case of aggregated regional BTFs, only β_0 confirms this result at $p \leq 0.05$ (t = 1.902). But, the H_o of $\beta_1 = 1$ is rejected at $p \leq 0.05$ (t = –2.8266, Adjusted R^2 0.013). The results suggest that the distribution of estimated WTP values using our aggregated regional BTFs does not fit the distribution of original WTP values well (Table V). We also corrected for possible heteroscedasticity in the BTF estimation but the above results remain unchanged.

The test statistics based on Pearson's correlation coefficient show a positive correlation between original and estimated WTP values (Table V). The correlation coefficient for the national BTF is 0.651, significant at $p \leq 0.01$, indicating that the original and estimated WTP estimates are positively correlated. The result suggests national BTF estimates higher benefit values for the site or resource where original WTP is larger. For regional BTF, the correlation is weakly positive ($r = 0.191$) but not significant implying no strong relationship between original and estimated WTP values.

Though average percentage difference values show fairly large differences between BTFs estimated and out-of-sample original WTP values and paired t-test results reveal that BTF estimated WTP estimates are statistically different from out-of-sample original WTP values, further comparisons of the results between national and regional BTFs show that national BTF consistently out performed the aggregated regional BTF suggesting a potential merit of national BTF in benefit transfer applications.

8. Summary and Conclusion

Recent recreation valuation literature demonstrates a strong desire to explore the validity of the benefit transfer approach to natural resource valuation. For the past several years various approaches to recreation benefit transfer have been studied. Benefit transfer using meta-analysis may be an improvement on these approaches to finding appropriate estimates of benefit values for a new policy site. In this study, we conducted a meta-analysis of outdoor recreation valuation studies of the U.S., and used the meta-regression models as our benefit transfer functions (BTF) to estimate WTP values for the policy site. We tested convergent validity of our benefit transfer comparing the BTFs estimated and out-of-sample original WTP values. In general, BTF over estimated the WTP values more often while using either national or regional BTFs. Absolute values of mean percent difference between original and estimated WTP values show similar estimation errors associated with national and regional BTFs. Further, the paired t-test results show no convergent validity of national and regional BTF estimates, a result consistent with fairly high mean percent differences (80–88%). But, evaluation of the Pearson's correlation coefficients reveals significant positive correlations between the national BTF estimated values and original WTP values. The results suggest that the national BTF estimated higher values for the original studies with higher WTP, but the likelihood of such estimations is statistically insignificant for regional BTFs. The results of the correlation analysis are also supported by regression results. The regression analyses show a better fit of the national BTF estimated WTP values to the distribution of original WTP estimates. Overall, the results suggest that national BTF can be a potentially useful benefit transfer function for recreation benefit estimation at a new policy site. However, caution should be taken while generalizing these results since our sample sizes used to estimate BTFs, particularly regional BTFs, and to test out-of-sample convergent validity are relatively small.

It is likely that government agencies and policy makers may increasingly rely on existing information in their natural resource and environmental decisions. While a fairly large number of primary studies on recreation valuation exist in the U.S., information on welfare impacts of new policy decisions with reference to a particular policy site or resources is not readily available. The high cost and extended time requirements for primary studies often limit a public agency's desire to acquire primary information. Thus, it will be very helpful and efficient if a systematic approach is established to utilize existing recreation valuation studies. Benefit transfer using meta-analysis is shown to be a useful approach in this particular context.

However, based on the information needed for recreation valuation and the size of an acceptable error in estimated WTP estimates, decision makers will have to use their own judgment to make a tradeoff between using benefit transfer values and conducting a primary study to generate original WTP estimates. Though, it is beyond the scope of this study, in principle, an analyst might be able to correct for some of the errors in the BTF estimated values to be used in real world benefit transfer. Feather and Hellerstein (1997) performed a calibration procedure to reduce biases in benefit function transfer for valuing the conservation reserve program in the U.S. It is important to acknowledge, however, that benefit transfer is not a panacea to recreation valuation but an approach to effectively utilize existing information and resources to provide a rough estimate when a "first best" valuation study is not affordable.

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Notes

1. First, a unit-day value transfer was used by the U.S. Water Resources Council and the U.S. Department of Agriculture (USDA), Forest Service (Loomis and Walsh 1997; U.S. Water Resource Council 1973, 1979, 1983). Since the Resource Planning Act of 1974 (RPA), the USDA Forest Service has been periodically updating unit-day value estimates based on review of existing recreation valuation studies. Second, a direct transfer approach, in which the benefit

is transferred from the best-matched study, is also used to estimate the benefit values (Boyle and Bergstrom 1992). Third, benefit function transfer approach is used where the benefit estimates can be adjusted for some of the resource characteristics (Loomis et al. 1995; Loomis 1992; Brouwer and Spaninks 1999; Downing and Ozuna 1996; Kirchhoff et al. 1997).

2. Meta-analysis is a method used to synthesize existing research findings in education, psychology, health, and other sciences (Glass 1976; Glass et al. 1981; Stanley 2001; Smith and Kaoru 1990; Sturtevant et al. 1998; Walsh et al. 1992). Meta-analysis in recreation valuation was introduced by Walsh et al. (1989, 1992) and Smith and Kaoru (1990), to explain variation in consumer surplus per day estimated from contingent valuation and/or travel cost methods. Some of the recent applications of meta-analysis in valuation include groundwater (Boyle et al. 1994), air quality (Smith and Huang 1995), endangered species (Loomis and White 1996), air pollution and visibility (Smith and Osborne 1996), health effects of air pollution (Desvousges et al. 1998), recreation fishing (Sturtevant et al. 1998), and wetlands (Brouwer et al. 1999; Woodward and Wui 2001).

References

AEI, UI and NA (1998), *Outdoor Recreation use and Value on Lower Snake River Reservoirs*. Report prepared for the Department of the Army Corps of Engineers, Agricultural Enterprise Inc. (AEI), University of Idaho (UI) and Normandean Associates (NA), Walla Walla, Washington.

Bateman, I. and A. Jones. Forthcoming. Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in UK Woodland Recreation Values. Forthcoming, Land Economics.

Bergland, O., K. Magnussen and S. Navrud (1995), *Benefit Transfer: Testing for Accuracy and Reliability*. Discussion Paper #D-03/1995, Department of Economics and Social Sciences, Agricultural University of Norway.

Bijmolt, T.H.A. and R.G.M. Pieters (2001), 'Meta-Analysis in Marketing when Studies Contain Multiple Measurements', *Marketing Letters* **12**(2), 157–169.

Boyle, K. and J. Bergstrom (1992), 'Benefit Transfer Studies: Myths, Pragmatism, and Idealism', *Water Resource Research* **28**(3), 657–663.

Boyle, K., G. Poe and J. Bergstrom (1994), 'What Do We Know about Groundwater Values? Preliminary Implications from a Meta Analysis of Contingent-Valuation Studies', *American Journal of Agricultural Economics* **76**, 1055–1061.

Boyle, K.J., B. Roach, D.G. Waddington, J. Clark and B. Lange (1998), *1996 Net Economic Values for Bass, Trout and Walleye Fishing, Deer, Elk and Moose Hunting, and Wildlife Watching-Addendum to the 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation*. U.S. Fish and Wildlife Service.

Brookshire, D.S. and H.R. Neill (1992), 'Benefit Transfer: Conceptual and Empirical Issues', *Water Resources Research* **28**(3), 651–655.

Brouwer R. and F.A. Spaninks (1999), 'The Validity of Environmental Benefits Transfer: Further Empirical Testing', *Environmental and Resource Economics* **14**, 95–117.

Brouwer, R., I.H. Langford, I.J. Bateman and R.K. Turner (1999), 'A Meta-Analysis of Wetland Contingent Valuation Studies', *Regional Environmental Change* **1**(1), 47–57.

Carson, R.T., J. Wright, A. Alberini, N. Carson and N. Flores (1994), *A Bibliography of Contingent Valuation Studies and Papers*. La Jolla, CA, NRDA, Inc.

Carson, R.T., N.E. Flores, K.M. Martin and J.L. Wright (1996), 'Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-public Goods', *Land Economics* **72**(1), 80–99.

Carson, R.T., N.E. Flores and N.F. Meade (2001), 'Contingent Valuation: Controversies and Evidence', *Environment and Resource Economics* **19**, 173–210.

Chakraborty, K. and J.E. Keith (2000), 'Estimating the Recreation Demand and Economic Value of Mountain Biking in Moab, Utah: An Application of Count Data Models', *Journal of Environmental Planning and Management* **43**(4), 461–469.

Cooper, J.C. (2000), 'Nonparametric and Semi-Nonparametric Recreational Demand Analysis', *American Journal of Agricultural Economics* **82**, 451–462.

Coupal, R.H., C. Bastian, J. May, and D.T. Taylor (1998), *The Economic Benefits of Snowmobiling in Wyoming: A Travel Cost Approach with Market Segmentation*. An unpublished paper, Dept. of Agricultural and Applied Economics, University of Wyoming.

Creel, M. and J. Loomis (1991), 'Confidence Intervals for Welfare Measures with Application to a Problem of Truncated Counts', *Review of Economics and Statistics* 63(2), 370–373.

Desvousges, W.H., M.C. Naughton and G.R. Parsons (1992), 'Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies', *Water Resource Research* **28**, 675–683.

Desvousges, W.H., F.R. Johnson, and H.S. Banzhaf (1998), *Environmental Policy Analysis With Limited Information: Principles and Applications of the Transfer Method*. Edward Elgar, Northampton, MA.

Downing, M. and T. Jr. Ozuna (1996), 'Testing the Reliability of the Benefit Function Transfer Approach', *Journal of Environmental Economics and Management* **30**, 316–322.

Feather, P. and D. Hellerstein (1997), 'Calibrating Benefit Function Transfer to Assess the Conservation Reserve Program', *American Journal of Agricultural Economics* **79**, 151–162.

Freeman, A.M. (1984), 'On the Tactics of Benefit Estimates Under Executive Order 12291', in V.K. Smith, ed., *Environmental Policy Under Regean's Executive Order: Role of Benefit Cost Analysis*. University of North Carolina Press, Chapel Hill, pp. 167–186.

Glass, G.V. (1976), 'Primary, Secondary, and Meta-Analysis of Research', *Educational Researcher* **5**, 3–8.

Glass, G.V., B. McGraw and M.S. Smith (1981), *Meta-Analysis in Social Research*. Sage Publications Inc., California & London.

Greene, W.H. (1997), *Econometric Analysis* (Third Edition). Prentice Hall, New Jersey.

Hackett, S.C. (1999), *The Recreational Economic Benefits from Wilderness Visitation in the Eastern Trinity Alps*. An unpublished paper, School of Business and Economics, California State University-Humboldt State University, Arcata, CA.

Hanemann, W.M. (1991), 'Willingness to Pay and Willingness to Accept: How Much Can They Differ', *The American Economic Review* **81**(3), 635–647.

Hansen, L., P. Feather and D. Shank (1999), 'Valuation of Agriculture's Multi-site Environmental Impacts: An Application of Pheasant Hunting', *Agricultural and Resource Economics Review* (October), 199–207.

Hilger, J.R. (1998), *A Bivariate Compound Poisson Application: The Welfare Effects of Forest Fire on Wilderness Day-Hikers*. An unpublished thesis, Resource and Applied Economics, University of Nevada, Reno.

Horowitz, J.L. and J.J. Louviere (1993), 'Testing Predicted Choices Against Observations in Probabilistic Discrete Choice Models', *Marketing Science* **12**(3), 270–279.

Kirchhoff, S., B.G. Colby and J.R. LaFrance (1997), 'Evaluating the Performance of Benefit Transfer: An Empirical Inquiry', *Journal of Environmental Economics and Management* **33**, 75–93.

Krupnick, A.J. (1993), 'Benefit Transfer and Environmental Improvements', *Resources* **110**(Winter), 1–6.

Leeworthy, V.R. and J.M. Bowker (1997), *Nonmarket Economic User Values of the Florida Keys/Key West*. The Study Conducted in Conjunction with US Forest Service, The University of Georgia, The Nature Conservancy, NOAA, and Monroe County Tourism Development Council.

Loomis, J.B. (1992), 'The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer', *Water Resources Research* **28**, 701–705.

Loomis, J.B. (2001), *Final Snake River Contingency Value Methodology Study Report*. The Report Submitted to the Wyoming Bureau of Land Management, Wyoming.

Loomis, J. and D. White (1996), 'Economic Benefits of Rare and Endangered Species: Summary and Meta-analysis', *Ecological Economics* **18**, 197–206.

Loomis, J.B. and R.G. Walsh (1997), *Recreation Economic Decisions: Comparing Benefits and Costs* (Second Edition). Venture Publishing, Inc., Pennsylvania.

Loomis, J., B. Roach, F. Ward and R. Ready (1995), 'Testing the Transferability of Recreation Demand Models Across Regions: A Study of Corps of Engineers Reservoirs', *Water Resources Research* **31**, 721–730.

Loomis, J.B., R. Rosenberger and R.K. Shrestha (1999), *Updated Estimates of Recreation Values for the RPA Program by Assessment Region and Use of Meta-Analysis for Recreation Benefit Transfer*. Final Report for the USDA Forest Service, Colorado State University, Fort Collins.

Loomis, J.B., S. Yorizane and D. Larson (2000), 'Testing Significance of Multi-Destination and Multi-Purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips', *Agricultural and Resource Economics Review* **29**(2), 183–191.

MacNair, D. (1993), *1993 RPA Recreation Values Database*. USDA Forest Service, RPA Program, Washington D.C.

Markowski, M., R. Unsworth, R. Paterson and K. Boyle (1997), *A Database of Sport Fishing Values*. Industrial Economics Inc. prepared for the Economics Division, U.S. Fish and Wildlife Service, Washington, D.C.

McConnell, K.E. (1992), 'Model Building and Judgment: Implication for Benefit Transfer With Travel Cost Models', *Water Resources Research* **28**(3), 695–700.

Moeltner, K. (1998), *Demand for Hiking In the Alpine Lakes Wilderness – A Travel Cost Analysis*. An unpublished paper, Dept. of Economics, University of Washington.

Piper, S. (1998), 'Modeling Recreation Decisions and Estimating the Benefits on North Dakota River Recreation', *Rivers* **6**, 251–258.

Roach, B., K. Boyle, J. Bergstrom and R. Reiling (1999), 'The Effect of Instream Flows on White-water Visitation and Consumer Surplus: A Contingent Valuation Application to the Dean River, Maine', *Rivers* **7**, 11–20.

Rosenberger R. and J. Loomis (2000), 'Panel Stratification of Meta-Analysis of Economic Studies: An Investigation of Its Effects in the Recreation Valuation Literature', *Journal of Agricultural and Applied Economics* **32**(3), 459–470.

Sirkin, R.M. (1995), *Statistics for the Social Sciences*. SAGE Publications, Thousand Oaks, California.

Smith, V.K. (1992), 'On Separating Defensible Benefit Transfer From "Smoke and Mirrors" ', *Water Resources Research* **28**(3), 685–694.

Smith, V.K. and J. Huang (1995), 'Can Markets Value Air Quality? A Meta-Analysis of Hedonic Property Value Models', *Journal of Political Economy* **103**, 209–227.

Smith, V.K. and Y. Kaoru (1990), 'Signals or Noise?: Explaining the Variation in Recreation Benefit Estimates', *American Journal of Agricultural Economics* **72**, 419–433.

Smith, V.K. and L. Osborne (1996), 'Do Contingent Valuation Estimates Pass a Scope Test?: A Meta-analysis', *Journal of Environmental Economics and Management* **31**, 287–301.

Smith, V.K., G.V. Houtven and S.K. Pattanayak (2002), 'Benefit Transfer via Preference Calibration: Prudential Algebra for Policy', *Land Economics* **78**(1), 132–152.

Stanley, T.D. (2001). 'Wheat from Chaff: Meta-Analysis as Quantitative Literature Review', *Journal of Economic Perspectives* 15(3), 131–150.

Sturtevant, L.A., F.R. Johnson and W.H. Desvousges (1998), *A Meta-analysis of Recreational Fishing*, Unpublished Manuscript. Triangle Economic Research, Durham, NC.

U.S. Water Resources Council (1983), *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. U.S. Government Printing Office, Washington D.C.

U.S. Water Resources Council (1979), 'Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C)', *Federal Register* **44**(243), 72892–72976.

U.S. Water Resources Council (1973), 'Principles, Standards, and Procedures for Water and Related Land Resource Planning', *Federal Register* **38**(174), Part III.

Valdes, S. (1995), *Non-market Valuation of Recreational Resources: Testing Temporal Reliability in Contingent Valuation Studies and an Explanation of Benefit Transfer Procedures with Discrete Choice Models*. An unpublished Ph.D. dissertation, The University of Maryland.

Walsh, R.G., D.M. Johnson and J.R. McKean (1989), 'Issues in Nonmarket Valuation and Policy Application: A Retrospective Glance', *Western Journal of Agricultural Economics* **14**, 78–188.

Walsh, R.G., D.M. Johnson and J.R. McKean (1992), 'Benefit Transfer of Outdoor Recreation Demand Studies: 1968-1988', *Water Resources Research* **28**, 707–713.

Willig, R.D (1976), 'Consumer Surplus Without Apology', *The American Economic Review* **66**(4), 589–597.

Woodward, R.T. and Y.S. Wui (2000), 'The Economic Value of Wetland Services: A Meta-analysis', *Ecological Economics* **37**, 257–270.

Appendix A

Table A1: Full specification of national meta-regression model

Variables	MODEL1	MODEL2	MODEL3
CONSTANT	19.159*(10.20)	13.987(15.86)	–33.326(109.92)
METHOD	–17.598*(6.81)	–17.678*(6.98)	–17.660*(6.98)
OE	–7.468*(3.82)	–7.254*(4.06)	–7.272*(4.06)
SPRP	–38.170*(10.73)	–37.597*(9.79)	–37.607*(9.76)
PAYCARD	–28.33(19.72)	–28.222(19.67)	–28.241(19.64)
SUBS	–20.277*(5.08)	–20.336*(5.92)	–20.325*(5.91)
PHONE	–18.626*(4.24)	–18.801*(4.73)	–18.787*(4.73)
VALUNIT	–5.820(4.12)	–6.019(5.54)	–6.002(5.54)
TREND	1.613*(0.38)	1.625*(0.46)	1.626*(0.47)
FSADMIN	–20.056*(3.93)	–20.349*(5.14)	–20.334*(5.14)
R2	–6.581(5.08)	–7.147*(4.14)	–7.189*(4.15)
R5	–10.448(6.96)	–11.473*(6.70)	–11.507*(6.73)
R6	–14.218*(4.55)	–14.917*(5.48)	–14.968*(5.56)
R8	–8.756*(3.74)	–8.917*(3.64)	–8.936*(3.64)
R9	–7.124*(3.83)	–7.984*(4.43)	–7.984*(4.47)
R10	–14.980*(8.50)	–15.959*(7.79)	–15.996*(7.88)
LAKE	–16.803*(6.61)	–16.754*(6.82)	–16.756*(6.82)
RIVER	17.747*(8.05)	17.659*(8.83)	17.674*(8.83)
PUBLIC	21.655*(5.66)	22.051*(7.20)	22.089*(7.24)
OFFRD	–7.898(5.08)	–8.180(8.38)	–8.186(8.39)

Table A1: Continued

Variables	MODEL1	MODEL2	MODEL3
BIKE	–13.569*(7.63)	–13.703(9.27)	–13.702(9.28)
SNOWMOB	–20.299*(9.74)	–19.896(14.07)	–19.899(14.05)
BGHUNT	12.478* (3.42)	12.573*(3.99)	12.576*(3.99)
WATFOWL	10.161*(4.25)	10.260*(4.89)	10.260*(4.89)
FISH	9.057*(4.12)	9.094*(4.62)	9.097*(4.62)
ROCKCL	39.738*(12.59)	38.674*(12.59)	38.718*(12.62)
HORSE	–11.841*(5.11)	–12.175*(6.29)	–12.190*(6.32)
INCOME	–	0.0003(0.0004)	5.230(10.95)
Adjusted R2	0.26	0.25	0.25
F-STAT	9.98*	9.60*	9.60*

MODEL1 is the linear model reported in Table III, MODEL2 is the linear model with INCOME added as explanatory variable, MODEL3 is the linear-log model with natural log of INCOME as the explanatory variable. Numbers in parentheses are standard errors of parameters corrected for heteroskesdasticity and serial correlation using the Newey-West version of White's consistent covariance estimators and lag 6 periods, * = $p < 0.10$ or better based on t-statistics from corrected standard errors of the estimated parameters.