AN ABSTRACT OF THE DISSERTATION OF

Arvin B. Vista for the degree of Doctor of Philosophy in Forest Resources presented on June 10, 2010.

Title: Three Essays on Meta-Analysis, Benefit Transfer, and Recreation Use Valuation.

Abstract approved:

Randall S. Rosenberger

This dissertation consists of three essays on meta-analysis, benefit transfer and recreation use valuation. The first two essays were based on the sportsfishing valuation literature in the US and Canada while the third essay was based on a study site in the Philippines and selected study sites from the US. The first essay evaluates the aggregation structure of primary research studies and its implications for benefit transfer using meta-regression analysis. Results indicate that single-site and regional studies should not be pooled without accounting for their differences in a meta-analysis. The second essay examines the implications of addressing dependency in the sportsfishing valuation literature using meta-regression analysis. Results indicate that median absolute percentage transfer error is lower for the meta-regression models based on a single value, i.e. average-set and best-set metadata than the meta-regression models based on all-set. The average-set and best-set are two treatments of the metadata for avoiding dependency. The third essay applies the methodological treatments learned from the first two essays to estimate the recreational value via benefit transfer of Taal Volcano Protected Landscape in the Philippines. Results show that single point estimate transfer worked better than the meta-regression benefit function transfer. Recommendations based from the three essays include: 1) the need

to account for aggregation differences among primary studies to minimize biased value estimates in benefit transfer depending on policy settings; 2) the importance to correct for dependency and other methodological pitfalls in meta-regression is always warranted; 3) metadata sample selection is best guided by the goals of the meta-analysis and perceived allowable errors in benefit transfer applications; and 4) the conduct of primary study is still the first best strategy to recreation use valuation, given time and resources.

Three Essays on Meta-Analysis, Benefit Transfer, and Recreation Use Valuation

by

Arvin B. Vista

A DISSERTATION

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Presented June 10, 2010
Commencement June 2011

Doctor of Philosophy dissertation of Arvin B.Vista presented on June 10, 2010.

APPROVED:

Major Professor, representing Forest Resources

Head of the Department of Forest Engineering, Resources and Management

---

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Arvin B. Vista, Author

ACKNOWLEDGEMENTS

I am grateful to many people for making this dissertation possible and successful.

First, I want to thank my major professor and mentor Randall Rosenberger for his guidance, advice and assistance in many forms throughout my PhD studies. Also, I would like to thank William Jaeger, Jeff Kline, Kreg Lindberg, and Steven Radosevich, for providing valuable comments and serving as my PhD committee.

Second, I would like to thank Lisa Ganio, Manuela Huso, and Robert Johnston for their statistical advice and assistance in estimating the models using jackknife data splitting technique. Funding for my research was supported in part by US EPA STAR grant #RD-832-421-01 to Oregon State University (Randall Rosenberger as PI).

I am also indebted to the following people: members of Knollbrook Christian Reformed Church through the leadership of Pastor Ken Van Shelven for continuous encouragement and prayers; Ipat Luna for providing background information on Taal Volcano Protected Landscape; and my mother-in-law, Loyola Viriña for providing comments on Essay 1 and helping us during her summer 2009 visit at Corvallis, Oregon;

Special thanks go to my wife, Loida for her support, patience, and understanding. And to our precious son Joshua Caleb who is our joy and delight.

Finally, I exhort my gratitude to our Lord Almighty for daily provisions, strength and grace. His words are constant source of inspiration to make things possible and worth fulfilling.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

THREE ESSAYS ON META-ANALYSIS, BENEFIT TRANSFER, AND RECREATION USE VALUATION

CHAPTER 1 – INTRODUCTION

Households combine time, skill, experience, market goods (e.g. equipment), and natural resources and facilities to produce their recreation experiences. Adapting the household production theory, an individual (i.e. the decision-maker in the household) is assumed to seek maximum enjoyment from all of life's activities, including recreation. The recreation economic rule is that an individual should continue to participate in available recreational activities that provide the most benefit, i.e. if the additional or marginal benefits are equal or greater than the price to experience that activity. An individual's participation is contingent upon their willingness-to-pay (WTP) and ability to pay. WTP represents the economic value of recreation, which is the amount an individual, is willing to pay rather than forego the recreation activity. Ability to pay, a constraint on WTP, is directly affected by an individual's income/money, available time, effort, and opportunity costs of recreation.

Given perfect information (i.e. price = marginal value), the choices of an individual reflect his or her value of recreational experiences. An individual's choices are constrained by income/money, time, experience, and/or resource availability. The benefit derived by an individual from some recreational activities, say freshwater fishing in a lake, is an economic measure that indicates how much pleasure, usefulness or utility the individual obtains from the experience.

This chapter discusses 1) the basic economic theory and concepts of economic valuation, with a focus on recreation, 2) why these values are needed and their applications; and 3) the organization of the dissertation.

Economic Valuation: Focus on Recreation

Economic valuation assigns quantitative values to the goods and services provided by environmental resources. Value is the quality of a thing according to which it is thought of as being more or less desirable, useful, estimable or important. One of the many possible ways to define and measure value is through the use of economic value. Economic values are useful to consider when making economic choices that involve exchange of property rights. Economic valuation is anthropocentric since it is based on preferences held by people.

Preferences are subjective values expressed in relative terms such that one thing is deemed to be more desirable or important than another. People's preferences are the basis for value judgments. Neoclassical economic theory assumes that each individual has a set of preferences over bundles of goods and services that can be ordered in terms of desirability. For example, consider an individual faced with possible consumption bundles of M market and N non-market goods and services. Market goods $M = [m_1, m_2, ..., m_n]$, are those goods or services traded in a market like fishing gear, boots, maps, etc., while non-market goods $N = [n_1, n_2, ..., n_n]$ are those goods or services not-traded in the market, like clean air and water, recreational fish stocks, etc. Neoclassical economists further assume that an individual’s utility increases at a decreasing rate as (M, N) increases, i.e. the law of diminishing marginal utility – an individual’s consumption declines from each additional unit or bundle of goods and services since the marginal utility or benefits also decline. In particular, increases in benefits get smaller and smaller with each additional recreation trip consumed.

In economics, the values of goods and services are measured in terms of utility which is the relative satisfaction from or desirability of consumption of various goods and services. Utility functions defined over these goods and services are used as an ordinal representation of an individual’s preferences. In this mathematical model, economists assume a utility-maximizing behavior of an individual (hence, termed rational) coupled with a description of underlying economic constraints (income, supply, and time and timing of good availability). Utility is maximized when no reallocation of one's budget can improve it.

Suppose an individual faces two bundles (M^A, N^A) and (M^B, N^B), then a utility function can be assigned to each bundle, resulting in the following utility functions: $U(M^A, N^A)$for bundle *A* and $U(M^B, N^B)$ for bundle *B*. A rational individual would choose that bundle of goods and services that provides the highest level of utility. If an individual prefers (M^A, N^A) over (M^B, N^B), given that preferences are complete, reflexive, transitive, continuous and strongly monotonic, then $U(M^A, N^A) > U(M^B, N^B)$. However, it is difficult to measure a person's utility or compare it with other individuals' utilities. Instead, economists observe individual behavior through choices made, which reflect one's preference ordering (e.g. an individual chooses bundle *A* over *B*). According to Holland (2002, p.17), "all choice is basically a form of exchange." The only way of understanding a person's real preference is to examine his actual choices. Hence, the relative value of a given resource is revealed by the choices that people make (Bromley and Paavola, 2002).

Fixed monetary income, *Y* and prices of goods and services, $P = (p_1, p_2, ..., p_n)$ constrain[1] the individual's choice of bundles of goods and services (M, N). An individual's problem then is to maximize utility by selecting some combination of (M, N), wherein the level of *N* is exogenously determined, subject to fixed income *Y* and prices of (M, N). Let 0 superscript denote the initial level/status quo condition, then the individual problem of utility maximization is written as:

$$\text{Max}_M\ U(M, N) \text{ subject to } P * M \leq Y,\ N = N^0. \qquad \text{Equation 1.1}$$

Ignoring boundary problems, the utility-maximizing choice vector $M^* = M(P, N, Y)$ must meet the budget constraint with equality. The vector $M^* = M(P, N, Y)$ lists the Marshallian demand function for each market good. The demand function relates *P* and *Y* to the demanded bundle *M*. The function $v(P, M, Y)$

that gives the maximum utility at prices *P* and income *Y* results in an indirect utility function. The individual's problem can be restated as:

$$v(P,N,Y) = \max U(M,N) \text{ subject to } P*M = Y. \qquad \text{Equation 1.2}$$

The individual's problem of utility-maximization can be written also as a cost-minimization problem. The individual's cost- or expenditure-minimization problem is given by:

$$e(P,N^0,\overline{U}) = \min_M (P*M)$$

$$\text{subject to } \overline{U}(M,N) \geq U(M,N^0) \qquad \text{Equation 1.3}$$

where $e(P,N^0,\overline{U})$ is the expenditure function, which is the minimum cost necessary to achieve fixed level of utility $\overline{U}$. The solution to this cost-minimization problem is the Hicksian vector of compensated demands $M^H = M(P,N,U)$.

Hicksian (compensated) demand functions correct for the income effect whereas Marshallian (ordinary) demand functions do not[2]. The demand curve for recreational activities is negatively sloped because it is constrained by income, presence of a substitute area, and diminishing marginal utility. A Marshallian or Hicksian demand schedule can be derived from the demand function that shows the number of trips taken at different prices. Prices, defined here as the summation of transportation cost, opportunity cost of travel time, and entrance fee.

Information about the demand for recreational activities is useful for estimating the economic value of recreation benefits (usually in a money metric measure), predict future recreation use, and estimate the effect of different factors on recreation use and value (e.g. entrance fee, quantity and quality changes in resources). The money metric measure is represented in terms of surplus, i.e. the net benefit or the difference between the benefits that an individual received from a given recreational activity less what it costs to experience it (where costs may include non-monetary costs, etc.). An individual chooses to engage in a given recreational activity as long as the benefit exceeds the costs at the margin.

Surplus Measures

There are five measures of surplus. Consumer surplus (CS) is the usual approximate measure of surplus. John Hicks (1941) identified four better measures of surplus, such as compensating variation (CV), equivalent variation (EV), compensating surplus (CoS), and equivalent surplus (ES).

Marshallian CS is a close and acceptable approximation to the Hicksian measures of the consumer welfare effects of a price change (CV and EV) only when the utility function is quasilinear, i.e. the function is linear in one of the goods but (possibly) non-linear in the other goods. In estimating the change in CS, it is assumed the there is only one good (i.e. there is no substitution effect) and the marginal utility of income is constant.

There are two Hicksian monetary measures of the utility change associated with price changes: 1) the CV, which is the change in the amount of income that would compensate an individual in keeping an old/initial utility level given a new price set, implying the status quo assignment of property right; and 2) the EV, which is the change in the amount of income that would bring an individual to a new utility level given old price set, implying new assignment of property right. Let 0 superscripts denote the initial level/status quo conditions and 1 superscripts denote new conditions, the CV measure using the indirect utility function is given by:

$$v\left(P^0, N^0, Y^0\right) = v\left(P^1, N^1, Y^1 - CV\right) \qquad \text{Equation 1.4}$$

while the EV measure is given by:

$$v\left(P^0, N^0, Y^0 + EV\right) = v\left(P^1, N^1, Y^1\right). \qquad \text{Equation 1.5}$$

Using the expenditure function and considering a policy that provides a price decrease, CV and EV measures for a price decrease for good *i* (such that $p_i^0 > p_i^1$) can also be represented as:

$$CV = e\left(p_i^0, P_{-i}^0, N^0, U^0\right) - e\left(p_i^1, P_{-i}^0, N^0, U^0\right) = \int_{p_i^1}^{p_i^0} m_i^h\left(s, P_{-i}^0, N^0, U^0\right) ds$$

Equation 1.6

$$EV = e\left(p_i^0, P_{-i}^0, N^0, U^1\right) - e\left(p_i^1, P_{-i}^0, N^0, U^1\right) = \int_{p_i^1}^{p_i^0} m_i^h\left(s, P_{-i}^0, N^0, U^1\right) ds$$

Equation 1.7

where P_{-i} refers to the price vector left after removing p_i, and s represents p_i along the path of integration.

Another name for CV and EV welfare measures are willingness-to-pay (WTP) and willingness-to-accept (WTA). WTP is the amount one has to offer to acquire a good which he/she does not have legal entitlement to it. WTA is the amount the subject asks to voluntarily give up a good. WTP is associated with a desirable change while WTA is associated with a negative change. In WTP, an individual does not currently have the good, while in WTA an individual has the legal entitlement to the good and is being asked to give up that good. Table 1.1 shows the monetary measures for price changes. WTA is usually substantially higher than WTP, the discrepancy of the two is due to 'weak' experimental features such as hypothetical payments, student subjects, or elicitation questions that are not incentive-compatible (Horowitz and McConnell, 2002).

Table 1.1. Hicksian monetary measures for price changes.

Welfare measure	Implied property right	Price decrease	Price increase
Compensating Variation	Status quo	Willingness-to-pay to obtain	Willingness-to-accept to accept
Equivalent variation	Change (new status)	Willingness-to-accept to forego	Willingness-to-pay to avoid

CV and EV are measured as the area under a compensated 'Hicksian' demand curve. For a price change, the CV is the area under the Hicksian demand curve, $m_i^h\left(p_i, P_{-i}^0, N^0, U^0\right)$ measured at the initial utility level and the two prices. Similarly, the EV is the area under the Hicksian demand curve, $m_i^h\left(p_i, P_{-i}^0, N^0, U^0\right)$ measured at the new utility level and the two prices. For a price decline, CV is equivalent to area (A), EV is equivalent to area (A+B+C), and CS is equivalent to area (A+B). Similarly for a price decline, CV < CS < EV. For a price rise, CV is equivalent to area (A+B+C), EV is equivalent to area (A), and CS is equivalent to area (A+B) (Figure 1.1).

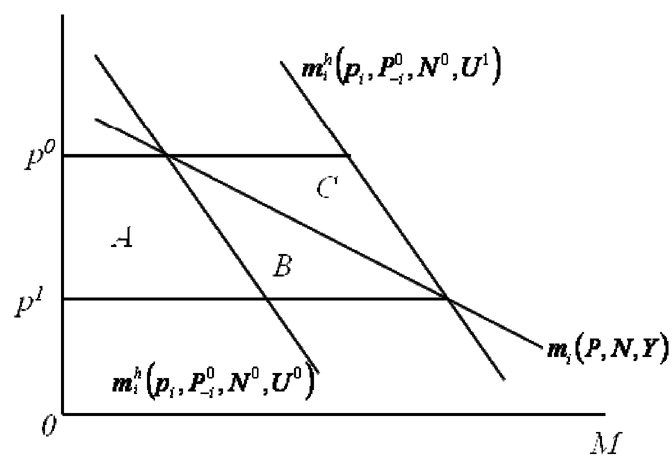

Figure 1.1 Consumer surplus, compensating and equivalent variations for a decline in price.

The budget allocated in recreation by a representative household is small hence income effect is not significant. In this regard, the welfare measure is equivalent to the Marshallian CS since CV and EV converges, assuming no substitution effects. In a study of the demand for deer hunting trips, Creel and Loomis (1991, p. 370) found that Hicksian measures to be "very close to the Marshallian measures, with similar confidence intervals" for different statistical models.

There are two Hicksian monetary measures of the utility change associated with changes in quality or quantity of environmental goods and services: 1) the CoS, which is the amount of income, either given or taken away, that would keep an individual at his/her old utility level, given a new quantity set; and 2) the ES, which is the amount of income, either given or taken away, that would bring an individual to a new utility level, given old quantity set. Using the expenditure function, CoS and ES measures for a quantity increase for good *j* (such that $n^0 < n^1$) is represented as:

$$CoS = e\left(p_i^0, n_j^0, N_{-j}^0, U^0\right) - e\left(p_i^0, n_j^1, N_{-j}^0, U^0\right) = \int_{n_j^0}^{n_j^1} m_i^v\left(s, P^0, N_{-j}^0, U^0\right) ds$$

Equation 1.8

$$ES = e\left(p_i^0, n_j^0, N_{-j}^0, U^1\right) - e\left(p_i^0, n_j^1, N_{-j}^0, U^1\right) = \int_{n_j^0}^{n_j^1} m_i^v\left(s, P^0, N_{-j}^0, U^1\right) ds$$

Equation 1.9

Table 1.2 summarizes the situation in regard to Hicksian monetary measures of the utility changes associated with changes in the quality/quantity of a non-market good. Compared to CV and EV, CS is not possible to use as approximation of CoS and ES measures (Bockstael and McConnell, 1993). An example of quantity changes is an increase in water flow in a river. They are shown, for the case of a quantity increase from n^0 to n^1 in Figure 1.2. For a quantity increase, CoS is equivalent to area (A) and ES is equivalent to area (A+B).

Table 1.2. Hicksian monetary measures for quantity changes.

Welfare measure	Implied property right	Quantity decrease	Quantity increase
Compensating Surplus	Status quo	Willingness-to-accept to accept	Willingness-to-pay to get
Equivalent Surplus	Change (new status)	Willingness-to-pay to avoid	Willingness-to-accept to forego

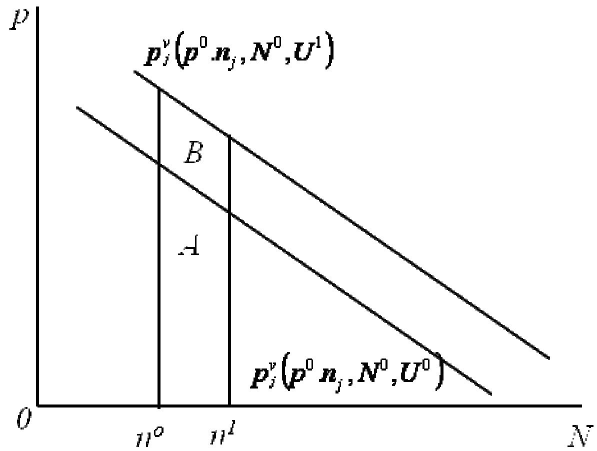

Figure 1.2. Compensating and equivalent surplus.

One important assumption in the economic valuation of recreational goods and services, specifically relevant for Hicksian monetary measures for quality/quantity changes, is weak complementarity. *M* and *N* goods are weak complements if the consumption of the market good (*M*) is zero the utility gained from the non-marketed good (*N*) is also zero. For example, if the fishing permits are too expensive (marketed good), then an individual does not value water quality changes (non-marketed good).

Measuring Recreational Value

The context of resource values is based on total economic value, defined as the summation of use and non-use values. Use value is the economic value derived from natural resources, either direct or indirect, through human use of these resources, such as tourism/recreation, fisheries, research/education, etc. On the other hand, non-use value is the economic value derived from resources without any current use of resources, such as bequest, option and existence values and is considered non-rival. This dissertation focuses only on the direct use values, i.e. recreational value measured in terms of CS or through different Hicksian monetary measures.

There are two main classifications of estimation methods for the demand function for recreational goods or services or direct estimate of monetary measures: 1) revealed preference (RP) methods; and 2) stated preference (SP) methods. RP methods are indirect approaches that infer an individual's values by observing their behaviors (actual choices) in related (complementary, surrogate or proxy) markets. Examples of RP methods are travel cost models (TCM), and hedonic property value methods (HPM). TCM are used to value recreational assets via the expenditures on traveling to the site while HPM assume that the price of a good is a function of its attributes. TCM recognizes that visitors to a recreation site pay an implicit price – the cost of traveling to it, including entrance fee and the opportunity costs of their time. TCM are oftentimes used to estimate use values for recreation activities and changes in these use values associated with changes in environmental quality/quantity.

SP methods use surveys to directly elicit an individual's values, based on hypothetical or constructed markets. Examples of SP methods are contingent valuation method (CVM) and choice modeling (CM) method. CVM uses surveys to directly elicit individuals' preferences and WTP for non-market goods, like a direct question *"What are you willing to pay for improvements in environmental quality?"* Choice modeling seeks to secure rankings and ratings of alternatives from which WTP can be inferred. Choice modeling is also known as choice experiments, contingent ranking, paired comparisons, and contingent rating. If the values for individual characteristics/attributes are required, then CM is preferable to CVM.

RP and SP methods differ in terms of the types of data used to estimate values. RP methods rely on data based on individual's actual choices, hence a revealed behavior. SP methods, on the other hand, rely on data from carefully designed survey questions asking respondents their choices for alternative levels of recreational experience, hence an intended behavior. RP methods typically provide estimates of Marshallian CS while SP methods can provide estimates of Hicksian surplus. SP methods are suggested when estimating non-use values given non-use generally precludes observable behavioral interactions with natural resources (Boyle, 2003). In choosing which valuation technique to apply, a researcher needs to 1) determine the management or policy question to be answered by the study; and 2) evaluate problems in recreation to estimate a) the recreation benefits at existing site and quality, b) recreation benefit with changes in quality and quantity of the resource, and c) public benefits from preservation of resource quality.

Recreational Values Used in the Analyses

Recreational values used in the analyses in this dissertation are obtained from primary valuation studies that reported economic measure of direct-use access value for recreation sites and activities. Access values are measures of the current level of benefits enjoyed by people using a resource in a recreation activity, or with versus without the resource/site being available. Marginal WTP values are not included in the metadata as they are measures of marginal changes in site or activity quality or availability. These primary valuation studies reported benefit measures in terms of compensating variation, equivalent variation, compensating surplus[3], and consumer surplus. Primary valuation studies included in the essays use revealed preference, stated preference and combination of RP and SP methods. Primary studies reporting the marginal value of fish are excluded in the analyses. Therefore, the recreational values used in the analyses are derived from multiple primary studies that reported summary statistics, such as value estimates. These estimates of recreational values are the outcomes of empirical quantitative research. When the policy questions reported in the primary studies are for changes in the quality or quantity of recreational experience (e.g. an improvement in water quality that improve recreational fishing), the recreational values encoded in the database are those representing the status quo situation (i.e. before the improvement), if reported.

Suppose the primary valuation study employed a TCM. This is referred here as the 'original model,' wherein the primary analysis was based on a regression model:

$$TRIPS = X\beta + \varepsilon \qquad \text{Equation 1.10}$$

where *TRIPS* is the *nx1* dependent variable - a vector of recreation demand, *X* is the *nxm* matrix of explanatory variables, β is the *mx1* vector of coefficients that was estimated and assumed fixed, and ε is the random error. In a single-site TCM, the relevant explanatory variables are trip costs (i.e. the access price), income, and a vector of some demographic variables. The estimated benefits (or monetary measure) of a recreational activity are measured by the area underneath the estimated recreation demand curve and above the access price faced by each individual. Adamowicz, Fletcher, and Graham-Tomasi (1989) show how to compute CS for different functional forms of the demand equation. On the other hand, Boyle (2003) provides a discussion on CVM while Holmes and Adamowicz (2003) provide a discussion on CM in regard to estimating monetary measures.

The estimated benefits, or consumer surplus per person per day, reported in the primary studies now constitute the dependent variable (i.e. the covariate *j* in the original model) of the 'meta-regression model' employed in this dissertation:

$$b_j = \beta + \sum_{k=1}^{K} \alpha_k Z_{jk} + e_j \qquad (j = 1,2,\ldots,L) \qquad \text{Equation 1.11}$$

where b_j is the reported estimate of welfare of the j^{th} study's sample in the recreation literature comprised of *L* studies, β is the 'true' value of the parameter of interest, Z_{jk}'s is the meta-independent variables which measure relevant characteristics of an empirical study and explains its systematic variation; α_k's is the meta-regression coefficients which reflect the biasing effect of particular study characteristics, and e_j is the meta-regression disturbance term. Meta-regression is the use of regression-based approaches to analyze metadata, which are the outcomes of empirical analyses. Meta-analysis is the process of statistically taking the stock of available empirical studies to synthesize research findings, test hypotheses and apply to benefit transfers (Smith and Pattanayak, 2002; Florax, Nijkamp, and Willis, 2002). It is an important methodological tool that can generate meaningful comparative results of empirical data to inform policy decisions.

Why these values are important and needed?

The recreation valuation techniques presented above show that there is a real economic value to the recreational benefits derived by a representative individual. Recreation provides enjoyment and contributes to a well-being of the participant that can be translated into monetary benefits, which can be compared to the costs to manage the recreation sites. An estimate of these recreational values is one of the criteria that may have significant influence on many recreation management decisions and resource allocations that are made by managers. For example, Duffield (1989) cited that estimate of the recreational value of fishing influenced the decisions by the Montana Department of Fish, Wildlife and Parks in acquiring public access for fishing.

One important motivation of recreational use valuation is to enable the recreational resources to be accounted for in benefit-costs analysis (BCA). BCA is a tool to aid decision-making and policy assessments. BCA is the process of adding up all the gains (benefits) from a policy, program or alternative options, subtract all the losses (costs), and choosing the option that maximizes net benefits. Benefits are anything that contributes to the objective while costs are anything that reduces an objective. BCA helps resource managers choose among alternative recreation programs and projects which vary in size, design, and purpose. For example, knowledge of the effects of stream flow on recreation for different activities and skill levels is an important ingredient in the determination of stream flow policies. To perform a BCA of changes in stream flow, researchers need to know how the demand function shifts with changes in flow or flow related variables, such as fish catch. Bishop et al., (1990) studied the release pattern that could increase the economic value of all the multiple purposes in Glen Canyon National Recreation Area and Grand

Canyon National Park. Later, Congress formalized these flows when it passed the Grand Canyon Protection Act of 1992.

Valuations also play a role in understanding the decisions made by individuals about which recreation activities they prefer to participate in, which sites to visit and how frequently, and if they are willing to pay higher fees or prefer not to visit. Based on the study by McCollum et al. (1999), the Colorado Division of Wildlife decided against proposing an increase in fishing license fees to the State Legislature after finding out in the Colorado Angler Survey that anglers were not willing to pay for an increased stocking. Hence, streams in certain areas of Western Colorado went to a two-trout-per-day bag limit.

Valuation studies are also used in the relicensing decisions of the Federal Energy Regulatory Commission (FERC). Loomis and Cooper (1990) cited that the Pacific Gas and Electric in California relied on valuation studies that estimate the recreation benefits associated with alternative stream flow requirements when making their FERC license renewal applications.

Furthermore, studies on recreational activities have been used in litigation and damage assessments. Smith (2000) cited the example of litigation over the American Trader for an oil spill offshore of Huntington Beach, California in 1990 wherein the jury levied $18.1 million dollars in damages and penalties against the owner of the tanker. Of the total judgment, $12.8 million was attributed to recreation losses due to the beach closures required by the oil spill. Estimates of the value of beach recreation were used in this case.

Knowledge and information on the value of recreation are needed by resource managers so that they are incorporated into planning, decision-making, and policy issuances. For example, the technical document prepared by Rosenberger and Loomis (2001) on benefit transfer of outdoor recreation use values supported the strategic planning of the US Forest Service. Over the past three decades, US Forest Service has shifted to a new paradigm, i.e. from seeing the forest as a specialized shops producing one (timber) or few products to an emporium of multiple products and diverse services (including recreation opportunities). Valuation studies on goods and services produced on public lands managed by the US Forest Service show that the value of recreation and wildlife services are more than timber, mineral, and range goods (Nordhaus and Kokkelenberg, 1999).

Estimated values from primary studies are also used in benefit transfer. Benefit transfer is the use of information from research conducted on other sites (study sites) to inform questions or decisions at a site that lacks primary research (policy site). Benefit transfer is considered a ‘second-best strategy’ to recreation use valuation. Benefit transfer is suggested when time and resource constrains the conduct of primary study. Estimated welfare values, whether by standard valuation methods or benefit transfer, are used to aid decision-making of agencies and help justify their decisions about how to allocate public investments. For example, primary studies that estimated the value of recreation in coastal environments after an oil spill can be used to inform values of recreation in coastal communities affected by a recent, but unstudied, oil spill incident (such as the recent BP oil spill at Louisiana Gulf) using benefit transfer. Detailed discussion of this approach is given in the body of the dissertation.

Organization of the Dissertation

This dissertation consists of three essays on meta-analysis, benefit transfer and recreation use valuation. The three essays focus only on the direct use values, i.e. the economic value derived from natural resources through human use of these resources, such as tourism/recreation, fisheries, research/education, etc. In particular, the use values discussed herewith focus on the access value of outdoor recreation, like sportfishing, hiking, etc., not marginal value of recreation resource.

The essays are thematically linked but can be read separately. The first two essays were based on the sportsfishing valuation literature in the US and Canada. The studies included in the recreation database were identified through searches of electronic databases and formal requests for documents/references via e-mail, listserve, postal mail, or phone. Other documents were obtained through private collections and interlibrary loans. The studies were screened based on a coding protocol template. In the creation of the sportfishing valuation database, documents reporting the marginal value of fish were excluded. Screened primary studies comprised the metadata, which are measured effects from primary data or empirical studies (e.g., in economic recreation valuation, they are empirical estimates of use values). Each primary study was encoded into the database following the master coding sheet that contains 109 fields of information for each welfare estimate. All study values or consumer surplus were adjusted to a ‘per person per day’ unit and updated from their original study year values to 2006 dollars using an implicit price deflator. After excluding possible outliers, the sportfishing metadata has 920 estimates from 140 primary studies. The third essay was based on a study site in the Philippines (Predo et al. 1999) and selected study sites from the broader US recreation use values database. The study site in the Philippines was selected since there were some degree of correspondence between the study site and policy site. Study sites included in the metadata were selected based on recreation activity, climate, and/or site characteristics/environment that mimics the policy site conditions.

The first essay evaluates the aggregation structure of primary research studies and its implication for benefit transfer using meta-regression analysis. Aggregation refers to the grouping of primary studies into single-site or regional models. Single-site models are comprised of primary studies that are specific in their location and scope, and may provide specific value estimates. Regional models are comprised of studies that are broadly defined in location and scope, and may provide general value estimates. The first essay answers the question: Are there statistical differences between single-site and regional models? Meta-regression models were specified following the best-practice guidelines for meta-analyses. In particular, the meta-regression models were corrected for panel effects using a random-effect model following by-study panel specification. Three models: a single-site model, a regional model, and a pooled model (combined single-site and regional studies) were compared based on their statistical significance, predictive power, and out-of-sample error predictions performance. The structural shift in the metadata was investigated by intersecting the aggregation variable with selected explanatory variables. The out-of-sample error evaluates the convergence between consumer surplus values estimated through meta-regression function and original out-of-sample consumer surplus values. A log-likelihood ratio test was used to test whether the two subsamples, single-site and regional models, are from the same population and therefore could be pooled. Essay 1 also incorporates test and correction for publication selection bias using *root-n* meta-regression analysis. Publication bias is essentially a result of selective sampling, and occurs when studies reporting statistically significant results or academic work containing positive results are being published and others are not (Florax, Nijkamp, and Willis, 2002).

The second essay explores the approaches in modeling and examines the implications of treating dependency in the sportsfishing metadata when performing meta-regression analysis and benefit transfer. Dependency or correlation refers to a departure of two random variables from independence due to 1) multiple sampling per study to obtain a sufficient number of observations for meta-analysis (i.e. between study correlated observations); and 2) researchers reporting more than one benefit measure for each primary study (i.e. multiple estimates from the same primary study—within-study autocorrelation). Essay 2 addresses the question, “Are the meta-regression model results statistically the same for the all-set, best-set, and average-set metadata? The all-set metadata uses all of the available benefit measures reported in the primary studies. Two approaches for controlling data dependency in the all-set metadata include weighting of the metadata and using panel data estimators. Two treatments of the metadata for avoiding dependency include a best-set metadata (comprised of the best available benefit measures reported in a study as identified by methodological and sample criteria) and an average-set metadata (comprised of the average of benefit measures reported in the primary studies). Best and average estimates, whether dependent or independent, are coded following the detection heuristics discussed in Essay 2. Dependent data are multiple observations in a single study that are derived for the same resource, using the same methods, and relying on the same underlying sample. Independent data are single observations from independent studies, and multiple estimates in a single study that are based on different samples, different resources, different valuation methods (e.g., stated preference and revealed preference data derived from the same sample), etc. The meta-regression models are compared based on regression statistics and in-sample benefit predictions performance (i.e. percentage transfer error) using a jackknife data splitting technique. The jackknife technique estimates *n-1* separate meta-regression benefit functions to predict the omitted observation in each case.

The third essay applies the methodological treatments learned from the first two essays to estimate the recreational value via benefit transfer of Taal Volcano Protected Landscape in the Philippines. A single point estimate was derived from a study site in the Philippines, while a meta-regression benefit function based on existing studies in the US was used to derive the estimates of recreational value. A benefit measure for the policy site was calculated by adapting the MR benefit function to the specific characteristics of the 'policy site,' Taal Volcano Protected Landscape. Implicit price deflators and purchasing power parities were incorporated to account for income and cost of living differences between the study and policy sites. The different recreational activities in the Taal Volcano Protected Landscape include hiking, day-camping, picnicking, bird watching, horseback riding, fishing, boating, wind surfing, sailing, rowing, and kayaking. The percentage transfer errors were computed for the meta-regression function transfer applications, using an in-sample benefit prediction and simple out-of-sample prediction with the single estimate from Predo et al. (1999) as the study site original value.

Notes

[1] For parsimonious reason, only income together with prices (i.e. excluding time, experience and resource availability) were included in the constrained utility maximization model.

[2] Marshallian and Hicksian welfare measures are not conceptually consistent to each other (Smith and Pattanayak, 2002). However, as Willig (1976) argues, when income effects are small, these welfare measures tend to converge on each other. Thus, in the metadata underlying this dissertation, conceptual differences in welfare measures are captured by a dummy variable differentiating Marshallian from Hicksian welfare measures.

[3] Note that "access values" are 'with' versus 'without' a site and conceptually are equivalent surplus measures. However, they are implicitly modeled through implied changes in prices, and thus are methodologically compensating and equivalent variation measures.

References

Adamowicz, W. L., J. J. Fletcher, and T. Graham-Tomasi. "Functional Form and the Statistical Properties of Welfare Measures." *American Journal of Agricultural Economics* 71, no. 2(1989): 414.

Bishop, R., et al. (1989) Grand Canyon and Glen Canyon Dam Operations: An Economic Evaluation, ed. K. Boyle, and T. Heekin, Department of Agricultural and Resource Economics, University of Maine, Orono.

Bockstael, N. E., and K. E. McConnell. "Public Goods as Characteristics of Non-Market Commodities." *The Economic Journal* 103, no. 420(1993): 1244-1257.

Boyle, K.J. (2003). Introduction to Revealed Preference Methods. In P. Champ, K. Boyle, and T. Brown (Eds.) *A Primer on Non-Market Valuation*. Boston, MA:Kluwer Academic Publishers.

Bromley, D. W., & Paavola, J. (2002). Economics, Ethics, and Environmental Policy. In W. Bromley & J. Paavola (Eds.), *Economics, Ethics, and Environmental Policy: Contested Choices*. MA: Blackwell Publishing.

Creel, M. D., and J. B. Loomis. "Confidence Intervals for Welfare Measures with Application to a Problem of Truncated Counts." *The Review of Economics and Statistics* 73, no. 2(1991): 370-373.

Duffield, J. (1989) Nelson Property Acquisition: Social and Economic Impact Assessment, Report for the Montana Department of Fish, Wildlife and Parks. Helena, MT.

Florax, R., P. Nijkamp, and K. Willis (2002) Meta-analysis and value transfer: Comparative assessment of scientific knowledge. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Hicks, J.R. "The Rehabilitation of Consumers' Surplus." *The Review of Economic Studies* 8, no. 2(1941):108-116.

Holland, A. (2002). Are Choices Tradeoffs? In D. W. Bromley & J. Paavola (Eds.), *Economics, Ethics, and Environmental Policy*. MA: Blackwell Publishing.

Loomis, J., and J. Cooper. "Economic benefits of instream flow to fisheries: A case study of California's Feather River." *Rivers* 1, no. 1(1990): 23-30.

McCollum, D. W., M. A. Haefele, and R. S. Rosenberger (1999) A Survey of 1997 Colorado Anglers and Their Willingness to Pay Increased License Fees (Project Report No. 39), Project Report for the Colorado Division of Wildlife. Fort Collins, CO: Colorado State University, and USDA Forest Service, Rocky Mountain Research Station.

Nordhaus, W. D., and E. C. Kokkelenberg (Eds.) (1999) Nature's Numbers: Expanding the National Economic Accounts to Include the Environment. Washington, D.C., National Academy Press.

Predo, C. D., et al. "Non-market Valuation of the Benefits of Protecting Lake Danao National Park in Ormoc, Philippines." *Journal of Environmental Science and Management* 2, no. 2(1999): 13-32.

Smith, V. K. "JEEM and Non-market Valuation: 1974-1998." *Journal of Environmental Economics and Management* 39, no. 3(2000): 351-374.

Smith, V., and S. Pattanayak. "Is Meta-Analysis a Noah's Ark for Non-Market Valuation?" *Environmental and Resource Economics* 22, no. 1(2002): 271-296.

Willig, R.D. "Consumer's Surplus Without Apology." *The American Economic Review* 66, no. 4(1976):589-597

CHAPTER 2 - ESSAY 1
PRIMARY STUDY AGGREGATION EFFECTS: META-ANALYSIS OF SPORTFISHING VALUES IN NORTH AMERICA

Abstract

There are many factors that affect the development, design and implementation of primary research projects that may carry forward in applications of benefit transfers. Meta-regression analyses have isolated and measured many patterns in the literature, including the effects of methodology, sample designs, and geographic region. This paper evaluates aggregation structure of primary research studies and its implication for benefit transfer using meta-regression analysis. Aggregation structures of primary research may be defined as single-site and regional models. Single-site models (SM) are based on primary studies that are specific in their location and scope, thus providing specificity in their value estimates. Regional models (RM), conversely, are based on primary studies that are broadly defined in location and scope, thus providing more generalized value estimates. Three meta-regression models are evaluated, including SM, RM, and a pooled model (PM, combined SM and RM studies). The application is applied to the sportfishing valuation literature, which consists of 140 individual studies that span from 1969 to 2006 and provides 920 welfare measures for the US and Canada. Log likelihood-ratio test shows that SM and RM are different from the PM in terms of how they explain welfare measures. Results indicate that single-site and regional studies should not be pooled without accounting for their differences in a meta-analysis. Following the ‘best practice’ guidelines for meta-analyses and given non-random out-of-sample benefit transfer estimates, the percent difference (i.e. comparing out-of-sample consumer surplus with meta-regression benefit transfer consumer surplus) was lowest using RM, although this results remain inconclusive. Not accounting for aggregation differences among primary studies leads to biased value estimates in benefit transfer, depending on the policy settings.

Introduction

Recognition of recreational benefits of ecosystem resources provides a sound rationale for management, conservation and planning options for nature-based recreation. Researchers have suggested that having comparable estimates of benefits and/or costs of resources not traded in markets (i.e., without prices) can aid the evaluation of socially efficient and welfare enhancing outcomes. Benefits are economic measures of value derived from recreation experiences, which are also called use values. Use values found in different studies are "more or less taken as valid and reliable reflections of people's valuation of [ecosystem] changes" (Brouwer, 2002, p. 101). These estimates of use values can help raise the awareness of resource users and decision-makers in making informed choices among policy alternatives. To date, there are numerous empirical studies on different recreation activities; so many, in fact, that researchers and policy makers can be overwhelmed by them. In this regard, researchers are directed to use meta-analysis, among others, to investigate the wide range of data on the value of recreation.

Meta-analysis is the process of statistically taking the stock of available empirical studies, with one application being the estimation of benefits from changes in environmental resources (Smith and Pattanayak, 2002). If statisticians deal with original observations; meta-analysts, on the other hand, statistically summarize or synthesize past research results using meta-regression analysis (MRA) (Stanley and Jarrell, 1989). MRA is used in bringing together empirical research findings from different studies for purposes of comparison or hypothesis testing, synthesis, knowledge acquisition, generalization and benefit transfer (BT) (Florax, Nijkamp, and Willis, 2002). It offers a means to increase the effectiveness of literature reviews in two ways: 1) it makes the process more systematic, and 2) it avoids bias in the reviews (Stanley, 2001). The conduct of BT through MRA is feasible with the accumulation of empirical research on resource valuation. BT is the “application of values and other information from a ‘study site’ with data to a ‘policy site’ with little or no data" (Rosenberger and Loomis, 2000 p. 1097). BT methods are used when policy-makers, resource managers or planners cannot conduct primary research because of budget and time constraints, or because the resource impacts are expected to be low or insignificant. The application of MRA for the purpose of BT is preferred over other BT methods, such as single point estimate and demand functions, since the benefit estimates for the 'policy site' are based on the “site characteristics, user characteristics, and temporal dimensions of recreation site and site choice” (Rosenberger and Loomis, 2001, p. 14), enabling the analyst to control for these dimensions.

Meta-analysis has a strong tradition in medicine and psychology. Pearson (1904) first applied meta-analysis in evaluating data from many studies to conclude that vaccination against intestinal fever was ineffective. Glass (1976) coined the word meta-analysis, which refers to the analysis of research outcomes where the metadata are derived from primary analyses (i.e. the original analysis of data) and secondary analyses (reanalysis of primary data). Metadata are measured effects from primary data or empirical studies (e.g., in economic recreation valuation, they are empirical estimates of use values). Meta-analysis is a growing area of inquiry in education, marketing and the social sciences. It was first applied in economics by Stanley and Jarrell (1989) and Walsh et al. (1989). In the field of natural resource and environmental economics, meta-analyses have been conducted for recreation values (Smith and Kaoru, 1990; Rosenberger and Loomis, 2000b); wetland resources (Woodward and Wui, 2001); water quality management (Van Houtven et al., 2007); water supply and demand (Scheierling et al., 2006); endangered species and biodiversity (Loomis and White, 1996; Brander et al., 2007); energy markets and resources (Espey, 1996); global warming, greenhouse gases and sustainability (Manley et al., 2005); hazardous wastes and pesticides (Florax et al., 2005); sportfishing values of aquatic resources (Johnston et al., 2006); and forested areas (Lindhjem, 2007), among others.

Several researchers have employed meta-analysis to estimate the sportfishing values of aquatic resources. Sportfishing, also called recreational fishing, is fishing for pleasure or competition. Sturtevant et al. (1996) estimated panel models to address the dependency in the freshwater recreational fishing demand literature. They also demonstrated the feasibility of meta-analysis as a benefit-transfer method using 26 freshwater fishing travel cost method (TCM) studies that span from 1980 to 1991. Platt and Ekstrand (2001), using Ordinary Least Squares (OLS) with a Newey-West version of White's consistent covariance estimator, estimated a national model and region specific model for sportfishing value per person per day of water-based recreation in the US. Koteen, Alexander and Loomis (2002) systematically analyzed the variation in the recreational value of water in the US given changes in six water quality parameters. Johnston et al. (2006[1]) estimated random-effect panel models with Huber-White standard errors and weights and found that moderator variables—resource, context, angler attributes and study methodology—are associated with systematic variation in willingness-to-pay (WTP) per fish among sportfishing anglers in North America. Finally, Moeltner, Boyle and Paterson (2007) employed Bayesian meta-regression (MR) framework in estimating welfare for freshwater sportsfishing in the US.

This paper builds upon previous studies enumerated above by evaluating the level of aggregation differences in welfare estimates in primary studies as a means to minimize this potential source of error in meta-regression benefit function transfer (MRBFT). The meta-regression protocol employed in this paper follows the 'best-practice' guidelines outlined by Nelson and Kennedy (2009). Aggregation refers to the grouping of primary studies into SM or RM. SMs are composed of primary studies that are specific in their location and scope, and may provide specific value estimates. For example, Jones and Stokes Associates, Inc. (1991) reported a consumer surplus (CS) estimate of sportfishing for the municipality of Juneau, Alaska. This estimate draws specific conclusions about this municipality. However, this estimate may only be applicable in a BT application if the policy site matches this study site on most salient dimensions of the valuation context. On the other hand, RMs are composed of studies that are broadly defined in location and scope, and may provide general value estimates. For example, Aiken and la Rouche (2003) estimated the net economic values of bass, trout, and walleye fishing using a contingent valuation method for each relevant state in the US and for the US as a whole. These estimates may be general conclusions about each state and the US. Therefore, regional estimates may be broadly applicable to many policy sites, but may lack the specificity of site-specific estimates.

Thus, the levels at which welfare estimates are aggregated as reported in the primary studies have implications when used in MRBFT. Accounting for the level of aggregation differences may reduce transfer errors when meta-analyses are used for the purpose of BT for a site or policy specific context. This approach is needed because standard applications of BT methods rely on highly aggregated information on people’s values, regardless of their aggregation differences. To address this gap, SM is compared with RM and both with PM by systematically analyzing the causes of variation or heterogeneity in the sportfishing metadata. This heterogeneity may be attributed to fishing environment, study methodology, surveyed population and mode, and study attributes in the primary studies. This approach seeks to contribute in the refinement and testing of meta-analyses as a BT tool, since the bulk of existing research illustrates the potential of MR models to generate BT estimates within a broad valuation framework (Moeltner, Boyle and Peterson, 2007).

Problem Definition

Sportfishing is an important economic sector in North America's fishing and tourism industry. In the United States, the economic activity generated by anglers is greater than the economies of 14 states. There are nearly 40 million anglers contributing $45.3 billion in retail sales, resulting in $125 billion in overall economic output, $16.4 billion in state and federal taxes, and over a million jobs supported. The National Sporting Goods Association ranked fishing sixth out of 42 recreation activities, preceded only by walking, swimming, exercising, camping and bowling (Southwick Associates, 2007). The 2005 survey of sportfishing in Canada reveals that over 3.2 million anglers contributed a total of $7.5 billion (2/3 of which were directly attributable to sportfishing investment and major purchases of durable goods) to various local economies in Canadian provinces and territories (Fisheries and Oceans Canada, 2007).

Sportfishing, among others, is an intensively studied outdoor recreational activity in the US and Canada. The number of primary studies that quantify the value of sportfishing is vast and continually growing. This accumulation of knowledge through empirical research then forms the opportunity for conducting meta-analyses and BT (Rosenberger and Stanley, 2006). The conduct of BT through MRA (i.e. addressing the average values of parameter estimates originating from different studies) is feasible with the accumulation of primary research on resource valuation. With meta-analysis, 'overwhelmed' researchers and policy makers can make sense of the vast available research findings, generate meaningful comparative assessment of results across studies, and help inform policy decisions without the extra cost of conducting primary studies.

A key issue in the conduct of BT is consistency across studies in terms of valuation concept, the commodity valued, and the degree of site correspondence (Rosenberger and Phipps, 2007). When the valuation concept, market area, or the commodity valued is consistent or comparable across studies, BT may lead to unbiased value estimates (Boyle and Bergstrom, 1992; Loomis and Rosenberger, 2006). Literature on BT emphasizes the importance of value transfer and function transfer validity and reliability (Ready and Navrud, 2006; Spash and Vatn, 2006), and the minimization of generalization and measurement errors (Rosenberger and Stanley, 2006). However, inherent heterogeneity in the primary studies, those undertaken under varying conditions, could provoke someone to question the validity of comparative analysis or the transferability of their results. According to Bergstrom and Cordell (1991), the variation in recreation welfare estimates reported in empirical studies is sensitive to differences in the characteristics of (1) the user population (e.g. income), (2) the site characteristics (e.g. quality or suitability), and (3) the model specification and estimation procedures of the primary studies, which are inherently transferred in

BT applications. Meta-analysis, by controlling for these differences across empirical studies, may provide a means for estimating unbiased welfare values for a variety of resource contexts, avoiding the need to find one-to-one correspondence between study sites and a policy site.

Dependency in primary estimates of CS is common in the sportfishing literature. Empirical studies often report multiple estimates when authors employed different model estimators (e.g. stated preference (SP) and/or revealed preference (RP) valuation methods), methodological treatments (e.g. different functional forms, treatment of substitutes, different cost per mile, etc.), and estimated welfare values for several different sites. This design in the primary studies creates panel data structure. Panel data, when used in MRA, produces a dataset with a grouped structure with possible intra-group error correlation (Moulton, 1986) implying biased standard error estimates.

Study-level averages or single estimate per primary study, random selection, and panel-data methods are suggested in dealing with correlated data (Nelson and Kennedy, 2009). However, when estimates are averaged, there is a loss of efficiency from increased intercorrelation among moderator variables (Brown and Nawas, 1973). Averaging the source estimates within one study makes the variance of the error term nonconstant (Bowes and Loomis, 1980; Vaughhan, Russell and Hazilla, 1982; Bateman et al, 2006) and may lead to aggregation bias in the meta-regression due to non-linear specifications (Stoker, 1993). Pooling aggregate results from heterogeneous studies may ignore the underlying individual heterogeneity (Smith and Pattanayak, 2002), thereby violating the consistency required in MRA and BT. Moreover, the use of aggregated[2] models undervalue changes in quality at more popular sites (Lupi and Feather, 1998). Finally, aggregating across a politically defined or economic jurisdiction influences the estimates of aggregate value (Smith, 1993; Loomis, 2000; Bateman et al., 2006). There are panel-data methods that address non-independence which are discussed below. One concern not given high priority by researchers is the selection of studies to include in the panel-corrected MR model that minimizes the error. This paper fills this gap.

The conventional MR models treat summary statistics from primary studies as units-of-observations in an aggregate regression framework, which may overlook possibly underlying heterogeneity in the source study observations. This conventional approach to MR model specification may lead to bias because estimates of use values in primary studies are oftentimes a function of the choice for an estimate's 'accounting stance, ' or 'geographic aggregation.' Estimates of use values are reported on the following scale or aggregation level: single site or sub-site (these are coded as single-site studies); national, ecoregional/multistate, state, county, multi-county, or multi-site (these are coded as regional studies). There is no clear rule as to the appropriate unit of analysis for recreation values of sportfishing, depending largely on the intended uses motivating the primary studies. It is possible that misspecification of the proper level of aggregation might partially explain bias in BT applications. If so, what are the implications to BT if the estimates and standard errors of use values in primary studies can be expressed in more than one geographic level? How do we choose the primary studies to include in an MRBT function that reduces the transfer error? These questions may be addressed through comparison of different MR model specifications and answering the question: Are there statistical differences between SM and RM? Without considering these levels of aggregation and how they affect the values transferred, the conclusions drawn from the MRA may be unclear.

Method

Data and preliminary meta-analysis

An in-depth search was performed for written documentation or studies reporting an economic measure of direct-use value estimates (i.e. access value only, not marginal values) for sportfishing in the US and Canada. Documents are identified through searches of electronic databases such as Environmental Valuation Reference Inventory (EVRI), EconLit, AgEcon Search, dissertation/thesis abstracts, Google scholar, and through formal requests for documents and/or references distributed via e-mail, listserve, postal mail, or phone. The formal requests were sent to all graduate degree granting economics departments in the US and Canada; US state natural resource agencies; Canadian provincial natural resource agencies; and to academic listserves, such as RESECON and W1133. Other documents are obtained through private collections and interlibrary loans. The empirical fishing studies are composed of journal articles, theses, dissertations, working papers, government agency reports, consulting reports, and proceedings papers. Screened documents are entered into the database based on a coding protocol template. Documents reporting the marginal value of fish are excluded. Terminal publications (i.e. journal articles, final reports) supercede earlier documents for specific models and outcomes. If the journal article differs in magnitude and scope (e.g., from a broader report), then both are coded as there is more information in the report than what is provided in the journal article.

The master coding sheet contains 109 fields of information for each of welfare estimate (Appendix A). The main coding categories include study source, study location, fishing activity, site characteristics, trip specific characteristics, angler-specific characteristics, survey characteristics, valuation method, SP and RP modeling characteristics, benefit measure, standardized CS estimates, and regression parameters. All study values, i.e., CS, are adjusted to a 'per person per day' unit and updated from their original study year values to 2006 dollars using an Implicit Price Deflator. Studies reporting estimates in Canadian dollars are converted to US dollars.

The number of estimates and studies on the welfare measures of sportfishing is indeed growing (Figure 2.1). In sum, there are 143 individual studies in the sportfishing use value database that span from 1969 to 2006. These studies are based on survey data conducted between 1960 and 2004. There are multiple estimates of the use value for most of the 143 primary studies that comprised the sportfishing metadata, which provide 934 benefit measures for the US and Canada. Thirty two of the 143 studies reported only one welfare estimate for sportfishing whereas the remaining 111 studies include up to 74 estimates of CS. Multiple estimates per study arise due to disaggregated estimate for multi-site studies, different model specifications and estimators (RP vs. SP or combined RP and SP), methodological treatments (e.g. looking at the effects of including and excluding opportunity cost of time), fish species, and water body type. On average, about four documents per year have been released since 1969. The significant increase in the number of estimates per year is associated with the release of benefit estimates from the US Fish and Wildlife Service (USFWS) in 1983, 1987/1988, 1994, and 2003. The USFWS's National Survey of Fishing, Hunting and Wildlife-Associated Recreation documents roughly provide one estimate per state in the US. Other state-scope studies contribute a large number of estimates.

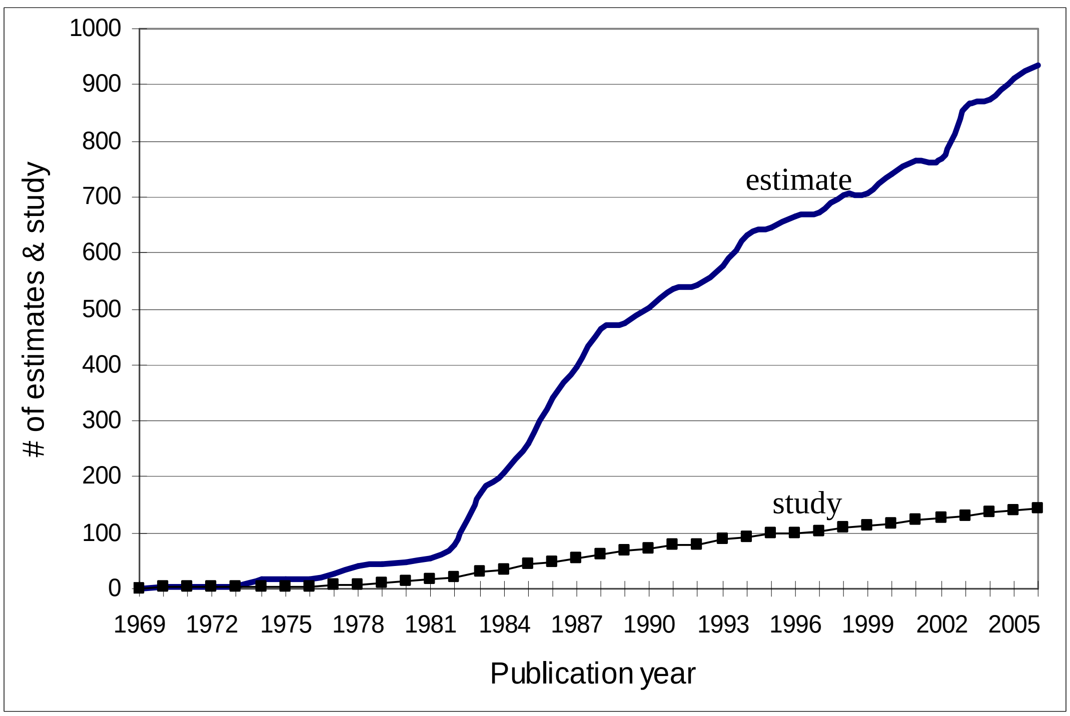

Figure 2.1. Cumulative number of estimates and studies from 1969 to 2006.

The 143 studies include 65 journal articles, 1 book chapter, 41 government agency or university reports, 12 consulting reports, 4 MS theses, 9 Ph.D. dissertations, 6 working papers, and 5 proceeding papers (Figure 2.2). Journals and agency reports are the primary sources of information in the metadata. Agency reports provide the greatest number of estimates although journal articles have the most number of studies. All of these studies provide estimates of the access value to sportfishing anglers, or provide sufficient information for such value to be calculated. These individual studies vary in several aspects, including geographic eco-region or location, level of aggregation in CS, the species being valued, fishing-type and mode, water-body type and name, site changes, trip characteristics (e.g. angler expenditure), valuation methodology and its characteristics (e.g. sample size, regression model, functional form, equation type, payment vehicle, cost/mile used, wage rate used, time cost treatment), survey characteristics (e.g. year data is collected), and angler characteristics (e.g. income, education, age).

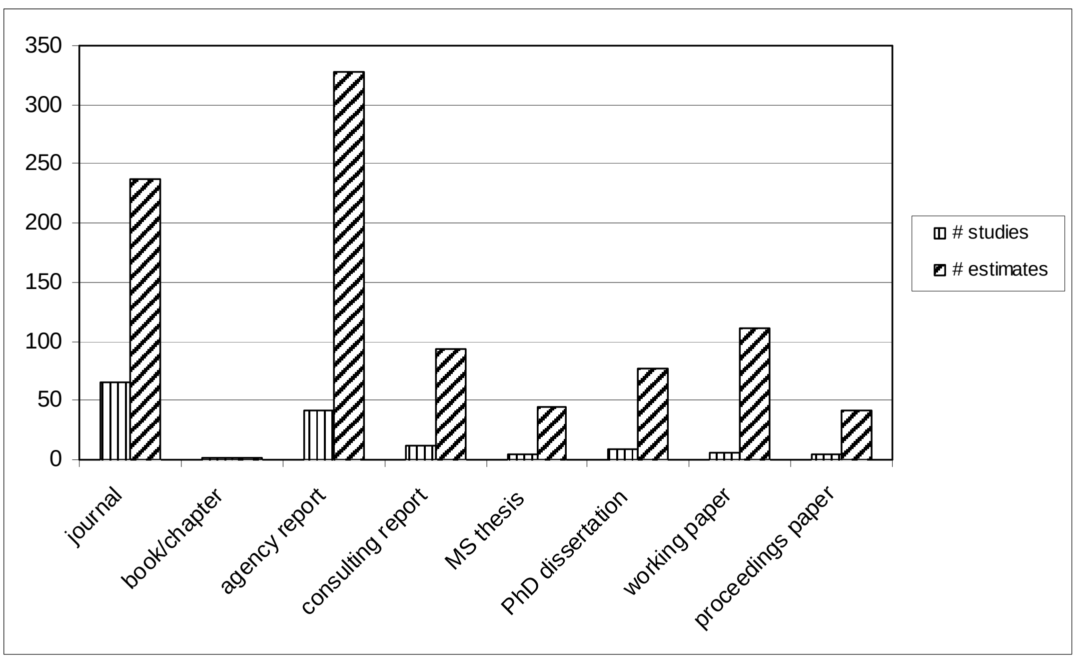

Figure 2.2. Number of studies and estimates by document type.

Study locations show 913 estimates from 137 studies were conducted in the US while only 21 estimates from 6 studies were conducted in Canada (Figure 2.3). Seventy nine regional studies account for 582 estimates while 64 single-site studies account for 352 estimates in the metadata. The vast majority of studies (108) and estimates (807) are for freshwater fishing. Out of the 108 studies on freshwater fishing, about 24 studies reported 330 estimates that did not specify fish species (reported only as coldwater, coolwater, or warmwater) or reported two or more freshwater species. Studies reporting coldwater (trout, salmon, steelhead), coolwater fishing (pike, perch, walleye), and warmwater (bass, chub, catfish) fishing are considered freshwater fishing in this paper. Among freshwater fish species, trout is the most studied species (236 estimates), followed by bass (156 estimates).

RP studies (zonal travel cost, individual travel cost and random utility model) are twice as prevalent as SP studies (open-ended, dichotomous choice, iterative bidding, payment card, and stated choice). Four hundred eighty six estimates from 101 studies are based on RP methods, 412 estimates from 52 studies are based on SP methods, and 36 estimates from 6 studies are based on combined SP and RP[3]. Study sample sizes ranges from 7 (SP with iterative bidding elicitation method) to 46,008 (random utility model), while survey response rates from the studies ranges from 7% to100 %.

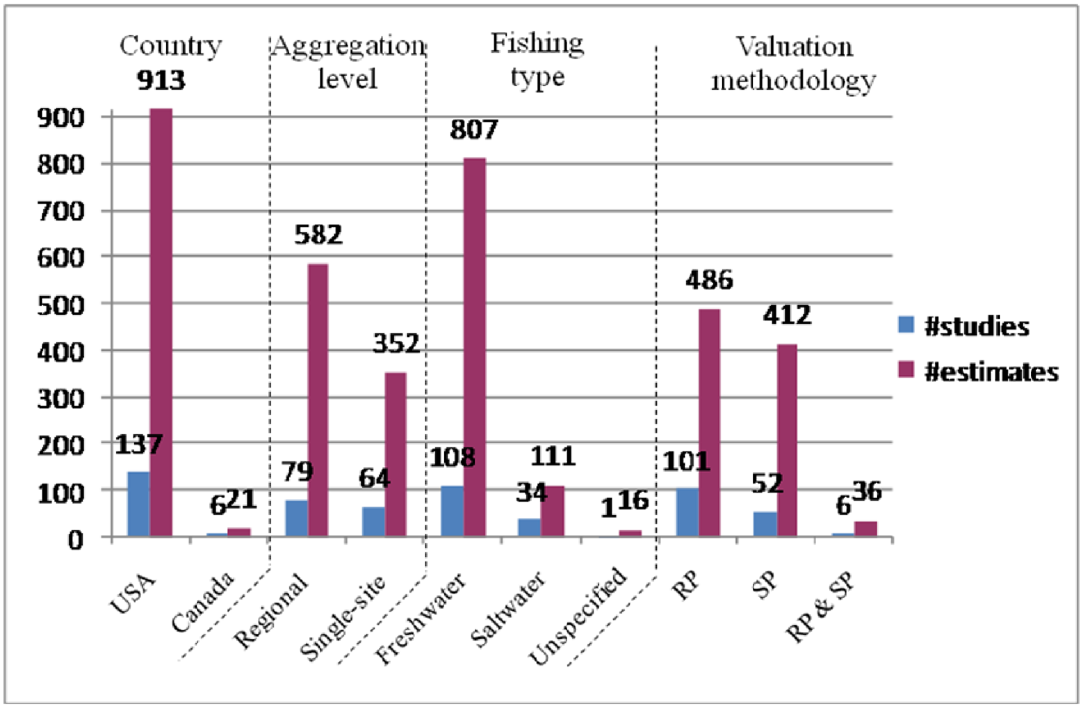

Figure 2.3. Number of studies and estimates by country, study aggregation level, fishing type, and valuation methodology.

CS per person per day based on 934 estimates (pooled studies) ranges from $0.22 to $994.93 with a mean of $66.47 (in 2006 dollars). Three hundred fifty two studies reporting welfare values for single site or sub-site studies have a lower median ($37.11 vs. $44.19) and mean ($63 vs. $69) CS than regional studies, though not statistically significant. Excluding possible outliers (14 estimates with CS/person/day > $350.00) in the metadata resulting in 920 estimates, CS per person per day ranges from $0.22 to $348.43, or an average of $58.88 (standard error is $1.94). The average CS for single-site studies is $55.79 (+/- $3.45) while the average CS for regional studies is $60.75 (+/- $2.31). Figure 2.4 shows the distribution of CS for the trimmed metadata. Appendix B provides a summary of selected characteristics of recreational angling valuation studies used in the meta-analyses while Appendix C provides the bibliography of studies used in the meta-analyses.

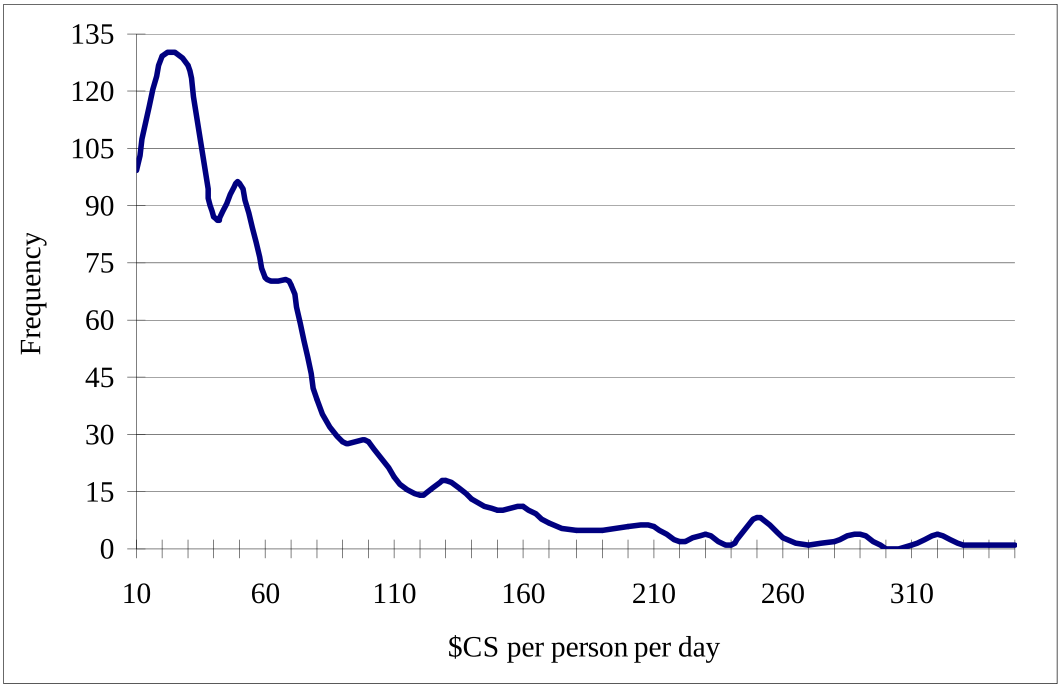

Figure 2.4. Distribution of consumer surplus per person per day estimates (in 2006 dollars) for outlier-trimmed dataset (N=920).

Based from 230 estimates, the average own price elasticity of demand for sportfishing is -0.83 (+/- 0.05 at the 95 % confidence interval), which is inelastic. This inelastic measure tells us that a 10% increase in the access price will result in an 8.3% decrease in the quantity of fishing demanded by the anglers, i.e. angler's demand for fishing is such that the quantity demanded will not respond very much to the change in price or cost of the sportfishing experience. This result confirms the inelastic price elasticity of demand for fishing and 22 other selected outdoor recreation activities in the US by Loomis and Walsh (1997). Only 57 out of the 143 studies report sample summary statistics of anglers—an indentified problem in metadata (Loomis and Rosenberger, 2006). Based on these 57 studies, the average income of sportfishing anglers is $63,561 in 2006 dollars. Male and white race anglers dominate in sportfishing activity, with an average 22 years of fishing experience. On average, anglers are 43 years of age, with at least 13 years of education.

Meta-regression model specifications

The meta-valuation function is "an envelope of a set of study site functions that relates site values to characteristics or attributes associated with each site, including market characteristics, physical site characteristics, spatial characteristics, and time" (Rosenberger and Stanley, 2006, p. 374). The MR model is defined as:

$$y_i = \alpha + \beta_k X_i + \varepsilon_i \qquad \text{Equation (1)}$$

where *y* is the dependent variable, which is the vector of the natural log of CS converted to 2006 dollars reported across the individual studies, *i* which indexes each observation; *X* is a matrix of explanatory variables (the identifiable characteristics among the different studies, like valuation method, etc.) that account for systematic components explaining the variation in *y*; ε is a random error component with mean zero and variance σ_ε^2 ; and α (constant term common across all observations) and β are parameters to be estimated.

Explanatory variables

This subsection describes the explanatory variables of Equation (1) that have been identified on the basis of theory and findings from the systematic comparison of the studies listed in Appendix B. Other regressors one would expect to be significant in the MR models are excluded because they are not reported, missing, or could not be identified in many of the studies listed in Appendix B. For example, only 57 of the 143 studies report income of anglers. Income is positively related to participation in outdoor recreation and in general, higher income households tend to participate more days per year in recreation (Loomis and Walsh, 1997). Exclusion of these variables in the MR models diminishes the explanatory power of the analysis but will not bias the estimated coefficients if these variables are uncorrelated with the included set (Kennedy, 2008).

The relevant explanatory variables are categorized into those characterizing (1) *fishing environment*, (2) *study methodology*, (3) *surveyed population and mode*, and (4) *study attributes*. The *fishing environment* attributes characterize the fishing and water-body types. Fishing type differentiates fishing experience into freshwater, saltwater or both. Water body type describes the affected water body or habitat, e.g., marine, estuary, lake, Great lakes, river or stream, and mixed-water body type. *Study methodology* attributes describes the valuation methodology (RP, SP, or combined RP & SP). RP variables characterize the RP types (zonal TCM, individual TCM, or random utility model (RUM)), and if substitute price or quality and time variables are included in the primary study regressions. SP variables include elicitation method (open-ended, dichotomous choice, iterative bidding, payment card, and stated choice) and if a substitute variable is included in the primary study regressions.

Surveyed populations and mode attributes distinguishes the survey type used to collect data for estimation (mail, in-person, phone, mixed mode, or web-based and other) and anglers' visitor types (resident, non-resident, both resident/non-resident, special interest group, and other). *Study attributes* describe the benefit unit, trend, publication in journal, and level of aggregation. The benefit unit compares the estimates in per day units versus per trip or per season. The trend variable is a proxy for methodological advances that may have some effect on welfare estimates in comparison with the rate of inflation over time. The journal variable differentiates between peer-reviewed journal articles versus other document types such as book chapters, government/university reports, consulting reports, dissertations, working papers and proceeding papers. The level of aggregation differentiates between single-site studies and regional studies as previously defined.

Table 2.1 summarizes the variables included in the analysis. SM and RM differ in select variables of fishing environment, study methodology, surveyed population, and literature type. For example, there are more lakes, Great Lakes, and river or stream resources valued in the SM than RM. Likewise, more RP valuation approaches were used in SM than RM. There are also more resident visitors and journal literature in SM than RM. These differences in the sub-metadata are expected to affect the estimated MR models.

Table 2.1. Meta-analysis variables and descriptive statistics.

Variable	Description	SM Mean (Std. Dev.)	RM Mean (Std. Dev.)	PM Mean (Std. Dev.)
Natural log of CS	Natural log value of consumer surplus (CS) per person per day and indexed to 2006 dollars	3.36 (1.28)	3.72 (0.96)	3.59 (1.10)
Fishing environment				
Freshwater	Qualitative variable: 1 if freshwater fishing is being valued; 0 otherwise	0.90 (0.30)	0.85 (0.36)	0.86 (0.34)
Saltwater [a]	Qualitative variable: 1 if saltwater fishing is being valued; 0 otherwise	0.05 (0.22)	0.15 (0.36)	0.11 (0.32)
Both or unspecified [a]	Qualitative variable: 1 if both freshwater and saltwater fishing or unspecified; 0 otherwise	0.05 (0.21)	0.00 (0.00)	0.02 (0.13)
Marine	Qualitative variable: 1 if marine or open ocean resource is valued; 0 otherwise	0.03 (0.16)	0.09 (0.29)	0.07 (0.25)
Estuary	Qualitative variable: 1 if estuary or bay resource is valued; 0 otherwise	0.04 (0.20)	0.03 (0.17)	0.03 (0.18)
Lake	Qualitative variable: 1 if lake, pond or reservoir resource is valued; 0 otherwise	0.31 (0.46)	0.03 (0.17)	0.14 (0.34)
Great lake	Qualitative variable: 1 if Great Lake resource is valued; 0 otherwise	0.16 (0.37)	0.05 (0.21)	0.09 (0.28)
River or stream	Qualitative variable: 1 if river or stream resource is valued; 0 otherwise	0.40 (0.49)	0.19 (0.40)	0.27 (0.44)
Mixed-water body [a]	Qualitative variable: 1 if mixed-water body is valued; 0 otherwise.	0.05 (0.22)	0.06 (0.23)	0.05 (0.22)
Study methodology				
Revealed preference	Qualitative variable: 1 if revealed preference (RP) valuation approach used; 0 otherwise	0.72 (0.45)	0.40 (0.49)	0.52 (0.50)
Stated preference [a]	Qualitative variable: 1 if stated preference (SP) valuation approach used; 0 otherwise	0.23 (0.42)	0.57 (0.49)	0.44 (0.50)
Combined [a]	Qualitative variable: 1 if both RP and SP valuation approaches used; 0 otherwise	0.05 (0.22)	0.03 (0.16)	0.04 (0.19)

Variable	Description	SM Mean (Std. Dev.)	RM Mean (Std. Dev.)	PM Mean (Std. Dev.)
Zonal TCM	Qualitative variable: 1 if RP and a zonal travel cost model is used; 0 otherwise	0.16 (0.37)	0.13 (0.34)	0.14 (0.35)
Individual TCM	Qualitative variable: 1 if RP and an individual travel cost model is used; 0 otherwise	0.53 (0.50)	0.25 (0.43)	0.35 (0.48)
RUM [a]	Qualitative variable: 1 if RP and random utility model is used; 0 otherwise	0.08 (0.27)	0.05 (0.21)	0.06 (0.24)
Substitute price	Qualitative variable: 1 if RP and substitute price, index or variable included in regression; 0 otherwise	0.46 (0.50)	0.22 (0.41)	0.31 (0.46)
RP Time	Qualitative variable: 1 if RP and time variable included in regression; 0 otherwise	0.52 (0.50)	0.32 (0.47)	0.39 (0.49)
Open-ended	Qualitative variable: 1 if SP and open-ended elicitation method was used; 0 otherwise	0.05 (0.22)	0.39 (0.49)	0.26 (0.44)
Dichotomous choice	Qualitative variable: 1 if SP and dichotomous choice elicitation method is used; 0 otherwise	0.12 (0.33)	0.17 (0.37)	0.15 (0.36)
Iterative bidding	Qualitative variable: 1 if SP and iterative bidding elicitation method is used; 0 otherwise	0.03 (0.16)	0.02 (0.13)	0.02 (0.15)
Payment card	Qualitative variable: 1 if SP and payment card elicitation method is used; 0 otherwise	0.00 (0.05)	0.02 (0.14)	0.01 (0.11)
Stated choice [a]	Qualitative variable: 1 if SP and stated choice [b] elicitation method is used; 0 otherwise.	0.01 (0.08)	0.00 (0.00)	0.00 (0.05)
Price or quality substitute	Qualitative variable: 1 if SP and substitute in price or quality treatment is used; 0 otherwise	0.03 (0.16)	0.04 (0.20)	0.04 (0.19)
Surveyed population and mode				
Resident	Qualitative variable: 1 if visitor type is resident; 0 otherwise	0.55 (0.50)	0.28 (0.45)	0.38 (0.49)
Non-resident	Qualitative variable: 1 if visitor type is non-resident; 0 otherwise	0.04 (0.20)	0.08 (0.27)	0.06 (0.25)
Both	Qualitative variable: 1 if visitor type is both resident and non-resident; 0 otherwise	0.40 (0.49)	0.53 (0.50)	0.48 (0.50)

Variable	Description	SM Mean (Std. Dev.)	RM Mean (Std. Dev.)	PM Mean (Std. Dev.)
Special interest group [a]	Qualitative variable: 1 if visitor type is special interest group (club); 0 otherwise	0.00 (0.00)	0.01 (0.07)	0.00 (0.06)
Other[a]	Qualitative variable: 1 if visitor type is other specifically targeted sub-population; 0 otherwise	0.01 (0.08)	0.10 (0.31)	0.07 (0.25)
Mail	Qualitative variable: 1 if used mail survey type; 0 otherwise	0.60 (0.49)	0.35 (0.48)	0.44 (0.50)
In-person	Qualitative variable: 1 if used in-person survey type; 0 otherwise	0.19 (0.39)	0.22 (0.42)	0.21 (0.41)
Phone	Qualitative variable: 1 if used phone survey type; 0 otherwise	0.06 (0.23)	0.32 (0.47)	0.22 (0.41)
Mixed mode	Qualitative variable: 1 if used mixed modes; 0 otherwise	0.12 (0.33)	0.09 (0.28)	0.10 (0.30)
Web-based and other [a]	Qualitative variable: 1 if used web-based & other survey type; 0 otherwise	0.03 (0.17)	0.03 (0.16)	0.03 (0.17)
Study attributes				
Benefit unit	Qualitative variable: 1 if CS is originally estimated as per person per day; 0 if otherwise [c]	0.51 (0.50)	0.55 (0.50)	0.53 (0.50)
Journal	Qualitative variable: 1 if literature-type is journal, 0 if otherwise	0.33 (0.47)	0.21 (0.41)	0.25 (0.44)
Trend	Qualitative variable: year when data is collected, coded as 1960 = 1, 1961 = 2,..., 2004 = 45	29.35 (9.41)	27.87 (8.51)	28.43 (8.89)
Aggregation	Qualitative variable: 1 if the primary study is single-site or subsite; 0 if regional studies (i.e. national, ecoregional/ multistate, state, county, multi-county & multi-site)			0.38 (0.48)
Number of observations		347	573	920

Note: [a] The omitted category.
[b] Also known as conjoint, choice experiment, attribute-based.
[c] For example, per group per day, per person per trip, per group per trip, per person per season, per group per season, per person per year, per group per year.

Variables such as time, substitutes, and journal warrant some additional explanation. Primary studies not incorporating time as a separate independent variable in the demand function may underestimate CS. When time costs are included in the demand function, anglers who incur larger direct costs or price per trip have an incentive to increase their length of stay at the site to economize the number of long distance trips to the site. On the other hand, primary studies not accounting for substitutes may overestimate CS. Individuals with more choices from available substitute sites have a flatter negative slope in the demand curve. The inclusion of the journal variable in the MR model is a preliminary test for possible presence of bias due to publication selection. A more formal test and correction for publication selection bias is discussed in the next section. Peer-reviewed literature tends to report systematically lower WTP estimates for outdoor recreation (Rosenberger and Stanley, 2006). Publication selection is influenced by the publication culture and/or researchers' self-selections (Rosenberger and Johnston, 2009). Publication bias is essentially a result of selective sampling, and occurs when studies reporting statistically significant results or academic work containing positive results are being published and others are not (Florax, Nijkamp, and Willis, 2002). Because of publication selection, if only those studies that passed statistical cut-off points are published, then non-published studies would be excluded from the metadata. Moreover, many studies (consultancy, government agency reports) undertaken in economics may not be accessible for quantitative meta-analysis. This situation results in the inevitable exclusion of a body of valuable information, suppressing information that may be important or relevant for BT (Smith and Pattanayak, 2002).

Weighting and selection of functional form

When more than one estimate of value is provided by a single study, the study provides relatively more influence on model results than a study providing a single estimate of value. Weights may be used to control for unequal influences, such as using CS standard errors or number of estimates per study. Within-study weights sum to one (see also Johnston et al., 2006; Mrozek and Taylor, 2002) when the number of observations obtained from each primary study is used as the weight. Hence, each study rather than each observation has an equal weight in determining the regression coefficients. However, when CS standard errors are used as weights, about two-thirds of the observations are lost due to a lack of reported standard errors in the primary study documents, resulting in much smaller metadata (292 estimates). Preliminary analyses show that the use of weights has little effect on the results, so an unweighted meta-regression model was used.

Since different functional forms imply differences in means and variances (Adamowicz, Flecther and Graham-Tomasi, 1989), both unweighted linear and semi-log MR models are estimated. Unweighted linear and semi-log MR models are compared using Akaike's Information Criterion (AIC), which is:

$$AIC = \log \frac{1}{N} \sum_{i=1}^{N} e_i^2 + \frac{2K}{N} . \qquad \text{Equation (2)}$$

AIC calculates the sum of a measure of the goodness-of-fit (i.e. squared residual error for observation *i*) and a penalty term for the number of free parameters (*K*) in the model. This criterion penalizes for increases in the number of estimators. The rule-of-thumb is to choose the model with the lower AIC.

Dealing with panel data

Panel data refer to instances where greater than one observation stems from the same study, i.e. one empirical study that reports multiple estimates for a single issue. Comparisons of functional form, different model specifications, or valuation methodologies result in multiple CS estimates from each primary study. Thirty two primary studies report a single estimate of CS while the rest of the studies (111) report multiple observations, ranging from 2 to 74 CS estimates. Panel effects may arise since many of the value estimates come from the same group of studies, so it is possible that the value estimates may be correlated. Correlated CS estimates imply biased standard error estimates (Nelson and Kennedy, 2009). The MR models should address and adjust for this potential correlation among observations provided by the same studies (Rosenberger and Loomis, 2000a; Bateman and Jones, 2003; Nelson and Kennedy, 2009).

When panel effects are present, the results from econometric estimation such as OLS given in equation (1) and related stepwise regression procedures "may lead to inefficient and inconsistent parameter estimates, leading to invalid inferences from seemingly significant factor effects” (Rosenberger and Loomis, 2000b, p. 460). To address this concern, different approaches are suggested, such as standardization of variables in metadata (e.g. one estimate per study or study-level averages) (Engel, 2002; Lipsey and Wilson, 2001), or the use of panel-data methods (Rosenberger and Loomis, 2000b; Sturtevant et al., 1996). The standardization of values may result in a loss of information (Nijkamp et al., 2002). The micro-foundations of studies used in meta-analysis are lost when regressing the average benefit values on average values of explanatory variables. Standardization of values puts the researcher in a 'N studies' vs. 'K regressors' dilemma: should the researcher (1) discard explanatory variables (K) that are not common to all studies (thus preserving N at the cost of K), or 2) discard studies that do not include all key regressors (thus preserving K at the cost of N) (Moeltner et al, 2007). Likewise, using one estimate per study or study-level averages may result in a small sample for the meta-analysis. On the other hand, Rosenberger and Loomis (2000b) suggested panel stratification of metadata using fixed-effect model (a panel-specific constant component), random-effect model (a panel-specific error component), and a mixed-effect model (both panel-specific error components).

Following Rosenberger and Loomis (2000b), the metadata is stratified 'by study' to capture dependency among estimates provided in a single document. In modeling the panel data, the fixed-effect and the random-effect models are used. Other candidate panel models are not tested, such as separate-variances model (no common error component) and a mixed-effect model (both panel-specific error components) in this paper. A generic panel model is defined as:

$$y_{ij} = \mu_{ij} + \beta' X_{ij} + \varepsilon_i \qquad \text{Equation (3)}$$

where *j* is the stratification index and μ_{ij} is the panel effect. In the fixed-effect model (FEM), the panel effect parameter, μ_{ij} (intercept term) becomes α_{ij}:

$$y_{ij} = \alpha_{ij} + \beta' X_{ij} + \varepsilon_i \qquad \text{Equation (4)}$$

The intercept term α_{ij} is the panel-specific constant component for each panel identified through 'by study' stratification indexing, and the error component, ε_i, is common to all observations across all panels. In the random-effect model (REM), the panel effect is part of the random error varying across studies:

$$y_{ij} = \alpha + \beta' X_{ij} + \varepsilon_i + \mu_{ij} \qquad \text{Equation (5)}$$

where μ_{ij} is the panel-specific disturbance component with mean zero and variance σ_μ^2, a common error component, ε_i, and a common constant component, α. In an unbalanced panel, which characterizes the metadata in this paper, the disturbances in the random-effect model have variance of the form:

$$\operatorname{var}\left[\varepsilon_i + \sum_j \frac{\mu_{ij}}{T_j}\right] = \sigma_{ij}^2 = \sigma_\varepsilon^2 + \frac{\sigma_\mu^2}{T_j}, \qquad \text{Equation (6)}$$

where *T* is the number of observations in study *j*. The random-effect with an unbalanced panel is heteroskedastic, so this model is estimated with generalized least squares (GLS) (Rosenberger and Loomis, 2000b).

Heteroskedasticity, i.e. unequal variances of the effect-sizes, is intrinsic to metadata due to different sample sizes, different estimation procedures, and sampling variance (Florax, 2002; Smith and Kaoru, 1990). When heteroskedasticity is present in metadata, coefficient estimates from meta-regression are inefficient, and the variance estimates using OLS are both biased and inconsistent. Furthermore, the usual *t*- and *F*- test statistics will be severely biased. Most authors address heteroskedasticity issues through the use of robust 'White-corrected' variance specifications (Rosenberger and

Loomis, 2000a; Woodward and Wui, 2001; Johnston et al., 2006) or use 'Huber-White covariance estimator' (Smith and Osborne, 1996). In this paper, the standard errors are approximated using White's heteroskedastic corrected covariance matrix estimator.

Breusch and Pagan's Lagrange multiplier statistic test for cross-sectional correlation and heteroskedasticity among the panels is used to test the first null hypothesis whether panel effects are significant in the metadata:

H_0: $\mu_{ij} = 0$, no panel effect (equal-effect) Equation (7)

H_1: $\mu_{ij} \neq 0$, panel effect.

When panel effect is present (H_0 in (7) rejected), the second null hypothesis of the REM against the FEM is tested using Hausman's Chi-squared statistic test, which test whether the panel effects are uncorrelated with other regressors. The REM assumes orthogonality of the panel effect and regressors.

H_0: μ_{ij} a random-effect Equation (8)

H_1: μ_{ij} a fixed-effect.

If the Breusch and Pagan's Lagrange multiplier fails to reject the H_0 hypothesis of equal-effect model, the Hausman specification test is not applicable. When the equal-effect cannot be rejected, the White's corrected variance estimator can be applied to ensure robust standard errors in the pooled OLS.

Panel models and poolability test

Four panel model specifications, all unweighted random-effect, are estimated after testing for panel effects (Table 2.2). SM is based on single-site studies only, wherein the 347 benefit estimates reported are aggregated on the single-site and/or sub-site levels. RM is based on regional studies, wherein the 573 benefit estimates reported are aggregated on the national, multi-state, state, county, multi-county, and/or multi-site levels. Both SM and RM are specified using 26 explanatory variables. PM^- (i.e. without aggregation variable) has the same 26 variables but was based on 920 estimates. PM^+ (i.e. with aggregation variable) was based on 920 estimates and all of the 27 explanatory variables (i.e. aggregation variable added).

Table 2.2. Meta-regression models.

	Single-site Model (SM)	Regional Model (RM)	Pooled Model w/o aggregation (PM^-)	Pooled Model w/ aggregation (PM^+)
Number of observations	347	573	920	920
Number of explanatory variables	26	26	26	27

The third hypothesis (poolability) tests whether the estimated coefficients (β) for *X* are the same across the split samples of primary studies aggregated as SM versus those primary studies aggregated as RM:

$$H_0 : \beta_{Xij}^{SM} = \beta_{Xij}^{RM}$$
$$H_1 : \beta_{Xij}^{SM} \neq \beta_{Xij}^{RM} \quad . \qquad \text{Equation (9)}$$

A Log-Likelihood Ratio (LLR) test is used to test whether the two subsamples, SM and RM, are from the same population and therefore can be pooled. LLR tests the equality of coefficients using a standard Chow test in which the estimated parameters are allowed to differ between aggregation partitions of the data. The LLR test statistic is:

$$-2*\{[LL(SM) + LL(RM)] - LL(PM^-)\} \qquad \text{Equation (10)}$$

with a χ^2 distribution and degrees of freedom equal to the number of restrictions imposed by the null hypothesis. LL(SM) is the log-likelihood of the subsample for primary studies aggregated as a SM while LL(RM) is the log-likelihood of the subsample for primary studies aggregated as RM. $LL(PM^-)$ is the log-likelihood for the PM^-. All the corresponding semi-log MR panel models are estimated using LIMDEP 8.0 (Green, 2002) and SAS 9.2.

Test and correction for publication selection bias

Conventional MRA is susceptible to the distortion of publication selection bias if uncorrected (Stanley, 2008). A standard practice in MRA is to include the standard errors (*se*) (or their inverse, i.e. precision) in a meta-regression model (e.g. Equation 1) to identify and correct for publication selection bias (Stanley, 2008), such that:

$$CS = \alpha + \lambda[se_i] + \beta_k X_i + \varepsilon_i \qquad \text{Equation (11)}$$

However, not all studies report an estimate of standard errors for CS measures they provide. Moreover, when a semi-log model is used to compute CS, the transformation of a statistical estimate β in the computation of CS: $CS = 1/\hat{\beta}$ (Adamowicz et. Al, 1989) results in simultaneous determination of CS and its standard error, which invalidates the MRA model in (11). Hence, Stanley and Rosenberger (2009) suggested using the square root of a study's sample size as a proxy for the standard error of welfare measures to avoid the simultaneity bias associated with welfare measures and standard errors of price coefficients. In theoretical models, publication bias is proportional to the inverse of the square root of sample size (Begg and Berlin, 1988).

This paper uses the square root of the sample size to identify publication selection bias. The meta-regression model corrected for publication selection bias is given by:

$$CS_i = \alpha + \lambda\left[\frac{1}{\sqrt{n}}\right] + \beta_i X_i + \varepsilon_i \qquad \text{Equation (12)}$$

When there is no publication bias, the estimated effects will vary randomly around the true effect *α*. The sign of *λ* indicates the direction of the bias. When there is no publication selection, the estimated price coefficients (and CS) will be independent of the sample size. The MR model will have heteroskedastic errors, so weighted least squares are used to estimate (12).

Model Results and Discussion

Unweighted linear and semi-log MR models are estimated according to the variables listed in Table 2.1. The MR models are based on 140 original primary studies reporting 920 estimates. The unweighted semi-log model has a lower AIC than the linear model (2.79 vs. 10.76), so semi-log is chosen as the appropriate functional form. As noted in Table 2.1, the dependent variable is the natural log of CS per person per day, indexed to 2006 dollars while the independent variables[4] are all linear, resulting in a semi-log functional form. The semi-log functional form is chosen over linear functional form because a) it fits well to the data by its ability to capture curvature in the valuation function and b) allows explanatory variables to influence CS in a multiplicative rather than an additive manner (Johnston et al., 2006).

The sportfishing metadata is stratified 'by study.' An unbalanced panel exists in the sportfishing metadata since the number of observations (CS estimates) is not constant across all studies. The number of panels (*j*) is 140, with each study being indexed as a panel. The number of estimates per panel (*i*) ranges from 1 to 74, with mean of 6.53 estimates and median of 3 estimates. Table 2.3 provides the result of hypotheses test for the panel effects following the ‘by study’ stratification. For the first hypothesis, the Lagrange multiplier statistic of 469.31 rejects the equal-effect model in favor of a panel effect (p-value <0.01). For the second hypothesis, the Hausman test is not successful in LIMDEP. In the literature, REM is preferred in meta-analysis over FEM on statistical grounds. Nelson and Kennedy (2009) suggest that RE is the appropriate model to be used because the degrees in freedom are retained in REM than FEM resulting in more efficient estimates. The FEM has disadvantages that may limit its applications, such as: 1) if perfect correlation exists between dummy variables, then the slope of those moderator variables cannot be estimated; and 2) FE software will eliminate observations from primary studies reporting only one estimate. Therefore, unweighted REM is used as the appropriate specification for the MR models.

Table 2.3. Hypothesis test results for panel stratification ‘by study’ (N=920; j = 140).

Test	Hypothesis	Statistic	Critical value (α=1%)	Result
Lagrange multiplier	H_0: no panel effect H_1: panel effect	469.31	6.64	Reject equal effect (p-value < 0.01)
Chi-square	H_0: random-effect H_1: fixed-effect	-	-	Random-effect preferred on statistical grounds

Note: N = number of observations in the metadata; j = number of panels in stratification approach.

All of the three unweighted REMs are statistically significant at p-value < 0.01 based on Chi-square statistics (Table 2.4). MR results for the PM^- were not reported in Table 2.4 since it was comparable with PM^+. Results show an increasing number of significant independent variables from SM (11) to RM (14) to PM^+ (19), which was expected. When SM and RM are pooled (PM^-), the equality of coefficients between β_{Xij}^{SM} and β_{Xij}^{RM} are rejected (Hypothesis 3). The log-likelihood results are -457.45 for SM, -640.65 for RM, and -1,231.55 for PM^-. The LLR test statistic is 266.90, which is much greater than the critical value of 40.11 (χ^2 distribution based on 27 degrees of freedom, p-value < 0.01). In this regard, the single-site studies and regional studies are different from the pooled model in terms of how the explanatory variables explain the predicted natural log of CS. This result is supported by the statistically significant 'aggregation' variable in PM^+. This suggests that model specifications with different aggregation levels of primary data will have significant multiplier effects on benefit transfer estimates.

Table 2.4. Unweighted random-effect meta-regression model results.

Category	Variable	Single-site Model		Regional Model		Pooled Model[+]	
		Parameter[a]	(SE)	Parameter[a]	(SE)	Parameter[a]	(SE)
	Constant	8.82***	(1.05)	5.08***	(0.68)	5.43***	(0.50)
Fishing environment	Freshwater fishing	-2.76***	(0.49)	-0.55***	(0.20)	-1.24***	(0.19)
	Marine	-0.74	(0.73)	-0.45**	(0.21)	-1.04***	(0.21)
	Estuary	-1.36***	(0.48)	-0.48*	(0.27)	-0.93***	(0.24)
	Lake	0.56	(0.38)	0.10	(0.22)	-0.15	(0.16)
	Great lakes	-0.19	(0.47)	0.09	(0.20)	-0.71***	(0.18)
	River or stream	0.47	(0.36)	0.29	(0.14)	0.13	(0.13)
Study methodology	Revealed preference	-0.94***	(0.39)	-1.33**	(0.59)	0.23	(0.24)
	Zonal TCM	-0.05	(0.30)	1.03***	(0.20)	0.51***	(0.17)
	Individual TCM	0.60**	(0.29)	1.19***	(0.19)	0.69***	(0.15)
	Substitute price	-0.08	(0.18)	-0.17	(0.16)	-0.32***	(0.12)
	RP time	0.37**	(0.16)	0.73***	(0.16)	0.51***	(0.11)
	Open-ended	-0.48	(0.47)	-0.62	(0.64)	0.87***	(0.29)
	Dichotomous choice	0.17	(0.37)	-0.35	(0.63)	1.46***	(0.28)
	Iterative bidding	-0.63	(0.55)	-0.59	(0.67)	0.97***	(0.35)
	Payment card	-1.42	(1.01)	-1.34*	(0.74)	0.31	(0.43)
	Price or quality substitute	-0.39	(0.38)	0.90***	(0.26)	0.23	(0.22)
Surveyed population and mode	Resident	-0.29	(0.69)	0.47	(0.33)	-0.27	(0.28)
	Non-resident	0.61	(0.74)	0.74**	(0.35)	0.26	(0.31)
	Both resident & non-resident	0.37	(0.71)	0.05	(0.33)	-0.06	(0.29)
	Mail	-1.73***	(0.38)	-0.12	(0.23)	-0.48**	(0.21)
	In-person	-1.06***	(0.36)	-0.80***	(0.26)	-1.05***	(0.22)
	Phone	-1.58***	(0.50)	-0.30	(0.27)	-0.74***	(0.24)
	Mixed mode	-1.59***	(0.43)	-0.23	(0.26)	-0.80***	(0.23)

Category	Variable	Single-site Model		Regional Model		Pooled Model	
		Parameter[a]	(SE)	Parameter[a]	(SE)	Parameter[a]	(SE)
Study attributes	Benefit unit	-0.41**	(0.19)	0.34***	(0.13)	-0.18*	(0.10)
	Journal	-0.12	(0.16)	-0.73***	(0.13)	-0.29***	(0.10)
	Trend	-0.04***	(0.01)	-0.02***	(0.01)	-0.02***	(0.01)
	Aggregation					-0.24**	(0.11)
	AIC[b]	918.9		1,285.3		2,465	
	Chi-square statistic	34.89***		60.89***		116.62***	
	Log-likelihood	- 457.45		- 640.65		-1,230.50	
	Number of observations	347		573		920	

Note: SE refers to standard errors, which is reported in parentheses, and calculated using White's heteroskedastic corrected covariance matrix estimator. TCM = travel cost method

[a] ***Statistically significant at the 1% level or better; **at the 5% or better, * at the 10% level or better.

[b] Smaller is better.

Influence of fishing environment

Freshwater fishing is negative and significant in the three MR models, meaning that if freshwater fishing is valued, it yields lower estimates than saltwater fishing or both freshwater and saltwater fishing combined. This result may be a function of the underlying metadata since freshwater fishing studies account for 86% of all the observations in the metadata. When *marine* is valued, it is significant in RM and PM^+, and yields lower estimates than mixed-water body. *Estuar*y is negative and significant for the three MR models. *Great lakes* variable is negative and significant only in PM^+, meaning that fishing in Great lakes yield higher estimates than fishing in mixed-water body. *Lake* and *river or stream* variables are not statistically significant.

Influence of study methodology

Revealed preference is negative and significant in SM and RM, but not in PM^+, suggesting that lower benefit estimates are associated with RP methods when compared with SP and combined RP/SP methods, which is not consistent with Rosenberger and Loomis (2000a). The use of a *zonal TCM* in RP models is positive and significant in RM and PM^+, implying that it produces higher benefit estimates than other valuation techniques. Moreover, the use of *individual TCM* in RP models is positive and significant for all the three MR models estimated, meaning that it produces a higher benefit estimate than other valuation techniques, which is consistent with Shrestha and Loomis (2003), and Zandersen and Tol (2009). The inclusion of *substitute price, index* or *variable* in RP models is negative and significant in PM^+, signifying that the when RP models correctly reflect the substitute variable, the associated benefit estimate is lower (Rosenthal, 1987). Moreover, the inclusion of *time* variable (not in $) in a regression increases the benefit estimate, which is not consistent with Rosenberger and Loomis (2000a) and Shrestha and Loomis (2003). The use of an *open-ended* elicitation method in SP models is significant and positive in PM, implying that it produces a higher benefit estimates than other elicitation methods. The same result can be said for *dichotomous choice* and *iterative bidding* elicitation methods. On the other hand, the use of *payment card* in SP models produces a significant increase in benefit estimate in RM than other elicitation methods. Finally, the inclusion of *substitute* in SP models is significant and positive in RM.

Influence of surveyed population and mode

When a *non-resident* visitor is coded in the RM, it produces a higher benefit estimates than other visitor types. *Resident and both resident/nonresident* variables are not statistically significant among the three MR models. The use of *mail, in-person, phone* or *mixed-mode* appears to lower benefit estimates than other survey types (SM and PM^{+}). Only *in-person* variable was significant in RM for the survey types.

Influence of study attributes

Benefit unit is negative and significant in SM and PM^{+}, suggesting that if the original study estimated benefits in units such as per trip or per season, then this tended to yield higher per day estimates than those already reported in activity day units. On the other hand, it was positive and significant in RM. There is a significant and negative effect on use value estimates when a dummy variable identifying those estimates published in journals is added to the regional model, which is consistent with Rosenberger and Stanley (2006)[5]. In other fishing MRA (Johnston et al. 2006[1]), the journal variable was not significant. The *trend* variable is significant and negative for the three MR models, indicating that specific CS have generally decreased at a greater rate than inflation over time, contrary to Rosenberger and Loomis (2001). This is expected since researchers over time develop more prudent survey designs leading to lower benefit measures (Johnston et al., 2005). The *aggregation* variable is significant in PM^+ ($p \leq 0.05$), meaning that if primary study is aggregated on a single-site or sub-site level, it has negative effect on benefit estimates than when a primary study is aggregated on a national, eco-regional/multi-state, state, county, multi-county or multi-site level. This finding confirms the result above that the single-site and regional sub-metadata are one of the many important sub-groups representing different populations.

To investigate the impact of different sub-metadata on the MR model, selected explanatory variables in the PM^+ are intersected with the aggregation variable. These intersections in the MR model accounted for structural differences between the sub-metadata. Intersected variables that have no statistical significance are dropped, signifying that the sub-metadata is structurally similar for that variable. Interpretations of the coefficients in Table 2.5 are the same as in Table 2.4. When interpreting the coefficients with a sub-metadata, the original variable measures the general effect of the unspecified group. For example, the *single-site studies* aggregation effects are measured by *aggregation*freshwater fishing*, *aggregation*estuary*, and *aggregation*mail* coefficients while the original variable coefficient (aggregation) measures the effect of the omitted metadata sample (*regional site studies*).

The coefficients for *aggregation* and *aggregation*freshwater fishing* are of the opposite sign, though the magnitude of the coefficients are not statistically different from each other. In this regard, *single-site studies* are more likely to provide smaller CS estimates when reporting for *freshwater fishing* (*aggregation*freshwater*). In the same way, *aggregation*estuary* is negative and statistically significant, suggesting a negative relationship with CS estimates. *Single-site studies* that included time variable in regression (*aggregation*RP time*) are more likely to provide smaller CS estimates. Likewise, single-site studies that surveyed resident visitors (*aggregation*resident*) or used mail survey type (*aggregation*mail*) are more likely to provide smaller CS estimates. On the other hand, the coefficients for *journal* and *aggregation*journal* were of the opposite sign, suggesting a positive relationship with CS estimates.

Table 2.5. Parameter (standard error) estimate for the sub-meta differences unweighted meta-regression model.

Category	Variable	Parameter[a]	SE
	Constant	5.45***	0.47
Fishing environment	Freshwater fishing	-0.40**	0.19
	Marine	-0.45**	0.20
	Estuary	-0.13	0.27
	Lakes	0.07	0.16
	Great Lakes	-0.09	0.18
	River or stream	0.28**	0.13
Study methodology	Revealed preference	-0.78***	0.25
	Zonal TCM	0.27*	0.16
	Individual TCM	0.69***	0.14
	Substitute price	-0.18	0.12
	RP time	1.05***	0.14
	Open-ended	-0.33	0.29
	Dichotomous choice	0.31	0.27
	Iterative bidding	-0.25	0.34
	Payment card	-0.92**	0.41
	Price or quality substitute	0.52***	0.21
Surveyed population and mode	Resident	0.35	0.27
	Non-resident	0.67***	0.29
	Both resident & non-resident	0.13	0.26
	Mail	-0.30	0.21
	In-person	-1.08***	0.20
	Phone	-0.76***	0.22
	Mixed mode	-0.89***	0.21
Study attributes	Benefit unit	0.04	0.09
	Journal	-0.88***	0.13
	Trend	-0.03***	0.01
	Aggregation	2.80***	0.29
Interaction variables	Aggregation*Freshwater fishing	-2.45***	0.26
	Aggregation*Estuary	-1.48***	0.38
	Aggregation*RP Time	-0.70***	0.17
	Aggregation*Resident	-0.85***	0.19
	Aggregation*Mail	-1.22***	0.21
	Aggregation*Journal	0.89***	0.18
AIC		2,283.4	
Log-likelihood		-1,139.70	
Chi-square		89.8	
Number of observations		920	

Note: SE refers to standard errors, which is reported in parentheses, and calculated using White's heteroskedastic corrected covariance matrix estimator. TCM = travel cost method. [a]***Statistically significant at the 1% level or better; **at the 5% or better, * at the 10% level or better.

Publication Selection Bias

This section addresses the question, Is publication selection likely to cause large biases in the sportfishing literature? If such publication selection bias exists, the result of the *root-n estimate* can give us a 'better' true effect estimate and direction of bias (Stanley and Rosenberger, 2009). The *root-n* MRA of sportfishing values, shown in Table 2.6, is estimated using Equation (12) discussed above. Recall that the raw average CS is $58.88 per person per day (in 2006 dollars), with a standard error of +/- $1.94. The estimated true effect (α), i.e. the magnitude of the empirical effect corrected for publication selection, is $98.42, with a standard error of +/- $26.12, which is statistically different and higher CS estimate than the sportsfishing literature mean of $58.88. There is also evidence of downward bias among sportfishing values (λ is negative, t=3.33). By this MRA estimate, a study that uses 100 observations underestimates CS by $10.31, while 10,000 observations imply an understatement by $1.03. Hence, sportfishing values reported for studies included in the analysis for this paper may be systematically underestimated.

Benefit Transfer Comparison

The results from SM, RM, and PM^+, referred to as meta-regression benefit transfer functions, are applied to predict out-of-sample CS per person per day values. Out-of sample original CS are obtained from sportfishing valuation studies in North America that have become available after the estimation of MRBT functions or studies not included in the metadata. If the original benefit estimates are not reported in per person per day, they are converted to CS per person per day. All original benefit estimates are adjusted to 2006 US dollars using an implicit price deflator.

Table 2.6. *Root-n* meta-regression analysis of sportfishing values.

Category	Variable	Parameter[a]	SE
True effect	α	98.42***	(26.12)
Direction of bias	λ	-103.06***	(30.96)
Fishing environment	Freshwater	-68.11***	(14.93)
	Marine	-34.53*	(18.22)
	Estuary	-54.13**	(23.09)
	Lakes	-31.71***	(7.22)
	Great Lakes	-37.09***	(8.33)
	Rivers or stream	0.49	(5.47)
Study methodology	Revealed Preference	56.85***	(9.82)
	Zonal TCM	22.81**	(11.28)
	Individual TCM	19.77*	(11.04)
	RP Substitute	-8.94	(7.36)
	Open-ended	57.67***	(18.11)
	Dichotomous choice	68.73***	(16.89)
	Iterative bidding	71.74***	(20.21)
	Payment Card	-13.28	(18.12)
	SP Substitute	38.07***	(11.65)
Surveyed population and mode	Resident	-33.40***	(11.73)
	Non-resident	7.26	(16.32)
	Both resident and non-resident	-44.44***	(11.49)
	Mail	-7.09	(13.74)
	In-person	-35.90***	(13.66)
	Phone	-28.04**	(13.54)
	Mixed-mode	-19.73	(15.29)
Study attributes	Benefit unit	-1.69	(5.50)
	Journal	2.19	(6.38)
	Trend	0.95***	(0.34)
	Aggregation	3.66	(7.33)
	F-statistic	10.75	
	Adjusted-R^2	0.24	
	Log-likelihood	-4,470.23	
	Number of observations	833	

Note: SE refers to standard errors, which is reported in parentheses, and calculated using White's heteroskedastic corrected covariance matrix estimator. TCM = travel cost method

[a]***Statistically significant at the 1% level or better; **at the 5% or better, * at the 10% level or better.

The characteristics of the selected non-random out-of sample studies are reported in Table 2.7. Three estimates from three of five out-of-sample studies belong to the two-tails of the in-sample CS distribution reported in Figure 2.4. The original benefit estimates ranges from \$1.16 to \$294.36. If high and low tails are excluded, the original benefit estimates ranges from \$18.88 to \$99.96. CS values computed using MRBTFs are estimated incorporating out-of-sample study characteristics. To do this, relevant variables in the MRBT function are set according to the original out-of-sample study (e.g. if freshwater fishing, this variable was set to 1, 0 otherwise). The *trend* variable is set to a number to reflect the year the data is collected. Estimated CS values using MRBTF are corrected for bias after logarithmic transformation following Stynes, Peterson, and Rosenthal (1986).

The out-of-sample original CS estimates are compared to the MRBTF estimated CS values, by computing the percentage difference (γ):

$$\gamma = \left[\frac{CS_{MRBTF} - CS_{Original}}{CS_{Originall}} \right] * 100\% ,$$

where CS_{MRBTF} is the benefit estimated using the MRBT functions while $CS_{Original}$ is the out-of-sample original benefit estimate. The percentage difference evaluates the convergence between the CS values estimated through MRBT functions and original out-of-sample CS values. When the out-of-sample study reports multiple estimates, γ is computed for each estimated CS values.

Table 2.7. Out-of-sample study characteristics and benefit comparison.

Study	Number of observations	Aggregation level	Study methodology	Original benefit estimate[a]	Estimated Benefit			γ (% difference)[b]		
					SM	RM	PM+	SM	RM	PM+
Parsons, Platinga and Boyle, 2000	1	State	RP, RUM	1.16	5.21	5.81	9.78	349.01	400.71	743.12
Kling and Thompson, 1996	6	Multi-site	RP, RUM	18.88	26.17	23.73	30.93	38.64	25.71	63.83
				18.60	26.17	23.73	30.93	40.69	27.57	66.25
				38.11	26.17	23.73	30.93	-31.33	-37.73	-18.85
				45.14	27.15	44.40	27.63	-39.86	-1.62	-38.79
				57.37	27.15	44.40	27.63	-52.68	-22.60	-51.84
				99.96	26.17	23.73	30.93	-73.82	-76.26	-69.06
Larson and Lew, 2005	1	Single-site	RP, Individual	96.15	49.66	45.36	55.33	-48.35	-52.83	-42.46
Ahn et al., 2000	1	State	RP, RUM	188.24	6.10	10.44	21.84	-96.76	-94.45	-88.40
Provencher, Baerenklau, and Bishop, 2002	1	Single-site	RP, RUM	294.36	8.23	22.96	9.06	-97.20	-92.20	-96.92
							Absolute average	86.83	83.17	127.95
							Absolute (excluding high/low tails)[c]	46.48	34.90	50.15

[a] Indexed to 2006 dollars, at 95% confidence interval. [b] A relatively smaller γ (% difference) indicates convergence. Negative γ indicate underestimation. [c]Based on two studies only, i.e. Kling and Thompson, 1996; and Larson and Lew, 2005. RP = revealed preference. SM = single site model. RM = regional model. RUM=random utility model. TCM = travel cost method.

The magnitude of γ is relative upon the original benefit estimate. Overestimation is of particular concern when original CS values are around $1 per person per day value. Original CS values falling in the high tail distribution of the in-sample CS result in underestimation. Excluding high and low tails, the absolute γ values was 34.90% for RM, 46.48% for SM, and 50.15% for PM+. As expected, RM predicted closer values of benefits with the out-of-sample CS since most values are regional estimates. There is no definitive conclusion that can be reached from this application given small out-of sample observation. Therefore, using certain protocol in BT applications, either RM or SM is expected to increase the likelihood of producing the lowest error when there is convergence in the 'study' and 'policy' sites characteristics. On the other hand, values that are broadly applied to the region cannot provide specific values for certain local 'policy' question of interest. Indeed, there is a trade-off associated with this specificity versus generalizability of results.

Conclusions

This paper evaluates aggregation structure of primary research studies and their implication for benefit transfer using meta-regression analysis. This goal is accomplished by following the 'best-practice' guidelines for meta-analyses using the sportfishing valuation studies. Unweighted semi-log model specification is used since it fits the metadata best. The MR models are also corrected for panel effects using a random-effect, following by study panel specification.

Three MR models: a single-site model, a regional model, and a pooled model (combined single-site and regional studies) are compared based on their statistical significance and predictive power based on out-of-sample error predictions. Structural shifts in the metadata are mainly attributed to the following variables: freshwater fishing, estuary, RP time, resident visitors, mail survey type and journal. Based upon the log-likelihood ratio test result, the two sub-metadata models (single-site and regional) are not from the same population. Overall, the regional model has more significant explanatory variables than single-site model. Using the out-of-sample validity test, results reveal that the estimated percent difference using the regional model is lower than single-site and pooled models. By excluding high/low original CS values for the transfer studies, the relative performance of the RM model increases over the other two models; however, with the small set of out-of-sample studies, these results remain inconclusive as to which model might work best in real-world policy settings.

Following the ‘best-practice’ guidelines for meta-analysis, this paper shows that welfare aggregation differences among primary studies influence the direction and magnitude of biases that are carried forward in benefit transfer applications. In particular, benefit transfer error depends on the researcher’s choice of primary studies to include in metadata, model specification, and the unit of welfare aggregation level to consider. The findings suggest that when doing benefit transfer based on meta-regression benefit function, researchers should consider the appropriate level of aggregation. Following certain protocol, it can be said that there is no single 'appropriate' level of aggregation. Depending on the available studies and objectives of the valuation study, some construct at different levels of aggregation may be better. It is possible that a particular unit of analysis may be appropriate in some instances.

There remain some challenges in conducting meta-analysis for benefit transfer. The general lack of reporting about characteristics of the primary study contexts in the literature, information which may be pertinent for benefit transfers, remains a concern (Rosenberger and Stanley, 2006). For example, site specific characteristics are rarely available in the primary valuation studies. Likewise, important socio-economic variables are not reported in many of the primary studies. There might be other variables that are significant in explaining the variation in CS values across empirical studies, which were not reported, but these factors remain as unobserved heterogeneity. The implication of poor reporting is that conventional and meta-analytic benefit transfers might be improved with more information provided by primary studies.

Although results indicate that the model's statistical fit is quite good, the sportfishing metadata is heavily skewed with the abundance of freshwater primary studies. This possible weakness in the metadata could be alleviated over time by increasing the number of original primary studies that valued saltwater fishing. Likewise, standardizing the types of variables to be included and facilitating access to data from these studies is necessary. It would be interesting for future research if the same result would come out when additional saltwater fishing studies are appended to this growing database of sportfishing articles.

Notes

[1] Welfare estimates are based on marginal value of fish, while this paper is based on access value of fishing

[2] Aggregation, in this paper by Lupi and Feather (1998), refers to the grouping of individual sites into larger sites.

[3] The number of studies employing each valuation methodology does not sum to the total number of studies because some studies used different valuation methods, from which multiple observations were derived.

[4] Some variables are excluded from the model because data are incomplete or missing from most studies in the sportfishing metadata. For example, only 57 out of 143 studies reported sample summary statistics of anglers. Some other variables are excluded because of a clear lack of variations in some of the estimated models.

[5] Care is needed in comparing the results. The metadata used in this essay is different from the metadata in Rosenberger and Stanley (2006) meta-analysis. Rosenberger and Stanley (2006) tested the publication dummy variables using the Rosenberger and Loomis (2001) meta-analysis, which include literature review that spans 1967 to 1998 and covers 21 recreation activities plus a category for wilderness recreation.

[6] When an OLS unweighted semi-log MR model is used instead of the random-effect panel MR models, the absolute γ values was 53.69% for PM, 63.46% for SM and 253.09% for RM.

References

Ahn S., J.E., De Steiguer, R.B. Palmquist, and T.P. Holmes. Economic Analysis of the Potential Impact of Climate Change on Recreational Trout Fishing in the Southern Appalachian Mountains: An Application of a Nested Multinominal Logit Model. *Climate Change* 45(2000), 493-509

Adamowicz, W. L., J. J. Fletcher, and T. Graham-Tomasi. "Functional form and the statistical properties of welfare measures." *American Journal of Agricultural Economics* 71, no. 2(1989): 414-421.

Bateman, I. J., and A. P. Jones. "Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values." *Land Economics* 79, no. 2(2003): 235-258.

Bateman, I. J., et al. "The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP." *Ecological Economics* 60, no. 2(2006): 450-460.

Bennear, L. S., R. N. Stavins, and A. F. Wagner. "Using Revealed Preferences to Infer Environmental Benefits:Evidence from Recreational Fishing Licenses." *Journal of Regulatory Economics* 28, no. 2(2005): 157-179.

Bergstrom, J. C., and H. K. Cordell. "An analysis of the demand for and value of outdoor recreation in the United States." *Journal of Leisure Research* 23, no. 1(1991): 67-86.

Boyle, K. J., and J. C. Bergstrom. "Benefit Transfer Studies: Myths, Pragmatism, and Idealism." *Water Resources Research* 28, no. 3(1992): 657–663.

Bowes, M. D., and J. B. Loomis. "A Note on the Use of Travel Cost Models with Unequal Zonal Populations." *Land Economics* 56(1980): 465-470.

Brander, L. M., P. Van Beukering, and H. S. J. Cesar. "The recreational value of coral reefs: A meta-analysis." *Ecological Economics* 63, no. 1(2007): 209-218.

Brouwer, R. (2002) Environmental value transfer: State of the art and future prospects. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Brown, W. G., and F. Nawas. "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions." *American Journal of Agricultural Economics* 55, no. 2(1973): 246.

Engel, S. (2002) Benefit function transfer versus meta-analysis as policy-making tools: a comparison. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Espey, M. "Explaining the variation in elasticity estimates of gasoline demand in the United States: A meta." *Energy Journal* 17, no. 3(1996): 49.

Fisheries and Oceans Canada (2007). Survey of Recreational Fishing in Canada 2005. Ottawa, Ontario. Economics Analysis and Statistics Policy Sector.

Florax, R. (2002) Methodological Pitfalls in Meta-analysis:Publication Bias. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Florax, R., P. Nijkamp, and K. Willis (2002) Meta-analysis and value transfer: comparative assessment of scientific knowledge. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Florax, R. J. G. M., C. M. Travisi, and P. Nijkamp. "A meta-analysis of the willingness to pay for reductions in pesticide risk exposure." *European Review of Agricultural Economics* 32, no. 4(2005): 441-467.

Glass, G. V. "Primary, Secondary, and Meta-Analysis of Research." *Educational Researcher* 5, no. 10(1976): 3-8.

Greene, W. H. *LIMDEP Version 8: Econometric Modelling Guide*: Econometric Software, Inc., 2002.

Johnston, R. J., et al. "What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values." *Marine Resource Economics* 21(2006): 1-32.

Johnston, R. J., et al. "Systematic Variation in Willingness to Pay for Aquatic Resource Improvements and Implications for Benefit Transfer: A Meta-Analysis." *Canadian Journal of Agricultural Economics* 53, no. 2-3(2005): 221-248.

Kennedy, P. A. *A Guide to Econometrics*. 6th ed. Malden, MA Blackwell Publishing, 2008.

Kling, C.L. and C.J. Thompson. "The Implications of Model Specification for Welfare Estimation in Nested Logit Models." *American Journal of Agricultural Economics* 78(1996):103-114.

Koteen, J., S. J. Alexander, and J. B. Loomis (2002) Evaluating Benefits and Costs of Changes in Water Quality, General Technical Report PNW-GTR-548. Portland, Oregon, US Forest Service.

Larson, D. M., and D. K. Lew. "Measuring the utility of ancillary travel: revealed preferences in recreation site demand and trips taken " *Transportation Research Part A: Policy and Practice* 39, no. 2-3(2005): 237-255

Lindhjem, H. "20 years of stated preference valuation of non-timber benefits from Fennoscandian forests: A meta-analysis." *Journal of Forest Economics* 12, no. 4(2007): 251-277.

Lipsey, M. W., and D. B. Wilson. *Practical Meta-Analysis*. Applied Social Research Method Series. Thousand Oaks, California: Sage Publications, Inc., 2000.

Loomis, J. B., and D. S. White. "Economic benefits of rare and endangered species: summary and meta-analysis." *Ecological Economics* 18, no. 3(1996): 197-206.

Loomis, J. B. "Vertically Summing Public Good Demand Curves: An Empirical Comparison of Economic versus Political Jurisdictions." *Land Economics* 76, no. 2(2000): 312.

Loomis, J. B., and R. S. Rosenberger. "Reducing barriers in future benefit transfers: Needed improvements in primary study design and reporting." *Ecological Economics* 60, no. 2(2006): 343-350.

Loomis, J. B., and R. G. Walsh. *Recreation Economic Decisions: Comparing Benefits and Costs* Second ed: Venture Publishing, Inc: State College, Pennsylvania, 1997.

Lupi, F., and P. Feather. "Using Partial Site Aggregation to Reduce Bias in Random Utility Travel Cost Models." *Water Resources Research* 34, no. 12(1998): 3595-3603.

Manley, J., et al. "Creating Carbon Offsets in Agriculture through No-Till Cultivation: A Meta-Analysis of Costs and Carbon Benefits." *Climatic Change* 68, no. 1(2005): 41-65.

Moeltner, K., K. J. Boyle, and R. W. Paterson. "Meta-analysis and benefit transfer for resource valuation-addressing classical challenges with Bayesian modeling." *Journal of Environmental Economics and Management* 53, no. 2(2007): 250-269.

Moulton, B. R. "Random Group Effects and the Precision of Regression Estimates." *Journal of Econometrics* 32(1986): 385-397.

Mrozek, J. R., and L. O. Taylor. "What determines the value of life? a meta-analysis." *Journal of Policy Analysis and Management* 21, no. 2(2002): 253-270.

Nelson, J. P., and P. E. Kennedy. "The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment " *Environmental and Resource Economics* 42(2009): 345-377.

Nijkamp, P., et al. (2002) Environmental quality in European space: a methodology for research synthesis. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Parsons, G. R., A. J. Plantinga, and K. J. Boyle. "Narrow Choice Sets in a Random Utility Model of Recreation Demand." *Land Economics* 76, no. 1(2000): 86-99.

Platt, J., and E. Ekstrand (2001) Meta-Analysis of Water Recreation, Report No. EC-2001-05. Washington, DC, Bureau of Reclamation, US Department of Interior.

Pearson, K. "Report on certain enteric fever inoculation statistics." *British Medical Journal* 3(1904): 1243-1246.

Provencher, B., K.A. Baerenklau, and R.C. Bishop. “A Finite Mixture Logit Model of Recreational Angling with Serially Correlated Random Utility.” *American Journal of Agricultural Economics* 84, no. 4(2002):1066-1075.

Ready, R., and S. Navrud. "International benefit transfer: Methods and validity tests." *Ecological Economics* 60, no. 2(2006): 429-434.

Rosenberger, R. S., and J. B. Loomis. "Using meta-analysis for benefit transfer: In-sample convergent validity tests of an outdoor recreation database." *Water Resources Research* 36, no. 4(2000a): 1097-1108.

Rosenberger, R. S., and J. B. Loomis. "Panel Stratification in Meta-Analysis of Economic Studies: An Investigation of Its Effects in the Recreation Valuation Literature." *Journal of Agricultural and Applied Economics* 32, no. 3(2000b): 459-470.

Rosenberger, R. S., and J. B. Loomis (2001) Benefit transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan (2000 revision). Fort Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, pp. 59.

Rosenberger, R. S., and T. T. Phipps (2007) Correspondence and convergence in benefit transfer accuracy: A meta-analytic review of the literature, ed. S. Navrud, and R. Ready. Environmental Values Transfer: Issues and Methods. Dordrecht, The Netherlands, Kluwer Academic Publishers. pp. 23-43.

Rosenberger, R. S., and T. D. Stanley. "Measurement, generalization, and publication: Sources of error in benefit transfers and their management." *Ecological Economics* 60, no. 2(2006): 372-378.

Rosenberger, R. S., and R. J. Johnston. "Selection Effects in Meta-Analysis and Benefit Transfer: Avoiding Unintended Consequences." *Land Economics* 85, no. 3(2009): 410-428.

Rosenthal, D. H. "The Necessity for Substitute Prices in Recreation Demand Analyses." *American Journal of Agricultural Economics* 69, no. 4(1987): 828.

Scheierling, S. M., R. A. Young, and G. E. Cardon. "Public subsidies for water-conserving irrigation investments: Hydrologic, agronomic, and economic assessment." *Water Resources Research* 42(2006).

Shadish, W. R., and C. K. Haddock (2009) Combining Estimates of Effect Size. In H. Cooper, L. V. Hedges, and J. C. Valentine (Eds.) The Handbook of Research Synthesis and Meta-analysis, 2nd Edition. New York, Russell Sage Foundation, pp. 257-277.

Shrestha, R. K., and J. B. Loomis. "Meta-Analytic Benefit Transfer of Outdoor Recreation Economic Values: Testing Out-of-Sample Convergent Validity." *Environmental and Resource Economics* 25, no. 1(2003): 79-100.

Smith, V. K. "Nonmarket valuation of environmental resources: An interpretive appraisal." *Land Economics* 69, no. 1(1993): 1-26.

Smith, V. K., and Y. Kaoru. "Signals or noise? Explaining the variation in recreation benefit estimates." *American Journal of Agricultural Economics* 72, no. 2(1990): 419.

Smith, V. K., and L. L. Osborne. "Do Contingent Valuation Estimates Pass a "Scope" Test? A Meta-analysis." *Journal of Environmental Economics and Management* 31, no. 3(1996): 287-301.

Smith, V., and S. Pattanayak. "Is Meta-Analysis a Noah's Ark for Non-Market Valuation?" *Environmental and Resource Economics* 22, no. 1(2002): 271-296.

Southwick Associates (2007). Sportfishing in America: An Economic Engine and Conservation Powerhouse. Produced for the American Sportfishing Association with funding from the Multistate Conservation Grant Program.

Spash, C. L., and A. Vatn. "Transferring environmental value estimates: Issues and alternatives." *Ecological Economics* 60, no. 2(2006): 379-388.

Stanley, T. D. "Wheat from Chaff: Meta-analysis as Quantitative Literature Review." *Journal of Economic Perspectives* 15, no. 3(2001): 131-150.

Stanley, T. D. "Meta-Regression Methods for Detecting and Estimating Empirical Effects in the Presence of Publication Selection." *Oxford Bulletin of Economics and Statistics* 70, no. 1(2008): 103-127.

Stanley, T. D., and S. B. Jarrell. "Meta-Regression Analysis: A Quantitative method of Literature Surveys." *Journal of Economic Surveys* 3, no. 2(1989): 161.

Stanley, T. D., and R. S. Rosenberger (2009) Are Recreation Values Systematically Underestimated? Reducing Publication Selection Bias for Benefit Transfer, Hendrix College and Oregon State University. Working Paper.

Stoker, T. M. "Empirical Approaches to the Problem of Aggregation over Individuals." *Journal of Economic Literature* 31(1993): 1827-1874.

Sturtevant, L. A., F. R. Johnson, and W. H. Desvousges (1996) A Meta-Analysis of Recreational Fishing, Working Paper, Triangle Economic Research.

Stynes, D.J., G.L. Peterson, and D.H. Rosenthal. 1986. "Log Transformation Bias in Estimating Travel Cost Models." *Land Economics* 62(1):94-103.

Van Houtven, G., J. Powers, and S. K. Pattanayak. "Valuing water quality improvements in the United States using meta-analysis: Is the glass half-full or half-empty for national policy analysis?" *Resource and Energy Economics* 29, no. 3(2007): 206-228.

Vaughan, W. J., C. S. Russell, and M. Hazilla. "A Note on the Use of Travel Cost Models with Unequal Zonal Populations: Comment." *Land Economics* 58, no. 3(1982): 400-407.

Walsh, R. G., D. M. Johnson, and J. R. McKean. "Issues in Nonmarket Valuation and Policy Application: A Retrospective Glance." *Western Journal of Agricultural Economics* 14, no. 1(1989): 178-188.

Woodward, R. T., and Y.-S. Wui. "The economic value of wetland services: a meta-analysis." *Ecological Economics* 37, no. 2(2001): 257-270.

Zandersen, M., and R. S. J. Tol. "A meta-analysis of forest recreation values in Europe." *Journal of Forest Economics* 15, no. 1-2(2009): 109-130.

CHAPTER 3 - ESSAY 2
ADDRESSING DEPENDENCY IN THE SPORTSFISHING VALUATION LITERATURE: IMPLICATIONS FOR META-REGRESSION ANALYSIS AND IN-SAMPLE BENEFIT PREDICTION PERFORMANCE

Abstract

The sportfishing literature contains about 140 papers that provide benefit estimates of the access value for fishing in the United States and Canada. This paper examines the implications of addressing dependency in the sportsfishing valuation literature using meta-regression analysis (MRA) and corresponding benefit-transfer (BT) performance. Meta-analysis is applied to various treatments of data dependency in the sportsfishing metadata. The 'all-set' metadata uses all of the available benefit measures reported in the primary studies. Two approaches for controlling data dependency in the 'all-set' metadata include weighting of the metadata and using panel data estimators. Two treatments of the metadata for avoiding dependency include a 'best-set' metadata (comprised of the best available benefit measures reported in a study as identified by methodological and sample criteria) and an 'average-set' metadata (comprised of the average benefit measures reported in the primary studies). Results show that the model fit is best achieved when the MRA is based on weighting the 'all-set' or using the 'average-set', which are complementary of each other. The weighted 'all-set' model resulted in the highest number of significant variables among the models estimated. Changing the underlying structure of the metadata changes the magnitude and sign of the estimated parameters of the fishing environment variables. Results of in-sample BT using jackknife data splitting technique show median absolute transfer errors of 40% to 48%. The median absolute percentage transfer error is lower for the meta-regression (MR) models based on a single value, i.e. 'average-set' and 'best-set' metadata than the MR models based on 'all-set.' Higher transfer error may be explained by dummy variables that are related to measurement errors and publication selection bias inherent in the primary studies.

Introduction

Meta-analysis is an important methodological tool that can generate meaningful comparative results of empirical data to inform policy decisions. Given its potential applications, there has been a dramatic increase in the use of meta-analysis over the past decade. Yet in spite of its potential contribution, Nelson and Kennedy (2009) noted that new meta-analyses appear to ignore several basic methodological and econometric issues that would define a complete and rigorous analysis. In particular, several methodological pitfalls may invalidate the conclusions of a meta-analysis when insufficient attention is given to routine problems encountered when basic statistical procedures are applied to metadata. Heterogeneity among studies and dependency among the observed effect sizes in the metadata are two of the methodological pitfalls that are detrimental to the validity of meta-analysis (Glass et al., 1981; Florax, 2002). Nelson and Kennedy (2009) emphasized the need to place a high priority on adjusting for correlated effect-size estimates, both within and between groups of studies. Awareness of these issues and corrections for possible biases caused by them will help increase the validity and reliability of meta-analysis results, and be able to detect the true effect size or true impact of moderator variables.

Heterogeneity in metadata refers to effect size estimates from primary studies not all estimating the same population effect (Nelson and Kennedy, 2008). There is heterogeneity in the metadata because of theoretical and modeling perspectives (valuation method, functional form, research design), behavioral aspect (population characteristics, income differentials) (Brouwer, 2002; Florax, 2002), and inherent data characteristics (Stanley and Jarell, 1989). Heterogeneity in primary study variables, estimated models, and recreation activities limit the parameters that can be included in meta-analysis, resulting in lower coefficient of determination (R^2) and higher error (ε) in MR models (Engel, 2002), which can be carried forward in BT. Heterogeneity of metadata may cause biased value estimates in meta-analyses due to underspecification when used for BT predictions (Boyle and Bergstrom, 1992; Loomis and Rosenberger, 2006) and may limit the ability to measure differences within a population at a higher resolution (Adamowicz and Deshazo, 2006). While heterogeneity is a fact of metadata and proper specification is important, it is not the focus of this paper.

Dependency or correlation refers to a departure of two random variables from independence. Correlated effect-size estimates imply biased standard error estimates (Nelson and Kennedy, 2009). Reasons for correlation include 1) multiple sampling per study to obtain a sufficient number of observations for meta-analysis (i.e. between study correlated observations); and 2) researchers reporting more than one benefit measure for each primary study (i.e. multiple estimates from the same primary study—within-study autocorrelation). In the sportfishing metadata, the average number of benefit estimates reported is 6.3 per primary study (median = 3) and range from one to 74 estimates. When multiple estimates from the same study are recorded in the metadata, meta-analysis results may be bias due to lack of independence of observations (Wood, 2008; Strube, 1987; Glass et al., 1981). Failure to adjust for dependency will inflate the likelihood of *Type I error* when comparisons are made *across* studies. Likewise, dependency will inflate the likelihood of *Type II error* when comparisons are made among or between different outcomes *within* studies (Strube, 1987). To minimize dependency, meta-analysts should use consistently defined outcome measures (effect-sizes), and similarly defined population characteristics and research objectives (Florax, Nijkamp, and Willis, 2002), when possible. Consistency and comparability of primary study outcomes is an important ingredient for a robust meta-analysis.

Since dependency and heterogeneity are inevitable in metadata, what approaches should be employed to minimize their effects? Lipsey and Wilson (2000) suggested two simple approaches to handle these issues. The first approach is to base the meta-analysis only on the 'best' evidence (i.e. selecting a single estimate) while the second approach is to use a single 'mean' value (i.e. taking the average). Other approaches that have been used to address these issues are panel model estimators (Rosenberger and Loomis, 2000b; Sturtevant et al., 1996), and hierarchical/multilevel estimation procedure (Bateman and Jones, 2003; Johnston et al., 2005) on all reported empirical estimates in primary studies. When research focus is on identifying the sources of heterogeneity in metadata, using all reported estimates in the literature is suggested (Doucouliagos and Ulubasoglu, 2008). So far, the issue of dependency through the use of single 'best' estimate and 'average' estimate has not yet been fully addressed through empirical research in environmental economics meta-analyses.

This paper examines meta-analytic procedures that are used when one or more of the studies in the metadata contain multiple measures of benefits. Specifically, this paper addresses the research question, “Are the MR model results statistically the same for the ‘all-set,’ ‘best-set,’ and ‘average-set’ metadata?” as applied to the sportfishing valuation literature. This paper concludes with recommendations for study selection and methodological protocol when conducting a meta-analysis.

Approaches to Multiple Estimates

Let the MR model be defined as:

$$y_i = \alpha + \beta_k X_i + \varepsilon_i \qquad \text{Equation (1)}$$

where *y* is the dependent variable, which is the vector of CS per person per day of sportsfishing converted to 2006 dollars reported across the individual primary studies, *i* that indexes each observation; *X* is a matrix of explanatory variables (the identifiable characteristics among the different studies) that account for systematic components explaining the variation in *y*; and ε is a random error component with mean zero and variance σ_ε^2. The parameters α (constant term common across all observations) and β (slopes) are estimated by:

$$\begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \left(X^{'} T^{-1} X\right)^{-1} X^{'} T^{-1} Y \qquad \text{Equation (2)}$$

where $T = W \Sigma W$, *W* is a diagonal matrix with weights and Σ is a block-diagonal matrix with error variances.

There are at least three approaches to deal with multiple estimates within studies: 1) 'all-set' approach; 2) 'best-set' approach; and 3) 'average-set' approach. When primary studies provide multiple estimates of value, one approach is to code all of the estimates reported in primary studies in the metadata (‘all-set’ metadata), treating each estimates as independent observations. Independence of studies (and/or estimates) suggests that the different studies (and/or estimates) included in the metadata are concerned with different groups of people or with different populations. When benefit measures are independent from each other, all the covariance terms are zero and the estimate of the standard deviation of the linear combinations of studies is based solely on the main diagonal of the variance-covariance matrix (Strube, 1987). In this approach, all weights equal 1, $W = I_M$, where I_M is the identity matrix of order *M x M*, and the error at the study level is assumed zero. The parameters, α and β, are estimated via ordinary least squares (OLS).

However, not all studies are contributing the same number of estimates; therefore, some form of weighting of the data is required. The use of weights is needed since studies with many estimates may have a larger effect on the results of the meta-analysis than studies with fewer estimates (Rosenthal, 1991). In this case, multiple estimates are treated as independent weighted estimates, where weights are defined by: $w_{mj} = M / M_j J$, for all $j = 1, 2, \ldots$, J. When the number of estimates from each primary study is used as the weight, the within-study weights sum to one (see also Johnston et al., 2006; Mrozek and Taylor, 2002). Hence, each primary study, rather than each observation, has an equal weight in determining the regression coefficients. In other words, the sum of the weights equals the number of estimates reported within a primary study. Weights are applied by placing the square root of the weights onto the diagonal of an MxM matrix, thereby forming the diagonal matrix W, with zero's as off-diagonal elements. The parameters, α and β, are estimated via weighted least squares (WLS).

Assuming multiple estimates from a single study are independent of each other is likely a weak assumption that can bias model results (Nelson and Kennedy, 2009). Panel data methods are one of the recommended approaches to controlling for dependency in metadata (Rosenberger and Loomis, 2000b; Sturtevant et al., 1996). A general panel meta- regression model is written as:

$$y_{ij} = \alpha + \beta_k X_{ij} + \varepsilon_{ij} \qquad \text{Equation (3)}$$

where *j* is the stratification index. Essay 1 provides a detailed discussion of the panel methods and associated hypotheses tests.

With current reporting practices, estimates of covariances are generally not given or difficult to estimate, implying greater difficulty for controlling dependency in the presence of multiple estimates. Thus, as previously noted, two approaches are suggested for removing data dependency due to multiple estimates from the same source by coding a single estimate per study: 1) the use of a single 'best' estimate per primary study (Doucouliagos and Ulubasogla, 2006; Nelson and Kennedy, 2009), or 2) the use of study-level averages (Hunter and Schmidt, 2004). In these approaches, multiple estimates are eliminated through the selection of a single estimate or avoided by aggregating multiple estimates (i.e., recording an average value for multiple estimates). In either case, the resulting metadata are comprised of independent observations that do not require the use of weights (i.e. $W = I_j$, where I_j is the identity matrix of order JxJ (Bijmolt and Pieters, 2001)) and do not have a panel data structure. The parameters, α and β, can then be estimated via OLS.

The 'best-set' approach uses only those studies that the analyst regards as superior according to some criterion. Examples are estimates favored by the author (Whitehead and Aiken, 2000), or used a particular state-of-the-art estimation procedure (Adamowicz, Louviere and Williams, 1994). For those studies reporting a single estimate, they are treated as best-estimates[1]. Although the simplest method of using one estimate from each primary study is often recommended (Lipsey and Wilson, 2000), it has been criticized in that results may summarize only a narrow domain of available evidence and have less generality since the analysis is based on a smaller sample.

The last approach in dealing with multiple estimates is to use the average estimated value $\left(\overline{CS_j}\right)$:

$$\overline{CS_j} = \frac{\sum[CS_i]}{n_j} \qquad \text{Equation (4)}$$

where *n* is the number of estimate for primary study *j*. In a study of wetlands-based recreation, Bergstrom et al. (1990) noted that average values may be useful for comparing aggregate values of wetland size relative to the size of the total area. However, this standardization of estimates may result in a loss of information, i.e. the micro-foundation of studies used in meta-analysis (Nijkamp et al., 2002). Again, if a study reported a single estimate, then this estimate is included in the ‘average-set’ metadata. The next section discusses the collection of studies and coding of best and average estimates.

Data Collection and Coding of Best and Average Estimates

Primary studies on the access value of outdoor recreation in the U.S. and Canada were collected through searching databases, formally requesting documents/ references via e-mail, listserves, postal mail and/or phone, analysis of citations and careful study of references. This study focuses on sportfishing valuation data in the broader outdoor recreation use values database because it has sufficient previous primary studies and reported the most number of estimates among outdoor recreation valuation studies. The sportfishing values metadata includes 140 primary studies that were published between 1969 and 2006 (Appendix B). Essay 1 describes the coding of variables for the 'all-set' metadata. The discussion below describes the coding of 'average' and 'best' estimate.

Two datasets (or sub-metadata) are generated out of the sportfishing metadata (i.e. ‘all-set’). The first dataset is the 'best-set,’ which is comprised of 'best estimates', while the second dataset is the ' average-set', which is comprised of 'average estimates.’ Both the ‘best-set’ and the ‘average-set’ contain independent and dependent observations depending on primary study treatments of their underlying sample data and the number of estimates reported. Independent data are single observations from independent studies, and multiple estimates in a single study that are based on different samples, different resources, different valuation methods (e.g., SP and RP data derived from the same sample), etc. Dependent data are multiple observations in a single study that are derived for the same resource, using the same methods, and relying on the same underlying sample. Therefore, even though some studies report multiple estimates, it is the data structure underlying these estimates that determines whether or not they are classified as potentially dependent.

Figure 3.1 outlines the detection heuristic in coding 'best' and 'average' estimates reported in the primary sportfishing studies. The first step starts with identifying studies that report a single estimate. This estimate is carried forward and coded independently as the 'best' and the 'average' estimate for these studies. A total of 31 primary studies (or 22% of the total number of primary studies) report single estimates of CS.

The second step evaluates primary studies reporting multiple estimates of welfare measures, whether each estimate provided is a link to a separate sample, i.e. multiple estimates, multiple samples, with a one-to-one correspondence. These estimates are carried forward as independent estimates and coded as 'best' or 'average' estimates. There are 65 primary studies (or 46% of the total number of primary studies) that reported multiple estimates but are treated as independent samples because of different sample sizes, geographic location, year the data is collected, visitor-type, water-body type, fish species, or valuation methodology. For example, Martin et al. (1974) in their study on the demand for and value of fishing in Arizona reported 13 independent estimates, one each from 13 different samples of anglers. Likewise, Morey et al. (2002) reported two independent estimates that correspond to mutually-exclusive resident and non-resident populations.

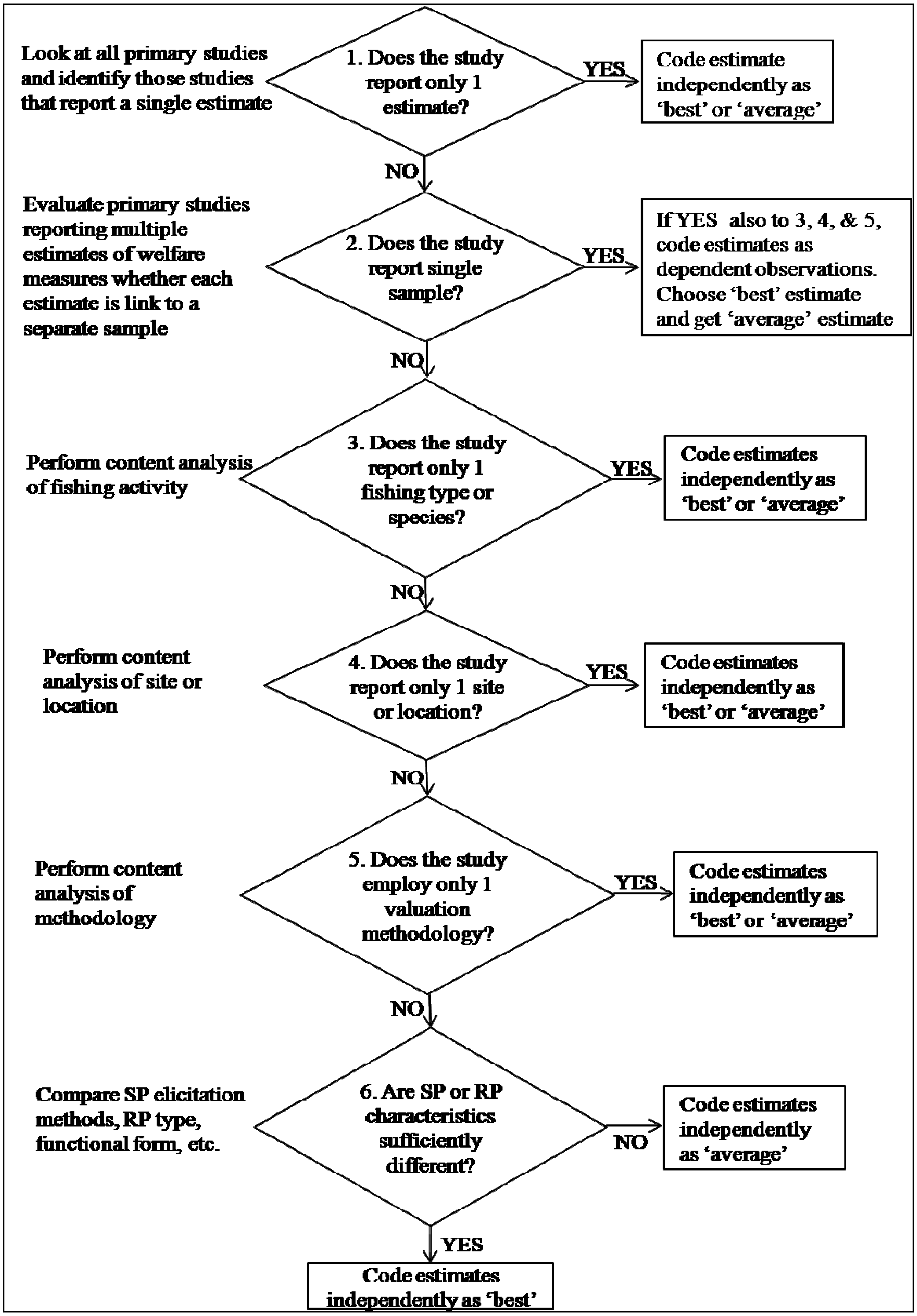

Figure 3.1. Detection heuristics in coding 'best' or 'average' estimates for sportfishing studies, whether dependent or independent observations.

The remaining 49 studies (or 35% of the total number of primary studies) report dependent observations. When a primary study reports multiple estimates but has a single sample, these estimates are coded as dependent observations. For example, Strong (1983) reported three dependent estimates from the same sample size of 81 but employed different RP functional forms. The ‘average’ is taken from these three dependent observations. On the other hand, the selected ‘best’ estimate is the one favored by the author. If the study author(s) did not explicity state a favored estimate, then a single best estimate is selected from dependent multiple estimates when 1) an estimate has a relatively lower standard error among reported price or bid coefficients, 2) an estimate has a relatively larger sample size than other estimates, or 3) an estimate is unique to a site, location, or species sought, *ceteris paribus*.

The third step performs a content analysis on fishing activity, such as fishing type, species sought by anglers, and mode of fishing. When a primary study reports multiple estimates, multiple samples with a one-to-one correspondence, and the same or different fishing activity, these estimates are coded independent observations. These independent estimates are coded ‘best’ and ‘average.’ For example, Cooper and Loomis (1990) used five different datasets from different years and sample sizes; these five estimates were coded as independent. US Fish and Wildlife Service studies like Waddington et al. (1994), report estimates for different fish species per US state, with each state having an independent sample of anglers that independently valued several fish species, thus each estimate provided is classified as independent.

The fourth step performs a content analysis on site characteristics and trip location. Comparisons of characteristics are made for water body type, number of sites evaluated, mode of trip, and total site visits. When a primary study reports multiple estimates, multiple samples with a one-to-one correspondence, and the same fishing activity and location, these estimates are coded independent observations. In the same way, primary studies reporting multiple estimates, *ceteris paribus,* but with different locations with one-to-one correspondence are coded independent observations and coded as 'best' or 'average' estimates. For example, three estimates reported by Mullen and Menz (1985) are coded independent observations, which corresponds to lakes or streams. Likewise, eight estimates reported by White and Habb (2000) are coded independent observations, one estimate each for the Southeastern states- Alabama, South Florida, North Florida, Georgia, Louisiana, Mississippi, North Carolina and South Carolina, all based on independent underlying samples of anglers.

The fifth step performs a content analysis on methodologies employed in the primary study. Comparisons of characteristics are made for valuation methodology, whether Revealed Preference (RP) or Stated Preference (SP) or both RP and SP are used. When a primary study reports multiple estimates, single sample, same fishing activity, location, or methodology, these estimates are coded dependent observations. However, when a primary study reports multiple estimates, multiple samples with a one-to-one correspondence, and the same fishing activity, location, or valuation methodology, these estimates are coded independent observations. In the same way, primary studies reporting multiple estimates are coded independent observations when they employed different valuation methodology for each estimate, *ceteris paribus*. These independent estimates are coded ‘best’ and ‘average.’ For example, Adamowicz, Louviere, and Williams (1994) reported one estimate for RP, one estimate for SP and one estimate for combined RP and SP[2].

The last step compares SP elicitation methods or RP types. If SP is coded, the SP elicitation method employed, etc. are compared. On the other hand, if RP is coded, RP types, functional form, time variable, etc. are compared. When multiple estimates vary only in methodological characteristics, such as a different wage rate used, they are coded dependent observations. A 'best' estimate is chosen among the estimates provided and coded in the 'best-set', while the average value is taken and coded in the 'average-set.' For example, Chizinski et al. (2005) estimated the economic value of angling at Lake Kemp with four different percentages of wage rates employed for the value of travel time: 25%, 33%, 50% and 100%. In this case, the estimate based on 33% of the wage rate is recorded as the 'best' estimate since this corresponds with the recommended level (e. g. Hellerstein, 1993; Englin and Cameron, 1996; Coupal et al., 2001; Bin et al., 2005; Hagerty and Moeltner, 2005), otherwise the estimates are averaged for the ‘average’ estimate.

For primary studies reporting multiple estimates with the same underlying sample but using different methodological treatments of the primary data, the author favored estimate is coded as the best estimate. For example, Douglas and Taylor (1998) report five estimates; all are based on a sample size of 591. One estimate is approximated using SP method (open-ended), hence coded independent observation (best/average), while the remaining four dependent estimates are derived using RP (individual travel cost) with different functional forms. For these four RP estimates, the author preferred estimate is recorded as the 'best' estimate while the average of the four estimates is entered in the 'average-set' metadata.

Studies reporting multiple estimates with the same underlying sample, but employing different valuation methods, such as Gillig, et al., (2003), each estimate is coded as independent and recorded as 'best' and 'average,' since they are essentially based on different questions in a survey. Conversely, studies reporting multiple estimates employing the same valuation methodology but different samples corresponding to each estimate are independently coded as 'best' and 'average' estimate. An example of this type is Hay (1988), which provides an estimate for each of the 48 US states, wherein each state estimate was based on 48 different samples.

Table 3.1 summarizes the variables included in the analysis. The relevant variables are grouped into those characterizing the (1) fishing environment, (2) study methodology, (3) surveyed population and mode, and (4) study attributes. The descriptions of the variables are fully discussed in Essay 1. The summary statistics, when evaluated across the treatment categories, show the relative proportions of the variables within each meta-dataset given all variables are dummy variables with the exception of TREND. For example, journal articles have a higher weight in the ‘all-set’ metadata relative to the other meta-datasets given they often report multiple estimates due to methodological testing (i.e., comparing different estimators using the same sample and data collection parameters).

Table 3.1. Variables and descriptive statistics.

Variable	Description	All-set(SE)	Best-Set(SE)	Average-Set(SE)
Fishing environment				
Freshwater	Qualitative variable: 1 if freshwater fishing is being valued; 0 otherwise	0.87 (0.01)	0.88(0.03)	0.86(0.01)
Marine	Qualitative variable: 1 if marine or open ocean resource is valued; 0 otherwise	0.07 (0.01)	0.11(0.01)	0.11(0.01)
Estuary	Qualitative variable: 1 if estuary or bay resource is valued; 0 otherwise	0.03(0.01)	0.08(0.01)	0.08(0.01)
Lake	Qualitative variable: 1 if lake, pond or reservoir resource is valued; 0 otherwise	0.14(0.01)	0.14(0.01)	0.14(0.01)
Great Lakes	Qualitative variable: 1 if Great Lake resource is valued; 0 otherwise	0.09(0.01)	0.04(0.01)	0.04(0.01)
Rivers or streams	Qualitative variable: 1 if river or stream resource is valued; 0 otherwise	0.27(0.01)	0.31(0.02)	0.31(0.02)
Study methodology				
Revealed preference	Qualitative variable: 1 if revealed preference (RP) valuation approach used; 0 otherwise	0.52(0.02)	0.45(0.02)	0.45(0.02)
Zonal TCM	Qualitative variable: 1 if RP and a zonal travel cost model is used; 0 otherwise	0.14(0.01)	0.11(0.01)	0.11(0.01)
Individual TCM	Qualitative variable: 1 if RP and an individual travel cost model is used; 0 otherwise	0.35(0.02)	0.29(0.02)	0.29(0.02)
Substitute price	Qualitative variable: 1 if RP and substitute price, index or variable included in regression; 0 otherwise	0.31(0.02)	0.24(0.02)	0.24(0.02)
Open-ended	Qualitative variable: 1 if stated preference (SP) and open-ended elicitation method was used; 0 otherwise	0.26(0.01)	0.31(0.02)	0.31(0.02)
Dichotomous choice	Qualitative variable: 1 if SP and dichotomous choice elicitation method is used; 0 otherwise	0.14(0.01)	0.17(0.01)	0.17(0.01)
Iterative bidding	Qualitative variable: 1 if SP and iterative bidding elicitation method is used; 0 otherwise	0.02(0.01)	0.03(0.01)	0.03(0.01)

Variable	Description	All-set(SE)	Best-Set(SE)	Average-Set(SE)
Payment card	Qualitative variable: 1 if SP and payment card elicitation method is used; 0 otherwise	0.01(0.00)	0.02(0.00)	0.02(0.00)
Price or quality substitute	Qualitative variable: 1 if SP and substitute in price or quality treatment is used; 0 otherwise	0.04(0.01)	0.05(0.01)	0.05(0.01)
Surveyed population and mode				
Resident	Qualitative variable: 1 if visitor type is resident; 0 otherwise	0.38(0.02)	0.32(0.02)	0.32(0.02)
Non-resident	Qualitative variable: 1 if visitor type is non-resident; 0 otherwise	0.06(0.01)	0.07(0.01)	0.07(0.01)
Both	Qualitative variable: 1 if visitor type is both resident and non-resident; 0 otherwise	0.48(0.02)	0.53(0.02)	0.53(0.02)
Mail	Qualitative variable: 1 if used mail survey type; 0 otherwise	0.44(0.02)	0.39(0.02)	0.39(0.02)
In-person	Qualitative variable: 1 if used in-person survey type; 0 otherwise	0.21(0.01)	0.22(0.02)	0.22(0.02)
Phone	Qualitative variable: 1 if used phone survey type; 0 otherwise	0.22(0.01)	0.28(0.02)	0.28(0.02)
Mixed mode	Qualitative variable: 1 if used mixed modes; 0 otherwise	0.10(0.01)	0.09(0.01)	0.09(0.01)
Study attributes				
Benefit unit	Qualitative variable: 1 if benefit measure is originally estimated as per person per day; 0 if otherwise [c]	0.53(0.02)	0.56(0.02)	0.56(0.02)
Journal	Qualitative variable: 1 if literature-type is journal, 0 if otherwise	0.25(0.01)	0.18(0.01)	0.18(0.01)
Trend	Qualitative variable: year when data is collected, coded as 1960 = 1, 1961 = 2,..., 2004 = 45	28.43(0.29)	29.23(0.34)	29.23(0.34)
Aggregation	Qualitative variable: 1 if the primary study is single-site or sub-site; 0 if regional studies (i.e. national, ecoregional/ multistate, state, county, multi-county & multi-site)	0.38(0.02)	0.32(0.02)	0.32(0.02)
Number of observations		920	720	720

Note: SE refers to standard errors, which is reported in parentheses.

Meta-Regression Model Specifications

Five model specifications are estimated, *Models* A_1, A_2, A_3, *B*, and *C*. The dependent variable for all models is CS per person per day in 2006 dollars, labeled as *CS*. All five models are specified with the same explanatory variables for ease of comparisons. The explanatory variables are grouped into four different matrices that include fishing environment in X_{fe} (i.e. fishing type and water-body types), the study methodology in X_{sm} (i.e. RP and SP characteristics), the surveyed population and mode in X_{ps} (i.e. visitor and survey types), and the study attributes in X_{sa} (i.e. benefit unit, journal, trend and aggregation). The estimated generic MR model is, in matrix notation:

$$CS_i = \alpha + \beta_{fe} X_{fe} + \beta_{sm} X_{sm} + \beta_{ps} X_{ps} + \beta_{sa} X_{sa} + u \qquad \text{Equation (5)}$$

where α is the constant term, μ a vector of residuals, and the vectors β containing all the estimated coefficients of the respective explanatory variables. In this linear model, the estimated coefficient measures the unit change in CS for a given absolute unit change in the value of the explanatory variable, holding all other independent variables constant.

The first three models, A_1, A_2 and A_3 are based on the 'all-set' metadata with 920 estimates. *Model* A_1 is an 'all-set' full specification, *Model* A_2 is an 'all-set' weighted full specification, and *Model* A_3 is an 'all-set' panel specification. *Model B* is based on 'best-set' metadata while *Model C* is based on 'average-set' metadata, both with 720 estimates. The common attribute among the five models is that they are all estimated with datasets that contain 630 independent estimates; or 68% of all observations for *Models* A_1, A_2 and A_3, and 88% of all observations in *Models B* and *C*.

In *Model* A_1, all estimates are treated as independent estimates and estimated via OLS following the MR model in Equation 5. In this regard, when primary studies reported three benefit estimates, then all three estimates are treated as independent estimates, i.e. without correlation. In *Model* A_2, all independent estimates are given weights equal to one, while dependent estimates are assigned weights based on the number of estimates within each relevant primary study. When primary studies report multiple independent and dependent estimates, then the independent estimates are given weights equal to 1 while the dependent estimates are given weight equal to the remaining number of estimates (excluding independent estimates) for that study. *Model* A_2 is estimated via WLS.

Model A_3 employs the panel data method to capture dependency among estimates provided in a single document (Rosenberger and Loomis, 2000b; Sturtevant et al., 1996). A random-effects MR model of the following linear form is estimated:

$$CS_{ij} = \alpha + \beta_{fe} X_{fej} + \beta_{sm} X_{smj} + \beta_{ps} X_{psj} + \beta_{sa} X_{saj} + u_{ij} + e_i \qquad \text{Equation (6)}$$

where j is the stratification index and μ_{ij} is the panel-specific disturbance component with mean zero and variance σ_{μ}^2. Equation 6 assumes that the source of some of the variation in CS is due to *random* differences (μ_{ij}) among studies that cannot be identified. The description of the panel method and associated hypotheses test are fully discussed in Essay 1. In this paper, the underlying data structure, and not 'study' is used as the method of panel stratification. Therefore, all independent estimates are each being indexed as a single panel, resulting in 630 panels while the rest of the studies with dependent estimates are each being indexed as a panel, resulting in 51 panels. The total number of panels is 681, with the smallest panel size of one, largest panel size of 44, and an average panel size of 5.2 estimates.

Finally, both *Models B* and *C* avoid dependency issues within studies by extracting a single estimate from the dependent estimates. These models are estimated via OLS following the MR model given in Equation 5.

Model Comparisons

To compare the performance of the five MR models, two sets of evaluation criteria are used: 1) regression statistics (*adjusted-*R^2, *F-test*, *t-test*); and 2) in-sample benefit prediction performance. The *adjusted-*R^2 (i.e., coefficient of determination) shows the proportion of variability in the metadata that is accounted for by the model, which is adjusted for the number of explanatory variables in the models. Based on this criterion, the model with the largest *adjusted-*R^2 is preferred. The *F-test* criterion tests the null hypothesis: $H_0 : \beta_{fe} = \beta_{sm} = \beta_{ps} = \beta_{sa} = 0$; i.e., testing the significance of the 26 explanatory variables in the MR model. The *t-value* is the coefficient *(β)* divided by its *standard error (SE)* which is used to test whether a particular explanatory variable (*X*) is a significant predictor of the dependent variable *CS*, over and above the other explanatory variables (i.e. t-test $H_o\colon \beta_i=0$).

The selection of an MR model based on regression statistics, which identify the most efficient model, is a necessary but not a sufficient criterion for assessing whether the estimated MR can be used for BT with any degree of confidence. In this paper, BT is defined as the prediction of sportfishing values using the meta-regression benefit transfer function (MRBTF). The MRBTF is a MR model estimated on the metadata comprising the study sites and optimized for significant and salient explanatory variables, which are then adjusted based on characteristics of the study site (Rosenberger and Loomis, 2000a). Therefore, the five models are compared based on their relative performances in predicting in-sample predictions of CS.

In estimating CS using the MRBTF, transfer errors are inevitable given the inherent heterogeneity and error of the metadata (i.e. 'study-site' and 'policy-site' correspondence). Given limited characterization of sportfishing variables in the primary studies, the use of dummy variables to characterize fishing types, water-body types, and angler's socio-demographics does not entirely capture the true variation in these characteristics. Likewise, it is difficult to capture the important quality and quantity differences of fishing sites (e.g. catch rates), since many of the primary studies did not report complete information about them, and so these variables are not included in the MRBTF.

The forecast performance of each model is judged using the percentage transfer error (PTE), defined as:

$$PTE = \left[\frac{CS_{estimated} - CS_{observed}}{CS_{observed}} \right] * 100\% \qquad \text{Equation (7)}$$

where $CS_{estimated}$ is the transferred (predicted) CS value from MRBTF while $CS_{observed}$ is the reported CS value in a primary study. A jackknife data splitting technique is used to estimate *n-1* separate MRBTFs defined above to predict the omitted observation in each case (Loomis, 1992; Brander, Florax, and Verrmaat, 2006; Johnston and Duke, 2009). The jackknife technique focuses on the samples that leave out one observation at a time:

$X_{(i)} = (X_1, X_2, ...X_{i-1}, X_{i+1}, ...X_n)$ for *i=1,2,… n* jackknife samples. Finally, the overall mean and median absolute PTE is generated for all the observations in the five models.

Meta-Regression Results

Table 3.2 presents the MR results of the five models. The models are closely and directly comparable since they all include the same explanatory variables. The predicted mean CS is statistically the same for all the models. The *adjusted*-R^2 value of the five models ranges from 0.21 to 0.32, with an average of 0.25 indicating that about one fourth of the variation in sportfishing value estimates is explained by the explanatory variables. *Model* A_2 has the highest *adjusted*-R^2 value of 0.32 followed by *Model C* with an *adjusted*-R^2 value of 0.28. The *adjusted*-R^2 of *Models* A_1, A_3 and *B* are similar. Care is needed in interpreting these results since *adjusted*-R^2 from random-effects MR model (A_3) is not directly comparable to *adjusted*-R^2 from the OLS MR models (*Models* A_1, *B* and *C*) and weighted MR model (*Model* A_2).

Table 3.2. Meta-regression model results.

Variables	All-set						Best-Set		Average-set	
	Model A_1		Model A_2		Model A_3		Model B		Model C	
	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)
Freshwater fishing	-68.71***	(12.19)	-56.94***	(10.32)	-56.75***	(10.04)	-20.84*	(11.72)	22.73	(18.37)
Marine	-33.69**	(16.12)	-49.52***	(15.11)	-43.11***	(11.77)	9.91	(12.10)	48.32***	(16.94)
Estuary	-53.18***	(17.60)	-52.11***	(15.34)	-44.24***	(13.12)	36.42***	(13.58)	48.24***	(15.41)
Lakes	-30.65***	(6.75)	-26.81***	(8.17)	-29.76***	(8.45)	-3.60	(6.90)	-9.95*	(5.94)
Great lakes	-36.68***	(7.96)	-1.03	(6.88)	-21.34**	(10.22)	21.72	(13.72)	-2.63	(8.20)
Rivers or stream	0.65	(5.25)	-8.20*	(5.09)	-4.24	(5.76)	10.22**	(5.40)	3.11***	(0.99)
Revealed preference	43.11***	(9.67)	65.92***	(19.45)	55.22***	(18.51)	51.88**	(21.40)	80.39***	(17.28)
Zonal TCM	17.38	(10.73)	-21.91**	(10.81)	-7.83	(10.39)	-6.33	(13.17)	-4.03	(13.30)
Individual TCM	13.39	(9.67)	-7.28	(10.24)	0.43	(9.27)	4.00	(13.10)	2.57	(11.40)
Substitute price	-9.46*	(5.76)	0.63	(7.18)	-1.84	(6.38)	-0.98	(6.78)	-8.89	(6.38)
Open-ended	39.84***	(14.54)	37.19**	(16.93)	38.51**	(18.14)	35.79*	(21.38)	55.54***	(17.18)
Dichotomous choice	54.93***	(13.84)	58.45***	(16.44)	55.42***	(18.33)	54.62**	(21.49)	81.13***	(16.09)
Iterative bidding	39.55***	(15.25)	37.96**	(16.13)	37.70*	(20.62)	42.48*	(23.99)	59.80***	(17.44)
Payment card	-20.87	(13.87)	-10.16	(16.44)	-12.19	(22.93)	10.95	(22.74)	12.83	(16.10)
SP Substitutes	35.05***	(10.96)	51.17***	(9.87)	44.11***	(9.79)	49.34***	(11.10)	46.59***	(10.97)
Resident	-31.50***	(10.68)	-31.25	(9.42)	-29.83***	(10.39)	-45.07***	(11.14)	-38.74***	(10.83)
Non-resident	7.65	(15.46)	5.56	(13.46)	9.89	(12.69)	-19.38	(14.97)	1.33	(16.13)
Both resident non-resident	-41.69***	(10.73)	-43.15***	(9.14)	-41.50***	(9.86)	-45.86***	(10.80)	-46.54***	(10.73)
Mail	-13.06	(10.34)	-25.95***	(9.36)	-19.32	(12.07)	-4.90	(12.45)	-16.40	(10.18)
In-person	-41.79***	(10.86)	-39.43***	(10.50)	-36.80***	(12.62)	-4.29	(13.70)	-32.30***	(11.22)
Phone	-33.77***	(10.23)	-40.11***	(10.02)	-35.19***	(12.66)	-30.69**	(13.13)	-35.44***	(9.84)
Mixed mode	-18.87	(11.89)	-30.32***	(11.00)	-22.71*	(13.49)	-0.26	(14.48)	-22.74**	(11.47)
Value unit	-0.18	(4.76)	0.62	(5.29)	-3.57	(4.90)	-5.66	(5.52)	3.18	(5.68)
Journal	2.87	(5.52)	-22.28***	(5.86)	-12.34**	(5.51)	-24.88***	(6.57)	-9.76	(6.66)

Variables	All-set						Best-Set		Average-set	
	Model A_1		Model A_2		Model A_3		Model B		Model C	
	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)	Parameter[b]	(SE)
Trend	0.71**	(0.31)	0.35	(0.27)	0.34	(0.31)	0.25	(0.30)	0.60*	(0.30)
Aggregation	5.07	(7.09)	17.96**	(8.16)	17.05***	(6.35)	-10.22	(6.58)	-4.92	(7.95)
Constant	115.56***	(22.69)	120.08***	(25.61)	117.14***	(26.98)	75.92**	(30.38)	2.20	(30.62)
Adjusted-R^2	0.22		0.32		0.20		0.21		0.28	
F-statistic	11.19***		17.66***		10.89***		8.38***		11.64***	
No. of significant variables	17		19		18		13		15	
N	920		920		920		720		720	
Predicted CS[a] (Std. error)	58.90 (1.94)		59.29(1.83)		58.90 (1.94)		58.87 (2.14)		58.47(2.06)	

Note: SE refers to standard errors, which is reported in parentheses, and calculated using White's heteroskedastic corrected covariance matrix estimator. Dependent variable = consumer surplus (CS) per person per day ($) for all models.

[a] Index to 2006 dollars.

[b] ***Statistically significant at the 1% level or better; **at the 5% or better, * the 10% level or better.

All models are statistically significant at $p \leq 0.01$ based on the *F-tests*. As expected, the significance and magnitude of many parameter estimates vary across the five models. *Model A_2* has the highest *F-statistic* of 17.66 while *Model B* has the lowest *F-statistic* of 8.38. *Model A_2* has the highest number of significant variables (19), based on *t*-values while *Model B* the lowest number of significant variables (13). There are no significant changes in statistical significances (*t-values*) or signs of the estimated parameters across *Models A_1, A_2* and *A_3,* which are based on the 'all-set' metadata. The same can be said between *Models B* and *C*, which are both based on 720 observations. However, there are differences in the signs of the significant estimated parameters for the fishing environment variables between the '*A*' models and '*B*' or '*C*' models, potentially exhibiting some loss of information when dropping observations or averaging them. The estimated constant for the models are positive and statistically significant (*p-value* ≤ 0.05), except for *Model C*. Note that taking the average estimate (*Model C*) more-or-less standardizes the data and forces it through the origin. This changed the magnitude of the estimated parameters for *Model C*, though not statistically different for all but one of the estimated parameters of *Model A_2*. *Models A_2* and *C* can be compared directly and are expected to be similar. However, *Model A_2* has four more significant variables than *Model C*, may be attributed to more observations in *Model A_2*.

Changing the underlying structure of the metadata changes the sign and magnitude of the estimated parameters of fishing environment variables. The significance and magnitude of the estimated coefficient for *freshwater fishing* was statistically different between the '*A*' models (*p-value* ≤ 0.01) and *Model B* (*p-value* $\leq$ 0.10). *Freshwater fishing* is significant in all models except *Model C*. As expected, *freshwater fishing* tends to provide lower benefit estimates than saltwater fishing or both freshwater and saltwater fishing combined. The estimated parameter for *marine* is negative and significant for the *'A' models* but is positive and significant for *Model C*. In the same way, the estimated parameter for *estuary* is negative and significant for the '*A*' *Models* but is positive and significant for *Models B* and *C*. The magnitude of the estimated coefficient for lake was statistically different between the '*A*' *Models* and *Model C*. *Lake* variable is negative and significant for all the models, except *Model B.* The *Great lakes* variable is only significant and negative for *Models* A_1 and A_3. *River or stream* is negative and significant in *Model* A_2 but is positive and significant for *Models B* and *C*.

The influences of study methodology variables are invariant to changes in the underlying structure of the metadata. *Revealed preference* is positive and significant in all models, suggesting that higher benefit estimates are associated with RP methods when compared with SP and combined RP-SP methods, which is consistent with Rosenberger and Loomis (2000a). For RP estimates, *zonal TCM* is negative and significant only in *Model* A_2, implying that it produces lower benefit estimates than other valuation techniques. As expected, the inclusion of *substitute price*, *index* or *variable* in the MR model is negative and significant only in *Model* A_1, signifying that when RP models correctly reflect substitution, the associated benefit estimate is lower (Rosenthal, 1987). For SP parameters, the elicitation methods: *open-ended, dichotomous choice*, and *iterative bidding* are positive and significant for all models, suggesting a higher benefit estimate than other elicitation methods. However, the inclusion of *substitute* in SP price or quality in the MR models increases the benefit estimate, which is the opposite of theoretical expectation; but given the low proportion of this variable in the metadata, it may be measuring some other effect (i.e. errors-in-variables).

The influence of surveyed population and mode variables, like study methodology variables, are also invariant to changes in the underlying structure of the metadata. The *resident* and *both resident/non-resident* variables have lower benefit estimates relative to non-residents, special interest groups, and other targeted sub-population. The *mail* survey mode is negative and significant only in *Model* A_2. The other survey modes: *in-person, phone, and mixed-mode* have lower benefit estimates relative to *web-based* and *other* survey modes.

Study attributes variables, like study methodology variables and surveyed population and mode variables, are also invariant to changes in the underlying structure of the metadata. The *journal* variable is negative and statistically significant in *Models* A_2, A_3 and *B.* The *trend* variable is positive and significant only in *Models* A_1 and *C*, indicating that CS estimates in these models have generally increased at a greater rate than inflation over time, similar to findings of Rosenberger and Loomis (2001). As expected, the *aggregation* variable (though only significant in *Models* A_2 and A_3) increases the benefit estimates (i.e., single site studies/models tend to provide higher estimates than regional studies/models). The *value unit* variable is not significant in any of the estimated models.

In-Sample Benefit Predictions Results

The PTE are computed for all five models using a jackknife data splitting technique. Mean absolute PTE for each of the five models is rather high, however, they range from 0.02% to 33,282.64%. For example, *Model* A_2 has mean absolute PTE of 303%, median absolute PTE of 54%, and ranges from 0.02% to 21,868.96% (Table 3.3). However, looking at the mean absolute PTE for different percentiles of the data series, ordering them by magnitude of the observed benefit estimates in ascending order, the mean PTE decreased significantly after the initial 10^{th} percentile of the observations. The 1-10^{th} percentile of the observations in *Model* A_2 is composed of observed benefit estimates from \$0.22 to \$9.50 per person per day. This result illustrates how the same magnitude difference between observed and predicted values can lead to substantially different PTE estimates, namely that lower observed or predicted values are associated with higher PTEs. Figure 3.2 shows the observed and predicted benefit estimates in \$2006 (upper panel) and absolute percentage transfer error (lower panel) associated with each observation ranked in ascending order of observed benefit value. There is indeed a considerable difference between the observed and predicted benefit values. About 30% of the observations show an absolute percentage transfer error over 100%. *Model* A_2 MRBTF systematically overpredicts very low observed sportfishing benefit values (around and below $1) and slightly under-predicts high sportfishing benefit values, which is also true for the other four MRBTFs. Moreover, the predicted mean absolute PTE was more robust for the observed benefit values between $54 and $133 (i.e. the 61th to 90th percentile) than the rest of the observations. The MRBT is not robust to predicting very low or very high values; however, it is the low values where the largest PTE are reported (a statistical artifact of low values).

Table 3.3. Mean absolute percentage transfer error (PTE) in *Model* A_2 following the jackknife data splitting technique.

Dataset Deciles	Observed Benefit ($)/person/day	Predicted Benefit $/person/day	Predicted Absolute PTE	Mean Absolute PTE
1-10th percentile	0.22 to 9.50	-16.24 to 103.82	6.13 to 21,868.96	2,201.03
11-20th percentile	9.57 to 16.15	-25.52 to 106.05	6.86 to 814.95	359.18
21-30th percentile	16.25 to 22.59	-25.57 to 105.66	0.02 to 444.72	130.31
31-40th percentile	22.65 to 31.65	-1.50 to 90.22	2.95 to 284.24	72.54
41-50th percentile	31.69 to 41.86	-0.71 to 97.89	0.76 to 184.63	59.53
51-60th percentile	41.89 to 53.11	-0.72 to154.46	0.30 to 268.73	48.78
61-70th percentile	53.56 to 64.77	-0.74 to 162.57	0.26 to 190.52	33.38
71-80th percentile	64.80 to 85.86	-26.05 to 127.22	0.16 to 130.41	30.36
81-90th percentile	85.96 to 132.99	11.52 to155.01	0.92 to 87.16	35.98
91-100th percentile	133.57 to 348.43	-26.43 to196.25	0.62 to 118.96	59.49
			0.02 to 21,868.96	303.06

Table 3.4 shows the mean and median absolute percentage transfer error for the five models, based on 90th percentile of the data series, i.e. excluding the initial 1-10th percentile of the observations. The mean absolute PTE is statistically different between the models based on ‘all-set’ and ‘best-set’ or ‘average-set’ metadata. Among the five models, *Model C* (based on ‘average-set’) has the lowest mean and median absolute PTE of 71.65% and 39.54%, respectively.

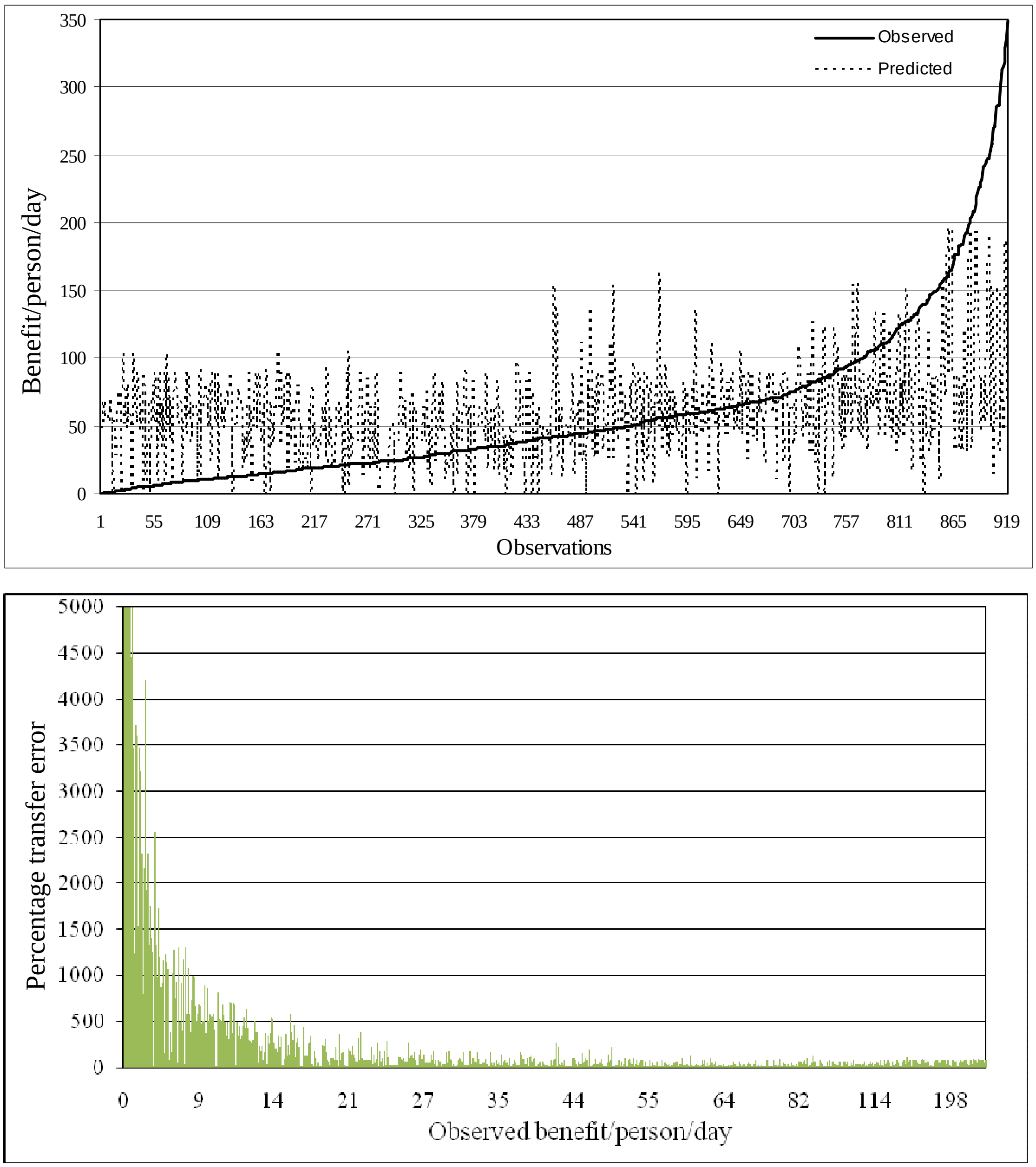

Figure 3.2. Observed and predicted benefit estimates (in 2006 dollars) and absolute percentage transfer errors for *Model* A_2, ranked in ascending order of the observed benefit value.

Table 3.4. Mean and median absolute percentage transfer error for the five models.

90^{th} percentile of the data series	All-set			Best-set	Average-set
	Model A_1	*Model* A_2	*Model* A_3	*Model B*	*Model C*
Mean (Standard error)	87.15 (4.09)	92.17 (4.46)	93.06 (4.45)	76.58 (4.13)	71.65 (3.76)
95% Confidence Interval	83.06-91.24	87.71-96.63	88.61-97.51	72.45-80.71	67.89-75.41
Median	47.8	47.16	47.85	39.79	39.54

To further analyze the determinants of heterogeneity in the transfer errors, the explanatory variables are regressed on the absolute transfer errors for the 'average-set.' Results of the MRA shows that the transfer errors are significantly negatively correlated with the dummies for the fishing environment variables (*freshwater fishing, estuary, rivers or stream*), study methodology variables (*revealed preference, zonal and individual TCM, open-ended, dichotomous choice, iterative bidding, payment card,* and *SP substitutes*), and *value unit* variable.

There is a significant positive correlation with the dummies for *in-person* survey mode, and *journal* variable, which warrant further explanations. A positive correlation with transfer error and *in-person* survey supports the contingent valuation survey findings of Leggett, et al. (2003), wherein the willingness-to-pay for a visit to Fort Sumter National Monument in South Carolina is higher when the survey is administered through face-to-face interviews rather than being administered by the respondent. Moreover, Woodward and Wui (2001) found that studies with weak econometrics tended to yield higher values. Rosenberger and Stanley (2006) refer to this type of bias as measurement error, which occurs when researchers' decisions (e.g. on valuation method, elicitation method, survey design/mode, and units of measurement) affect the accuracy of the transferability of values.

The positive correlation between the *journal* dummy variable and absolute transfer error may be attributed to publication selection bias, i.e. the empirical literature is not an unbiased sample of empirical evidence. Journal publications tend to have smaller aggregate mean recreational use value estimates than non-journal publications, when a dummy variable identifying those estimates published in peer-reviewed journals is added to the MR model. Smaller benefit estimate would imply a higher transfer error as noted above. There is also greater variation in estimates provided across published studies than unpublished studies (Rosenberger and Stanley, 2006).

Conclusions

This paper explored approaches in modeling and treating data dependency in the sportsfishing metadata when performing MRA and BT. The MRA is applied on ‘all-set,’ ‘best-set,’ and ‘average-set’ metadata. The ‘best-set’ and ‘average-set’ grouping of primary studies is used to avoid dependency among the observed benefit measures in the ‘all-set’ metadata. Three MR models are considered using the ‘all-set’ metadata: 1) using all observations as independent samples; 2) using weights based on underlying data structure; and 3) employing a random-effect panel model. The five MR models are compared based on regression statistics and in-sample benefit predictions performance.

The degree of explanatory power among MR models is best achieved in an ‘all-set’ weighted specification and in using an ‘average-set’ metadata, which are complementary treatments of data dependency. When the underlying structure of the metadata is modified as in the ‘best-set’ and ‘average-set’ treatments, the magnitude and sign of the estimated parameters of the fishing environment variables changed too. This result affirms the findings of Essay 1 that the structural shift in the metadata is influenced by fishing environment variables. Other variables, such as study methodology, surveyed population and mode, and study attributes did not change given modification of the underlying structure in the metadata.

The median absolute percentage transfer error is lower for the MR models based on a single value, i.e. ‘average-set’ and ‘best-set’ metadata than the MR models based on ‘all-set’, contrary to Bijmolt and Pieters (2001). However, this increased performance in in-sample predictions is not substantial. Meta-analytic procedure representing each study with multiple estimates by an 'average' or 'best' value, though, may result in loss of information. One significant observation from in-sample predictions is that the absence of very low and very high estimates in the metadata will likely result in a more robust MRBT (i.e. MRBT does not predict well in the tails of the distribution of observed values, as expected). Caution is recommended when selecting studies for point or function transfers that provide very low estimates. We may be more confident with MRBT when the metadata include those observations that fall within two standard deviations of the mean. However, in small sample MRBT, mean CS may not be a good indicator when selecting studies to include in the metadata since it is more sensitive to extreme benefit values (very low and very high). Findings also suggests that the dummies related to measurement errors (*in-person* survey mode) and publication selection bias (*journal*) are important predictors of transfer errors. This result supports the recommendations by Stanley and Rosenberger (2009) to detect the true effect and correct for possible publication selection bias, when conducting a meta-analysis for BT.

Based on the results of the study, the following implications and recommendations can be drawn. First, the importance to correct for methodological pitfalls in MRA is always warranted. Nelson and Kennedy (2009) outline the 'best-practice guidelines' in conducting a complete MRA. Second, the choice of whether to include all estimates of primary studies or to include only the 'average' or 'best' estimates from the primary studies is best guided by the goals of the meta-analysis, and perceived allowable errors in BT applications. When the goal of meta-analysis is knowledge acquisition, synthesis/generalization of the literature and hypothesis testing (e.g. explaining heterogeneity) that is beyond predicting values, metadata sample selection may not be an issue. But when doing meta-regression benefit function transfer, metadata sample selection is an important issue that needs to be addressed. Third, more research is needed to analyze the implications of metadata sample selection in the context of BT. In particular, future research should evaluate the downward bias associated with the different metadata sample sizes when used in BT applications. Further research is also warranted to know if the results found here can be confirmed with other data dependency models, such as hierarchical/multilevel models and clustering techniques.

Acknowledgments

The author would like to thank Lisa Ganio, Manuela Huso, and Robert Johnston for their assistance with estimating the models using jackknife data splitting technique. Any shortcomings of this paper are the sole responsibility of the author.

Notes

[1] Selection criteria for inclusion in the 'best-set' metadata of single estimate studies could be applied as well. For example, early valuation approaches did not use (or have available) what is currently considered state-of-the-art estimators. However, we chose to include all single estimate studies and control for their differences through model specification (i.e., include variables that identify methodology).

[2] While the latter estimate is likely partially correlated with the previous ones, it is treated as independent in the metadata.

References

Adamowicz, W. L., and J. R. Deshazo. "Frontiers in Stated Preferences Methods: An Introduction." *Environmental and Resource Economics* 34(2006): 1-6.

Adamowicz, W., J. Louviere, and M. Williams. "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." *Journal of Environmental Economics and Management* 26, no. 3(1994): 271-292.

Bateman, I. J., and A. P. Jones. "Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values." *Land Economics* 79, no. 2(2003): 235-258.

Bergstrom, J. C., et al. "Economic value of wetlands-based recreation." *Ecological Economics* 2, no. 2(1990): 129-147.

Bijmolt, T. H. A., and R. G. M. Pieters. "Meta-Analysis in Marketing when Studies Contain Multiple Measurements." *Marketing Letters* 12, no. 2(2001): 157-169.

Bin, O., C. E. Landry, C. Ellis, and H. Vogelsong. “Some consumer surplus estimates for North Carolina beaches.” *Marine Resource Economics* 20, no. 2(2005), 145–161.

Boyle, K. J., and J. C. Bergstrom. "Benefit Transfer Studies: Myths, Pragmatism, and Idealism." *Water Resources Research* 28, no. 3(1992): 657–663.

Brander, L. M., R. J. G. M. Florax, and J. E. Vermaat. "The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature." *Environmental and Resource Economics* 33, no. 2(2006):223-250.

Brouwer, R. (2002) Meta-analysis and Benefit Transfer: Synergy, Lessons and Research Agendas. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Chizinski, C. J., et al. "Economic Value of Angling at a Reservoir with Low Visitation." *North American Journal of Fisheries Management* 25, no. 1(2005): 98-104.

Coupal, R., C. Bastian, J. May, and D. Taylor. The economic benefits of snowmobiling to Wyoming residents: A travel cost approach with market segmentation. *Journal of Leisure Research* 33, no. 4(2001):492–510.

Doucouliagos, C., and M. A. Ulubasoglu. "Economic freedom and economic growth: Does specification make a difference?" *European Journal of Political Economy* 22, no. 1(2006): 60-81.

Doucouliagos, H., and M. A. Ulubaşoğlu. "Democracy and Economic Growth: A Meta-Analysis." *American Journal of Political Science* 52, no. 1(2008): 61-83.

Douglas, A. J., and J. G. Taylor. "Riverine based eco-tourism: Trinity River non-market benefits estimates." *International Journal of Sustainable Development & World Ecology* 5, no. 2(1998): 136-148.

Efron, B., and R. J. Tibshirani. *An Introduction to the Bootstrap*. London: Chapman and Hall, 1993.

Engel, S. (2002) Benefit function transfer versus meta-analysis as policy-making tools: a comparison. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Englin, J. and T. A. Cameron. “Augmenting travel cost models with contingent behaviour data: Poisson regression analyses with individual panel data.” *Environmental and Resource Economics* 7(1996): 133–147.

Florax, R. (2002) Methodological Pitfalls in Meta-analysis: Publication Bias. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Gillig, D., et al. "Joint Estimation of Revealed and Stated Preference Data: An Application to Recreational Red Snapper Valuation." *Agricultural and Resource Economics Review* 32, no. 2(2003): 209-221.

Glass, G. V., B. McGaw, and M. L. Smith. *Meta-Analysis in Social Research*. Beverly Hills, CA: Sage Publications, Inc, 1981.

Hagerty, D. and K. Moeltner. “Specification of driving costs in models of recreation demand.” *Land Economics* 81, no. 1(2005):127–143.

Hay, M. J. (1988) Net economic value for deer, elk and waterfowl hunting and bass fishing, 1985., Report 85-1. Washington, DC: USDI Fish and Wildlife Service.

Hellerstein, D. and R. Mendelsohn. “A theoretical foundation for count data models.” *American Journal of Agricultural Economics* 75, no. 3(1993):604–611.

Hunter, J., and F. Schmidt. *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings*. London: Sage, 2004.

Johnston, R. J., and J. M. Duke. "Informing Preservation of Multifunctional Agriculture when Primary Research Is Unavailable: An Application of Meta-Analysis." *American Journal of Agricultural Economics* 91, no. 5(2009): 1353-1359.

Johnston, R. J., et al. "Systematic Variation in Willingness to Pay for Aquatic Resource Improvements and Implications for Benefit Transfer: A Meta-Analysis." *Canadian Journal of Agricultural Economics* 53, no. 2-3(2005): 221-248.

Johnston, R. J., et al. "What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values." *Marine Resource Economics* 21(2006): 1-32.

Jones and Stokes Associates, Inc. "Southeast Alaska sport fishing economic study." Final Research Report. December, 1991. (JSA 88-028). Prepared for Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Section, Anchorage, AK.

Leggett, C. G., et al. "Social Desirability Bias in Contingent Valuation Surveys Administered Through In-Person Interviews." *Land Economics* 79, no. 4(2003): 561-575.

Lipsey, M. W., and D. B. Wilson. *Practical Meta-Analysis*. Applied Social Research Method Series. Thousand Oaks, California: Sage Publications, Inc., 2000.

Loomis, J. B. "The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer." *Water Resources Research* 28, no. 3(1992): 701-705.

Loomis, J. B., and R. S. Rosenberger. "Reducing barriers in future benefit transfers: Needed improvements in primary study design and reporting." *Ecological Economics* 60, no. 2(2006): 343-350.

Martin, W. E., F. H. Bollman, and R. L. Gum. "Economic Value of Lake Mead Fishery." *Fisheries* 7, no. 6(1982): 20-24.

Morey, E. R., et al. "Estimating recreational trout fishing damages in Montana's Clark Fork River basin: summary of a natural resource damage assessment." *Journal of Environmental Management* 66, no. 2(2002): 159-170.

Mrozek, J. R., and L. O. Taylor. "What determines the value of life? a meta-analysis." *Journal of Policy Analysis and Management* 21, no. 2(2002): 253-270.

Mullen, J. K., and F. C. Menz. "The Effect of Acidification Damages on the Economic Value of the Adirondack Fishery to New York Anglers." *American Journal of Agricultural Economics* 67, no. 1(1985): 112-119.

Nelson, J. P., and P. E. Kennedy. "The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment " *Environmental and Resource Economics* 42(2009): 345-377.

Nijkamp, P., et al. (2002) Environmental quality in European space: a methodology for research synthesis. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Rosenberger, R. S., and J. B. Loomis. "Using meta-analysis for benefit transfer: In-sample convergent validity tests of an outdoor recreation database." *Water Resources Research* 36, no. 4(2000a): 1097-1108.

Rosenberger, R. S., and J. B. Loomis. "Panel Stratification in Meta-Analysis of Economic Studies: An Investigation of Its Effects in the Recreation Valuation Literature." *Journal of Agricultural and Applied Economics* 32, no. 3(2000b): 459-470.

Rosenberger, R. S., and T. D. Stanley. "Measurement, generalization, and publication: Sources of error in benefit transfers and their management." *Ecological Economics* 60, no. 2(2006): 372-378.

Rosenthal, R. Meta-analytic procedures for social research. Newbury Park Sage Publications, 1991.

Rosenthal, D. H. "The Necessity for Substitute Prices in Recreation Demand Analyses." *American Journal of Agricultural Economics* 69, no. 4(1987): 828.

Stanley, T. D., and S. B. Jarrell. "Meta-Regression Analysis: A Quantitative method of Literature Surveys." *Journal of Economic Surveys* 3, no. 2(1989): 299-308.

Stanley, T. D., and R. S. Rosenberger (2009) Are Recreation Values Systematically Underestimated? Reducing Publication Selection Bias for Benefit Transfer, Department of Economics, Hendrix College and Department of Forest Ecosystems and Society, Oregon State University.

Strong, E. J. "A Note on the Functional Form of Travel Cost Models with Zones of Unequal Populations." *Land Economics* 59, no. 3(1983): 342-349.

Sturtevant, L. A., F. R. Johnson, and W. H. Desvousges (1996) A Meta-Analysis of Recreational Fishing, Working Paper, Triangle Economic Research.

Strube, M. J. "Meta-Analysis and Cross-Cultural Comparison: Sex Differences in Child Competitiveness." *Journal of Cross-Cultural Psychology* 12, no. 1(1981): 3-20.

Strube, M. J. "A general model for estimating and correcting the effects of nonidependence in meta-analysis." *Multiple Linear Regression Viewpoints* 16, no. 2(1987): 40-47.

Waddington, D. G., K. J. Boyle, and J. Cooper. "1991 net economic values for bass and trout fishing, deer hunting, and wildlife watching." Washington, DC: US Fish and Wildlife Service.

Whitehead, J. C., and R. Aiken (2000) An analysis of trends in net economic values for bass fishing from the national survey of fishing, hunting and wildlife-associated recreation, East Carolina University, Department of Economics Working Paper.

Whitehead, J. C., and T. C. Haab. "Southeast marine recreational fishery statistical survey: distance and catch based choice sets." *Marine Resource Economics* 14, no. 4(2000).

Wood, J. A. "Methodology for Dealing with Duplicate Study Effects in a Meta-Analysis." *Organizational Research Methods* 11, no. 1(2008): 79-95.

Woodward, R. T., and Y.-S. Wui. "The economic value of wetland services: a meta-analysis." *Ecological Economics* 37, no. 2(2001): 257-270.

CHAPTER 4 - ESSAY 3
THE RECREATIONAL VALUE OF TAAL VOLCANO PROTECTED LANDSCAPE: AN EXPLORATORY BENEFIT TRANSFER APPLICATION

Abstract

Some landscapes that have significant value to people are protected through statute. Protected landscapes that serve as popular recreational resources and destinations hold significant use values for those people that visit them. Recognition of these recreational benefits of protected landscapes provides a sound economic rationale for their management. The objective of this essay is to estimate the recreational value via benefit transfer (BT) of Taal Volcano Protected Landscape (TVPL) in the Philippines—a major tourist attraction and designated as one of the key priority biodiversity areas in the Philippines for priority protection. A foundation of BT is the use of information from research conducted on other sites to inform questions at a site that lacks primary research. In this case, the research question is "What is the potential magnitude of recreational benefits at TVPL?" BT approaches include transferring of values or functions from a single site or set of similar sites, and estimating a meta-regression (MR) transfer function that can be used to predict values for the policy site in question. One study site in the Philippines was selected and used in a point estimate transfer application. Likewise, an MR transfer function model was estimated based on selected 'study sites' from the US. Results show that single point estimate worked better than MR benefit function transfer. While in-sample BT prediction of the MR model show an absolute percentage transfer error (PTE) of 18%, simple out-of-sample prediction has very high absolute PTE (1,231%). The estimated welfare estimate of recreational access using single point estimate transfer was PHP 36 per person per trip. The aggregated recreational benefits at TVPL was PHP 9.7 million from 155,701 visitors at Batangas side and PHP118.9 million from 1,906,242 visitors at the Cavite side in 2006. These values may be used as an economic basis for financial commitments by the institutions responsible for the TVPL management and may inform policy issuances and ordinances, e.g. user-fee system for TVPL.

Introduction

The Protected Area Management Board (PAMB[1]), the policy and decision-making body of the Taal Volcano Protected Landscape (TVPL), embarked on a comprehensive 10-year (2010-2020) Management Plan. Proponents of the plan boast of its community participation, co-management and local stakeholders' involvement and funding. The PAMB *en banc* approved the plan on September 26, 2009, with a proposed annual administrative budget of PHP 11.7 million and a start-up cost of PHP 97.1 million. The Protected Area Superintendent (PASu), within the Department of Environment and Natural Resources (DENR), serves as the chief operating officer of the TVPL. One set back confronting the PASu Office is its limited staff of [seven] persons with almost no dedicated resources (Luna and Gonzales, 2007). Funds needed to implement the plan would be generated through available funds from the institutions in the PAMB. These institutions are composed mainly of third, fourth, and fifth class municipalities[2], which in most cases have scarce financial resources.

Among the strong features of the plan are: (1) strong law enforcement and agreement to comply; (2) a strong push for keeping the population levels constant for the next ten years and beyond: (3) zoning the majority of the land area as agro-tourism zone and setting aside forest reserves and a fish sanctuary; 4) water quality monitoring and biodiversity survey; (5) disaster planning and climate change adaptation; (6) a research council, center and bi-annual technical conference; and (7) institutional development of the PASu office and the PAMB. High priority actions were identified to address the following components: water quality and the health of Taal Lake; aquatic living natural resources; terrestrial/watershed, recreation and cultural resources; disaster preparedness and management; population and socio-economics; research program and knowledge center; policy and institutional strengthening; management zones on land and water; and work plan and budget.

One of the critical knowledge gaps identified under management requirements is visitor's willingness-to-pay (WTP), which could serve as basis for determining future entrance fees at Taal Volcano Island and the process of fee-setting and collection. Due to the lack of funds and limited time for the PASu and PAMB to conduct primary research (first-best strategy), a benefit transfer (BT) application is suggested to provide a first approximation of recreational use value. BT is the use of recreational benefit estimates and other information from a 'study site' with data to a 'policy site' with little or no data (Rosenberger and Loomis, 2000). BT is considered a 'second-best strategy,' in which already existing estimates from other sites (study sites) are used to inform decisions at the site of interest (policy site).

BT is increasingly applied to a wide variety of environmental goods and services, such as benefits of agricultural wildlife management (Brouwer and Spaninks, 1999); water resources (Muthke and Holm-mueller, 2004); mortality risk valuation (Krupnick, 2007); health impacts related to air and water quality (Ready et al., 2004); air pollution and acute respiratory illness (Alberini and Krupnick, 1998); avoided health effects from water pollution (Barton and Mourato, 2003); and outdoor recreation (Shrestha and Loomis, 2001). Most of these authors conclude that value transfer, i.e. single point estimate, worked better than function transfer, although function transfers and meta-analysis transfer functions have been shown to be more broadly accurate than value transfers (Loomis, 1992; Rosenberger and Stanley, 2006). Shrestha and Loomis (2001) tested meta-analysis as a method for international BT applications to recreation valuation and found that the absolute average percentage error of meta-predictions may be within an acceptable range. There might be a trade-off between precision and accuracy when conducting BTs using point, function, and meta-regressions.

This paper explores both value and function transfers as a means to estimate visitors' recreational benefits at the TVPL, Philippines. A single point estimate is derived from a 'study site' in the Philippines, while a meta-regression benefit function based on existing studies in the US is used to derive estimates of recreational values by adapting it to characteristics of the 'policy site' (i.e. TVPL). Implicit price deflators and purchasing power parity (PPP) are incorporated to account for income and cost of living differences between the study and policy sites. Exogenous factors, such as differences in individual preferences, and cultural and institutional conditions between countries are beyond the scope of this paper, but they have the potential to invalidate an international BT. Results of this BT exercise are targeted to provide an economic basis for financial commitments by the PAMB institutions for the TVPL management and may be translated into policy issuances and ordinances, e.g. a user-fee system for TVPL.

The Taal Volcano Protected Landscape

Taal Volcano Protected Landscape consists of around 62,292.13 ha of the Taal Lake Basin, with 24,236 ha. inside it comprising the lake area (excluding the islands) (Figure 4.1). Protected landscapes are areas of national significance that are characterized by the harmonious interaction of people and land while providing opportunities for public enjoyment through recreation and tourism within the normal lifestyle and economic activity of these areas. It is designated as number 27 among the 128 Key Priority Biodiversity Areas for priority protection (Ong, Afuang, and Rosell-Amball, 2002). There are 65 proclaimed protected areas in the Philippines, 36 of which (including TVPL) are designated as protected landscapes. Howard Hillman, an author specializing in travel, cooking, and wine, consider TVPL as unique in this world because of the positions of its five components: Taal Volcano, Taal Lake, Volcano Island, Crater Lake, and Vulcan Point.

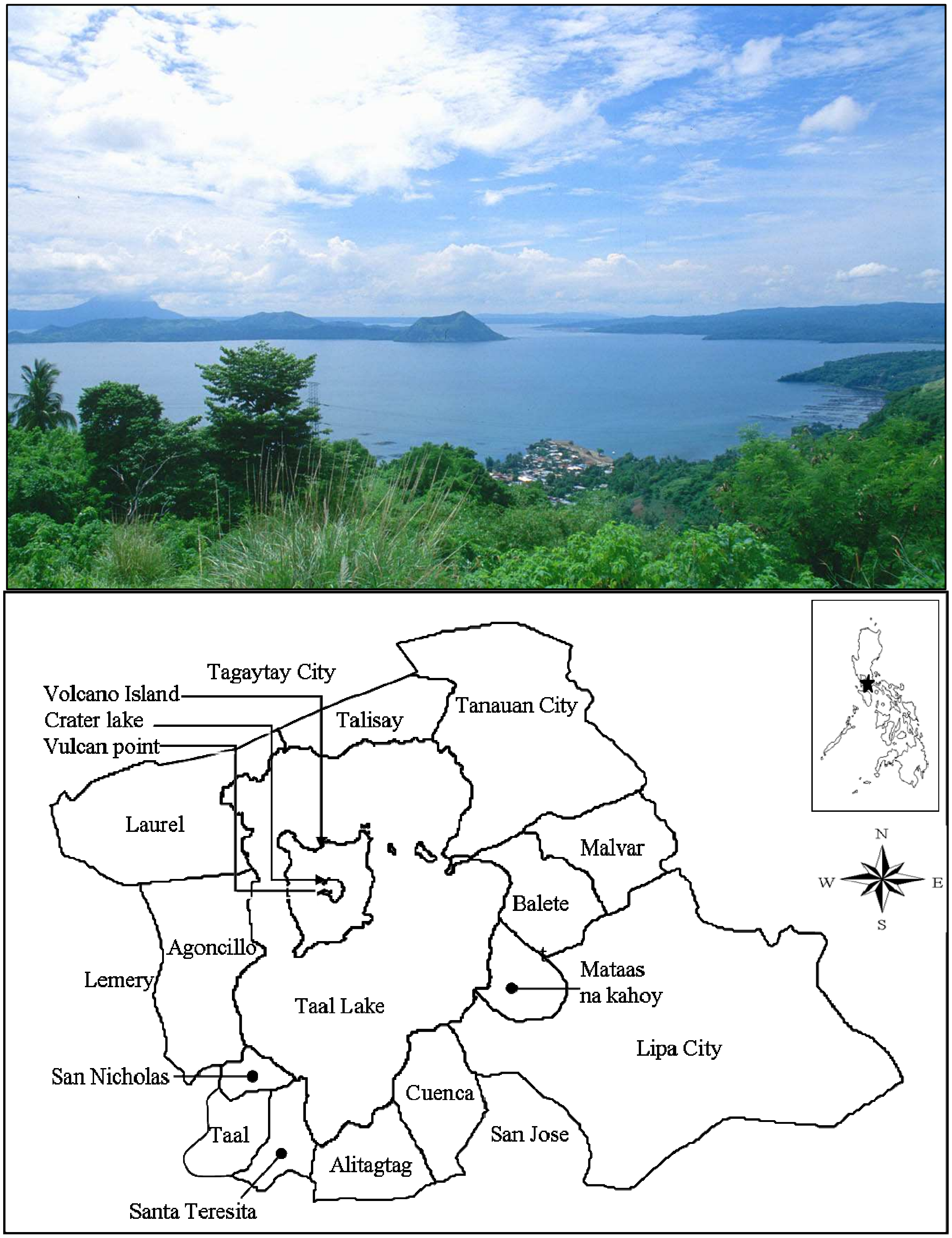

Figure 4.1. Photo and map of Taal Volcano Protected Landscape, Philippines (Vista, 2003).

The TVPL basin spans the Municipalities of Talisay, Laurel, Agoncillo, San Nicholas, Taal, Lemery, San Jose, Santa Teresita, Alitagtag, Cuenca, Mataas na Kahoy, Balete, Malvar, and the Cities of Lipa and Tanauan in the Province of Batangas; and Tagaytay City in the Province of Cavite. These lakeshore municipalities and cities have a scenic view of the volcano ridges. The ridge of the basin is in the viewing area of the Taal Volcano Island and Lake, with Tagaytay City considered the 'town of the ridge.' Tagaytay City is a popular summer vacation getaway because its climate is cooler than Manila. The municipality of Talisay is the major jump-off point where boats are available to reach the Taal Volcano Island. TVPL watershed has 38 tributary rivers draining into the lake. The only outlet to Balayan Bay is the Pansipit River. From the Southern Tagalog Arterial Road Tollway, and Batangas-Cavite provincial highways, the lakeshore municipalities and cities are accessible within 15 minutes or more by vehicle. TVPL is about 60 km SSE of the capital Manila.

Taal Volcano has a crater within the Volcano island within Taal Lake within the island of Luzon. Taal Volcano, considered the smallest volcano in the world, is active and has erupted about 40 times from 1592 to 1977 (Hargrove, 1991). In 1967, the Taal Volcano Island became a National Park through Proclamation No. 235. In 1993, Taal Volcano and its surrounding coastal municipalities were declared tourism zones by virtue of Republic Act 7623. In 1996, Proclamation 235 was amended by Presidential Proclamation 923, declaring the Taal Volcano Island, Taal Lake and the watershed areas as a protected landscape under National Integrated protected Area System (NIPAS[3]) Act of 1992. Taal Volcano Island has an area of 4,537 ha. and a crater lake of about two kilometers in diameter at its center (Yokoyama, Alcaraz and Peña, 1975). The main crater lake of the Volcano Island is four meters above sea level (masl), while the highest elevation along the ridge is about 600 masl. Maximum depth in the crater lake is about 90m. The highest elevation in the basin is 835 masl at the peak of Mt. Maculot. The slope of the area in the Volcano Island is gentle, from four to ten percent. The climate in the area is Type-I, i.e. dry season from November to

April and wet during the rest of the year. There are 47 identified cones and craters that constitute the Volcano Island.

Taal Lake is a major tourist attraction and considered the third largest lake in the Philippines. The lake has an average depth of 60.1 m, with a maximum depth of 198 m and a circumference of 120 km (Folledo and Cruz, 1999). The entire Taal Lake is within a crater of a great volcano, a caldera with surrounding mountains as its walls that are 150-304 m high. It hosts *Hydrophis semperi*, a freshwater sea snake, and the *Sardinella tawilis*, a freshwater sardine - two of the vertebrates that are endemic to the lake. About 20,000 fisherfolk are dependent on the lake's resources. The lake provides multiple and often conflicting services to various users. Current uses of the lake include: (1) open water fishing; (2) fish cage culture of tilapia (*Sarotherodon nilotica*), bangus (*Chanos chanos*) and maliputo (*Caranx ignobilis*); (3) navigation routes; (4) recreation/tourism; (5) water source for the City of Tagaytay; and (6) a source of food for waterfowl. The water quality in the lake is deteriorating due to nutrient pollution from fish cages (Vista et al., 2006). Fish cage operators rely on the water of Taal Lake as an input into 'intensive' fish production and as a waste repository. Excessive amounts of nutrients (nitrogen and phosphorous) accumulating from the cages leads to nutrient enrichment, endangering the industry itself and the general health of the lake ecosystem.

The operational management of TVPL rests on the PASu's Office, duly formed by DENR. The Task Force on Environmental Law Enforcement (TFELE) assists the PASu Office in law enforcement. The Task Force is instrumental in the enforcement of the Unified Rules and Regulations on Fisheries, and many environmental laws, rules and ordinances in the area.

Taal Volcano and Lake are of great interest to tourists, scientists, business investors, and others because of their beauty and economic opportunities they provide. Fertile land is a natural magnet for tillers, and benefits from tourism and fish cages have attracted more occupants to the volcano. As of 2009, there are more than 5,000 people residing on Volcano Island, despite classification of the area as very high risk due to different volcanic hazards, e.g. lava flows, acidic flashes from crater lake, lakeshore flooding, etc. At present, an estimated 1,500 horses are on Volcano Island, most of which are used for tourism purposes. In 2007, an estimated 343,749 people lived within the boundaries of the TVPL. About 20,000 residents are dependent on lake resources. The TVPL Management Plan envisions population remaining at the 2007 level.

The different recreational activities in the TVPL include hiking, day-camping, picnicking, bird watching, horseback riding, fishing, boating, wind surfing, sailing, rowing, and kayaking. A typical visit to the Volcano Island would require a boat rental for PHP 1,800, which can accommodate five persons. A municipal landing fee of PHP 20 is collected by the municipality at the boat ramp in Talisay. There are three trails in the Volcano Island for hikers/trekkers: a) the regular tourist/horse trail; b) the Kalawit trail, and c) the Kristie Kenney trail. About 80% of the visitors rent horses to do the Volcano trek for PHP700. The regular tourist/horse trail is wide, unpaved, about 1.7 km and closest to the boat ramp from the Municipality of Talisay. The ride to the rim using the regular/tourist and Kalawit trails takes about 30 minutes each way. The ride into the crater and back, takes over an hour. The Kristie Kenney trail is primarily a walking trail with much more vegetation than the dusty and exposed regular tourist/horse trail. At present, there are no permanent bathrooms in the area for visitors' use.

The beautiful scenic view that Taal Volcano and Lake provides, attracts more visitors to Tagaytay City, Cavite than to the coastal communities and Volcano Islands. From 915,925 visitor arrivals in Tagaytay City in 2001, it grew to 2,006, 571 (95% are domestic travelers) visitor arrivals in 2006. In 2006, about 169,240 (92% are domestic travelers) visited Taal Volcano Island and lake for different recreational activities.

There are complementary attractions within the TVPL and adjacent areas. In Tagaytay City, tourists can also visit Peoples Park, Picnic Grove, 11th Airborne Marker, Japanese Garden, Residence Inn Mini Zoo, Tagaytay Highlands/Midlands, and Tagaytay City Museum. Other attractions in the province of Batangas include Mt.

Maculot for mountaineers, Fantasy World in Lemery, Mt. Malarayat Golf Course in Lipa City, religious/ historical/ cultural sites, and various resorts. Vista (2003) provides a detailed discussion of other important information on TVPL.

Valuation Framework

The context of resource values is based on total economic value, defined as the summation of use and non-use values. Use value is the economic value derived from natural resources, either direct or indirect, through human use of these resources, such as tourism/recreation, fisheries, research/education, etc. On the other hand, non-use value is the economic value derived from resources without any current use of resources, such as bequest, option and existence values. These non-use values are considered non-rival[4]. This essay focuses only on the direct use values, specifically the recreational value of the TVPL.

Recreational value is represented in terms of economic benefits, which are economic measures that indicate how much utility (pleasure or usefulness) is derived from a recreation experience. Since it is difficult to measure a person's utility or compare it with other individuals' utilities, economists observe individuals' behaviors by looking at the choices they make (observed and stated), which reflects their preference ordering of goods (e.g. an individual chooses commodity *X* over *Y*). These choices then can be used to directly or indirectly infer their WTP for different goods. The horizontal summation of each person's WTP results in an aggregate measure of WTP, or a measure of social welfare. Figure 4.2 shows the conceptual composition of the TVPL related recreational benefits. Benefit refers to the additional amount visitors would pay to continue to have access to TVPL or for an improvement in their recreational experience in the area beyond what they actually pay (e.g., travel costs, time costs, and entrance fees, etc.). At low prices, the demand for recreation trips is high and falls as price increases, as depicted in the negatively sloped demand curve. At price *P*, the number of trips is equivalent to *Q* (point *e* on the demand curve).

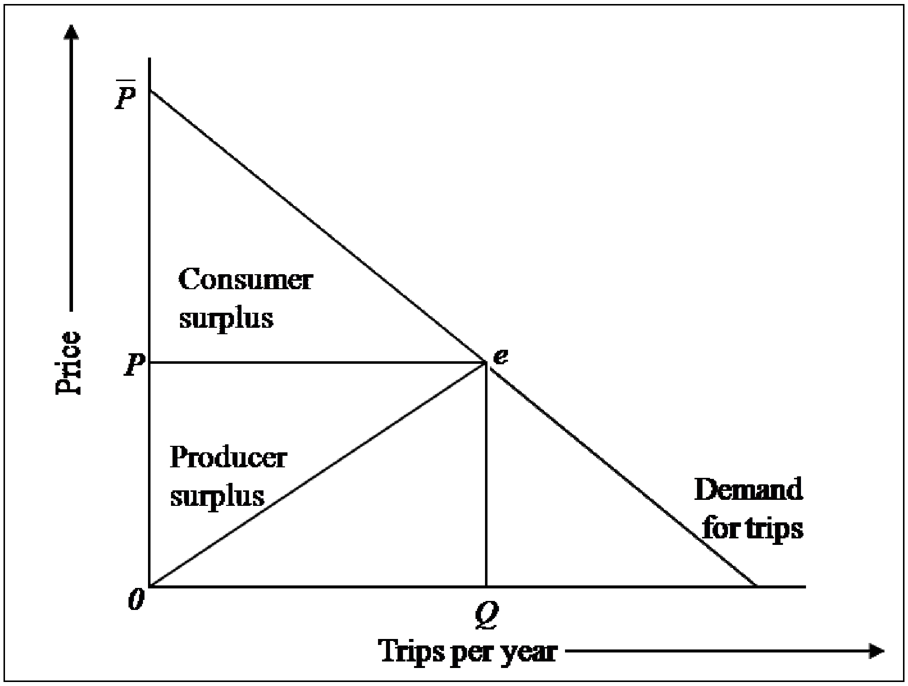

Figure 4.2. Conceptual composition of the Taal Volcano Protected Landscape related recreational benefits.

Both producers and consumers benefit from the different recreational opportunities available at the TVPL. Net WTP consists of consumer and producer surplus. The consumers, or visitors, are willing to pay as much as the area $0\overline{P}eQ$ but are only paying as much as $0PeQ$. The difference between the two is consumer surplus (CS) $\left(P\overline{P}e\right)$, i.e. the amount of residual benefits over and above what they actually pay. It is the value of a recreation activity beyond what must be paid to enjoy it. Moreover, the producers would have been willing to offer their services at a value equal to the area, $0eQ$, and receive as much as $0PeQ$ in revenue. The difference between the two is the producer surplus $\left(0Pe\right)$, i.e. the amount of net benefits producers get from offering the recreational activities to TVPL visitors. The recreational value of TVPL is the sum of CS and PS. Only the CS part of recreation total value is estimated for the TVPL using BT methods.

Benefit Transfer Techniques

BT[5] methods use estimated measures from study site *i*, V_{Si}, to estimate the needed measure for policy site *j*, V_{Pj}. When V_{Si} is transferred to the policy site *j*, the study site value becomes the transfer value, i.e. $V_{Si} \Rightarrow V_{BT}$ (Rosenberger and Loomis, 2003). In this exercise, TVPL is the policy site, (i.e., the area or resource for which benefit estimates are needed but do not exist). This exploratory BT exercise may also help determine whether original research is warranted (Rosenberger and Loomis, 2003); i.e., uncertainty regarding the BT estimates and/or predicted magnitude of recreational values.

Boyle et al. (2009, p. 1328) proposed four necessary conditions for valid BT: a) utility must be separable in unobserved site characteristics; b) the study site and policy site models must be correctly specified; c) people must not be sorted between sites according to unobserved features of their preferences; and d) adequate data on the characteristics of consumers and their choices. In addition, there should be correspondence or similarity between study and policy sites in terms of a) resource or commodity conditions, b) site characteristics, c) market characteristics (Desvousges, Naughton, and Parsons, 1992), and d) welfare and empirical benefit measure (Boyle and Bergstrom, 1992; Loomis and Rosenberger, 2006). Rosenberger and Loomis (2001) provide a detailed list of criteria for an effective and efficient BT, reiterating the conditions above.

Potential problems associated with the application of BT methods are provided by Rosenberger and Loomis (2001). BT problems may be contributed by original valuation studies their methodological applications (i.e., measurement error), and a lack of correspondence between the study site and the policy site (i.e., generalization error). It is important to identify the potential sources of errors that affect the accuracy of BT and employ means for overcoming them (Rosenberger and Stanley, 2006). For example, BT transfer estimates from more ‘generic study sites’ may be considered lower bounds given the ‘uniqueness’ factor associated with TVPL. Designation of TVPL as a ‘priority protected landscape’ may have higher values than ‘generic protected landscapes’ due to its proximity to population centers such as Manila and CALABARZON[6] and its uniqueness. However, evidence reported in the literature itself may not be representative of generic protected landscapes. There are many social and political factors (e.g., highly valued, close to populations, awareness, threatened by external factors, etc.) that may direct research resources toward certain landscapes (Hoehn, 2006). If the literature is dominated by these research priority sites, then use of this literature may result in upwardly biased estimates for more generic applications (Rosenberger and Johnston, 2009).

However, being classified as a protected landscape may not always be positive since there is an accelerated human population growth at protected area edges due to economic opportunities they provide (Wittemyer et al. 2008). Furthermore, when a resource site generates use value, the density of users will be higher near to that site (Bateman et al., 2006). Resource users typically hold higher values than non-users and we would expect average values to decay with increasing distance from a site. These limitations and problems could lead to biased BT estimates and decreased robustness of BT procedure, if not fully addressed.

The summarized BT procedures for estimating the access value of recreation in TVPL, as suggested by previous studies (Boyle and Bergstrom, 1992; Brouwer, 2000; Rosenberger and Loomis, 2001), are illustrated in Figure 4.3. The first step is to *describe the resource, commodity or context of the policy site*. Here we need to specify the theoretical definition of the value(s) to be estimated and needed at the policy site j. In this paper, all benefit estimates, i.e. access value of recreation are expressed in terms of CS per person per trip (PHP 2006). Primary studies reporting benefit estimates other than CS/person/trip are adjusted to per trip units, and estimates derived from earlier studies are converted to 2006 PHP using the Implicit Price Deflator[7]. The information needed in this step include description of the environmental resource, and possibly, evaluation of expected change in the resource. Moreover, factors that can influence benefit estimates should be defined, such as socio-economic characteristics of the affected population (e.g., income, education, age, and gender) and physical characteristics of the policy site (e.g., environmental quality, geographic location, and accessibility conditions). Depending on resource conditions and informational needs, the level of required accuracy of BT estimates can be determined in this step (Kask and Shogren, 1994).

The second step involves *conducting a thorough literature search and locating relevant study sites*. Primary studies on the access value of recreation in the US and The Philippines are collected through searching databases (EVRI, USAID Development Experience Clearinghouse, Google Scholar), formally requesting documents/ references via e-mail, listserves, postal mail and/or phone, analysis of citations, and careful study of references. The primary studies are composed of journal articles, theses, dissertations, working papers, government agency reports, consulting reports, and proceedings papers.

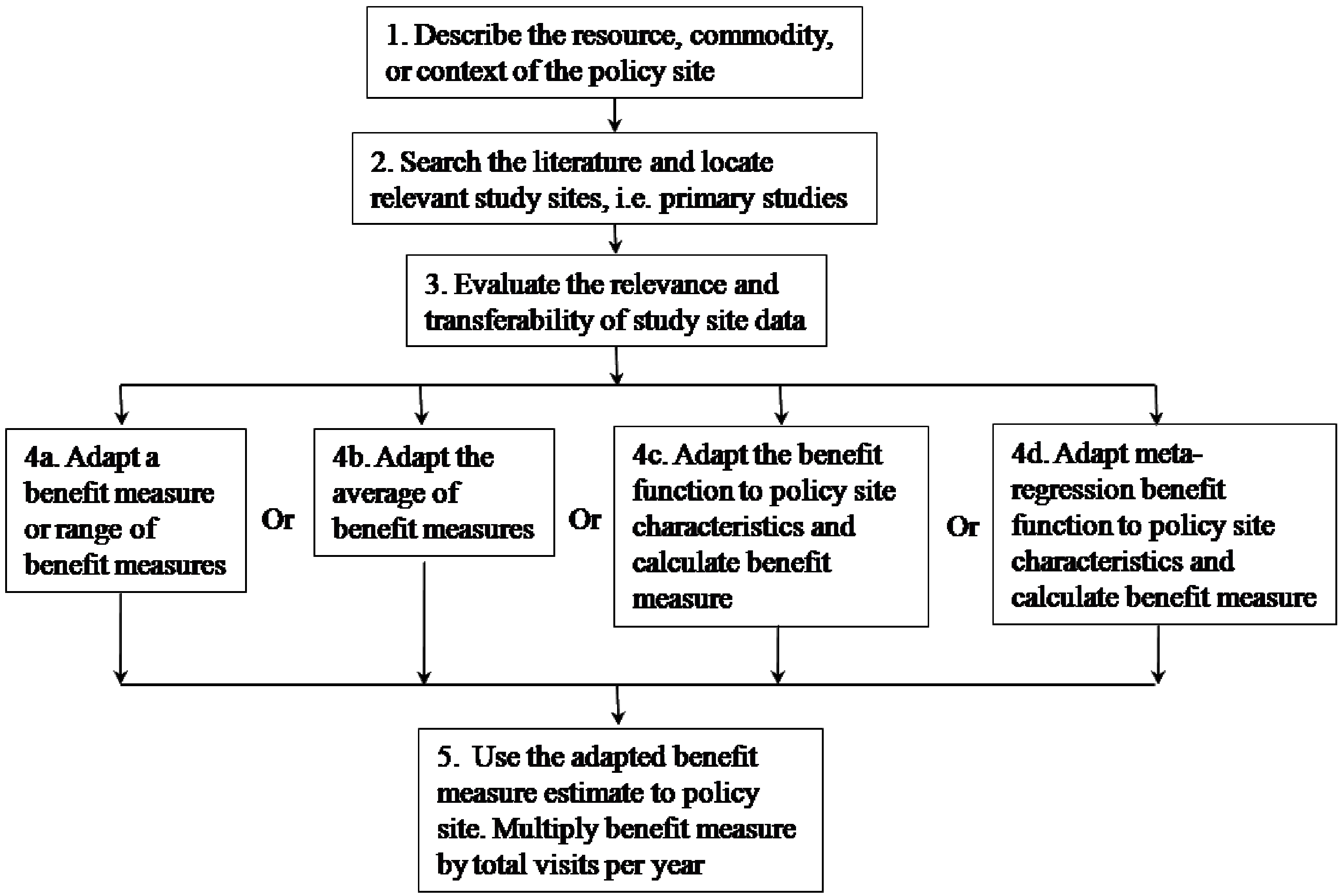

Figure 4.3. Steps to performing benefit transfers.

The third step is to *evaluate study site data in terms of relevance and transferability*. Primary studies obtained from the literature search are screened whether they are relevant to the policy site *j*. Transferability needs to be evaluated using BT criteria discussed above and in terms of the overall quality of the study site data, such as adequacy or scientific soundness. For example, unbiased estimates are preferred for a valid BT. Some bias may be acceptable in a BT; the level of which depends on the circumstances of decision settings and ultimate usage of BT estimates. State-of-the-art guides on non-market valuation can be useful in this evaluation (e.g. Champ, Boyle and Brown, 2003; Haab and McConnell, 2002).

The fourth step is to *adapt the benefit measure(s) or function to policy site characteristics.* Depending on the BT approach used, whether 1) value transfer or 2) function transfer, necessary adjustments may be needed to reflect the differences in the study and policy sites to get a more reliable and valid BT estimates for the policy site *j*. However, some potentially important characteristics may not be measured or reported for the study or policy sites. This is an identified problem in BT (Loomis and Rosenberger, 2006). Therefore, this missing information at the policy site may be sourced out from other sources. For example, study sites can be supplemented with external data like Census measures. When key characteristics of the user population are measured using a very short and inexpensive survey, it is important that these measures are in the study sites as well. For cases where one cannot supplement may lead to an increased generalization errors (Rosenberger and Stanley, 2006). A more detailed discussion of the BT approaches is given below.

The fifth step is to *apply the adapted benefit measure estimate to policy site*. This is the final stage where actual BT estimates for the policy site are calculated and can be aggregated by multiplying the benefit measure (CS/person/day in 2006 PHP) by total visits per year (or total number of affected population).

Value transfer

Value transfer consists of transferring a single point estimate from study site *i* or a measure of central tendency (e.g. average value) for several benefit estimates from study site(s) *i* to the policy site *j*. Single point estimate transfer is accomplished by using the measures of the study site value (V_{Si}), given the context of the study site *i*, (X_{Si}), to predict the needed policy site value (V_{Pj}), given the context of the policy site *j*, (X_{Pj}):

$$V_{Pj} \middle| X_{Pj} = V_{Si} \middle| X_{Si} \qquad \text{Equation (1).}$$

Single point estimate transfer is convergently valid when there is a correspondence between the study and policy site in terms of the commodity, site characteristics, and the relevant population (Ready, 2009). It is assumed that the welfare of a representative visitor at the study site *i* is the same as the 'expected' welfare of a representative visitor at the policy site *j*, *ceteris paribus*.

Measure of central tendency is similar to point estimate transfer except for the use of mean, median or other measure of central tendency to predict the needed policy site value. This approach is defined as:

$$V_{Pj} \middle| X_{Pj} = \overline{V_{Si}} \middle| \overline{X_{Si}} \qquad \text{Equation (2)}$$

where $\overline{V_{Si}} | \overline{X_{Si}}$ is the measure of central tendency for all or a subset of study site measures given each study site's context.

Value transfer approaches are suggested when 1) the mean values of the regression independent variables for the policy site *j*, or 2) the valuation regression model of the study site, are not available or reported in the primary studies.

Function Transfer

Function transfers include the transfer of an entire demand or benefit function estimated for a study site, or the use of meta-regression benefit function derived from various study sites. Function transfers then adapt the function to fit the specifics of the policy site, such as socioeconomic characteristics, extent of market and environmental impact, and other measurable characteristics that systematically differ between the study site and the policy site. The adapted function is then used to predict or forecast a benefit measure for the policy site.

The demand or benefit function transfer is defined as:

$$V_{Pj} = f_S\left(X_{S|Pj}\right) \qquad \text{Equation (3)}$$

where V_{Pj} is the needed value for the policy site *j*, which is derived from the study site demand or benefit function, f_S, adapted to the context of the policy site $\left(X_{S|Pj}\right)$. To predict a tailored policy site estimate, the regression coefficients estimated at the study site are adjusted by the policy site measures for the associated regression variables. Function transfer assumes that the underlying behavioral relationship between a recreation trip and the variables representing site and population characteristics is identical, and adjusts to the differences in these variables between the policy and study sites.

Loomis (1992) argued that the benefit function transfer method is a more rigorous and robust method of BT compared with point estimate transfer methods. Benefit function transfer can be fitted to the characteristics of the policy site and more information is effectively taken into account in the transfer. In this regard, function transfer can result in smaller BT error than value transfers (Rosenberger and Loomis, 2003). Rosenberger and Phipps (2007) added that functional transfers have the potential to reduce generalization errors compared to point estimate transfers. Generalization error occurs when a measure of value is generalized to unstudied sites or resources. It is hypothesized to be inversely related to the correspondence between study sites and policy sites.

While function transfer may be better than value transfer, it is still considered a second-best strategy for recreation valuation (Rosenberger and Loomis, 2001). One drawback with benefit function transfer is the exclusion of relevant variables in the WTP function estimated in a single study due to lack of variation in those variables. There might be variables relevant to the study site but not to the policy site. To address this problem, the study site should be chosen to be as similar as possible to the policy site, or use meta-regression transfer function.

If benefit function transfer is based on a single study, meta-regression transfer function, on the other hand, is based on the statistical summary or synthesis of outcomes from several studies. The conduct of BT through MRA is feasible with the accumulation of primary studies on recreation valuation. MRA is the statistical summarizing or synthesizing of past research results using multivariate regression analysis (Stanley and Jarrell, 1989). Meta-analysis has been used for synthesizing research findings, hypothesis testing, knowledge acquisition, benefit transfer (Smith and Pattanayak, 2002; Florax, Nijkamp, and Willis, 2002) and to improve the process and quality of literature reviews (avoiding bias) of valuation studies (Stanley, 2001). More detailed steps in conducting a MRA is provided by Stanley (2001).

The MRA transfer function is defined as:

$$V_{Pj} = f_S\left(\overline{X}_{S|Pj}, \overline{M}_{S|Pj}, \overline{Q}_{S|Pj}\right) \qquad \text{Equation (4)}$$

where V_{Pj} is the needed value for the policy site *j*, which is a function $\left(f_s\right)$ of the following variables: $\overline{X}$ is a vector of site and population characteristics relevant to the policy site *j*; $\overline{M}$ is a vector of methodological variables; and $\overline{Q}$ is a vector of other quantity/quality variables. In MRA transfer function, V_{Pj} is a summary statistic (CS/person/day) from each individual studies. This statistical function, the MRA transfer function, becomes the link between the knowledge derived from applied research and its application to policy settings.

In a meta-analysis, several original studies are analysed as a group, where the result from each study is treated as a single observation in a regression analysis. If multiple results from each study are used, various meta-regression specifications can be used to account for such panel effects (Nelson and Kennedy, 2009; Rosenberger and Loomis, 2000b).

The conduct of meta-analysis is not a perfect science. It also has its limits. Study sites may be biased because of reliance on published sources (publication bias); and lack of standardization in methodology. In response to these basic problems in meta-analysis, Button (2002) described the following necessary conditions to consider when conducting meta-analysis: a) acceptance of general values; b) sufficient previous studies; c) compatibility of studies; d) stability of the parameters with rapidly changing technology and tastes; e) nature of information needed; and f) independence of studies.

The validity and reliability of applying meta-analysis to inform policy choices is highly dependent upon the primary studies. Its contributions can be limited by the quantity and quality of available documentation from primary research (Loomis and Rosenberger, 2006) and the inherent heterogeneity of metadata (i.e., the literature). Hence, meta-analysis explanatory power will usually not exceed that of the underlying individual studies (Brouwer, 2002).

Convergent Validity of Benefit Transfer

Convergent validity is about the accuracy of generalization; i.e., measures of the same theoretical construct correspond to each other—they converge. Validity tests investigate the extent to which the welfare values and functions are transferable from a statistical point of view. Convergent validity test answers the question how valid is the measures of benefits at unstudied sites (Desvousges, Johnson and Banzhaf, 1998). For example, convergent validity tests by Rosenberger and Loomis (2000b) suggest that a national model is more robust to changes in application than regional models, in part due to the greater coverage of the distribution of recreation values. Testing a value transfer or function transfer model for convergent validity can be empirically done by comparing a transfer value (V_{BT}) to the 'true' value for a site (V_S), where the true value comes from an original study at the site. The associated error (ε) with the BT is defined as:

$$\varepsilon = \frac{V_S - V_{BT}}{V_S} \qquad \text{Equation (5)}$$

If more than one transfer estimates is generated, say from single point estimate and meta-regression benefit function, these two transfer estimates can be compared to determine if the BT method applied is invariant to judgment by the meta-analyst. If a model has poor explanatory power for the study site, there is little confidence in the accuracy for BT. In the same way, if there is limited convergence between 'study site' and 'policy site' estimates, there is little confidence in the BT estimation.

The 'true' value in itself is an estimate of an unknown value. 'Study site' estimates are considered the best approximation of the true value (V_S). This is a concern since there are no primary study estimates available at the policy site (TVPL). When MR model is adapted, meta-analysis can employ an in-sample prediction (Nelson and Kennedy, 2009) and the results are tested if the MR model supports a BT application (Smith and Pattanayak, 2002).

Benefit Transfer Applications to TVPL

Value Transfer: Single Point Estimate

Transfers conducted within [country] perform better than transfers conducted between [country] (Rosenberger and Loomis, 2001). In this regard, an in-depth search for relevant study sites reporting an economic measure of direct-use value estimates (i.e. access value only, not marginal values) for 'nature-based' recreation in the

Philippines was performed. A list of valuation studies conducted in the Philippines between 1988 and 2002, categorized in terms of environmental services, is provided by REECS, Inc. (2003). Three of the seven potential study sites on protected landscape are available and were collected (Predo et al., 1999; Navarro, Paca and Rimas, 2008; and Rosales, 2001). However, only one study site (Predo et al., 1999) passed the relevance and transferability criteria. The studies by Navarro, Paca and Rimas (2008) and Rosales (2001) can be excluded because these 'potential study sites' estimated the recreational benefits derived from a mountain ecosystem. The study by Predo et al. (1999) estimated the recreational use, option use, existence, and bequest values, through WTP for protection of Lake Danao National Park (LDNP) in Ormoc City, Leyte, Philippines (Figure 4.4). The study used CVM with three WTP question formats – open-ended, payment card, and iterative bidding. Tobit (censored regression) model was used to analyzed the different factors affecting WTP bid for protecting LDNP based on 210 respondents.

There is some degree of correspondence between TVPL and LDNP (Table 4.1) in terms of the technical criteria for transferability of study sites values (Boyle and Bergstrom, 1992). The policy site value based on Predo et al. (1999) is PHP35.65 per person per trip or PHP62.40 per person per year (2006). At 95% confidence interval, the policy site value ranges from PHP21 and PHP50.35/person/trip or between PHP36.70 and PHP88.10/person/year (i.e. 41.20% margin of error (MOE)).

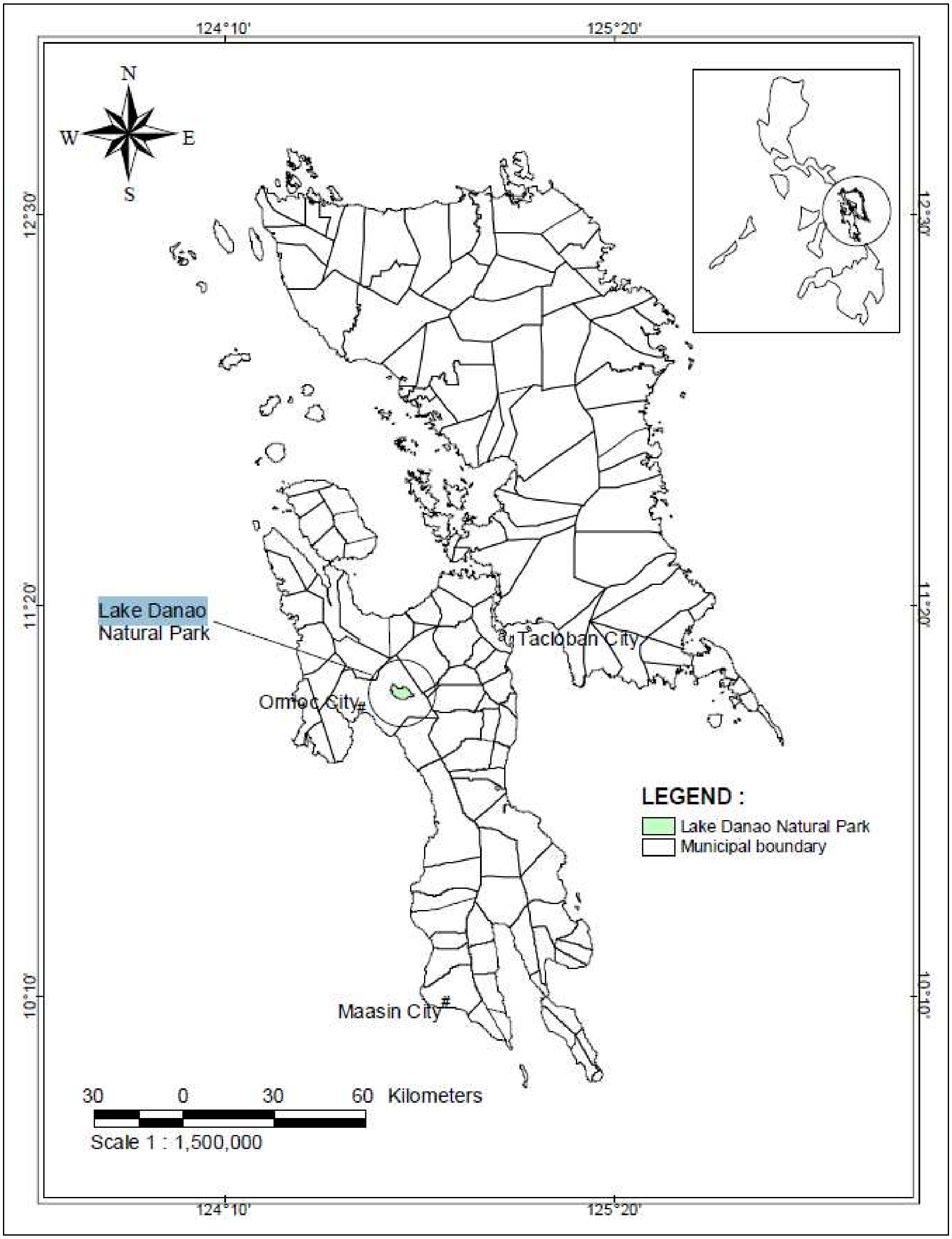

Figure 4.4. Map of Leyte, Region 8 showing the location of Lake Danao National Park (Garcia et al., 2005)

Table 4.1. Significant features of Taal Volcano Protected Landscape (policy site) and Lake Danao National Park (study site) and their watersheds.

Characteristics	Taal Volcano Protected Landscape	Lake Danao National Park
Biophysical		
Location	Batangas, Philippines	Leyte, Philippines
Landscape area (ha)	4,537	2,193
Basin Area (ha)	62,292	107,625[b]
Lake area (ha); max. depth (m)	314[a]; 90[a]	140; 182
Distance to nearest City (km)	13 (Tagaytay City)	17 (Ormoc City)
Geology		
Elevation range (masl)	4 (lake), 835 (Mt. Maculot Peak)	620 (lake), 1,020 (Mountain peak)
Soils	Volcanic	Volcanic
Climate		
Average rainfall/year (mm)	1,833	2,592
Average temperature (^{o}C)	28.0	24.2
Conservation and research priority area in inland waters?	Yes, #11th of 24	Yes, # 19th of 24
Land Tenure	Government owned, under NIPAS[c]	Government owned, under NIPAS[c]
Land Use	Aquaculture, fishing, outdoor recreation, agroforestry, etc.	Fishing, outdoor recreation, forestry, etc.
Population (2007 census)	343,749	177,524

[a]crater lake area. [b]The reservation area of the Philippine National Oil Corporation (PNOC) where LDNP is located. PNOC is a geothermal power-generating company that supplies 708 MW of electric energy. [c]National Integrated Protected Area System
Source: Garcia et al., 2005; Ong et al, 2002; Predo et al., 1999; Vista, 2003.

Function Transfer: Meta-Regression Analysis

Benefits are more often transferred from developed countries, e.g. the US where numerous primary studies have been conducted, to developing countries, e.g. The Philippines where there is a limited number of primary studies. An important prerequisite for conducting a robust meta-regression analysis for the purpose of BT is the availability of sufficient studies on recreation valuation, which is true for US. While a number of valuation studies have been conducted in the Philippines and the

Southeast Asia region, the reality is that the vast majority of the recreation literature originated from developed countries. For example, Zhai and Susuki (2009) studied the possibility of using international BT to value coastal zones and found that transfer errors are fewer when transferring from a developed country (Japan) to the developing country (China) than vice versa. They also compared the transferability of three attributes associated with coastal resources and found that economic promotion has more transferability than environmental improvement and risk reduction.

In this paper, primary studies ('study sites') included in the metadata are based on the broader North American recreation use values database. 'Study sites' are selected based on recreation activity, climate, and/or site characteristics/environment. The following recreation activities were selected: freshwater fishing in lakes, swimming, boating, camping, floating/rafting/canoeing, waterskiing, hiking, picnicking, sightseeing, and general recreation. 'Study sites' with hot, humid or dry regional climate, which mimics the climate in the 'policy site,' are selected. These sites include the southeast region (Florida, Georgia, Alabama, Tennessee, South Carolina, and North Carolina); southern region (Mississippi, Louisiana, Arkansas, Texas, and Oklahoma); and southwest region[8] (Arizona, California, Nevada, New Mexico, and Utah). After excluding five possible outliers (CS> $350), there are 213 benefit measures from 47separate primary studies in the metadata that spans from 1958 to 2006. Appendix D provides a summary of selected characteristics of the original study used in international BT while Appendix E provides the bibliography of recreational valuation studies used in international BT.

A linear specification fit the data better. Since the metadata resembles a panel type, the metadata was stratified 'by study' and 'by underlying data structure' to capture dependency among estimates provided in a single document. Results of Hausman's Chi-squared statistic test, based on 'by study' stratification, favored fixed-effect specification but only one of 28 study dummy variables and only one of the 42 estimated panel constants was statistically significant. On the other hand, only five of the 28 study dummy variables were retained in the panel model when the stratification was based on the 'underlying data structure.' In this regard, panel effects in the metadata are not significant (Rosenberger and Loomis, 2000b). Moreover, classical ordinary least squares (OLS) and weighted least squares (WLS) meta-regression models were estimated. Results show that there are 18 significant variables in an OLS MR model and only 10 significant variables in the WLS MR model. To further test the performance of the two MR models, an in-sample benefit prediction using a jackknife data splitting technique was employed. In the WLS MR model, all independent estimates are given weights equal to one, while dependent estimates are assigned weights based on the number of observations obtained from each primary study. At 95 % confidence level, the median and mean absolute percentage transfer error (PTE) for the OLS MR model were 17.86% and 30.51%, with standard error of 2.39%, which is statistically the same with Shrestha and Loomis (2001). On the other hand, the median and mean absolute PTE for the WLS MR model were, 34.20% and 43.16%, with standard error of 2.77%. Therefore, a classical OLS MR model was estimated and reported below.

The estimated MR model equation is, in matrix notation:

$$CS_{ij} = \alpha + \beta_1 SITE_{ij} + \beta_2 METHOD_{ij} + \beta_3 ACTIVITY_{ij} + u_{ij} \qquad \text{Equation (5)}$$

where subscript *ij* stands for estimate *i* from study *j*, α is the constant term, μ a vector of residuals, and the vectors β containing all the estimated coefficients of the respective explanatory variables. SITE represents a vector of site-specific variables that identify the primary environment, geographic location of the natural resource setting in which the recreation take place, and site aggregation. METHOD represents a vector of method variables, which control for the SP and RP valuation methods used, survey type employed, visitor type, and value unit. ACTIVITY represents a vector of recreation activity variables that are modeled in the study. Table 4.2 provides a description of variables tested in the meta-regression analysis.

Table 4.2. Description of variables tested in the meta-regression analysis.

Variables	Description
Dependent variable:	
CS	Consumer surplus per person per day ($ 2006 dollars)
Environment variables	
Lake	Qualitative variable: 1 if primary environment is lake, pond or reservoir resource; 0 if otherwise
River or stream	Qualitative variable: 1 if primary environment is river or stream; 0 if otherwise
Grassland	Qualitative variable: 1 if primary environment is grassland; 0 if otherwise
Public	Qualitative variable: 1 if the resource is owned publicly; 0 if otherwise
Park	Qualitative variable: 1 if the resource is designated as park (national or state) ; 0 if otherwise
SE Region	Qualitative variable: 1 if the study site is Southeast Region (Florida, Georgia, Alabama,Tennessee,South Carolina, North Carolina); 0 if otherwise
Single-site	Qualitative variable: 1 if the primary study is single-site or sub-site; 0 if regional studies.
Method variables	
Stated Preference	Qualitative variable: 1 if stated preference (SP) valuation approach used; 0 if otherwise
Individual TCM	Qualitative variable: 1 if RP and an individual travel cost model is used; 0 if otherwise
Substitute price	Qualitative variable: 1 if RP and substitute price, index or variable included in regression; 0 if otherwise
Open-ended	Qualitative variable: 1 if stated preference (SP) and open-ended elicitation method was used; 0 if otherwise
Dichotomous choice	Qualitative variable: 1 if SP and dichotomous choice elicitation method is used; 0 if otherwise
Iterative bidding	Qualitative variable: 1 if SP and iterative bidding elicitation method is used; 0 if otherwise
Price or quality substitute	Qualitative variable: 1 if SP and substitute in price or quality treatment is used; 0 if otherwise
Mail	Qualitative variable: 1 if used mail survey type; 0 if otherwise
In-person	Qualitative variable: 1 if used in-person survey type; 0 if otherwise
Phone	Qualitative variable: 1 if used phone survey type; 0 if otherwise
Resident	Qualitative variable: 1 if visitor type is resident; 0 if otherwise
Value Unit	Qualitative variable: 1 if CS is originally estimated as per person per day; 0 if otherwise
Recreation activity variables	
Fishing….waterskiing	Qualitative variables: 1 if the relevant recreation activity was studied; 0 if otherwise. The recreation activities are: Fishing, Swimming, Boating, Camping, Floating/Rafting/Canoeing, Waterskiing, Hiking, Picnicking and Sightseeing.

Table 4.3 presents the final estimated MR model including the standard errors estimated using White's heteroskedastic corrected covariance matrix estimator, and mean of the dependent and independent variables. The explanatory power (adjusted-R^2) of the MR model is 0.51, considerably above that of Shrestha and Loomis (2001) and Rosenberger and Loomis (2001). This may be due to reduced heterogeneity among the data when the selection criteria are more limiting in their scope and coverage (e.g., region and activity types). An adjusted-R^2 of 51% indicates that about half of the variance in benefit measures is explained by the model. For the dummy variables, the mean value represents the proportions of the 'study sites' with a value of one. For instance, the mean of 0.35 for the dummy variable *lake* denotes that 35% of the 'study sites' were from a lake environment. Following similar interpretation, 93% were located on public lands, 15% were designated as park, 70% were aggregated as single-site or sub-sites, etc. The estimated MR model is statistically significant at $p \leq 0.01$ based on the *F-tests.* The model has a standard error of 3.05, which means that at a 95% confidence interval, it has a 6% MOE in prediction. Out of 28 variables, 18 were statistically significant at p-value ≤ 10%.

The resulting MR model reported in Table 4.3 was used to calculate the meta-predicted value for the 'policy site.' A benefit measure for the policy site was calculated by adapting the MR function to the specific characteristics of the 'policy site.' An example of adaptation of meta-regression benefit function for fishing is shown in Table 4.4. All variables were set to their sample mean values except for those that have corresponding measures at the policy site, in which case they are set to the policy site levels. For instance, the Southeast Region variable in the model was not directly relevant in this estimation as it is used to incorporate climatic effects in the MR model estimation, and therefore normalized into their mean in obtaining MR model predicted CS values.

Table 4.3. Ordinary least squares regression model result.

Variable	Coefficient[a]	Standard error[b]	Mean of variable
CS	-	-	41.75
Constant	35.25**	17.53	-
Lake	26.81***	8.98	0.35
River or stream	58.55***	15.72	0.26
Grassland	-70.75***	20.24	0.03
Public	-44.01***	13.89	0.93
Park	41.70**	17.56	0.15
SE Region	-18.75**	8.43	0.26
Stated Preference	53.54**	26.75	0.22
Individual TCM	47.55***	11.96	0.27
Substitute price	11.90	8.50	0.47
Open-ended	-68.14***	24.13	0.07
Dichotomous choice	-13.07	21.20	0.12
Iterative bidding	-83.18***	32.63	0.03
Price or quality substitute	-54.63***	18.91	0.01
Mail	38.99***	11.12	0.36
In-person	43.98***	9.99	0.50
Phone	30.38	23.29	0.03
Resident	-27.99***	6.63	0.41
Fishing	-6.73	14.06	0.10
Camping	0.66	6.36	0.17
Hiking	19.23	14.95	0.05
Floating	5.24	18.13	0.21
Swimming	-7.95	10.42	0.03
Boating	-56.33***	11.70	0.12
Picnicking	22.20*	13.18	0.03
Sightseeing	9.61	15.39	0.04
Waterskiing	-19.18	16.72	0.01
Value unit	-28.23***	9.15	0.43
Single-site aggregation	-8.76	10.85	0.70
Adjusted-R^2	0.51		
F-stat $_{[28,184]}$	8.85***		
Number of observations	213		

Note: Dependent variable = consumer surplus (CS) per person per day ($ 2006)
[a]***Statistically significant at the 1% level or better; **at the 5% or better, * the 10% level or better.
[b]Standard errors are calculated using White's heteroskedastic corrected covariance matrix estimator. Overall MOE is ± 6% based on standard error of 3.05 and 95% confidence interval.

Table 4.4. Example adaptation of meta-regression benefit function for fishing.

Variable	Coefficient	Adaptation value	Incremental consumer surplus
Constant	35.25	1	35.25
Lake	26.81	1	26.81
River or stream	58.55	0	0.00
Grassland	-70.75	0	0.00
Public	-44.01	0	0.00
Park	41.70	1	41.70
SE Region	-18.75	0.26	-4.93
Stated Preference	53.54	0.22	11.81
Individual TCM	47.55	0.27	12.93
Substitute price	11.90	0.46	5.53
Open-ended	-68.14	0.07	-4.80
Dichotomous choice	-13.07	0.12	-1.59
Iterative bidding	-83.18	0.03	-2.73
Price or quality substitute	-54.63	0.005	-0.26
Mail	38.99	0	0.00
In-person	43.98	0.50	21.89
Phone	30.38	0	0.00
Resident	-27.99	0.95[a]	-26.59
Fishing	-6.73	1	-6.73
Camping	0.66	0	0.00
Hiking	19.23	0	0.00
Floating	5.24	0	0.00
Swimming	-7.95	0	0.00
Boating	-56.33	0	0.00
Picnicking	22.20	0	0.00
Sightseeing	9.61	0	0.00
Waterskiing	-19.18	0	0.00
Value unit	-28.23	0.43	-12.06
Single-site aggregation	-8.76	0.70	-6.13
Total consumer surplus, US $ 2006			90.10

[a]Actual proportion of visitors in the ‘policy site.’

The adaptation value used for the resident variable was 0.95, to reflect the actual proportion of visitors in the ‘policy site.’ The policy site definition for resident visitors are those defined as domestic Filipino travelers and returning overseas Filipino workers while non-resident visitors are defined as foreign travelers. All other variables in the MR model applicable to the ‘policy site’ were set to one, and zero otherwise. For instance, the policy site is designated as *park*, so the adaptation value was set to one. The explanatory variable *park* is an adjustment factor that directly addresses some of the characteristics of the policy site – protected, unique, and high quality. Likewise, the policy site has a *lake* environment setting, so the adaptation value was set to one. *Fishing* variable, the targeted recreation activity, was set to one, while all other recreation activity variables were set to zero. In sum, the following variables were set to zero – *river, grass, public*[9], *mail*[10], *phone*[10], *camping, hiking, floating, swimming, boating, picnicking, sightseeing*, and *waterskiing*. The calculated benefit measure per fishing day, after adapting the MR model specifically to the policy site, is $90.10, or between $84.72 and $95.48 at 95% confidence interval.

Adjustments are needed before transferring values from the 'study site' to 'policy site,' so that transfer errors are reduced. To adapt the calculated benefit measure to the policy site, the income levels between the two countries was adjusted using purchasing power parity (PPP[11]). PPP is the exchange rate that equalizes market prices and is appropriate for converting into a common currency. On average, resident visitors made only 1.6 trips per year and 1.75 days per trip (NSO-DOT, 2006). The adjusted benefit measure for the policy site for each of the recreation activities is given in Table 4.5. Among the recreation activities, sightseeing experiences occur mostly at the town of the ridge-Tagaytay City, Cavite Province.

MRBT was used to predict the policy site value of Predo et al. (1999) as a simple out-of-sample test. Separate estimates are generated for all recreation activities estimated in Table 4.5 and its average was assumed to be equal to the recreational value of LDNP. The same procedure discussed above was followed in this estimation. The estimated policy site value using MRBT was PHP474.80 per person per trip, resulting in an absolute percentage transfer error of 1,231%. Given the high margin of difference between the original value in Predo et al. (1999) and the MRBT predicted value (PHP35.65/person/trip vs. PHP474.80/person/trip), caution is suggested in using the MRBT numbers. The MRBT predicted estimates in Table 4.5 were very different from the predicted value for LDNP because the stated preference variables (open-ended and iterative bidding) in the MR model were applicable to the LDNP and were set to one. Lower recreational value may also be associated for LDNP than TVPL since the latter's uniqueness factor is more evident than the former.

Table 4.5. Estimated consumer surplus (CS) for different recreation activities at the policy site based on the meta-regression benefit transfer function.

Recreation activity	CS/person/day ($2006)	CS/person/day (PHP2006)	CS/person/trip (PHP2006)	CS/person/year (PHP2006)
Fishing	90	2,000	3,500	5,601
Camping	71	1,569	2,746	4,393
Hiking	89	1,981	3,467	5,548
Floating	102	2,266	3,965	6,344
Swimming	89	1,973	3,453	5,525
Boating	40	899	1,573	2,517
Picnicking	92	2,047	3,582	5,732
Sightseeing[a]	80	1,768	3,094	4,950
Waterskiing	78	1,724	3,017	4,826
Average =	81	1,803	3,155	5,048

[a]Experiences occur mostly at Tagaytay City, Cavite.

Recreational Value of Taal Volcano Protected Landscape

An estimate of the aggregate recreational value of TVPL was derived using the result of the single point estimate transfers. The MRBFT was not used in the aggregation process since the out-of-sample test resulted in high absolute PTE (1,231%), eventhough in-sample test revealed an absolute PTE of only 31%. While the MRBTF resulted in an acceptable precision (31 % PTE), it may be not an accurate estimate since the adjustments using PPP did not fully captured differences between the study and policy sites. The aggregate recreational value of TVPL equals the consumer suplus per person per year times the number of resident visitors in 2006. Non-resident visitors were excluded in the aggregation since no data was available about their trip characteristics. In this regard, the forecasted aggregate recreational value of TVPL is considered lower bound (conservative). Aggregate CS estimates are provided for the Cavite (Tagaytay City) and Batangas sides since the visitation/activity patterns for these two provinces are quite different. For the Batangas Province alone, the estimated 2006 recreational value was about PHP9.7 million based on point estimate transfer. For the Cavite side, the estimated 2006 recreational value was about PHP118 million based on point estimate transfer. In sum, about PHP128 million was estimated the value of access to TVPL in 2006. This access value is not the amount that PASu could earn through user fees. Setting a fee and projecting fee revenue requires the use of elasticities and other behavioral aspects of users.

Table 4.6. Recretional value of Taal Volcano Protected Landscape based on Filipino resident travellers, 2006.

	No. of Visitors	No. of Resident visitors	Aggregate CS (PHP 2006) Single point estimate
Batangas	169,240	155,701	9,715,730
Cavite (Tagaytay)	2,006,571	1,906,242	118,949,529
		Total	128,665,259

Discussions, Conclusions, and Policy Implications

Benefit transfer methods are increasingly used to aid decision-making, especially when time and resource constraints the conduct of primary study. It has many potential applications in developing countries, wherein collecting primary data is significantly constrained by limited financial resources. This paper has used BT to estimate the recreational value of Taal Volcano Protected Landscape, Philippines. Two welfare measures are estimated from a 1) single point estimate transfer based on a Philippines 'study site' and 2) meta-regression benefit function based on selected US 'study sites.'

Following BT protocol, the adapted welfare measures, reported in PHP 2006 CS per person per trip and per year, are adjusted to the policy site conditions and common unit. The MR transfer function was tested using in-sample benefit prediction performance. The median and mean absolute PTE support the conclusion that the MR transfer function model can be used to predict the welfare estimates at the policy site. However, simple out-of-sample test of the MRBT resulted in very high absolute PTE (1,231%). Since the absolute PTE in the out-of-sample BT prediction was greater than the in-sample BT prediction, the estimated welfare values using MRBT were not recommended for adaptation in TVPL. A smaller welfare estimates per person per trip and per year (with a MOE equal to 41%) were estimated using single point estimate than the MR transfer function model. Given with this evidence, the single point estimate outperforms MRBT. Even though the point estimate transfer generates second best CS estimates, the adapted welfare measure can be used to help guide policies in the area. These values can be incorporated into resource management decisions of PASu, PAMB, and various local governments within TVPL.

Results of this essay can inform PASu, PAMB, and the visitors of TVPL the total value of recreational access in the area. PASu may be able to use the visitation data and estimated aggregated value per province in the determination of financial commitments by the different municipalities and cities within TVPL. In particular, Tagaytay City may be asked to provide more funding towards the implementation of the management plan since the city captures more investments and revenues associated with tourism in the area. Tagaytay City mainly benefits from the scenic beauty of TVPL through tourism surplus, including rise in land values, tourism-related livelihoods, business permits, and taxes. In fact, about 80% annual revenue of the City Government of Tagaytay are generated from tourism only. Tagaytay City is currently a `free rider' to the positive externalities of Taal Volcano Island and Lake, while the DENR-PASu and other municipalities/cities within the basin pay the cost of protection in the area. Interestingly, the PASu office and Provincial Government's Task Force, with the help of municipalities of Talisay, Laurel, Agoncillo and Tanauan City are the ones regulating the intensive cage culture, infrastructure development, and pollution within Taal Volcano Island and Lake but they are not shared with these tourism suplus. Knowledge of the recreational value of TVPL creates incentives for the Provicial Task Force on Environmental Law Enforcement and concerned local governments to ensure protection and conservation of their unique resources. To do this involves costs on the part of PASu, PAMB and the local governments within TVPL.

The estimated recreational value of TVPL is not equivalent to economic resources that can be generated when visitor use fees or recreational boat licenses are imposed to the users. User fees should be based on a WTP study that captures public perceptions and WTP fees, among others. If PASu would like to capture some of the recreational value in TVPL, a user fee may be imposed on visitors at the Taal Volcano Island. The recommended *ad hoc* user fee per visit is PHP86/person. This amount was based on the budget for recreation and cultural resources priority activities from the management plan (PHP14.62 million) divided by the number of visitors in 2006 in Batangas Province (169,240). This amount is about twice that of the recommended fee of PHP44 per person per visit for the Sohotan Natural Bridge National Park in Samar, Philippines (Rosales, 2001). Higher fees at unique sites may have little or no effect on visitation levels (Benitez, 2001). Proceeds from user fees shall go to the Integrated Protected Areas Fund (IPAF[12]). Capturing monetary payments can be used to compensate TVPL for service provisioning and maintaining the area for its scenic beauty. Likewise, these revenues could be used to support TVPL biodiversity conservation and funding the alternative employment opportunities for affected locals who are barred from tilapia cage farming.

Given the time and funding, it is important to get an accurate assessment of the value of goods and services the area provides. This can be done through conduct of primary valuation studies that captures public perceptions and WTP fees, visitation carrying capacity, etc. Moreover, future research may focus on comparing tourism impacts on TVPL before and after management plans. In particular, after the 10-year management plan, it is imperative to assess if the goal of maintaining the population at TVPL is maintained below 350,000. In other protected areas in Africa and Latin America, parks attract human settlement. There is an accelerated human population growth at protected area edges due to economic opportunities they provide (Wittemyer et al. 2008). If the same trend happens in TVPL, then it is imperative that economic developments should be targeted at areas more distant from the basin that aids local communities while simultaneously reducing human pressure on TVPL.

Notes

[1] PAMB membership now stands at 157, with 35 Executive Committee members.

[2] Municipalities are divided into income classes according to their average annual income during the last three calendar years: First class = annual income of PHP 50,000,000 or more; Second class = annual income between PHP 40,000,000 and PHP 49,999,999; Third class = annual income between PHP 30,000,000 and PHP 39,999,999; Fourth class = annual income between PHP 20,000,000 and 29,999,999; Fifth class = annual income between PHP 10,000,000 and PHP 19,999,999. While most of the municipalities that spans TVPL are considered 3rd, 4th or 5th class, the Province of Batangas ranked 6th among 77 provinces in the Philippines in terms of Human Development Index for 2000. In 2003, Batangas ranked 16th place in HDI. HDI is the summary measure of human development, which has three basic dimensions: longevity, knowledge, and standard of living.

[3] NIPAS law provides for the establishment and management of national integrated protected areas system, defining its scope and coverage. These include natural park, natural monument, wildlife sanctuary, protected landscapes and seascapes, resource reserve, natural biotic areas, and other categories established by law, conventions or international agreements which the Philippine Government is a signatory. The NIPAS designation is equivalent to the International Union for Conservation of Nature and Natural Resources (IUCN) Category V.

[4] Non-rival goods are goods whose consumption by one person does not prevent simultaneous consumption by other persons.

[5] ‘Benefit’ transfer and ‘value’ transfer means the same. Other authors use the word 'value' and not 'benefit' to make a distinction between 'costs' and 'benefits.'

[6] Region IV-A, portmanteau of the names of the provinces: CAvite, LAguna, BAtangas, Rizal, QueZON. It is the second most densely populated region in the Philippines, next to Metro Manila.

[7] Consumer Price Index for areas outside the National Capital Region is available at http://www.cesus.gov.ph .

[8] Colorado was excluded in the selection criteria since the over-all climate of the state is different from the targeted policy site.

[9] The *public* variable identifies all studies conducted on recreation on public lands, including US Forest Service, Bureau of Land Management, US Army Corps of Engineers, county, municipality, etc. The values are typically lower than other estimates because these sites are easily accessible and more general in nature. This variable is not adaptable to TVPL. The variable *park* captures the premium for high quality, unique protected sites.

[10] *Phone*, *mail* or *web-based* surveys are not often used in the Philippines since many targeted respondents don't have access to them. Hence, *in-person* survey is the dominant type of survey data collection. In developing countries, like The Philippines, local cultures and socio-economic conditions matter [or may influence] in benefit estimation (Alam, 2006).

[11] Purchasing Power Parity conversion factor used was $1=PHP22.2 (WorldBank, 2010). There's a caveat in PPP adjusted benefit measures since it will not be able to correct for differences in individual preferences, and cultural and institutional conditions between the two countries that they have the potential to invalidate an international BT.

[12] Department Administrative Order No. 25, Series of 1992 – NIPAS Implementing Rules and Regulations states that "at least 75% of the revenues generated by a protected area shall be retained for the development and maintenance of that area and utilized subject to the IPAF Board guidelines… with the balance being remitted to the Central IPAF Fund."

References

Alam, K. 2006. "Valuing the environment in developing countries: problems and potentials." *Asia Pacific Journal on Environment and Development* 13(1 & 2):27-44.

Alberini, A., and A. Krupnick. "Air Quality and Episodes of Acute Respiratory Illness in Taiwan Cities: Evidence from Survey Data." *Journal of Urban Economics* 44, no. 1(1998): 68-92.

Barton, D. N., and S. Mourato. "Transferring the benefits of avoided health effects from water pollution between Portugal and Costa Rica." *Environment and Development Economics* 8, no. 02(2003): 351-371.

Bateman, I. J., et al. "The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP." *Ecological Economics* 60, no. 2(2006): 450-460.

Benitez, S. P. (2001) Visitor User Fees and Concession Systems in Protected Areas, Galapagos National Park, Ecuador, Tourism and Protected Areas Publication Series, The Nature Conservancy, Arlington, VA.

Boyle, K. J., and J. C. Bergstrom. "Benefit Transfer Studies: Myths, Pragmatism, and Idealism." *Water Resources Research* 28, no. 3(1992): 657–663.

Boyle, K. J., et al. "Necessary Conditions for Valid Benefit Transfers." *American Journal of Agricultural Economics* 91, no. 5(2009): 1328-1334.

Brouwer, R. "Environmental value transfer: state of the art and future prospects." *Ecological Economics* 32, no. 1(2000): 137-152.

Brouwer, R., and F. A. Spaninks. "The Validity of Environmental Benefits Transfer: Further Empirical Testing." *Environmental and Resource Economics* 14, no. 1(1999): 95-117.

Button, K. J. (2002) An evaluation of the potential of meta-analysis in value and function transfer. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Champ, P. A., K. J. Boyle, and T. C. Brown (Eds.) (2003). *A primer on nonmarket valuation*. Economics of non-market goods and resources Vol. 3. Dordrecht, Boston Kluwer Academic Publishers.

Desvousges, W. H., M. C. Naughton, and G. R. Parsons. "Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies." *Water Resour. Res.* 28, no. 3(1992): 675–683.

Desvousges, W. H., F. R. Johnson, and H. S. Banzhaf. *Environmental policy analysis with limited information: principles and applications of the transfer method*. Northampton, MA: Edward Elgar Publishing, 1998.

Florax, R., P. Nijkamp, and K. Willis (2002) Meta-analysis and value transfer: Comparative assessment of scientific knowledge. In R. Florax, P. Nijkamp, and K. Willis (Eds). *Comparative Environmental Economic Assessment*. MA, USA, Edward Elgar Publishing, Inc.

Folledo Jr., R. A., and R. V. O. Cruz. "Taal Lake Watershed: Ecological Profile, Sources of Ecological Perturbations and Watershed Restorations Strategies." College of Forestry and Natural Resources, University of the Philippines Los Banos, 1999.

Garcia, P. P., et al. (2005) Multi-Sectoral Watershed Planning in Lake Danao Natural Park through Participatory Approaches: Terminal Report, Leyte State University.

Haab, T. C., and K. E. McConnell. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation* Northampton, Mass., USA: Edward Elgar Publishing, 2002.

Hargrove, T. R. *The Mysteries of Taal: A Philippine volcano and lake, her sea life and lost towns*. Makati, Metro Manila: Bookmark, 1991.

Hoehn, J. P. "Methods to address selection effects in the meta regression and transfer of ecosystem values." *Ecological Economics* 60, no. 2(2006): 389-398.

Kask, S. B., and J. F. Shogren. "Benefit transfer protocol for long-term health risk valuation: A case of surface water contamination." *Water Resour. Res.* 30, no. 10(1994): 2813-2823.

Krupnick, A. "Mortality-risk Valuation and Age: Stated Preference Evidence." *Rev Environ Econ Policy* 1, no. 2(2007): 261-282.

Loomis, J. B. "The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer." *Water Resources Research* 28, no. 3(1992): 701-705.

Loomis, J.B., and R.S. Rosenberger. 2006. "Reducing barriers in future benefit transfers: Needed improvements in primary study design and reporting." *Ecological Economics* 60(2):343-350.

Luna, M. P. G., and V. Gonzales. (2007). The Test of Effective Participation in Management Planning. Jaipur, India.

Muthke, T., and K. Holm-mueller. "National and International Benefit Transfer Testing with a Rigorous Test Procedure." *Environmental and Resource Economics* 29, no. 3(2004): 323-336.

Nelson, J. P., and P. E. Kennedy. "The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment " *Environmental and Resource Economics* 42(2009): 345-377.

NSO-DOT. (2006) "2005 Household Survey on Domestic Visitors: Final Report." National Statistics Office and Department of Tourism, Republic of the Philippines.

Ong, P. S., L. E. Afuang, and R. G. Rosell-Ambal (Eds.) (2002). Philippine Biodiversity Conservation Priorities: A second iteration of the national biodiversity strategy and action plan. DENRPAWB, CI-Philippines, Biodiversity Conservation Program (BCP) – University of the Philippines Center for Integrative and Development Studies (UPCIDS) and Foundation for the Philippine Environment (FPE), Quezon City, Philippines.

Predo, C. D., et al. "Non-market Valuation of the Benefits of Protecting Lake Danao National Park in Ormoc, Philippines." *Journal of Environmental Science and Management* 2, no. 2(1999): 13-32.

Resources Environment and Economics Center for Studies (REECS), Inc. (2003). "Developing Pro-Poor Markets for Environmental Services in the Philippines: Final Report." International Institute for Environment and Development.

Republic Act No. 7586. National Integrated Protected Area System Act of 1992.

Ready, R. C. "Advances in Environmental Benefit Transfer: Discussion." *American Journal of Agricultural Economics* 91, no. 5(2009): 1351-1352.

Ready, R., et al. "Benefit Transfer in Europe: How Reliable Are Transfers between Countries?" *Environmental and Resource Economics* 29, no. 1(2004): 67-82.

REECS (Resources, Environment and Economics Center for Studies), Inc. (2003) Developing Pro-poor Markets for Environmental Services in the Philippines. Final Report prepared for the International Institute for Environment and Development.

Rosales, R. M. P. (2001) "Estimating Recreational Values of the Sohotan Natural Bridge National Park ". US Agency for International Development.

Rosenberger, R. S., and J. B. Loomis (2001) Benefit transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan (2000 revision). Fort Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, pp. 59.

Rosenberger, R. S., and J. B. Loomis (2003) Benefit Transfer: *A Primer on Nonmarket Valuation*, P. A. Champ, K. J. Boyle, and T. C. Brown (Eds). Dordrecht, Netherlands: Kluwer Academic Press.

Rosenberger, R. S., and R. J. Johnston. “Selection effects in meta-analysis and benefit transfer: Avoiding unintended consequences.” *Land Economics* 85, no. 3(2009): 410-428.

Rosenberger, R. S., and T. T. Phipps (2007) Correspondence and convergence in benefit transfer accuracy: A meta-analytic review of the literature, ed. S. Navrud, and R. Ready. Environmental Values Transfer: Issues and Methods. Dordrecht, The Netherlands, Kluwer Academic Publishers. pp. 23-43.

Rosenberger, R. S., and T. D. Stanley. "Measurement, generalization, and publication: Sources of error in benefit transfers and their management." *Ecological Economics* 60, no. 2(2006): 372-378.

Shrestha, R. K., and J. B. Loomis. "Testing a meta-analysis model for benefit transfer in international outdoor recreation." *Ecological Economics* 39, no. 1(2001): 67-83.

Smith, V., and S. Pattanayak. "Is Meta-Analysis a Noah's Ark for Non-Market Valuation?" *Environmental and Resource Economics* 22, no. 1(2002): 271-296.

Stanley, T. D. "Wheat from Chaff: Meta-analysis as Quantitative Literature Review." *Journal of Economic Perspectives* 15, no. 3(2001): 131-150

Stanley, T. D., and S. B. Jarrell. "Meta-Regression Analysis: A Quantitative method of Literature Surveys." *Journal of Economic Surveys* 3, no. 2(1989): 161.

World Bank. (2010, May 21) Purchasing power parities (PPP) conversion factor, local currency unit to international dollar. Retrieved from http://search.worldbank.org/data?qterm=ppp&language=EN&format=html

Yokoyama, I., A. Alcaraz, and O. Peña. "Gravimetric studies of Taal Volcano, Philippines." *Bulletin of Volcanology* 39, no. 3(1975): 479-489.

Vista, A., et al. "Nutrient Loading and Efficiency of Tilapia Cage Culture in Taal Lake, Philippines." *Philippine Agricultural Scientist* 89, no. 1(2006): 48-57.

Vista, A. B. "Cost-effectiveness of nutrient pollution reduction in Taal Lake, Philippines." MS Thesis. Michigan State University, 2003.

Wittemyer, G., et al. "Accelerated Human Population Growth at Protected Area Edges." *Science* 321, no. 5885(2008): 123-126.

Zhai, G., and T. Suzuki. "International Benefit Transfer Related to Coastal Zones: Evidence from Northeast Asia." *Marine Resource Economics* 24, no. 2(2009): 171-186.

CHAPTER 5 - CONCLUSION

This dissertation has presented three essays on meta-analysis, benefit transfer, and recreation use valuation. Summaries of results, contributions, conclusions and recommendations of the three essays are presented in this section.

The goal of the first essay was accomplished by following the best-practice guidelines for meta-analyses using the sportfishing valuation studies. Based upon the log-likelihood ratio test, the two sub-metadata models (single-site and regional) are not from the same population and should not be pooled without accounting for their differences in a meta-analysis. Overall, the regional model has more significant variables and lower percent difference (i.e. transfer error) in the out-of-sample validity test than single-site model. When high/low original consumer surplus values for the transfer studies were excluded in the out-of-sample validity test, the relative performance of the regional model increases over the single-site and pooled models. However, these results remain inconclusive as to which model might work best in real-world policy settings given small set of out-of-sample studies. Essay 1 has shown that welfare aggregation differences among primary studies influence the direction and magnitude of bias that are carried forward in benefit transfer applications. In particular, benefit transfer error depends on the meta-analyst's choice of primary studies to include in metadata, model specification, and the unit of welfare aggregation level to consider. Therefore, meta-analysts should consider the appropriate level of aggregation when doing benefit transfer based on meta-regression benefit function. There is no single 'appropriate' level of aggregation. Some construct at different levels of aggregation might be better depending on the number of available studies and desired outcome being studies.

The second essay examined meta-analytic procedures that are used when one or more of the studies in the metadata contain multiple measures of benefits. Results show that the degree of explanatory power among the meta-regression models was best achieved in an all-set weighted specification and in using an average-set metadata, which are complementary treatments of data dependency. There were changes in the magnitude and signs of the estimated parameters of the fishing environment variables when the underlying structure of the metadata was modified into best-set and average-set. This result affirmed the findings of Essay 1 that the structural shift in the metadata was influenced by fishing environment variables. Moreover, results indicate that median absolute percentage transfer error is lower for the meta-regression models based on a single value, i.e. average-set and best-set metadata than the meta-regression based on all-set. However, this increased in in-sample predictions is not substantial since the single value approach may result in a loss of information. One significant observation from in-sample predictions is that the absence of very low and very high estimates in the metadata will likely result in more robust meta-regression benefit transfer. Therefore, caution is recommended when selecting studies for point or function transfers that provide very low estimates. Instead, it is recommended to select those observations that fall within two standard deviations of the mean, given large sample. Findings also suggest that the dummy variables related to measurement errors and publication selection bias are important predictors of transfer errors.

The third essay estimated the recreational value of Taal Volcano Protected Landscape in the Philippines. Results show that single point estimate transfer worked better than the meta-regression benefit function transfer. The meta-regression benefit function was not used since the out-of-sample test resulted higher absolute transfer error than in-sample test absolute transfer error. Therefore, caution is suggested in using the estimated numbers using meta-regression benefit function. The estimated welfare estimate of recreational access using single point estimate transfer was PHP 36 per person per trip. Given different trip characteristics of visitors, separate aggregate estimates of recreational value were estimated for the Batangas Province and Cavite Province. The aggregated recreational benefits at Taal Volcano Protected Landscape was PHP 9.7 million from 155,701 visitors at Batangas side and PHP 118.9 million from 1,906,242 visitors at the Cavite side in 2006. The number of visitors corresponds only to the domestic Filipino travelers and returning overseas Filipino workers. Foreign visitors (about 5%) were excluded in the aggregation since no data was available about their trip characteristics. The estimated PHP128.6 represents the value of access to Taal Volcano Protected Landscape in 2006.

There remain some challenges in conducting meta-analysis for benefit transfer. In particular, there is a general lack of reporting about characteristics of the primary study contexts in the literature. In this regard, the following observations are recommended when conducting meta-analysis and benefit transfer: 1) the need to account for aggregation differences among primary studies to minimize biased value estimates in benefit transfer depending on policy settings; 2) the importance to correct for dependency and other methodological pitfalls in meta-regression; 3) metadata sample selection is best guided by the goals of the meta-analysis and perceived allowable errors in benefit transfer applications; and 4) the conduct of primary study is still the first best strategy to recreation use valuation, given time and resources. More research is needed to analyze the implications of metadata sample selection in the context of benefit transfer. In particular, future research should evaluate the downward bias associated with the different metadata sample sizes when used in benefit transfer applications.

APPENDIX A: MASTER CODING SHEET FOR RECREATIONAL FISHING STUDIES.

Fish	RUVD			
F000	V000	Document Code		
		STUDY SOURCE		
F001	V001	Study code	[#]	Fxxxyyy; x = study; y = estimate number; start F101001 (Write this no. at the top of the document)
F001a	V002	Author(s)	[text]	List all by last name
F001b	V003	Title	[text]	Title of document
F001c	V004	Source reference	[text]	Note journal or report, etc.
F001d	V005	Publication date	[year]	Year published
F002	V006	Literature-type	[#]	1=journal; 2=book or book chapter; 3=gov't agency or university report; 4=consulting report; 5=MS thesis; 6=PhD dissertation; 7=working paper; 8=proceedings paper; 9=web-report
F003	V009	Primary contribution	[#]	1=Introduce efficient estimator; 2=introduce efficiency in survey instruments (e.g., bid design); 3=test of validity/reliability of method (e.g., bias, protests and other treatments of the data); 4=New estimate of value
F004	V010	Multiple estimates	[#]	1=multiple estimates reported; 2=single estimate provided; 3=multiple estimates provided in the study but only one for fishing
		STUDY LOCATION		
F005	V011	Country	[#]	1=USA; 2=Canada
F006	V012	State	[text]	State or province name (list all)
F007	V012a	Ecoregion	[#]	1=Pacific Northwest Marine (Washington, Oregon, and California); 2=Desert Southwest (California, Arizona, New Mexico and Texas); 3=Gret Basin Steppe (Nevada, Oregon and Idaho); 4=Rocky Mountains (Colorado, Wyoming, Montana, and New Mexico); 5=Midwest Prairie and Steppe (North Dakota, South Dakota, Minnesota, Iowa, Illinois, Nebraska, Missouri, Kansas, Oklahoma, and Texas); 6=Ozark and Ouchita Mountains (Arkansas); 7=Northeast and Great Lakes (Wisconsin, Illinois, Indiana, Ohio, Michigan, kentucky, Tennessee, West Virginia, and Pennsylvania; 8=Southeast Subtropical and Southern Florida (Mississippi, Louisiana, Alabama, Georgia, Florida, South Carolina, North Carolina, and Virginia); 9=Appalachian Mountains (Maryland, West Virginia, Virginia, North Carolina, South Carolina, Tennessee, Georgia, and Alabama); 10=New England and Warm Continental (Maine, New Hampshire, Vermont, New York, Connecticut, Rhode Island, New Jersey, and Pennsylvania); 11= Pacific archipelago; 12=Alaska; 13= Hudson plains; 14=Boreal plains; 15= Montane Cordillera; 16=Atlantic maritime; 17=Taiga

F008	V048	Geographic location (aggregation)	[#]	1=National; 2= ecoregional/multistate; 3=state; 4=county; 5=multi-county; 6=multi-site; 7=single site; 8=sub-site; 9=other
F009	V013	County	[text]	County name (list all)
F010	V014	Water-body name	[text]	Water body name (list all)
		FISHING ACTIVITY		
F011	V020a	Fishing Type	[#]	1=Freshwater Fishing; 2=Saltwater Fishing; 3=both or unspecified
F012	V021	Fishing Species	[#]	1=big game; 2=smallgame; 3=flatfish; 4=other saltwater; 5=salmon; 6=steelhead trout; 7=walleye/pike; 8=bass, 9=panfish, 10=rainbow trout and other trout; 11= other freshwater (smelt)
F013		Fishing mode	[#]	1=shore/pier fishing; 2=private and charter boat fishing; 3=fly fishing, artificial lures, bait; 4= ice fishing; 5= surf fishing
		SITE CHARACTERISTICS		
F014	V032	Site quality	[#]	1=high; 2=moderate; 3=low; 4=not reported by author
F015		Water-body type	[#]	1=marine, open ocean; 2=estuary/bay; 3=lake, pond, reservoir; 4=great lakes, 5=river and stream; 6 = others (wetland)
F016a		Catch rate	[#]	Catch rate for the species valued
F016b		Number of fish caught per trip	[#]	Number of fish caught
F017	V035	Size of site (length of coastline)	[#]	In acres, if listed or miles length
F018		Population density at site	[#]	
F019		Availability of facilities (parking,bathroom, food, etc.)	[#]	1=yes; 0 = no
F020		Fishing regulation	[#]	1=fishing only; 2= catch limits; 3 = catch and release; 4= catch-and-keep
F021	V026	Site change evaluated	[#]	1=change in site condition evaluated in paper; 2=only access value at existing conditions evaluated in paper
F022	V027	Marginal change	[#]	1=marginal change; 2=total change
F023	V029	Site change percent	[%]	Percentage of site change being evaluated
F024	V030	Change description	[text]	Briefly describe the change being evaluated including the exact baseline and scenario features (catch rates, fees, etc.)
F025	V033	Number of sites	[#]	Number of sites being evaluated
F026	V036	Site characteristics	[#]	1=site characteristics included (e.g., size, amenities, environ quality, facilities) 2=not included in model
F027	V037	Number of site characteristics	[#]	Number of site characteristics included in model
F028	V038	Source of site info	[#]	1=gathered independently; 2=gathered as part of survey (respondent perceptions)

		TRIP-SPECIFIC		
F029		Mode	[#]	1=shore-based; 2=residential boat ramps and docks; 3= publicly owned and commercially available boat ramps and moorage
F030	V057	On-site time	[#]	Average hours reported for on-site activities
F031	V034	Total site visits	[#]	Total number of site visits
F032		Angler expenditures/trip	[$]	fishing expenditure data per trip
F033	V112	Trip type	[#]	1= private trip; 2=chartered or guided trip; 3= both
F034	V113	Trip length	[#]	1=day trip; 2=overnight trip; 3=combined day and overnight trips
F035	V114	Group size	[#]	Number of people per group
F036	V115	Average trips	[#]	Average number of trips per person; per group; per season; or per year
F037	V116	Days per trip	[#]	Average days per trip
		ANGLER-SPECIFIC CHARACTERISTICS		
F038	V052	Visitor type	[#]	1=Resident; 2=Non-residents; 3=both; 4=special interest group (clubs); 5=other specifically targeted sub-population
F039	V053	Sample summary statistics provided	[#]	1=Yes (sociodemographics, attitudes, etc.); 2=No
F039a		Income	[#]	1≤ 20k; 2 = 20k ≤ 40k; 3 = 40k ≤ 60k; 4 = 60k≤80k; 5=80k≤100k; 6≥ 100k
F039b		Education	[#]	Years of education
F039c		Age	[#]	Average age of respondents
F039d		Gender	[%]	% male
F039e		Race	[%]	% white
F039f		Experience	[#]	Number of years of fishing experience
		SURVEY CHARACTERISTICS		
F040	V049	Data source	[#]	1=Primary data; 2=Secondary data
F041	V050	Survey type	[#]	1=Mail; 2=In-person interview; 3=Phone; 4=Web-based; 5=Mixed modes; 6=other
F042	V051	Data year	[#]	Year data was collected
F043	V054	Response rate	[%]	Reported response rate (100%=1.00)
F044	V055	Number of surveys returned	[#]	Number of surveys returned
F045	V056	Sample frame	[#]	1=On-site; 2=User list; 3=General pop'n; 4=other
		VALUATION METHOD		
F046	V058	Valuation methodology	[#]	1=Stated Preference; 2=Revealed Preference; 3= Combined RP/SP
F047	V059	Regression Model Provided	[#]	1=Yes; 2=No
F048	V060	Sample Size	[#]	Sample size for regression model
		STATED PREFERENCE CHARACTERISTICS		
F049	V061	Elicitation method	[#]	1=Open-ended; 2=Dichotomous Choice; 3=Iterative Bidding; 4=Payment Card; 5=Double or Multiple Bounded; 6=Stated Choice (aka Conjoint, Choice Experiment, Attribute-Based)

F050	V062	Payment vehicle	[#]	1=Trip Cost; 2=Access Fee; 3=Annual Pass; 4=Taxes; 5=Donations; 6=Other
F051	V063	Payment type	[#]	1=One-off; 2=Per use; 3=Annual in perpetuity; 4=Annual fixed period; 5=Other
F052	V064	Dichotomous choice model form	[#]	(iff Elicitation Method =2) 1=Probit; 2=Logit; 3=Nonparametric; 4=Semi-nonparametric; 5=Other
F053	V065	Open-Ended Model Form	[#]	(iff Elicitation Method = 1) 1=OLS; 2=2SLS; 3=Tobit; 4=Other
F054	V066	Payment Card Model Form	[#]	(iff Elicitation Method = 4) 1=OLS; 2=Grouped Tobit (Cameron/Huppert Function); 3=Other
F055	V067	SP Truncated	[#]	1=Yes (upper limit); 2=No
F056	V068	No Negative DC	[#]	1=no negative WTP allowed (lnBid or $1/B_1*\ln(1+e^{B0})$; 2=negative values allowed
F057	V069	SP Outliers	[#]	1=Outliers removed; 2=not removed
F058	V070	SP Censoring	[#]	1=Regression censored; 2=not censored
F059	V071	SP Censor Point	[#]	Censor point (e.g., at 0, 1, etc.)
F060	V072	SP Substitutes	[#]	1=mentioned or treated substitutes in price or quality; 2=no substitutes information
F061	V073	Protests	[#]	1=Protests removed; 2=Protests set to $0; 3=Protests set at mean$; 4=Protests included but not set at $0 or $mean;5=don't know
F062	V074	Bias Testing	[#]	1=study investigated bias (anchoring, framing); 2=no bias testing
F063	V075	Choice Set	[#]	Number of choice sets in stated choice model
		REVEALED PREFERENCE CHARACTERISTICS		
F064	V076	RP Type	[#]	1=Zonal TCM; 2=Individual TCM; 3=Hedonic TCM; 4=RUM
F065	V077	Zones	[#]	Number of zones included in Zonal TCM
F066	V078	Sites	[#]	1=Single site model; 2=Multiple site model
F067	V079	Model Sites	[#]	Number of sites included in multi-site/RUM model
F068	V080	Demand System	[#]	1=Continuous demand system; 2=Discrete choice RUM; 3=Kuhn-Tucker RUM; 4=other
F069	V081	Participation Modeled	[#]	1=participation is modeled; 2=participation is not modeled
F070	V082	Choice Aspects	[#]	1=site; 2=mode; 3=species; 4=on-site time; 5=other (list___________________)
F071	V083	Choice Set Specification	[#]	1=distance-based; 2=familiarity-based; 3=endogenously determined; 4=other
F072	V084	Equation Type	[#]	1=OLS; 2=2SLS; 3=Tobit; 4=Count Data (Poisson or Negative Binomial); 5=Multinomial Logit/Probit; 6=Nested Logit; 7=Mixed Logit (random parameters); 8=Kuhn-Tucker; 9=other
F073	V085	Functional Form	[#]	1=Linear-linear; 2=Log-linear; 3=Linear-log; 4=Log-log (for Q, P relationship)
F074	V086	RP Substitutes	[#]	1=mentioned or treated substitutes in price or quality; 2=no substitutes information
F075	V087	Substitute Price	[#]	1=Substitute price, index or variable included in regression; 2=not included
F076	V088	RP Truncation	[#]	1=Observations truncated; 2=not truncated

F077	V089	Endogenous Stratification	[#]	1=Corrected for endog strat; 2=not corrected
F078	V090	Cost/Mile Used	[$]	Cost per mile used
F079	V091	Other Cost	[#]	1=Other costs besides time included in travel cost variable; 2=Not included
F080	V092	Time Variable	[#]	1=Separate time variable (not in $) included in regression; 2=Not included
F081	V093	Time Cost	[#]	1=Opportunity cost of time used in price variable; 2=Used separately in regression; 3=Not used
F082	V094	Opp Cost Time	[#]	1=Wage rate; 2=Self-reported; 3=Other; 4=Unknown
F083	V095	Wage Rate	[%]	Percent of wage rate used
F084	V096	Cost Type	[#]	1=Per person; 2=Per group
F085	V097	Value Truncated	[#]	1=Integration truncated @ max TC; 2=not truncated
F086	V098	RP Outliers	[#]	1=Outliers removed; 2=Not removed; 3=Don't know
F087	V099	RP Censoring	[#]	1=regression censored; 2=not censored
F088	V100	RP Censor Point	[#]	Censor point (e.g., 0 trips, 1 trip, etc.)
F089	V101	Single Destination	[#]	1=Single destination trips only; 2=Single and multiple destination trips; 3=don't know
F090	V102	Primary Purpose	[#]	1=Only used respondents who are primary purpose visitors; 2=explicitly mentions multiple purpose trips included; 3=don't know
		BENEFIT MEASURE		
F091	V104	Estimate Type	[#]	1=CV (compensating variation); 2=EV (equivalent variation); 3=CoS (compensating surplus); 4=ES (equivalent surplus); 5=CS (consumers surplus)
F092	V105	Favored Estimate	[#]	1=estimate favored by author; 2='best' estimate provided; 3=estimate based on relatively 'bad' model
F093	V106	Central Tendency	[#]	1=Mean value reported; 2=Median value reported
F094	V107	CS-current	[$]	Benefit estimate (use mean value when available)
F095	V118	Value Year	[year]	Year of reported value
F096	V108	CS-std error	[#]	Standard error of CS estimate
F097	V109	CI-measured	[#]	1=directly from estimates of CS; 2=bootstrapped from VarCov of regression; 3=Other; 4=Not reported
F098	V110	CI-range	[#]	Range in confidence interval for mean estimate reported
F099	V111	Unit	[#]	1=Per person per day; 2=Per group per day; 3=Per person per trip; 4=Per group per trip; 5=Per person per season; 6=Per group per season; 7=Per person per year; 8=Per group per year
F100	V117	Fishing effort	[#]	Season length in days
		STANDARDIZED CS ESTIMATES		
F101	CS01	CPI factor	[#]	CPI conversion factor, 2006 base year
F102	CS02	CS_real	[#]	CS in real tems (CS_current / CPI factor)
F103	CS03	CS_day	[#]	CS in real terms and common units (per person per day)

F104	CS04	Unit conversion	[#]	1=values converted to per person per day from original units; 0=not converted (i.e., reported as CS/person/day)
		REGRESSION PARAMETERS		
F105	R001	Price Coefficient	[#]	Estimated coefficient on travel cost variable
F106	R002	Price-Standard Error	[#]	Standard error of Price Coefficient
F107	R003	Price Elasticity	[#]	Own price elasticity of demand
F108	R004	Elasticity Calculated	[#]	1=elasticity calculated; 0=reported by authors
F109	R005	Price in Dollars	[#]	1=price measured in $$; 0=measured in miles (distance)
F110	R006	Bid Coefficient	[#]	Estimated coefficient on bid in CVM
F111	R007	Bid-Standard Error	[#]	Standard error of Bid Coefficient
F112	R008	Comments #2 - regarding regression model	[text]	

APPENDIX B: SELECT CHARACTERISTICS OF RECREATIONAL ANGLING VALUATION STUDIES USED IN THE META-ANALYSES.

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Kalter and Gosse, 1969	1	State	NY	Revealed Preference, Individual TCM	$37.68	Freshwater
Beardsley, 1970	2	Single-site	CO	Revealed preference, Zonal TCM	$6.62	Freshwater (trout)
				Stated Preference, iterative bidding	$6.87	Freshwater (trout)
Martin, Gum, and Smith, 1974	13	Multi-site	AZ	Revealed Preference, Zonal TCM	$9.32 to $35.77	Freshwater (trout)
					$14.51 to $129.56	Freshwater (bass, catfish)
Sublette and Martin, 1975	2	Single-site	AZ	Revealed Preference, Individual TCM	$57.78 to $64.35	Freshwater (trout)
Hansen, 1977	5	State	ID, NV, UT, WY	Stated Preference, open-ended	$56.49 to $105.15	Freshwater
Michalson,1977	4	Single-site	ID	Revealed Preference, Individual TCM	$15.11 to $85.00	Freshwater (salmon, steelhead trout)
Charbonneau and Hay, 1978	12	National	USA	Stated Preference, open-ended	$55.93 to $190.16	Freshwater
					$59.66 to $272.19	Saltwater
Ziemer and Musser, 1978	1	State	GA	Revealed Preference, Individual TCM	$121.50	Freshwater
Brown and Plummer, 1979	2	Single-site	WA, OR	Revealed Preference, Zonal TCM	$66.98 to $119.87	Freshwater
McConnell,1979	1	State	RI	Revealed Preference, Individual TCM	$99.09	Saltwater (winter flounder)
King and Walka, 1980	1	Multi-state	AZ	Revealed Preference, Individual TCM	$13.71	Freshwater (trout)
Walsh, et al., 1980	1	Multi-site	CO	Stated Preference, open-ended	$32.40	Freshwater (trout)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Ziemer, Musser, and Hill, 1980	3	State	GA	Revealed Preference, Individual TCM	$26.96 to $104.23	Freshwater
Daubert and Young, 1981	2	Single-site	CO	Stated Preference, iterative bidding	$87.87 to $152.79	Freshwater (trout)
Steinnes and Raab, 1981	5	Single-site	MN	Revealed Preference, Zonal TCM	$1.17 to $5.86	Freshwater (smelt)
			AZ		$11.28 to $311.80	Freshwater
			ME		$21.34 to $73.03	Freshwater
			TN		$31.65 to $176.76	Freshwater
Walsh and Olienyk, 1981	1	Multi-site	CO	Stated Preference, iterative bidding	$21.76	Freshwater
Bell, 1982	10	Multi-county	FL	Stated preference, open-ended	$41.86 to $127.97	Saltwater (snapper, sea trout, grouper, catfish)
Kealy,1982	3	Single-site	WI	Revealed Preference, RUM	$70.43 to $97.72	Freshwater (salmon, trout)
Martin, Bollman, and Gum, 1982	2	Single-site	AZ, NV	Revealed Preference, Individual TCM	$42.67 to $63.70	Freshwater (largemouth bass)
Sutherland, 1982	4	Single-site	MT	Revealed Preference, Zonal TCM	$10.84 to $13.11	Freshwater (trout)
Vaughan and Russell, 1982	4	National	USA	Revealed Preference, Zonal TCM	$30.28 to $53.85	Freshwater (trout)
					$19.34 to $34.48	Freshwater (catfish)
Weithman and Haas, 1982	1	Single-site	MO	Revealed Preference, Zonal TCM	$24.34	Freshwater (rainbow trout)
Adamowicz and Phillips, 1983	3	State	AB	Stated Preference, open-ended	$46.31	Freshwater
				Revealed Preference, Individual TCM	$6.92 to $13.84	Freshwater

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Harris, 1983	4	Single-site	CO	Revealed Preference, Zonal TCM	$24.79 to $33.92	Freshwater
Menz and Wilton, 1983a	15	Multi-site	NY	Revealed Preference, Individual TCM	$54.40 to $176.10	Freshwater (bass)
Menz and Wilton, 1983b	9	Multi-site	NY	Revealed Preference, Individual TCM	$29.72 to $147.58	Freshwater (muskellunge)
Miller, 1983	51	Multi-county	ID	Revealed Preference, Individual TCM	$24.34 to $176.76	Freshwater
			MN		$31.65 to $390.45	Freshwater
Palm and Malvestuto, 1983	4	Single-site	AL, GA	Revealed Preference, Zonal TCM	$15.09 to $74.49	Freshwater (bass, crappie)
Snyder, 1983	3	Multi-site	CT, MA, RI, NJ, NY, MD, VA	Revealed Preference, Individual TCM	$101.66 to $138.22	Freshwater (bass)
Strong, 1983	3	State	OR	Revealed Preference, Zonal TCM	$31.29 to $45.93	Freshwater (steelhead)
				Stated Preference, open-ended	$15.65 to 21.40	Freshwater
Agnello and Anderson, 1984	3	National	USA	Revealed Preference, Individual TCM	$9.19 $31.44 $9.14	Saltwater (bluefish) Saltwater (flounder) Saltwater (weakfish)
Dutta, 1984	24	Single-site	OH	Revealed Preference, Individual TCM	$5.15 to $46.78	Freshwater (walleye, white bass, yellow perch)
Green, 1984	4	State	FL	Revealed Preference, Individual TCM	$41.89 to $258.13	Saltwater (snapper)
Miller and Hay, 1984	5	Multi-county	ID, MN, AZ, ME, TN	Revealed Preference, Individual TCM	$31.65 to $87.64	Freshwater

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Donnelly, et al., 1985	4	State	ID	Revealed Preference, Zonal TCM	$21.20 to $29.71	Freshwater (steelhead)
				Stated Preference, iterative bidding	$39.76 to $42.18	Freshwater (steelhead)
Hsiao, 1985	6	Multi-site	OR	Revealed Preference, Zonal TCM	$28.20 to $287.33	Freshwater (salmon)
King and Hof, 1985	1	Single-site	AZ	Revealed Preference, Zonal TCM	$62.64	Freshwater (trout)
Mullen and Menz, 1985	3	Single-site	NY	Revealed Preference, Zonal TCM	$44.67 to $79.08	Freshwater (bass, trout)
Richards, Wood, and Caylor, 1985	2	Single-site	AZ	Revealed Preference, Zonal TCM	$75.39 to $105.60	Freshwater (brook and rainbow trout)
Roberts, Thompson, and Pawlyk, 1985	1	Single-site	LA	Stated Preference, iterative bidding	$61.61	Saltwater
Rowe, et al., 1985	3	State	CA, OR, WA	Revealed Preference, RUM	$106.16 to $133.57	Saltwater
Sample and Bishop, 1985	11	Sub-site	WI	Revealed Preference, Zonal TCM	$0.71 to $41.63	Freshwater (trout, salmon)
Violette, 1985	21	Single-site	NY	Revealed Preference, Individual TCM	$34.75 to $79.16	Freshwater
Arndorfer and Bockstael, 1986	1	Single-site	FL	Revealed Preference, Individual TCM	$990.22	Saltwater (king mackerel)
Brown and Shalloof, 1986	8	State	OR, WA	Revealed Preference, Zonal TCM	$21.24 to $56.96	Freshwater (salmon)
					$57.92	Freshwater (Steelhead)
Huang, 1986	44	Single-site	MN	Revealed Preference, Individual TCM	$4.51 to $55.01	Freshwater
Kealy and Bishop, 1986	3	Single-site	MI	Revealed Preference, Zonal TCM	$60.12 to $226.20	Freshwater

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Sorg and Loomis, 1986	6	State	ID	Revealed Preference, Zonal TCM	$29.71 to $54.80	Freshwater
				Stated Preference, iterative bidding	$24.99 to $42.18	Freshwater
Wegge, Hanemann, and Strand, 1986	18	Multi-site	CA	Revealed Preference, Individual TCM	$44.31 to $533.72	Saltwater (Pacific mackerel, rockfish, kelp bass)
				Stated Preference, iterative bidding	$24.65 to $108.76	Saltwater (Pacific mackerel, rockfish, kelp bass)
Bishop et al., 1987	2	Single-site	AZ	Stated Preference, dichotomous choice	$57.03 to $71.28	Freshwater (trout)
Brown and Hay, 1987	46	State	AL to WY	Stated Preference, open-ended	$17.04 to $68.17	Freshwater (trout)
Cameron and James, 1987	1	State	BC	Stated Preference, dichotomous choice	$94.28	Freshwater (chinook and coho salmon)
Duffield, Loomis, and Brooks, 1987	4	State	MT	Revealed Preference, Zonal TCM	$60.55 to 184.23	Freshwater (trout)
Johnson and Walsh, 1987	1	Single-site	CO	Stated Preference, iterative bidding	$34.36	Freshwater (salmon, trout)
Oster et al., 1987	2	Single-site	WY	Revealed Preference, Zonal TCM	$16.15 to $19.53	Freshwater (lake trout)
Talhelm, Hanna, and Victor, 1987	1	Multi-site	ON	Revealed Preference, Zonal TCM	$49.17[a]	Freshwater(lake trout)
Abdullah, 1988	2	Multi-site	OR	Revealed Preference, Zonal TCM	$44.36 to $66.80	Freshwater (salmon)
Duffield and Allen, 1988	2	Multi-site	MT	Stated preference, dichotomous choice	$147.30	Freshwater (trout)
				Stated preference, open-ended	$46.23	Freshwater (trout)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Hay, 1988	48	State	AL to WY	Stated Preference, open-ended	$13.05 to $44.74	Freshwater (bass)
Hushak, Winslow, and Dutta, 1988	9	Single-site	OH	Revealed Preference, Zonal TCM	$5.47 to $11.48	Freshwater (walleye)
					$5.16 to $8.72	Freshwater (yellow perch)
					$0.48 to $1.21	Freshwater (walleye, yellow perch, white bass)
Milon, 1988	4	Single-site	FL	Revealed Preference, Individual TCM	$3.36 to $38.05	Saltwater
Smith and Palmquist, 1988	2	Multi-site	NC	Revealed preference, zonal TCM	$85.86 to $269.55	Saltwater (Croaker, weakfish, spot)
Boyle, 1989	3	Multi-site	WI	Stated Preference, open-ended	$17.25 to $20.11	Freshwater (brown trout)
Bowes and Krutilla, 1989	1	Ecoregional/ multi-state	NH, ME	Revealed Preference, Zonal TCM	$10.60	Freshwater
Hanemann, Wegge, and Strand, 1989	2	State	CA	Revealed Preference, Individual TCM	$5.80 to $105.51	Saltwater
Huppert, 1989	3	Single-site	CA	Revealed Preference, Individual TCM	$111.65 to $541.77	Freshwater (chinook salmon, striped bass)
Platt, 1989	1	Sub-site	FL	Revealed Preference, Individual TCM	$95.33	Saltwater (grouper)
Bockstael et al., 1990	4	State	MD	Revealed Preference, Individual TCM	$12.49 to $139.40	Freshwater (striped bass)
Cooper and Loomis, 1990	5	Single-site	CA	Revealed Preference, Zonal TCM	$42.64 to $52.90	Freshwater
Duffield et al., 1990	8	Multi-state	MT	Stated Preference, dichotomous choice	$64.55 to $312.71	Freshwater

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
McCollum, et al., 1990	10	Ecoregional/ multi-state	US States	Revealed Preference, Zonal TCM	$13.67 to $44.07	Freshwater
Bergstrom and Cordell, 1991	4	National	USA	Revealed Preference, Zonal TCM	$22.13 to $41.62 $46.79	Freshwater Saltwater
Boyle et al., 1991	2	Single-site	ME	Stated Preference, open-ended	$13.95 to $14.44	Freshwater (Salmon, bass, trout, shad, smelt)
Boyle, et al., , 1991	11	State	ME	Stated Preference, open-ended	$22.37 to $57.71 $3.90 $6.20 to $7.34 $2.41 to$3.44 $3.90 to $4.93	Freshwater Freshwater (bass) Saltwater (bluefish) Saltwater (mackerel) Saltwater (cod, flounder, pollock)
Brooks, 1991	2	State	MT	Stated Preference, dichotomous choice	$127.48	Freshwater
Connelly and Brown, 1991	1	State	NY	Stated Preference, open-ended	$23.20	Freshwater (trout)
Jones and Stokes Associates, Inc., 1991	16	Single-site	AK	Revealed Preference, RUM	$55.96 to $328.96	Both (salmon, steelhead, trout, halibut, rockfish)
Duffield, Neher, and Brown, 1992	6	Single-site	MT	Stated Preference, dichotomous choice	$79.02 to $420.57	Freshwater (trout)
Adler, 1993	2	Single-site	WY	Revealed Preference, Individual TCM	$10.57 to $10.81	Freshwater (trout)
Agnello and Han, 1993	3	Multi-site	NY	Revealed Preference, Individual TCM	$35.14 to $42.92	Saltwater
Choi, 1993	9	Single-site	OK	Revealed Preference, Individual TCM	$44.09 to $117.05	Freshwater (trout)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Englin and Cameron, 1993	11	State	NV	Combined RP and SP	$92.46 to $458.29	Freshwater
Harpman, Sparling, and Waddle, 1993	1	Single-site	CO	Stated Preference, dichotomous choice	$47.00	Freshwater (trout)
Lyke, 1993	3	Multi-site	WI	Revealed Preference, Zonal TCM	$61.91	Freshwater (trout, salmon)
				Stated preference, dichotomous choice	$39.22 to $49.04	Freshwater (trout, salmon)
Morey, Rowe and Watson, 1993	1	Multi-site	ME	Revealed Preference, RUM	$42.46	Freshwater (salmon)
Shafer, et al., 1993	2	Single-site	PA	Revealed Preference, Individual TCM	$27.30 to $ 75.46	Freshwater (trout)
Taccogna, 1993	2	Single-site	BC	Revealed Preference, Zonal TCM	$0.77 to $2.82	Freshwater
Whitehead, 1993	1	National	NC	Revealed Preference, Individual TCM	$20.62	Freshwater
Adamowicz, Louviere, and Williams, 1994	3	Single-site	AB	Stated Preference, stated choice	$8.75	Freshwater (mountain whitefish, rainbow and brown trout)
				Revealed Preference, RUM	$2.14	Freshwater (mountain whitefish, rainbow and brown trout)
				Combined RP and SP	$2.15	Freshwater (mountain whitefish, rainbow and brown trout)
Green, Moss, and Thunberg, 1994	1	Ecoregional/ multi-state	FL, AL, LA, MS, TX	Revealed Preference, Individual TCM	$994.93	Saltwater (grouper and snapper)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
McConnell et al., 1994	2	Ecoregional/ multi-state	NY, NJ, DE, MD, VA, NC, SC, GA, FL	Stated Preference, dichotomous choice	$65.40 to 132.99	Saltwater
Waddington, Boyle and Cooper, 1994	44	State	AL to WI	Stated Preference, dichotomous choice	$7.36 to $69.22 $194.41 to $22.09	Freshwater (bass) Freshwater (trout)
Wilemon, Riechers, and Ditton, 1994	2	Single-site	TX	Revealed preference, zonal TCM	$113.55 to $126.83	Saltwater
Englin and Lambert, 1995	6	Ecoregional/ multi-state	NY, NH, VT, ME	Revealed Preference, Individual TCM	$46.00 to $57.92	Freshwater (rainbow, brown, and brook trout)
Englin and Shonkwiler, 1995	3	Single-site	NY, VT	Revealed Preference, Individual TCM	$18.12 to $35.06	Freshwater
Hausman, Leonard, and McFadden, 1995	2	Multi-site	AK	Revealed Preference, RUM	$85.18 to $105.94	Saltwater
Siderelis, Brothers, and Rea, 1995	1	Multi-site	NC	Revealed Preference, RUM	$7.74	Freshwater
Shonkwiler, 1995	3	Single-site	NV	Revealed Preference, Individual TCM	$16.31 to $25.53	Freshwater
Hunt and Ditton, 1996	4	Single-site	TX	Stated preference, open-ended	$39.71 to $51.05	Freshwater (largemouth bass, crappie, catfish)
Layman, Boyce and Criddle, 1996	16	Single-site	AK	Combined RP and SP	$20.73 to $84.40	Freshwater (Chinook salmon)
Englin, Lambert, and Shaw, 1997	1	Ecoregional/ multi-state	NY, NH, VT, ME	Revealed Preference, RUM	$28.22	Freshwater
Greene, Moss, and Spreen, 1997	2	Multi-site	FL	Revealed Preference, RUM	$4.53 to $9.87	Saltwater (Snook, redfish, trout, and grouper)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Leeworthy and Bowker, 1997	2	County	FL	Revealed Preference, Individual TCM	$98.45 to $127.13	Saltwater
Wellman and Noble, 1997	1	Single-site	TX	Revealed Preference, Individual TCM	$474.77	Saltwater
Bhat et al., 1998	2	Ecoregional/ multi-state	CO,WY, MD,WV	Revealed Preference, Individual TCM	$29.98 to $36.75	Freshwater
Boyle, Roach, and Waddington, 1998	18	Ecoregional/ multi-state	US States	Stated Preference, dichotomous choice	$2.56 to $48.58	Freshwater (trout)
					$3.84 to $30.68	Freshwater (bass)
					$12.79 to $134.24	Freshwater (bass and trout)
Ditton and Sutton, 1998	2	Single-site	TX	Stated preference, dichotomous choice	$0.90 to $0.95	Freshwater (black bass)
Ditton,Bohnsack, and Stoll	3		NC	Stated preference, open-ended	$139.57 to $285.26	Saltwater (blue fin tuna)
Douglas and Taylor, 1998	5	Single-site	CA	Revealed Preference, Individual TCM	$10.78 to $12.66	Freshwater (salmon, steelhead)
				Stated Preference, open-ended	$1.74	Freshwater (salmon, steelhead)
Piper, 1998	1	Multi-site	ND	Revealed Preference, Individual TCM	$41.55	Freshwater
Henderson, Criddle, and Lee, 1999	2	Single-site	AK	Revealed Preference, Zonal TCM	$26.20 to $29.26	Freshwater (Chinook, sockeye, and coho salmon)
Hushak, Kelch, and Glenn, 1999	4	County	OH	Revealed Preference, Individual TCM	$13.08 to $22.59	Freshwater (Yellow perch, walleye)
Breffle and Morey, 2000	5	Single-site	ME	Revealed Preference, RUM	$32.42 to $149.61	Freshwater (Atlantic salmon)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, 2000	11	State	NF to YT	Stated preference, payment card	$5.16 to $11.44	Freshwater
Nowell and Kerkvliet, 2000	1	Single-site	ID	Revealed Preference, Individual TCM	$203.68	Freshwater (trout)
Whitehead and Aiken, 2000	6	State	USA	Stated preference, dichotomous choice	$31.40 to $40.02	Freshwater (bass)
		Ecoregional/ multi-state	USA		$15.53 to $17.41	
Whitehead and Haab, 2000	8	Multi-county	AL, FL, GA, lA, MS, NC, SC	Revealed Preference, RUM	$0.22 to $9.65	Saltwater
Duffield et al., 2001	5	Multi-site	AK	Stated preference, dichotomous choice	$126.74 to $484.23	Freshwater (arctic grayling)
	5	Single-site			$44.50 to $90.43	Freshwater (rainbow trout)
		Single-site			$61.44	Freshwater (northern pike)
	5	Multi-site			$85.34 to $622.25	Freshwater (salmon)
Johns et al., 2001	2	Multi-county	FL	Stated Preference, dichotomous choice	$3.46 to $9.89	Saltwater
Thomas and Stratis, 2001	6	Single-site	FL	Stated preference	$1.37 to $14.71 $13.98 to $82.52	Freshwater Saltwater
Upneja et al., 2001	1	State	PA	Revealed Preference, Individual TCM	$149.57	Freshwater (trout)
Woodward et al., 2001	1	Ecoregional/ multi-state	FL, AL, LA, MS, TX	Revealed Preference, Individual TCM	$167.90	Saltwater (red snapper)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Johnston et al., 2002	1	County	NY	Revealed Preference, Individual TCM	$52.98	Saltwater
Morey et al., 2002	2	Multi-site	MT	Revealed Preference, RUM	$9.02 to $20.26	Freshwater (trout)
Aiken and la Rouche, 2003	74	State	AL to VA	Stated Preference, open-ended	$22.65 to $244.66	Freshwater (bass)
			AK to WY		$32.85 to $208.42	Freshwater (trout)
			MI to WI		$29.45 to $91.75	Freshwater (walleye)
Gillig et al., 2003	3	Ecoregional/ multi-state	FL, AL, LA, MS, TX	Revealed Preference, Individual TCM	$14.51	Saltwater (red snapper)
				Stated preference, open-ended	$5.71	
				Combined RP and SP	$21.36	
Harding, Thomas, and Stratis, 2003	1	Single-site	FL	Revealed Preference, Individual TCM	$100.58	Freshwater
Williams and Bettoli, 2003	16	Single-site	TN	Revealed preference, zonal TCM	$8.56 to $20.85	Freshwater (trout)
				Stated preference, dichotomous choice	$49.24 to $106.81	
Bergstrom, Dorfman, and Loomis, 2004	3	State	LA	Combined RP and SP	$37.00 to $71.09	Freshwater (redfish and speckled trout)
Bennett, Provencher, and Bishop, 2004	4	Multi-site	WI	Combined RP and SP	$110.34 to $719.07	Freshwater (Steelhead, chinook or coho salmon, brown trout)
Bowker, Bergstrom and Gill, 2004	2	Single-site	VA	Revealed Preference, Individual TCM	$12.79 to $27.52	Freshwater

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Cantrell et al., 2004	1	State	HI	Stated preference, open-ended	$9.57	Saltwater (pacific threadfin)
Schuhmann and Schwabe, 2004	2	Single-site	NC	Revealed Preference, RUM	$22.37 to $26.19	Freshwater (bass)
Chizinski et al., 2005	4	Single-site	TX	Revealed Preference, Individual TCM	$69.09 to $138.19	Freshwater (channel catfish, largemouth bass, spotted bass, striped bass, white bass, white crappies)
Loomis, 2005	32	Single-site	ID	Revealed Preference, Individual TCM	$15.79 to $91.54	Freshwater (trout)
				Stated Preference, dichotomous choice	$38.30 to $111.40	Freshwater (trout)
			WY	Revealed Preference, Individual TCM	$47.45 to $132.09	Freshwater (trout)
				Stated Preference, dichotomous choice	$57.25 to $158.54	Freshwater (trout)
				Revealed Preference, RUM	$132.99	Saltwater
Oh et al., 2005	1	Single-site	TX	Revealed Preference, Individual TCM	$242.27	Freshwater (largemouth bass, crappie, catfish)
Rosenberger, Collins, and Svetlik, 2005	1	Single-site	WV	Stated preference, payment card	$5.13	Freshwater (trout)
Haab, Hicks, and Whitehead, 2006	4	State	WA, OR CA	Revealed Preference, RUM	$27.56 to $65.06 $98.91 to $241.16	Saltwater
Loomis, 2006	6	Single-site	WY	Stated preference, dichotomous choice	$9.35 to $20.46	Freshwater (trout)
				Revealed Preference, Individual TCM	$8.66 to $139.88	Freshwater (trout)

Author and year	Number of observations	Aggregation level	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	Fishing type (Species)
Stoll and Ditton, 2006	6	Single-site	NC	Stated preference, open-ended	$207.37 to $388.40	Saltwater (Atlantic blue fin tuna)
Williams and Bowman, 2006	7	Single-site	AR	Stated preference, iterative bidding	$22.93 to $39.01	Freshwater (trout)

Note: [a] Converted from Canadian dollar to US Dollar.

APPENDIX C: BIBLIOGRAPHY OF RECREATIONAL FISHING VALUATION STUDIES, 1969 TO 2006

Abdullah, N.M. 1988. "Estimation of average and incremental economic values of Oregon ocean sport-caught salmon: An aggregated travel cost approach." PhD dissertation, Oregon State University.

Adamowicz, W.L., and W.E. Phillips. 1983. "A comparison of extra market benefit evaluation techniques." *Canadian Journal of Agricultural Economics* 31:401-412.

Adamowicz, W. L., J. Louviere, and M. Williams. "Combining revealed and stated preference methods for valuing environmental amenities." *Journal of Environmental Economics and Management* 26(1994): 271-292.

Adler, L. L. "Measuring the value of recreation: The impacts of substitute sites." PhD dissertation, University of Wyoming, 1993.

Agnello, R.J., and L.G. Anderson (1984) The value of fish and fishing days: A partial solution to managing recreational fisheries with stock externalities, Working paper. University of Delaware.

Agnello, R. J., and Y. Han. "Substitute Site Measures in a Varying Parameter Model with Application to Recreational Fishing." *Marine Resource Economics* 8(1993): 65-77.

Aiken, R., and G. P. la Rouche (2003) Net Economic Values for Wildlife-Related Recreation in 2001: Addendum to the 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation, Report 2001-3. Washington, DC: US Fish and Wildlife Service.

Arndorfer, D.J., and N. Bockstael (1986) Estimating the effects of King Mackerel bag limits on charter boat captains and anglers, Miami, FL: National Marine Fisheries Service.

Beardsley, W. (1970) Economic value of recreation benefits determined by three methods, Research Note Rm-176. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Bell, F.W., P.E. Sorensen, and V.R. Leeworthy (1982) The economic impact and valuation of saltwater recreational fisheries in Florida, Florida Sea Grant College Program, Florida State University, Tallahassee, FL, Sea Grant Report ID FLSGP-T-82-005.

Bennett, M., B. Provencher, and R. Bishop (2004) Experience, expectations and hindsight: Evidence of a cognitive wedge in stated preference retrospectives, Staff Paper No. 468. Madison, WI: Department of Agricultural and Applied Economics, University of Wisconsin-Madison.

Bergstrom, J.C., and H.K. Cordell. 1991. "An analysis of the demand for and value of outdoor recreation in the United States." *Journal of Leisure Research* 23(1):67-86.

Bergstrom, J. C., J. H. Dorfman, and J. B. Loomis. "Estuary management and recreational fishing benefits." *Coastal Management* 32(2004): 417-432.

Bhat, G., et al. "An ecoregional approach to the economic valuation of land- and water-based recreation in the United States." *Environmental Management* 22, no. 1(1998): 69-77.

Bishop, R.C., K.J. Boyle, M.P. Welsh, R.M. Baumgartner, and P.R. Rathbun (1986) Glen Canyon Dam releases and downstream recreation: An analysis of user preferences and economic values, Final Report to the Recreation Subteam of the Glen Canyon Environmental Studies. Madison, WI: HBRS.

Bockstael, N.E., I.E. Strand Jr., K.E. McConnel, and F. Arsanjani. 1990. "Sample Selection Bias in the Estimation of recreation Demand Functions: An Application to Sportfishing." *Land Economics* 66(1):40-49.

Bowker, J. M., J. C. Bergstrom, and J. Gill (2004) The Waterway at New River State Park, Final Report Prepared for the Virginia Department of Conservation. Athens, GA: USDA Forest Service, Southern Research Station and the University of Georgia.

Boyle, K.J., M.F. Tiesl, J. Moring, and S.D. Reiling (1991) Economic benefits accruing to sport fisheries on the lower Kennebec River from the provision of fish passage at Edwards Dam, Staff paper. Orono, ME: Department of Agricultural and Resource Economics, University of Maine.

Boyle, K.J., S.D. Reiling, M. Teisl, and M.L. Phillips (1991) A study of the impact of game and nongame species on Maine's economy, Staff Paper No. 423. Orono, ME: Department of Agricultural and Resource Economics, University of Maine.

Boyle, K. J., B. Roach, and D. G. Waddington (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., Report 96-2. Washington, DC: US Fish and Wildlife Service.

Bowes, M.D., and J.V. Krutilla (1989) Recreation valuation for forest planning. In M.D. Bowes, and J.V. Krutilla (Ed.) Multiple use management: The economics of public forest lands. Washington, DC, Resources for the Future, pp. 213-247.

Boyle, K.J. 1989. "Commodity specification and the framing of contingent valuation questions." *Land Economics* 65(1):57-63.

Breffle, W. S., and E. R. Morey. "Investigating preference heterogeneity in a repeated discrete-choice recreation demand model of Atlantic salmon fishing." *Marine Resource Economics* 15(2000): 1-20.

Brooks, R. (1991) Warm water fishing in Montana: A contingent valuation assessment of angler attitudes and economic benefits for selected waters statewide, Helena, MT: Montana Department of Fish, Wildlife and Parks.

Brown, G. M., and M. Plummer (1978) Recreation valuation: An economic analysis of nontimber uses of forestland in the Pacific Northwest, Pullman, WA: Forest Policy Project, Washington State University.

Brown, W.G., and F.M. Shalloof (1986) Recommended values for Columbia River salmon and steelhead for current fishery management decisions, Final report. Corvallis, OR: Department of Agricultural and Resource Economics, Oregon State University.

Brown, G., and M.J. Hay (1987) Net economic recreation values for deer and waterfowl hunting and trout fishing, 1980, Working Paper No. 23. Washington, DC: US Fish and Wildlife Service.

Cameron, T.A., and M.D. James. 1987. "Efficient estimation methods for "closed-ended" contingent valuation surveys." *Review of Economics and Statistics* 69(2):269-276.

Cantrell, R. N., et al. "Recreational anglers' willingness to pay for increased catch rates of Pacific threadfin (*Polydactylus sexfilis*) in Hawaii." *Fisheries Research* 68(2004): 149-158.

Charbonneau, J. J., and M. J. Hay. "Determinants and economic values of hunting and fishing." *Transactions of the North American Wildlife and Natural Resources Conference* 43(1978): 391-403.

Chizinski, C. J., et al. "Economic value of angling at a reservoir with low visitation." *North American Journal of Fisheries Management* 25(2005): 98-104.

Choi, S. "Economic analysis of the Mountain Fork trout fishery in southeastern Oklahoma using travel cost method." PhD dissertation, Oklahoma State University., 1993.

Connelly, N. A., and T. L. Brown. "Net economic value of the freshwater recreational fisheries in New York." *Transactions of the American Fisheries Society* 120(1991): 770-775.

Cooper, J.C., and J.B. Loomis. 1990. "Pooled time-series cross-section travel cost models: Testing whether recreation behavior is stable over time." *Leisure Sciences* 12:161-171.

Daubert, J. T., and R. A. Young. "Recreational demands for maintaining instream flows: A contingent valuation approach." *American Journal of Agricultural Economics* 63, no. 4(1981): 666-676.

Ditton, R. B., and S. G. Sutton (1998) A Social and Economic Study of Fort Hood Anglers, Department of Wildlife and Fisheries Sciences, Texas A&M University.

Ditton, R. B., B. L. Bohnsack, and J. R. Stoll (1998) A Social and Economic Study of the Winter recreational Atlantic Bluefin Tuna Fishery in Hatteras, North Carolina, Report prepared for the American Sportfishing Association.

Donnelly, D.M., J.B. Loomis, C.F. Sorg, and L.J. Nelson (1985) Net economic value of recreational steelhead fishing in Idaho, Resource Bulletin RM-9. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Douglas, A. J., and J. G. Taylor. "Riverine based eco-tourism: Trinity River non-market benefits estimates." *International Journal of Sustainable Development and World Ecology* 5(1998): 136-148.

Duffield, J.W., J.B. Loomis, and R. Brooks (1987) The net economic value of fishing in Montana, Helena, MT: Montana Department of Fish, Wildlife and Parks.

Duffield, J.W., and S. Allen (1988) Angler preference study final economics report: Contingent valuation of Montana trout fishing by river and angler subgroup, Prepared for Montana Department of Fish, Wildlife and Parks. Missoula, MT: University of Montana.

Duffield, J.W., C. Neher, D. Patterson, and S. Allen (1990) Instream flows in the Missouri River basin: A recreational survey and economic study, Missoula, MT: Montana Department of Natural Resources and Conservation.

Duffield, J. W., C. J. Neher, and T. C. Brown. "Recreation benefits of instream flow: Application to Montana's Big Hole and Bitterroot Rivers." *Water Resources Research* 28, no. 9(1992): 2169-2181.

Duffield, J. W., C. Neher, and M. Merritt (2001) Alaska Angler Survey: Use and Valuation Estimates for 1996, with a focus on Arctic Grayling in Region III, Alaska Department of Fish and Game, Special Publication Number 01-05, Anchorage.

Duffield, J. W., C. Neher, and M. Merritt (2001) Alaska Angler Survey: Use and Valuation Estimates for 1995, with a focus on Tanana Valley Major Stocked Waters, Alaska Department of Fish and Game, Special Publication Number 01-4, Anchorage.

Duffield, J. W., C. Neher, and M. Merritt (2001) Alaska Angler Survey: Use and Valuation Estimates for 1997, with a focus on Salmon Fisheries in Region III, Alaska Department of Fish and Game, Special Publication Number 01-2, Anchorage.

Dutta, N. 1984. "The value of recreational boating and fishing in the central basin of Ohio's portion of Lake Erie." MS thesis, The Ohio State University.

Englin, J., and T. Cameron (1993) Comparing Observed and Multiple-Scenario Contingent Behavior: A Panel Analysis Utilizing Poisson Regression Techniques, W-133 Proceedings, pp. 266-281.

Englin, J., and D. Lambert. "Measuring angling quality in count data models of recreational fishing." *Environmental and Resource Economics* 6, no. 4(1995): 389-399.

Englin, J., and J. S. Shonkwiler. "Modeling recreation demand in the presence of unobservable travel costs: Toward a travel price model." *Journal of Environmental Economics and Management* 29(1995): 14-22.

Englin, J., D. Lambert, and W. D. Shaw. "A structural equations approach to modeling consumptive recreation demand." *Journal of Environmental Economics and Management* 33, no. 1(1997): 33-43.

Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians (2000) The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities, Ottawa, Ontario: Environment Canada.

Gillig, D., et al. "Joint estimation of revealed and stated preference data: an application to recreational red snapper valuation." *Agricultural and Resource Economics Review* 32 no. 1(2003): 209-221.

Green, T.G. 1984. "Compensating and equivalent variation of the Florida saltwater tourist fishery." PhD dissertation, Florida State University.

Green, G., C. B. Moss, and E. M. Thunberg (1994) Estimation of Recreational Anglers' Value of Reef Fish in the Gulf of Mexico, Food and Resource Economics Department, Institute of Food and Agricultural Sciences, University of Florida. SP94-12.

Greene, G., C. B. Moss, and T. H. Spreen. "Demand for Recreational in Tampa Bay, Florida: A Random Utility Approach." *Marine Resource Economics* 12(1997): 293-305.

Haab, T. C., R. L. Hicks, and J. C. Whitehead (2006) The Economic Value of Marine Recreational Fishing: Analysis of the MRFSS 1998 Pacific Add-on, Paper presented at the "Fisheries, Fisherman, and Fishing Communities: Socioeconomic perspectives on the West Coast, Alaska, and Hawaii," Symposium during the 2005 American Fisheries Society Annual Meeting in Anchorage, Alaska.

Hanemann, W.M., T.C. Wegge, and I.E. Strand (1989) Development and application of a predictive model to analyze the economic effects of species availability, Administrative Report SWR. Terminal Island, CA: National Marine Fisheries Service.

Hansen, C. (1977) A report on the value of wildlife: With 1979 Addendum, Miscellaneous Pub No.1365.

Harding, D., M. Thomas, and N. Stratis (2003) The Economics of Selected Florida Wildlife Management Areas, Final Report. Tallahassee, FL: Florida Fish and Wildlife Commission.

Harpman, D. A., E. W. Sparling, and T. J. Waddle. "A methodology for quantifying and valuing the impacts of flow changes on a fishery." *Water Resources Research* 29, no. 3(1993): 575-582.

Harris, C.C. 1983. "Assessing the validity of economic methods for evaluating sport fishery benefits: A behavioral approach." PhD dissertation, University of Michigan.

Hausman, J. A., G. K. Leonard, and D. McFadden. "A utility-consistent, combined discrete choice and count data model: Assessing recreational use losses due to natural resource damage." *Journal of Public Economics* 56, no. 1(1995): 1-30.

Hay, M.J. 1988. *Net economic value for deer, elk and waterfowl hunting and bass fishing, 1985:* Report 85-1. Washington, DC: USDI Fish and Wildlife Service.

Henderson, M. M., K. R. Criddle, and S. T. Lee. "The economic value of Alaska's Copper River personal use and subsistence fisheries." *Alaska Fishery Research Bulletin* 6, no. 2(1999): 63-69.

Hsiao, C. 1985. "An evaluation of alternative estimates of demand for and benefits from Oregon salmon sport fishing." PhD dissertation Oregon State University.

Huang, C. 1986. "The recreation benefits of water quality improvement in selected lakes in Minnesota." PhD dissertation, University of Minnesota.

Hunt, K. M., and R. B. Ditton (1996) A Social and Economic Study of the Lake Fork Reservoir Recreational Fishery, Report prepared for the Texas Parks and Wildlife Department and the Sabine River Authority of Texas. HD-608.

Huppert, D. 1989. "Measuring the Value of Fish to Anglers: Application to Central California Anadromous Species." *Marine Resource Economics* 6:89-107.

Hushak, L.J., J.M. Winslow, and N. Dutta. 1988. "Economic value of Great Lakes sportfishing: The case of private-boat fishing in Ohio's Lake Erie." *Transactions of the American Fisheries Society* 117:363-373.

Hushak, L. J., D. O. Kelch, and S. J. Glenn. "The economic value of the Lorain County, Ohio, artificial reef." *American Fisheries Society Symposium* 22(1999): 348-362.

Johns, G. M., et al. (2001) Socioeconomic study of reefs in Southeast Florida, Final Report, October 19, 2001. Hollywood, FL: Hazen and Sawyer, P.C.

Johnson, D.M., and R.G. Walsh (1987) Economic benefits and costs of the fish stocking program at Blue Mesa Reservoir, Colorado, Technical Report No. 49. Fort Collins, CO: Colorado Water Resources Research Institute, Colorado State University.

Johnston, R. J., et al. "Valuing estuarine resource services using economic and ecological models: The Peconic Estuary System Study." *Coastal Management* 30(2002): 47-65.

Jones and Stokes Associates, Inc. (1991) Southeast Alaska sport fishing economic study, Final Research Report. December, 1991. (JSA 88-028). Prepared for Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Kalter, R. J., and L. E. Gosse (1969) Outdoor recreation in New York State: Projections of demand, economic value, and pricing effects for the period 1970-1985, Special Cornell Series No. 5. Ithaca, NY: Cornell University.

Kealy, M.J. 1982. "Travel cost estimates of recreation demand: Theoretical, empirical and policy issues." PhD dissertation Madison, WI: University of Wisconsin.

Kealy, M.J., and R.C. Bishop. 1986. "Theoretical and empirical specifications issues in travel cost studies." *American Journal of Agricultural Economics* 68(3):660-667.

King, D. A., and A. W. Walka (1980) A market analysis of trout fishing on Fort Apache Indian Reservation, Final Report. Tucson, AZ: School of Renewable Natural Resources, University of Arizona.

King, D.A., and J.G. Hof. 1985. "Experiential commodity definition in recreation travel cost models." *Forest Science* 31(2):519-529.

Layman, R. C., J. R. Boyce, and K. R. Criddle. "Economic valuation of the Chinook salmon sport fishery of the Gulkana River, Alaska." *Land Economics* 72, no. 1(1996): 113-128.

Leeworthy, V. R., and J. M. Bowker (1997) Linking the Economy and Environment of Florida Keys/Florida Bay: Nonmarket Economic User Values of the Florida Keys/Key West, Monroe County Tourist Development Council.

Loomis, J. B. (2005) The economic values of recreatinoal fishing and boating to visitors and communities along the upper Snake River, Final Report. Fort Collins, CO: Colorado State University.

Loomis, J. B. "A comparison of the effect of multiple destination trips on recreation benefits as estimated by travel cost and contingent valuation methods." *Journal of Leisure Research* 38, no. 1(2006): 46-60.

Lyke, A. J. "Discrete choice models to value changes in environmental quality: A Great Lakes case study." PhD dissertation, University of Wisconsin-Madison, 1993.

Martin, W. E., R. Gum, and A. Smith (1974) The demand for and value of hunting, fishing, and general outdoor recreation in Arizona, Technical Bulletin 211. Tucson, AZ: Agricultural Experiment Station, University of Arizona.

Martin, W.E., F.H. Bollman, and R.L. Gum. 1982. "Economic Value of Lake Mead Fishery." *Fisheries* 7(6):20-24.

McCollum, D.W., G.L. Peterson, J.R. Arnold, D.C. Markstrom, and D.M. Hellerstein (1990) The net economic value of recreation on the National Forests: Twelve types of primary activity trips across nine Forest Service Regions, Research Paper RM-289. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

McConnell, K. E. "Values of marine recreational fishing: Measurement and impact of management." *American Journal of Agricultural Economics* 61(1979): 921-925.

McConnell, K. E., et al. (1994) The economic value of mid and south Atlantic sportfishing, Report between the University of Maryland, the US Environmental Protection Agency, the National Marine Fisheries Service, and the National Oceanic and Atmospheric Administration. Cooperative agreement no. CR-811043-01-0. College Park, MD: University of Maryland.

Menz, F.C., and D.P. Wilton. 1983. "Alternative ways to measure recreation values by the travel cost method." *American Journal of Agricultural Economics* 65:332-336.

Menz, F.C., and D.P. Wilton. 1983. "An economic study of the muskellunge fishery in New York." *New York Fish and Game Journal 30(1):12-2* 30(1):12-29.

Michalson, E. L. (1977) An attempt to quantify the esthetics of wild and scenic rivers in Idaho, General Technical Report NC-28. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station. pp.320-328.

Miller, J.R. (1983) On estimating the value of freshwater fishing in substate regions, Working paper #18. Washington, DC: US Fish and Wildlife Service.

Miller, J.R., and M.J. Hay. 1984. "Estimating substate values of fishing and hunting." *Transactions of the North American Wildlife and Natural Resources Conference* 49:345-355.

Milon, J.W. 1988. "Travel cost methods for estimating the recreational use benefits of artificial marine habitat." *Southern Journal of Agricultural Economics* 20(1):87-101.

Morey, E. R., R. D. Rowe, and M. Watson. "A repeated nested-logit model of Atlantic salmon fishing." *American Journal of Agricultural Economics* 75, no. 3(1993): 578-592.

Morey, E. R., et al. "Estimating recreational trout fishing damages in Montana's Clark Fork River basin: Summary of a natural resource damage assessment." *Journal of Environmental Management* 66(2002): 159-170.

Mullen, J.K., and F.C. Menz. 1985. "The Effect of Acidification Damages on the Economic Value of the Adirondack Fishery to New York Anglers." *American Journal of Agricultural Economics* 67(1):112-119.

Nowell, C., and J. Kerkvliet. "The economic value of the Henry's Fork fishery." *Intermountain Journal of Sciences* 6, no. 3(2000): 285-292.

Oh, C., et al. "Understanding differences in nonmarket valuation by angler specialization level." *Leisure Sciences* 27(2005): 263-277.

Oster, J.M., D.T. Taylor, J.J. Jacobs, and E.B. Bradley (1987) Reservoir eutrophication and recreational activity on Flaming Gorge Reservoir, Experiment Station Bulletin No. 908. Laramie, WY: University of Wyoming.

Palm, R.C., and S.P. Malvestuto. 1983. "Relationships between economic benefit and sport-fishing effort on West Point Reservoir, Alabama-Georgia." *Transactions of the American Fisheries Society* 112:71-78.

Piper, S. "Modeling recreation decisions and estimating the benefits of North Dakota river recreation." *Rivers* 6, no. 4(1998): 251-258.

Platt, J.L. (1989) Estimating the Economic Impacts of Hypothetical Grouper Bag Limits in the Destin/panama City, Florida Charterboat Fishery, NOAA Technical Memorandum NMFS-SEFC-227.

Richards, M.T., D.B. Wood, and D.A. Caylor (1985) Sportfishing at Lees Ferry, Arizona: User differences and economic values, Final Report to Northern Arizona University Organized Research Committee. Flagstaff, AZ: Northern Arizona University.

Roberts, K.J., M.E. Thompson , and P.W. Pawlyk. 1985. "Contingent valuation of recreational diving at petroleum rigs, Gulf of Mexico." *Transactions of the American Fisheries Society* 114:214-219.

Rosenberger, R. S., A. R. Collins, and J. B. Svetlik. "Private provision of a public good: Willingness to pay for privately stocked trout." *Society and Natural Resources* 18(2005): 75-87.

Rowe, R.D., E.R. Morey, A.D. Ross, and W.D. Shaw (1985) Valuing marine recreation fishing on the Pacific Coast, Boulder, CO: Energy and Resource Consultants, Inc.

Sample, K.C., and R.C. Bishop. 1985. "Estimating the value of variations in anglers' success rates: An application of the multiple-site travel cost method." *Marine Resource Economics* 2(1):55-74.

Shafer, E. L., et al. "Economic amenity values of wildlife: Six case studies in Pennsylvania." *Environmental Management* 17, no. 5(1993): 669-682.

Schuhmann, P. W., and K. A. Schwabe. "An analysis of congestion measures and heterogeneous angler preferences in a random utility model of recreational fishing." *Environmental and Resource Economics* 27(2004): 429-450.

Shonkwiler, J. S. (1995) Systems of travel cost models of recreation demand, In D. Larson (comp), Western Regional Research Publication, W-133 Benefits and Costs Transfer in Natural Resource Planning. Eighth Interim Report. Davis, CA: University of California, Davis.

Siderelis, C., G. Brothers, and P. Rea. "A boating choice model for the valuation of lake access." *Journal of Leisure Research* 27, no. 3(1995): 264-282.

Smith, V.K., and R.B. Palmquist (1988) The value of recreational fishing on the Albemarle and Pamlico Estuary, North Carolina State University and Environmental Protection Agency, EPA #88-13.

Sorg, C.F., and J.B. Loomis. 1986. "Economic value of Idaho sport fisheries with an update on valuation technique." *North American Journal of Fisheries Management* 6:494-503.

Snyder, B.R. 1983. "Specification errors and consumer surplus values for recreational striped bass fishing." MS Thesis, University of Maryland.

Steinnes, D. N., and R. L. Raab. "The economics of a 'happening': Spring smelt fishing on Lake Superior." *Regional Science Perspectives* 11, no. 1(1981): 32-41.

Stoll, J., and R. Ditton. "Understanding Anglers' Willingness to Pay Under Alternative Management Regimes." *Human Dimensions of Wildlife* 11, no. 1(2006): 27-42.

Strong, E.J. 1983. "A note on the functional form of travel cost models with zones of unequal populations." *Land Economics* 59(3):342-349.

Sublette, W., and W. Martin (1975) Outdoor recreation in the Salt-Verde Basin of central Arizona: Demand and value, Technical Bulletin 218. Tucson, AZ: Agricultural Experiment Station, University of Arizona.

Sutherland, R.J. (1982) Recreation and preservation valuation estimates for Flathead River and Lake system, Kalispell, MT: Flathead River Basin Commission.

Taccogna, G. S. "The economic value of recreation in the Seymour River corridor: A comparison of developed and protected river reaches using the travel cost method." MS thesis, Simon Fraser University, Canada, 1993.

Talhelm, D.R., J.E. Hanna, and P. Victor. 1987. "Product travel cost approach: Estimating acid rain damage to sport fishing in Ontario." *Transactions of the American Fisheries Society* 116:420-431.

Thomas, M. H., and N. Stratis (2001) Assessing the Economic Impact and Value of Florida's Public Piers and Boat Ramps, Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Upneja, A., et al. "Economic benefits of sport fishing and angler wildlife watching in Pennsylvania." *Journal of Travel Research* 40(2001): 68-78.

Vaughan, W.J., and C.S. Russel. 1982. "Valuing a fishing day: An application of a systematic varying parameter model." *Land Economics* 58(4):450-463.

Violette, D.M. (1985) A model to estimate the economic impacts on recreational fishing in the Adirondacks from current levels of acidification, Proceedings of the AERE Workshop on Recreation Demand Modeling, May 17-18, 1985. Boulder, CO: Energy and Resource Consultants, Inc.

Waddington, D. G., K. J. Boyle, and J. Cooper (1994) 1991 net economic values for bass and trout fishing, deer hunting, and wildlife watching, Washington, DC: US Fish and Wildlife Service.

Walsh, R. G., et al. (1980) An empirical application of a model for estimating the recreation value of instream flow, Fort Collins, CO: Colorado Water Resources Research Institute, Colorado State University.

Walsh, R.G., and J.P. Olienyk (1981) Recreation demand effects of mountain pine beetle damage to the quality of forest recreation resources in the Colorado Front Range, Final Report to USDA Forest Service. Fort Collins, CO: Department of Economics, Colorado State University.

Wegge, T.C., W.M. Hanemann, and I.E. Strand (1986) An economic assessment of marine recreational fishing in southern California, Sacramento, CA: Jones & Stokes Associates, Inc.

Weithman, A.S., and M.A. Haas. 1982. "Socioeconomic value of the trout fishery in Lake Taneycomo, Missouri." *Transactions of the American Fisheries Society* 111:223-230.

Wellman, K. F., and B. Noble (1997) Selected recreational values of the Corpus Christi Bay National Estuary Program study area, Publication CCBNEP-18. Corpus Christi, TX: Corpus Christi Bay National Estuary Program.

Whitehead, J. "Benefits of Quality Changes in Recreational Fishing: A Single-Site Travel Cost Approach." *Journal of Environmental Systems* 21(1993): 357-364.

Whitehead, J. C., and R. Aiken (2000) An analysis of trends in net economic values for bass fishing from the national survey of fishing, hunting and wildlife-associated recreation, East Carolina University, Department of Economics Working Paper.

Whitehead, J. C., and T. C. Haab. "Southeast marine recreational fishery statistical survey: distance and catch based choice sets." *Marine resource economics* 14, no. 4(2000): 283-298.

Wilemon, J. M., R. K. Riechers, and R. B. Ditton (1994) Estimating the Economic Value of the Recreational Boat Fishery in Galveston Bay, Texas, Proceedings of the 46th Gulf and Caribbean Fisheries Institute.

Williams, J. S., and P. W. Bettoli (2003) Net value of trout fishing opportunities in Tennessee Tailwaters, Fisheries Report 03-21. Final report submitted to the Tennessee Wildlife Resource Agency.

Williams, J., and D. Bowman (2006) Arkansas Trout Permit Holder Survey--2003, AGFC Trout Management Report, Report #TP-06-06. Little Rock, AR: Arkansas Game and Fish Commission.

Woodward, R. T., et al. "The Welfare Impacts of Unanticipated Trip Limitations in Travel Cost Models." *Land Economics* 77, no. 3(2001): 327-338.

Ziemer, R. F., W. N. Musser, and R. C. Hill. "Recreation Demand Equations: Functional Form and Consumer Surplus." *American Journal of Agricultural Economics* 62, no. 1(1980): 136.

APPENDIX D. SELECT CHARACTERISTICS OF THE ORIGINAL STUDY USED IN INTERNATIONAL BENEFIT TRANSFER[A].

Study	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	No. of observations	Recreation good valued	Study site
Trice and Wood, 1958	California	Revealed Preference, Zonal TCM	$14.67 to $15.41	3	General recreation	Feather River, Truckee River
Wennergren, 1965	Utah	Revealed Preference, Zonal TCM	$1.18 to $19.81	6	Motorboating	Hyrum Reservoir, Mantua Reservoir, Bear Lake,
Grubb and Goodwin, 1968	Texas	Revealed Preference, Zonal TCM	$2.24	1	General recreation	Various sites in Texas
Brown and Hansen, 1974	Texas	Revealed Preference, Zonal TCM	$12.35 to $15.03	2	General recreation	Fort Worth District, Sacramento District
Brown and Hansen, 1974	Texas	Revealed Preference, Zonal TCM	$21.15	1	General recreation	Reservoirs
Gibbs, 1974	Florida	Revealed Preference, Individual TCM	$32.12	1	General recreation	Kissimmee River Basin
Martin, Gum and Smith, 1974	Arizona	Revealed Preference, Zonal TCM	$ 13.04 to $71.75	7	General recreation	Region 1 to Region 7
Moncur, 1975	Hawaii	Revealed Preference, Zonal TCM	$1.77	1	General recreation	Keaiwa Heiau (Alea Hts.)
Sublette and Martin, 1975	Arizona	Revealed Preference, Individual TCM	$38.04	1	Camping	Luna Lake
			$57.78 to $64.35	2	Freshwater fishing	Black Canyon, Knoll Lake
Knetsch, Brown and Hansen, 1976	California	Revealed Preference, Zonal TCM	$2.29 to $20.24	14	General recreation	Isabella Reservoir, Pine Flat Reservoir, Success Reservoir, Lake Kaweah, New Hogan Reservoir, Black Butte Reservoir, Englebright Reservoir, Pine Flat Reservoir
Leuschner and Young, 1978	Texas	Revealed Preference, Zonal TCM	$6.36 to $13.67	6	Camping	Sam Rayburn COE, BA Steinhagen

Study	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	No. of observations	Recreation good valued	Study site
Bowes and Loomis, 1980	Utah	Revealed Preference, Zonal TCM	$ 19.74 to $25.66	2	Floating/rafting/ canoeing	Westwater Canyon
Haspel and Johnson, 1982	Arizona, Utah	Revealed Preference, Zonal TCM	$ 14.82 to $23.25	6	General recreation	Bryce Canyon National Park
Keith, Halverson and Farnworth, 1982	Arizona	Stated Preference, iterative bidding	$4.34 to $4.39	2	Floating/rafting/ canoeing	Salt River
		Revealed Preference, Individual TCM	$56.14	1		
Martin, Bollman, and Gum, 1982	Arizona, Nevada	Revealed Preference, Individual TCM	$42.67 to $63.70	2	Freshwater fishing	Lake Mead
Ward, 1982	New Mexico	Revealed Preference, Individual TCM	$7.87 to $65.56	8	Camping, motorboating, swimming	Lake Avalon, Bottomless Lakes State Park, Lake Carlsbad Recreation Area, Lake McMillan
Palm and Malvestuto, 1983	Alabama, Georgia	Revealed Preference, Zonal TCM	$15.09 to $74.49	4	Freshwater fishing	West Point Reservoir
Klemperer, et al., 1984	Georgia, South Carolina	Revealed Preference, Zonal TCM	$18.08 to $5.77	4	Floating/rafting/ canoeing	Section IV, Chattooga River
Stavins, 1984	California	Revealed Preference, Zonal TCM	$76.18 to $111.64	2	Floating/rafting/ canoeing	Tuolumne River
Sellar, Stoll and Chavas, 1985	Texas	Revealed Preference, Individual TCM	$20.32 to $50.20	4	Motorboating	Lake Conroe, Lake Livingston, Lake Somerville, Lake Houston,
		Stated Preferences, Open-ended	$10.79 to $12.88	3		
		Stated Preferences, Dichotomous choice	$17.31 to $32.96	3		
Bishop et al., 1987	Arizona	Stated Preferences, Dichotomous choice	$48.47 to $330.09	13	Floating/rafting/ canoeing	Colorado River
Ralston and Park, 1989	Tennessee	Revealed Preference, Zonal TCM	$60.67	1	General recreation	Reelfoot Lake

Study	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	No. of observations	Recreation good valued	Study site
Richards, et al., 1990	Arizona	Revealed Preference, Zonal TCM	$6.47 to $25.69	10	Camping	Coconino National Forest
		Stated Preferences, Open-ended	$1.80 to $11.12	10	Camping	
Hansen et al., 1990	Texas	Stated Preferences, Open-ended	$2.48	1	General recreation	Buffalo Bayou
McCollum et al., 1990	Arizona, New Mexico, California, Arkansas, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee	Revealed Preference, Zonal TCM	$4.26 to $24.94	6	Camping	Apache-Sitgreaves, Tonto, Santa Fe, Gila, Angeles, Los Padres, Sierra, Lake Tahoe Basin MU, Inyo, Klamath, Ozark-St Francis, NFS, Chattahoochee-Oconee, Francis Marion and Sumter, Cherokee
			$25.28 to $41.69	3	Hiking	
			$9.00 to $21.54	3	Picnicking	
			$10.41 to $29.55	3	Sightseeing	
			$15.79 to $19.62	2	Swimming	
			$7.92 to $13.45	3	General recreation	
Ralston, Park and Frampton, 1991	Tennessee	Stated Preferences, Open-ended	$4.30	1	General recreation	Reelfoot Lake
Cordell and Bergstrom, 1993	North Carolina, Georgia	Stated Preferences, Dichotomous choice	$6.28	1	Motorboating	Lake Chatague, Lake Fontana, Lake Hiwassee, Lake Santeetlah
Teasley, Bergstrom, and Cordell, 1994	Georgia, South Carolina	Stated Preferences, Dichotomous choice	$4.71 to $6.83	4	General recreation	Cherokee National Forest, George Washington Nat’l Forest
Williams, 1994	Utah	Revealed Preference, Individual TCM	$18.96 to $159.56	2	Motorboating	Bear River, Wasatch Front

Study	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	No. of observations	Recreation good valued	Study site
Loomis, et al., 1995	California, Arkansas, Tennessee	Revealed Preference, Zonal TCM	$5.47 to $21.71	6	General recreation	Reservoirs
Siderelis and Moore, 1995	California	Revealed Preference, Individual TCM	$5.13 to $17.82	6	Hiking	Lafayette/Moraga Trail
Siderelis, Brothers, and Rea, 1995	North Carolina	Revealed Preference, RUM	$7.74	1	Freshwater fishing	Catawba River Basin
			$10.45	1	Motorboating	
			$18.80	1	Waterskiing	
Shonkwiler, 1995	Nevada	Revealed Preference, Individual TCM	$16.31 to $25.53	3	Freshwater fishing	Topaz Lake, Walker Lake, Pyramid Lake
		Stated Preferences, Dichotomous choice	$4.86 to $27.16	2		Bear River
Bowker, English, and Donovan, 1996	Georgia, South Carolina, North Carolina	Revealed Preference, Individual TCM	$123.59 to $267.46	10	Floating/rafting/ canoeing	Chatooga River, Nantahala River
English and Bowker, 1996	Georgia, South Carolina	Revealed Preference, Zonal TCM	$10.28 to $26.29	6	Floating/rafting/ canoeing	Chatooga River
Bhat et al., 1998	Southeast States	Revealed Preference, Individual TCM	$19.45	1	Camping	Southeast Subtropical, South Florida
	Southwest States		$40.83	1	Motorboating	Desert Southwest
	SE and SW States		$114.54 to $156.12	3	Sightseeing	Ozark and Ouchita Mountains, SE Subtropical, South Florida, Desert SW
Fadali and Shaw, 1998	California, Nevada	Revealed Preference, RUM	$9.64	1	Motorboating	Walker Lake, Lahontan Reservoir, Topaz Reservoir, Pyramid Lake, Boca/Stampede Reservoir

Study	State(s)	Study Methodology (Elicitation method or RP type)	CS in 2006 $, per person per day	No. of observations	Recreation good valued	Study site
Siderelis, Moore and Lee, 2000	North Carolina	Revealed Preference, Individual TCM	$69.43	1	Hiking	NC
Zawacki and Marsinko, 2000	South Carolina	Revealed Preference, Individual TCM	$46.92 to $61.34	3	Picnicking	SC Parks
Hammer, 2001	Arizona	Revealed Preference, Zonal TCM	$10.70 to $25.10	2	Floating/rafting/ canoeing	Colorado River
Hesseln et al., 2003	New Mexico	Revealed Preference, Individual TCM	$147.52	1	Hiking	Trails on five national forests
Leggett et al., 2003	South Carolina	Stated preference, payment card	$9.62	1	Sightseeing	Fort Sumter National Monument
Mathews, Stewart and Kask, 2003	North Carolina	Revealed Preference, Individual TCM	$18.45	1	Sightseeing	Blue Ridge Parkway
Siderelis, Whitehead and Thigpen, 2004	North Carolina	Stated Preference, Dichotomous choice	$31.43	1	Floating/rafting/ canoeing	NC
		SP and RP	$91.68 to $94.82	2		
Chizinski et al., 2005	Texas	Revealed Preference, Individual TCM	$69.09 to $138.19	4	Freshwater fishing	Lake Kemp
Oh et al., 2005	Texas	Revealed Preference, Individual TCM	$242.27	1	Freshwater fishing	Sam Rayburn Reservoir
Williams and Bowman, 2006	Arkansas	Stated preference, iterative bidding	$22.93 to $39.01	5	Freshwater fishing	Beaver Tailwater, Bull Shoals Tailwater, Greer's Ferry Tailwater, Norfolk Tailwater, Narrows Dam

[a]Note: TCM = travel cost method

APPENDIX E: BIBLIOGRAPHY OF RECREATIONAL VALUATION STUDIES USED IN INTERNATIONAL BENEFIT TRANSFER, 1958 TO 2006

Bhat, G., et al. "An ecoregional approach to the economic valuation of land- and water-based recreation in the United States." *Environmental Management* 22, no. 1(1998): 69-77.

Bishop, R.C., K.J. Boyle, M.P. Welsh, R.M. Baumgartner, and P.R. Rathbun (1987) Glen Canyon Dam releases and downstream recreation: An analysis of user preferences and economic values, Final Report to the Recreation Subteam of the Glen Canyon Environmental Studies. Madison, WI: HBRS.

Bowes, M.D., and J.B. Loomis. 1980. "A Note on the Use of Travel Cost Models with Unequal Zonal Populations." *Land Economics* 56:465-470.

Bowker, J. M., D. B. K. English, and J. A. Donovan. "Toward a value for guided rafting on southern rivers." *Journal of Agricultural and Applied Economics* 28, no. 2(1996): 423-432.

Brown, R. E., and W. J. Hansen (1974) A Preliminary Analysis of Day-Use Recreation and Benefit Estimation Models for Selected Reservoir, IWR Research Report 74-R1, Volume III of V. Fort Belvoir, VA: US Army Corps of Engineers.

Brown, R. E., and W. J. Hansen (1974) A generalized recreation day use planning model, IWR Research Report 74-R1, Volume V of V. Fort Belvoir, VA: US Army Engineer Institute for Water Resources.

Chizinski, C. J., et al. "Economic value of angling at a reservoir with low visitation." *North American Journal of Fisheries Management* 25(2005): 98-104.

Cordell, H. K., and J. C. Bergstrom. "Comparison of recreation use values among alternative reservoir water level management scenarios." *Water Resources Research* 29, no. 2(1993): 247-258.

English, D. B. K., and J. M. Bowker. "Sensitivity of Whitewater Rafting Consumers' Surplus to Pecuniary Travel Cost Specifications." *Journal of Environmental Management* 47, no. 1(1996): 79-91.

Fadali, E., and W. D. Shaw. "Can recreation values for a lake constitute a market for banked agricultural water?" *Contemporary Economic Policy* 16(1998): 433-441.

Gibbs, K.C. 1974. "Evaluation of outdoor recreational resources: A note." *Land Economics* 50:309-311.

Grubb, H., and J. Goodwin (1968) Economic evaluation of water oriented recreation in the preliminary Texas water plan, Texas Water Development Board Report 84.

Hammer, M. Z. "Applying the TCM with secondary data to white water boating in Grand Canyon National Park." MS thesis, Colorado State University, 2001.

Hansen, W.J., A.S. Mills, J.R. Stoll, R.L. Freeman, and C.D. Hankamer (1990) A case study application of the contingent valuation method for estimating urban recreation use and benefits. National Economic Development Procedures Manual - Recreation, Volume III, IWR Report 90-R-11. Fort Belvoir, VA: US Army Corps of Engineers.

Haspel, A., and F.R. Johnson. 1982. "Multiple destination trip bias in recreation benefit estimation." *Land Economics* 58(3):364-372.

Hesseln, H., et al. "Wildfire effects on hiking and biking demand in New Mexico: A travel cost study." *Journal of Environmental Management* 69(2003): 359-368.

Keith, J.E., P. Halverson, and L. Farnworth (1982) Valuation of a free flowing river: The Salt River, Arizona, Final Report to the U.S. Army Corps of Engineers for Contract No. DACW09-81-M-2439. Logan, UT: Utah State University.

Klemperer, W.D., G.J. Buhyoff, P.S. Verbyla, and L.D. Joyner (1984) Valuing white-water river recreation by the travel cost method. Baton Rouge, LA, pp. 709-719.

Knetsch, J.L., R. Brown, and W. Hansen (1976) Estimating expected use and value of recreation sites: In C. Gearing, W. Swart, and R. Var (eds.) Planning for Tourism Development: Quantitative Approaches. New York, NY, Praeger.

Leggett, C. G., et al. "Social Desirability Bias in Contingent Valuation Surveys Administered Through In-Person Interviews." *Land Economics* 79, no. 4(2003): 561-575.

Leuschner, W.A., and R. Young. 1978. "Estimating the southern pine beetle's impact on reservoir campsites." *Forest Science* 24:527-537.

Loomis, J. B., et al. "Testing transferability of recreation demand models across regions: A study of Corps of Engineers reservoirs." *Water Resources Research* 31, no. 3(1995): 721-730.

McCollum, D.W., G.L. Peterson, J.R. Arnold, D.C. Markstrom, and D.M. Hellerstein (1990) The net economic value of recreation on the National Forests: Twelve types of primary activity trips across nine Forest Service Regions, Research Paper RM-289. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Martin, W.E., R. Gum, and A. Smith (1974) The demand for and value of hunting, fishing, and general outdoor recreation in Arizona, Technical Bulletin 211. Tucson, AZ: Agricultural Experiment Station, University of Arizona.

Martin, W.E., F.H. Bollman, and R.L. Gum. 1982. "Economic Value of Lake Mead Fishery." *Fisheries* 7(6):20-24.

Mathews, L. G., S. Stewart, and S. Kask (2003) Blue Ridge Parkway Scenic Experience Project, Phase 2 Final Report. Asheville, NC: University of North Carolina--Asheville, Department of Economics.

Moncur, J.E. 1975. "Estimating the value of alternative outdoor recreation facilities within a small area." *Journal of Leisure Research* 7:301-311.

Oh, C., et al. "Understanding differences in nonmarket valuation by angler specialization level." *Leisure Sciences* 27(2005): 263-277.

Palm, R.C., and S.P. Malvestuto. 1983. "Relationships between economic benefit and sport-fishing effort on West Point Reservoir, Alabama-Georgia." *Transactions of the American Fisheries Society* 112:71-78.

Ralston, S. N., and W. M. Park. "Estimation of potential reductions in recreational benefits due to sedimentation." *Water Resources Bulletin* 25, no. 6(1989): 1259-1265.

Ralston, S. N., W. M. Park, and E. J. Frampton. "Contingent valuation and recreational demand." *Journal of Applied Business Research* 7, no. 3(1991): 116-119.

Richards, M.T., D.A. King, T.C. Daniel, and T.C. Brown. 1990. "The lack of an expected relationship between travel cost and contingent value estimates of forest recreation value." *Leisure Sciences* 12:303-319.

Sellar, C., J. R. Stoll, and J. Chavas. "Validation or empirical measures of welfare change: A comparison of nonmarket techniques." *Land Economics* 61, no. 2(1985): 156-175.

Shonkwiler, J. S. (1995) Systems of travel cost models of recreation demand, In D. Larson (comp), Western Regional Research Publication, W-133 Benefits and Costs Transfer in Natural Resource Planning. Eighth Interim Report. Davis, CA:

Siderelis, C., and R. Moore. "Outdoor recreation net benefits of rail-trails." *Journal of Leisure Research* 27, no. 4(1995): 344-359.

Siderelis, C., G. Brothers, and P. Rea. "A boating choice model for the valuation of lake access." *Journal of Leisure Research* 27, no. 3(1995): 264-282.

Siderelis, C., R. Moore, and J. Lee. "Incorporating users' perceptions of site quality in a recreation travel cost model." *Journal of Leisure Research* 32, no. 4(2000): 406-414.

Siderelis, C., J. Whitehead, and J. Thigpen (2004) Paddle trails and contingent fee data, Working paper. Raleigh, NC: Department of Parks, Recreation and Tourism Management, North Carolina State University.

Stavins, R. (1984) The Tuolumne River: Preservation or development? An economic assessment, Berkeley, CA: The Environmental Defense Fund.

Sublette, W., and W. Martin (1975) Outdoor recreation in the Salt-Verde Basin of central Arizona: Demand and value, Technical Bulletin 218. Tucson, AZ: Agricultural Experiment Station, University of Arizona.

Teasley, R.J., J.C. Bergstrom, and H.K. Cordell. 1994. "Estimating revenue-capture potential associated with public area recreation." *Journal of Agricultural and Resource Economics* 19(1):89-101.

Trice, A. H., and S. E. Wood. "Measurement of recreation benefits." *Land Economics* 34(1958): 195-207.

Ward, F.A. (1982) The demand for and value of recreational use of water in southeastern New Mexico, Las Cruces, NM: Agricultural Experiment Station, New Mexico State University.

Wennergren, E. B. (1965) Value of water for boating recreation, Bulletin 453. Logan, UT: Agricultural Experiment Station, Utah State University.

Williams, J. T. "Utah boating and fishing survey: Applying contingent valuation and travel cost methods to estimate recreation values in northern Utah for the Bear River water development project." MA Thesis, Utah State University, 1994.

Williams, J., and D. Bowman (2006) Arkansas Trout Permit Holder Survey--2003, AGFC Trout Management Report, Report #TP-06-06. Little Rock, AR: Arkansas Game and Fish Commission.

Zawacki, W., and A. Marsinko (2000) Using Geographic Information Systems with travel cost models: A case study, In G. Kyle (comp., ed.), 2000, Proceedings of the 1999 Northeastern Recreation Research Symposium. General Technical Report NE-269. Newtown Square, PA.