Valuation of Recreation in the National Parks: Estimating Micro Meta Models for Benefit Transfer[1]

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Introduction

The 397 units of the U.S. National Park System (NPS) are an extremely important U.S. recreational asset, supporting upwards of 280 million recreational visits annually (Street 2012) and driving the tourism economies of many U.S. regions (Stynes *et al.* 2000). Recreation values are an important policy analysis tool to inform management decisions affecting those park units. However, until very recently recreation values had only been directly estimated for a relatively small number of parks (Kaval and Loomis 2003; Duffield *et al.* 2009). Benefit transfer is an efficient approach for estimating values for a given park unit based on known values from sites that have been previously studied. This paper presents empirical estimates of benefit transfer functions for the U.S. National Park System based on stated preference survey responses from an NPS visitor survey administered at a cross-section of NPS park units. The study focuses on a subset of ecosystem service values including recreational, aesthetic, historical, and cultural values associated with on-site visitation. Left unaddressed is consideration of any passive use values.

Recreation use values are human benefits received from ecosystems such as rivers, wetlands, forests, etc. (Daily 1997; Brown *et al.* 2007). In national parks, nearly all the recreation is non-market in the sense that many sites are free and, where charged, entrance fees are only nominal amounts. Being non-market, economists must infer the non-priced benefits of ecosystems using visitor travel behavior (travel cost method), intended behavior as stated in surveys (for example, contingent valuation method) or from existing values in the literature derived from these methods. This last method is known as benefit transfer. Economic information developed for a given study site is used to make inferences about the economic value of environmental goods and services at another place and time, often referred to as the policy site (Boyle and Bergstrom 1992).

The motivation for benefit transfer is that regulatory and land management agencies are often required to assess the full economic benefits and costs of management and policy decisions. For example under Executive Order 12866, U.S. federal agencies must evaluate the benefits and costs from every economically-significant regulatory action. However, even if funding was available to complete original studies as needed, rarely can studies be completed in a timely way because of another federal policy: the Paperwork Reduction Act of 1995, which requires a lengthy Office of Management and Budget (OMB) review (often taking up to a year or more) of survey sample plans and instruments for federally funded research prior to conducting any survey work. Not all proposed surveys are approved. Given these time and resource constraints, it is not feasible to conduct original research for every regulatory issue that arises. As Ready and Navrud (2006) observe (at p. 198): “The choice is not between benefit transfer

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and conducting original studies. The choice, in many cases, is between conducting a benefit transfer and not including any estimate of the benefits from environmental goods and services."

Like the other federal natural resource management agencies, the NPS has a need for valuing recreation for policy, management, planning, and natural resource damage assessment. The founding legislation for the national parks in 1916 defined the dual mandate under which these parks are managed: "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same" (U.S. Department of Interior 1995). The "use and enjoyment" side of this mandate is manifested in the nearly 300 million visits to the system annually. These visits for recreational, aesthetic, cultural, and historical uses are an important component of the value derived from national parks.

While national parks were among the first settings considered for application of nonmarket valuation (Hotelling 1949; Clawson 1959), to date, valuation of recreational visits to NPS park units has been largely unsystematic and fragmented. Duffield *et al.* (2009) updated a literature review of NPS valuation studies by Kaval and Loomis (2003), and identified 27 different studies of NPS visitor WTP which included 128 different estimates of WTP. These estimates ranged from valuation of a trip floating the whitewater of the Grand Canyon of the Colorado (Bishop *et al.* 1989) to valuing the impact of climate change on recreational benefits in Rocky Mountain NP (Richardson and Loomis 2005). Hardner and McKenny (2006) developed a generalized estimate of total NPS system visitor WTP based on benefits transfer from existing studies of park unit net economic value (Kaval and Loomis 2003; Leggett *et al.* 2003). Heberling and Templeton (2009) were the first to use data collected by the NPS Visitor Services Project (VSP) within a count data travel cost (TC) model to estimate visitor WTP at Great Sand Dunes NP and Preserve. Building on the methods of Heberling and Templeton, a forthcoming paper used a broad spectrum of VSP survey data to estimate count data TC model estimates of park visitor WTP at 58 different NPS units system wide. These estimates were in turn employed in a meta-regression analysis to predict average visitor WTP per trip for all units in the NPS system (Neher *et al.* forthcoming).

While significant advances have been made in recent years in estimation of NPS visitor WTP, the current paper offers four unique extensions of this work. First, the paper reports WTP estimates for 12 NPS-sponsored representative cross-sectional park surveys that to date have not been reported in the literature. Second, the multi-park underlying data used in the analysis is stated preference, based on a dichotomous choice (DC) CV survey question. This CV methodology distinguishes the work from the recent revealed preference TC estimates reported by Neher *et al.* (forthcoming) and Heberling and Templeton (2009). The third contribution is in the reporting and comparison of estimated park-level WTP from both separate park-level CV models, and from an aggregated individual observation model of CV responses. A final contribution lies in exploring the robust nature of an estimated micro-meta model of WTP based on only 12 park observations. These different models are compared in terms of statistical model selection criteria, including model validity, usefulness for benefit transfer, and theoretical consistency.

Kaval and Loomis (2003) suggest that benefit transfer results may be biased because of uniqueness of the study site. While it could be argued that national parks fall into this category where benefit transfer results might be biased, we view the general recreation models presented as addressing this issue. These models are based on park visitor responses and are intended to be applied to other NPS units with similar park or visitor characteristics. Estimating WTP of the "average" core-season visitor to a specific park unit minimizes the severity of potential bias associated with a unique site (as compared to use of an estimated value from a different, dissimilar site. However, in the case of specialized user subgroups or activities (such as snowmobilers in Yellowstone NP), the general visitor WTP estimates provided could be biased. In these cases, researchers or park managers should also reference the broader set of valuation studies in the literature for estimates more closely tailored to the issues at hand.

The authors recognize the limitations of inherent in a meta-regression model based on only 12 park units. Accordingly, the meta-regression results are offered as a preliminary "proof of concept" rather than a definitive final model for general application to other park units. The methods and models presented are intended to inform the ongoing search for convergent validity in WTP estimation methods for NPS visitation, and for an appropriate reference methodology for use in valuation.

Methods for Benefit Transfer

Rosenberger and Loomis (2003) and Wilson and Hoehn (2006) provide overviews of methods for benefit transfer. Benefit transfer is generally one of three types: value transfer, value function transfer, and meta-analysis benefit transfer. Value transfer is simply using the most similar point estimate, for example of value per visitor day or per trip, or using an average of similar studies (for example the average value from all studies of a given type of activity). Value function transfer applies the estimated willingness to pay, or demand function, based on individual observations from an original study to the policy setting by setting the covariates in the estimated function at their policy-setting levels. The transferred function is modified in order to fit the specifics of the policy site by varying such factors as socioeconomic characteristics, extent of market, and environmental impact, and other characteristics that differ between the study site and the policy site. Meta-analysis benefit transfers utilize an estimated meta-regression equation where each observation is at the estimate or study level, the dependent variable is the willingness to pay measure, and the covariates typically include methodological variables, site specific variables, and user characteristics. However, practitioners must recognize that all three of these benefit transfer approaches are only as good as the underlying quality of the primary studies.

Data

We utilize a data set based on visitor surveys related to the NPS Fee Demonstration Program (Duffield *et al.* 1999). The 1998 NPS visitor survey was administered at 12 NPS park units selected to be representative of the diversity of the NPS system in terms of unit location, size, and type. The surveys used a stratified random sampling design and a repeat contact handout-mail back survey design (Dillman 1978; 2000). Overall, 2,644 of 3,735 distributed surveys were completed and returned for a response rate of 70.8%. Surveys were administered within the primary June-August tourist season, and were distributed over a one week period at each park.

The survey included one dichotomous choice contingent valuation question intended to value the visitors current trip, using increased travel costs as a payment vehicle (Boyle and Bishop 1988; Loomis and Caughlan 2003) and employing seven bid amounts ranging from $10 to $1,000 in roughly equal log intervals, to facilitate non-parametric analysis (for example, *Kriström 1990*) and to support tests for goodness of fit. Because the study was sampling for and valuing the average trip (not sampling for the average visitor), there was no need to correct for endogenous stratification (Shaw 1988).

Estimated Models

As a base-case model specification, bivariate logistic regression models, with log bid as the explanatory variable, were fit to the data for each park. The bid coefficients were all statistically significant (regression coefficients are not reported to conserve space). However, deviance goodness of fit statistics (Table 1) indicated the model did not fit well for some parks. Some smaller P-values are expected even if the model fits at all parks because of the multiple tests being performed, but not to the extent observed (four less than 0.05). Two alternatives were considered. One was including covariates in the logit models to obtain a better fit, which would complicate estimation of median WTP. Inclusion of covariates in the individual park models resulted in either varying specifications across parks or equivalent specifications with a large number of non-significant covariate parameters within the models. Both methods were problematic in regards to comparing estimated WTP across park units. The second alternative considered was using a nonparametric model for each park based on isotonic regression (*Kriström* 1990). However, sample sizes for some parks were too small to reliably estimate median WTP non-parametrically. Hence, we chose the median trip values calculated from the 12 separate bivariate logit models as reported in Table 1. Like some other analysts (Hanemann 1989), we prefer the median here as a more robust measure that is not as sensitive to the "fat tails" of the skewed willingness to pay distributions (Boyle *et al.* 1988) often identified in dichotomous choice studies. Estimated median trip valuation estimates (Table 1) range from a low of $44 per person at Allegheny National Historic Site to a high of $179 at Yellowstone National Park in 1998 (study year dollars).

Table 1. NPS 12-Park study park-level bivariate logit model results.

		Bivariate Logit Model			
Park Unit	**Sample Size**	**Median WTP($)**	**SE**	**Deviance**	**P-value[a]**
Allegheny	104	43.8	21.3	1.83	0.873
Colonial	232	79.1	19.4	17.04	0.004
Everglades	151	85.5	26.9	5.14	0.399
Frederick Douglass	26	69.9	42.6	3.97	0.554
Glen Canyon	142	138.0	44.4	11.32	0.045
Golden Gate	253	84.6	18.2	6.79	0.236
Grand Canyon	233	116.8	20.8	7.14	0.210
Independence	166	65.8	16.2	7.07	0.215
Mesa Verde	179	132.9	30.6	1.98	0.852
Sleeping Bear	112	45.2	13.2	9.93	0.077
Yellowstone	394	179.3	29.4	21.44	0.001
Yosemite	371	95.6	13.8	12.31	0.031

[a] from chi-square distribution with 5 d.f.

For comparison to the base-case estimates in Table 1, two other models were also specified. The first was an aggregated individual observation CV model combining the data from all park surveys. The second specification was a meta-regression model with the Table 1 bivariate WTP estimates as the dependent variable. In each case, the commodity valued was the current trip. Hanemann and Kanninen (1999) provide formula for measures of central tendency for Hicksian consumer surplus measures per trip for this model. Trip valuation was estimated rather than day values because the trip is the primary decision unit for NPS visitors, and trip values are a better match to how the NPS quantifies recreational use (reporting visits rather than activity days).

Model #1 Micro-data Meta-Analysis Model Based on Sample of 2,073 Individuals

There is some support in the literature for increased accuracy of benefit transfers using regional, pooled data models (Loomis 1992; VandenBerg *et al*. 2001; Piper and Martin 2001; Rosenberger and Stanley 2006). The Fee Demonstration data set was used to build a pooled WTP model via logistic regression using all 2,073 individuals across the 12 parks. We used log(BID), rather than BID, as an explanatory variable, both because the models tended to fit better with log (BID), and because it implies a non-negative WTP distribution. Because using log(BID) implies the WTP distribution is skewed to the right , we used median WTP as the measure of consumer surplus.

We selected a set of individual and park-level variables as candidates for inclusion in the model (Table 2). The variables selected were mostly the "core economic variables" suggested by theory (Bergstrom and Taylor 2006) and include visitor characteristics such as income, age and gender, and three park characteristics. With only 12 parks, it was not possible to consider a large set of park characteristics.

Table 2. NPS 12-Park Sample Models, Variable Coding.

	Variable Coding	
Variable	**Individual Observation Model**	**12 Park Meta-analysis Model**
BID	DCCV bid; 7 bid levels were included ranging from $10 to $1000	--
GENDER	0 or 1; 1 = male	Proportion of visitors who are male
AGE	Age in years	Mean age in years
UNDER25K	0 or 1; 1= person reported household income under $25,000	Proportion of visitors reporting household income under $25,000
OVER65K	0 or 1; 1= person reported household income over $65,000	Proportion of visitors reporting household income over $65,000
DAYS	Reported number of days spent at park (less than 1 day coded as 1 day)	Mean number of days spent at park
AFTER	0 or 1; 1 if visitor decided to visit the park after already being in the area	Proportion of visitors deciding to visit the park after already being in the area
NP	0 or 1; 1 if park unit is classified as a National Park	0 or 1; 1 if park unit is classified as a National Park
HISTORIC	0 or 1; 1 if park unit is classified as a National Historic Park or National Historic Site	0 or 1; 1 if park unit is classified as a National Historic Park or National Historic Site
ACRES	Size of the park unit in acres	Size of the park unit in acres

We selected the final model based on AIC and cross-validation (Fox 2008). In cross-validation, the data are partitioned into disjoint subsets of one or more individuals each. Each subset is considered in turn. The model is fit to all the data except that subset and the resulting model is used to predict the values of the response for the omitted subset. After all the subsets have been treated in this way, a predicted value has been generated for each individual that is based on data not including that individual. A measure of discrepancy between the actual and predicted values is then computed and aggregated over the entire data set. Since our data were collected by park, for the cross-validation we omitted all the data from each park in turn and used the candidate model fit to the remaining parks to predict responses for all the individuals in the omitted park. To measure the agreement between the observed 0-1 responses and the predicted probabilities, we used the sum of squared deviance residuals (Hosmer and Lemeshow 2000).

We first fit a model including all the variables (the right-skewed variables ACRES and DAYS were log-transformed) which fit adequately (Hosmer-Lemeshow goodness-of-fit test (Hosmer and Lemeshow 2000), X^2= 12.3, df=8, P=0.14). We then sought a reduced set of variables with adequate explanatory power using AIC as the criterion. The main effects model with lowest AIC and lowest cross-validation prediction error is given in Table 3 as Model 1A (the same model with GENDER had almost identical AIC and cross-validation accuracy; we chose the model with fewer variables). The fit of Model 1A was also adequate (Hosmer-Lemeshow X^2= 12.1, df=8, P=0.15) and the likelihood ratio test (LRT) test of this model versus the full model was not significant (G^2=2.10, df=3, P=0.55). The signs of the coefficients on all variables including income were consistent with expectations. The only park level variable retained in the model was NP, an indicator of whether the park is a national park.

Table 3. Model 1A: 12-park individual observation model.

Variable	Estimate (*b*)	Std. Error	*z*	Pr(>|z|)	exp(*b*)
(Intercept)	2.416	0.274	8.81	< 0.001	
log(BID)	-0.781	0.039	-19.96	< 0.001	0.46
NP	0.328	0.111	2.95	0.003	1.39
AGE	0.016	0.004	3.89	< 0.001	1.02
log(DAYS)	0.225	0.094	2.38	0.017	1.25
UNDER25K	-0.637	0.190	-3.35	0.001	0.53
OVER65K	0.749	0.110	6.83	< 0.001	2.12
AFTER	-0.395	0.156	-2.53	0.011	0.67

Hosmer-Lemeshow goodness-of-fit test: X^2 =12.13, df=8, P=0.145

We next investigated interactions among the variables (excluding BID) in Model 1A. As a group, the interactions were not statistically significant (LRT: G^2=11.8, df=14, P=0.62) and no interaction or combination of interactions improved the fit of the model as measured by cross-validation and AIC. Therefore, we retained Model 1A as the final model. The coefficients all had the expected signs. The column "Exp(*b*)" can be interpreted as the increase in the odds of a positive response for a one-unit increase in that variable. For example, the odds that a person with income level below $25K will respond positively to a given bid are estimated to be 0.529 times less than the odds that a person with income $25K-65K will respond positively, other variables being equal. In turn, the odds that a person with income over $65K will respond positively to a given bid are estimated to be 2.115 times greater than the odds that a person with income $25K-65K will respond positively, given other variables equal.

The estimated median WTP for a fixed set of values of the explanatory variables is exp(-*b'x/a*) where *x* is the vector of explanatory variables, excluding log(BID) but including a 1 for the constant, *b* is the vector of estimated coefficients corresponding to those variables, and *a* is the coefficient on log(BID) (Hanemann 1989). A standard error can be computed via the delta method from the estimated covariance matrix of *b* and *a*.

The use of Model 1A for park-level predictions is complicated by the fact that the model is for individuals. One way to use the model is to estimate median WTP for a representative sample of visitors to a park for which the appropriate covariates (such as age and income) have been recorded and then average the estimated WTP's. We tried this approach on the current data and found the estimated mean WTP's to be substantially higher in some cases than estimated median WTP from a bivariate logit model fit to each park. The reason was that some individual predicted WTP's were unrealistically high (usually for individuals at extremes of the covariates where prediction is much less reliable). More reasonable estimates were obtained by estimating median WTP at the average of the explanatory variables for each park and are reported in Table 5. However, this approach is not completely satisfying either as the WTP of an "average visitor" to a given park is not the same as the mean WTP across all visitors to the park. Alternative approaches would be to truncate the estimates for individuals in some way before aggregating, or to use the median of the median values for individual observations.

In order to apply this model to calculate estimated median WTP for out-of-sample parks, it was necessary to consider which variables are available from existing surveys for national park units. The NPS Visitor Services Project (VSP) located at the University of Idaho has surveyed many park units and all VSP park reports are available on the VSP website (Visitor Services Project 2009). While the VSP data set has many surveys that include most of the explanatory variables in Model 1A, only a few have a variable that corresponds well to AFTER. Income and days per trip are also reported in only a limited number of surveys. Income is problematic in that the reported measure is sometimes on a per-person basis and sometimes on a household basis in the VSP data set. There is also a problem with varying endpoints for income categories (e.g., under $25,000 versus under $20,000) and with adjusting for changes in income across different years.

In order to utilize the VSP data set, we identified the income category that corresponded most closely to variables UNDER25K and OVER65K after adjusting for inflation. To address the limited availability of AFTER, we built a second model, Model 1B, excluding this variable (Table 4). Although omission of the variable AFTER caused both the full model and the reduced model to have a significant lack of fit by the Hosmer-Lemeshow test (X^2 = 21.9,df=8, P=0.005 for the full model, X^2 = 21.9,df=8, P=0.005 for Model 1B), Model 1B fit nearly as well as Model 1A according to AIC and cross-validation. Predicted values at the covariate means and standard errors for the in-sample parks were also similar for the two models (Table 5). The significant Hosmer-Lemeshow tests may be a function of the large sample size and corresponding high power to detect small deviations from the model (a test of fit based on smoothed residuals was not significant for either model). The leave-one-out (LOO) park estimates of median WTP are, in general, very similar to the fitted values for both models with the exception of Yosemite National Park where the LOO estimate was about 30% higher than the full model estimate ($229 vs. $176). This indicates the models are fairly robust to small changes in the data set.

Table 4. Model 1B: 12-park individual observation model. Same as Model 1A with variable AFTER omitted.

Variable	Estimate (*b*)	Std. Error	*z*	Pr(>|z|)	exp(*b*)
(Intercept)	2.372	0.271	8.74	< 0.001	
log(BID)	-0.783	0.039	-20.08	< 0.001	0.46
NP	0.365	0.110	3.32	0.001	1.44
AGE	0.015	0.004	3.72	< 0.001	1.02
log(DAYS2)	0.269	0.093	2.89	0.004	1.31
UNDER25K	-0.670	0.189	-3.53	< 0.001	0.51
OVER65K	0.745	0.109	6.81	< 0.001	2.11

Hosmer-Lemeshow goodness-of-fit test: X^2 = 21.9,df=8, P=0.005

Table 5. Comparison of estimated median WTP from individual park bivariate logit models with model 1A and 1B predictions at park-level covariate means. Also includes leave-one-out (LOO) estimated WTP for each park from models 1A and 1B fitted to the data excluding that park.

	Bivariate Logit		Model 1A			Model 1B		
Park	**Estimate**	**SE**	**Estimate**	**SE**	**LOO**	**Estimate**	**SE**	**LOO**
Allegheny	43.8	21.3	63.2	7.1	63.5	65.2	7.2	65.5
Colonial	79.1	19.4	85.7	8.6	85.6	84.1	8.4	83.6
Everglades	85.5	26.9	108.8	11.4	109.9	110.4	11.4	112.3
Frederick Douglass	69.9	42.6	66.2	7.2	66.5	70.2	7.3	70.6
Glen Canyon	138.0	44.4	128.2	20.2	121.1	125.3	19.5	117.7
Golden Gate	84.6	18.2	89.3	9.4	83.9	86.9	9.0	80.1
Grand Canyon	116.8	20.8	122.5	11.2	118.1	119.4	10.8	115.5
Independence	65.8	16.2	83.7	8.5	85.3	85.5	8.5	87.3
Mesa Verde	132.9	30.6	109.5	10.8	100.4	112.1	10.9	103.0
Sleeping Bear	45.2	13.2	69.8	7.4	75.0	71.4	7.4	77.3
Yellowstone	179.3	29.4	146.9	13.8	134.2	146.8	13.8	133.3
Yosemite	95.6	13.8	175.1	20.0	220.5	175.9	20.0	228.7

We then used Model 1B to predict median WTP at a selection of eight VSP-surveyed park units (Table 6). These parks were chosen as having the most recent VSP survey data available for average length of visitor trip. Also reported are 95% confidence intervals for the median consumer surplus at the park in question. Relative to the in-sample estimates, the predicted values have a broad and reasonable range from $54 for Stones River National Battlefield in Tennessee to $237 for Katmai National Park.

Table 6. Model 1B: 12-park individual observation micro-meta model out-of-sample predicted median WTP at covariate means.

PARK	NP	Mean Age	Mean Days	Under 25K	Over 65K	Predicted WTP	SE	95% CI
Bryce Canyon NP	1	43.22	1.37	0.233	0.470	110.5	10.6	89.7 -- 131.3
Biscayne NP	1	45.19	1.76	0.159	0.372	120.8	10.7	99.8 -- 141.9
Crater Lake NP	1	47.81	1.30	0.334	0.220	86.0	9.2	67.9 -- 104.1
Stone River NB	0	49.64	1.10	0.296	0.210	53.7	6.4	41.2 -- 66.2
Apostle Islands NL	0	48.83	4.02	0.212	0.307	97.9	18.0	62.8 -- 133.0
Katmai NP & Preserve	1	51.02	2.02	0.041	0.797	237.1	25.7	186.6 -- 287.5
Great Smokey Mtns. NP	1	49.64	2.21	0.134	0.499	165.6	16.3	133.8 -- 197.5
City of Rocks NR	0	45.45	2.28	0.201	0.406	83.6	11.0	62.1 -- 105.2

Model #2: Meta-Analysis Model Based on Identical CV Methods Applied to 12 Parks

Another approach to using the 12-park data set is to build a park-level prediction model, as in Model 1, where an estimated WTP value for each park from Table 1 is used as the dependent variable in a linear regression model. The advantage of this data set is that the methodology and survey time frame are identical across parks compared to the disparate methods and dates of the expanded Kaval-Loomis data set. Potential explanatory variables (Table 4) are analogous to those used in Model 1, but aggregated or averaged at the park level. Since the number of cases was small, we considered a limited set of explanatory variables based on Model 1 and the variables available for prediction at parks outside of the data set. These variables include NP, HISTORIC, ACRES (log transformed), AGE (mean), UNDER25K (proportion), and OVER65K (proportion).

Compared to Model 1, there are several potential advantages of this approach. There may be a stronger relationship between aggregated WTP and park-level explanatory variables than between individual WTP and individual-level and park-level explanatory variables. Second, individual data are not required for prediction. Finally, the response is an aggregated WTP rather than a binary response which makes interpretation of the coefficients easier. Disadvantages are the limited number of data points (one per park) and the loss of information about individuals that may be useful in a predictive model. In addition, the value attached to each park in the sample must be estimated from the dichotomous choice CV data in some fashion and the resulting model may be dependent on how this is done.

Table 7. Model 2: 12-park weighted regression meta-model.

Variable	Estimate	SE	z	Pr(>|z|)
(Intercept)	4.466	0.167	26.78	< 0.001
NP	0.601	0.144	4.21	0.002
UNDER25K	-3.336	1.340	-2.49	0.034

$R^2 = 0.71$, F = 11.2 on 2 and 9 df, P = 0.0036

Model 2 is estimated using median WTP values (MEDIAN) derived from the bivariate logit models at each park separately (see Table 1). We also estimated the variance of each estimated median and used weighted least squares (with weights inversely proportional to the variances) to model log(MEDIAN) as a function of the explanatory variables. We again used AIC and cross-validation (with the sum of the weighted squared errors as the criterion), focusing primarily on the latter, to build a model. The final model, Model 2 in Table 7, had only two explanatory variables, NP (0 or 1) and UNDER25K (proportion of visitors with income under $25K). Two models with more variables and lower AIC performed considerably worse by cross-validation. Residual analysis of both the full and final weighted least squares models indicated no problems with the standard regression assumptions regarding uncorrected heteroskedasticity or excessive non-normality.

Table 8. Comparison of median WTP (estimated from individual park bivariate logit models) to predicted median WTP from Model 2.

			Bivariate Logit		Model 2		
Park	**NP**	**UNDER 25K**	**Estimate**	**SE**	**Prediction**	**95% CI[a]**	**LOO[b]**
Allegheny	0	0.148	43.8	21.3	53.1	42.0 – 67.2	55.2
Colonial	0	0.052	79.1	19.4	73.2	56.6 – 94.6	71.3
Everglades	1	0.120	85.5	26.9	106.4	82.5 – 137.3	109.8
Frederick Douglass	0	0.160	69.9	42.6	51.0	39.5 – 65.9	50.2
Glen Canyon	0	0.069	138.0	44.4	69.1	55.0 – 86.6	67.3
Golden Gate	0	0.048	84.6	18.2	74.1	56.9 – 96.5	70.1
Grand Canyon	1	0.167	116.8	20.8	91.0	67.5 – 122.8	82.3
Independence	0	0.049	65.8	16.2	73.8	56.8 – 95.9	78.7
Mesa Verde	1	0.118	132.9	30.6	107.0	83.0 – 138.1	104.6
Sleeping Bear	0	0.182	45.2	13.2	47.4	35.0 – 64.2	54.0
Yellowstone	1	0.110	179.3	29.4	110.1	85.3 – 142.1	104.0
Yosemite	1	0.090	95.6	13.8	117.4	90.1 – 153.0	145.0

[a] Since Model 2 used log(median WTP) as the response variable, the 95% confidence intervals for the predicted values were computed by transforming back 95% confidence intervals for log(median WTP).

[b] Leave-one-out predicted value.

Since the response variable is logged, exp(*b*) is an estimate of the multiplicative effect of a one-unit increase in a variable on estimated median WTP. Thus a national park has estimated value exp(0.6013) = 1.82 times higher than a non-national park given the same income distribution of visitors. A 0.01 (one percentage point) increase in the proportion of visitors with incomes under \$25K results in a predicted median WTP exp(.01 x -3.3362)= 0.967 times as big, or a 3.3% reduction in predicted median WTP. Table 8 shows a comparison of the original Table 1 median WTP estimates and the estimates based on Model 2.

Predicted values for the out-of-sample parks using Model 2 are reported in Table 9. Even though Model 2 has only two explanatory variables, the predicted values have a reasonable range relative to the literature, from \$32 for Stones River National Battlefield to \$138 for Katmai National Park.

Table 9. Model 2: 12-park weighted regression meta model out-of-sample predicted median WTP.

			Model 2	
Park	**NP**	**UNDER25K**	**Prediction**	**95% CI[a]**
Bryce Canyon NP	1	0.233	72.9	47.0 – 113.2
Biscayne NP	1	0.159	93.5	70.2 – 124.6
Crater Lake NP	1	0.334	52.1	25.5 – 106.1
Stone River NB	0	0.296	32.4	17.6 – 59.5
Apostle Islands NL	0	0.212	42.9	29.4 – 62.5
Katmai NP & Preserve	1	0.041	138.4	98.7 – 194.1
Great Smokey Mtns. NP	1	0.134	101.5	78.2 – 131.8
City of Rocks NR	0	0.201	44.5	31.4 – 63.1

[a] Confidence intervals back-transformed from confidence intervals for log(WTP) as in Table 8.

Discussion

We have estimated two different models that can provide a basis for benefit transfer related to visitor use at sites in the National Park System based on a 1998 NPS survey of 12 NPS units. Our conclusion is that both models work as demonstrated however their wide applicability is limited by the small sample of park units available for the analysis. What is needed is to expand this set of consistently estimated park values. The estimated models demonstrate that it is feasible to predict values for a large set of park units from a relatively small set of original studies. We further compared the models in terms of model validity, consistency with theoretical guidelines, and usefulness for benefit transfer.

Both Models 1 and 2 are valid and theoretically consistent models that can be utilized in benefit transfer. Their utility in conjunction with the existing VSP data set is demonstrated on an out-of-sample set of parks (Tables 6 and 9). These predictions have sufficiently precise confidence intervals to inform valuation differences across parks. For the models estimated, using a consistent methodology on an original data set avoids some of the problems associated with studies of varying age, sampling methods, and valuation methodology.

The chief limitation of these models is that they are based on a relatively small sample of parks. One way to increase the sample would be by including a valuation question in the on-going VSP studies referenced earlier. We would also recommend including standardized measures of core economic variables such as income. Including a valuation question in future VSP surveys would parallel in part the valuation effort by the U.S. Fish and Wildlife Service for wildlife refuges in the U.S. (Aiken and La Rouche 2003), and would quickly expand the sample of parks available for modeling. It should be noted, however, that NPS is limited under its OMB approval in the type and wording of questions allowed in the VSP surveys. Inclusion of additional valuation questions would necessitate securing OMB approval under the Paperwork Reduction Act. Expansion of the set of park unit survey data sets available for CV modeling would also facilitate inclusion of an expanded set of park and visitor characteristics in the WTP models.

A second possible limitation of the models presented is they do not provide activity-specific values, but rather average visitor values. Many park planning decisions involve consideration of actions specific to specialized subsets of the visitor population. Examples might be changes in park access policy for snowmobiles in Yellowstone NP or for whitewater floaters in Grand Canyon NP. In these cases values for the average visitor (based on a sample of summer visitation) may provide a biased estimate. If a given policy issue requires activity-specific values, an alternative is to use an average activity-specific value from the larger literature (for example, as summarized in Rosenberger and Loomis (2001)). For the specific activity of fishing, sources are Markowski et al. 1997 and Aiken and La Rouche (2003). However, in many cases, and for many NPS units (such as the myriad of relatively small historical sites), visitor use is likely much more homogeneous than in the cases of high-profile, large area units such as Yellowstone or the Grand Canyon. In these cases, WTP estimates for the average core season visitor are likely a good metric to use in policy analysis. Significant expansion of the park unit data available for analysis could also allow for inclusion of activity-specific covariates in estimated models, thus mitigating to an extent this limitation of the current analysis.

In sum, there are a variety of benefit transfer approaches that can be tailored to the available data on a particular ecosystem service. While it is true that benefit transfer only provides an approximate estimate of the value of an ecosystem service relative to original site-specific survey based estimates, omission of economic values of recreation often implies a zero value to many decision makers. Any of the benefit transfer models presented in this paper yield estimates statistically greater than zero. While economists should continue to improve the accuracy of benefit transfer, we should not lose sight of the fact that it is important to convey to decision makers and the public that recreation does in fact have economic value that is in addition to visitor expenditure impacts on local economies.

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