Technical Documentation of Benefit Transfer and Visitor Use Estimating Models of Wildlife Recreation, Species and Habitats

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EXECUTIVE SUMMARY

Within the limits of the available literature and data, we have provided up-to-date benefit transfer values and estimated meta-analysis equations for benefit function transfer. Tabular values by region of the country have been developed for wildlife recreation use values for hunting (big game, migratory and small game), fishing and viewing. Meta-analyses for benefit function transfer have been developed to calculate total economic values of habitats (e.g., wetlands, aquatic resources and terrestrial) and species (e.g., salmon and T&E species). We have also estimated wildlife recreation use estimation models for National Wildlife Refuges that are applicable to state Wildlife Management Areas. Finally, we have estimated state level wildlife recreation use estimation models for the lower 48 states that can be applied to privately owned and public lands that are potential habitat for game and non-game species.

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1. Defining Benefit Transfer

Benefit transfer involves applying a benefit per unit estimate (per visitor day, per household, per acre) **from an existing study site to an unstudied policy site** where such a benefit per unit value is needed. Benefits are defined by economists for economic efficiency or benefit-cost analyses as the user's **willingness to pay in excess of current costs (e.g., net willingness to pay) or consumer surplus**. This is the benefit measure used by federal water agencies for benefit-cost analysis (U.S. Water Resources Council, 1983), by federal agencies for natural resource damage assessment (U.S. Department of Interior, 2004) and by regulatory agencies such as U.S. Environmental Protection Agency for benefit-cost analysis (U.S. EPA, 2000). This is also the benefit measure required by U.S. Office of Management and Budget (2000) when federal agencies perform a benefit cost analysis.

Defining Economic Benefits in More Detail

Those users with training in economics or familiar with the concept of consumer surplus or net willingness to pay can skim this next section that distinguishes economic values from economic impacts. Those without such training may save themselves and others much confusion by taking a few minutes to read this next section as much unnecessary disagreement often occurs between biologists and economists, and between local officials and analysts over what is meant by benefits. As noted above, benefits are defined as how much more the user (e.g., visitor, household) would pay to continue to have access to a given natural resource or for an improvement in the natural resource (e.g., increased fish catch of a desired species). This amount the user would pay is in addition to their cost of travel, equipment, etc. In essence, in order to evaluate the net gain to society from an investment to improve habitat, we wish to know what are the additional benefits received by the user in order to be able to compare that to the costs of the habitat improvement.

One cannot use the actual visitor cost or expenditures as a measure of benefit, because these dollars have already been spent on gasoline, bait, ammunition, etc. Those dollars are not available to pay for the habitat improvement. What is relevant for determining if the benefits of the habitat improvement exceed the cost of the habitat improvement, is whether the habitat improvement generates sufficient additional monetary benefits that the user would be able to pay for that improvement. For example, if there is an annual cost of a conservation easement of $1000, we want to know if the 100 hunters that would use those lands would pay, on average, $10 each year to hunt there. If so, the benefits equal the cost and this is an economically justifiable decision. We can't use the $20 the hunters would spend on travel as a measure of benefits, since that $20 is given to the gas station to pay the travel cost and is not available to pay for the conservation easement. Only the "consumer surplus" or benefits in excess of the $20 travel cost, are available to pay for the easement. Users interested in estimating spending by recreationists and associated economic impacts on total sales, income, employment and tax revenues can obtain information in the Toolkit Introduction on where to obtain the required data.

Units of Analysis for Benefit Transfer and Implications for Appropriate Analysis

The typical application of benefit transfer involves selecting a per unit benefit measure from a listing of existing studies or a table of average values and applying it to the site/activity for which values are needed. These per unit values can be per visitor day, per household or per acre. The per unit measure is then multiplied by the change in human use (e.g., number of visitors or households) or number of acres associated with a policy or management action. In an EIS, the per unit value may be multiplied by the human use without the management action and with the management action so that the economic value of each alternative can be compared in monetary terms.

Benefit transfer analysis that uses a constant value per visitor day or per acre is reasonably accurate only for evaluating small changes in visitor days or acres due to a project. Thus, use of a constant value per day or acre is appropriate for evaluating the protection of 10,000 acres as habitat but not for evaluating the protection of 1 million acres. Neither is it appropriate for valuing the protection of all the habitat in the entire state. For very large increases, these constant per unit values will overstate visitor or household willingness to pay. This occurs because there is diminishing marginal utility or marginal benefit for additional units of any good. At some point satiation may take hold, or there is simply not time to visit all the recreation areas, or visits to new areas come at the expense of visits to existing areas (i.e., substitution effects).

However, the reverse is also true. The constant per unit values will be accurate to value small losses in habitat or recreation visitor days, but ***understate*** the loss in value for large losses. Thus conversion of a 100,000 acres of open space into a new housing development and business center, will result in a larger loss to society than would be estimated assuming a constant per unit value. This occurs because with large losses, there is growing scarcity of the resource, raising its value.

Both these concepts are illustrated with a demand curve for acres of wetland in Figure 1. MBo is the current Marginal Benefit associated with the current amount of wetlands protected (WAo). This value is a close approximation for evaluating a change in acres of wetlands to WA+1 or WA-1. But as can be seen, a constant value MBo would understate the benefit of WA-3 of wetlands. Corresponding, MBo would overstate the gain in WA+3 in wetlands.

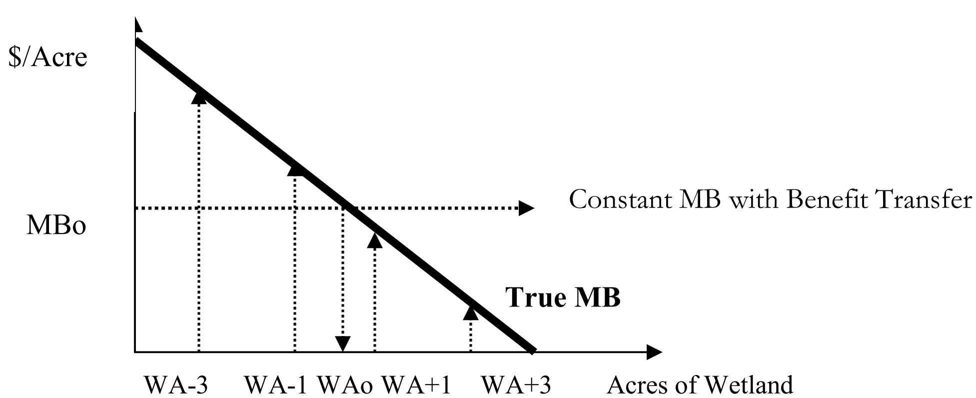

Figure 1

This concern that using average consumer surplus yields a constant marginal value has been recognized by Morey (1994). Attempting to value a site quality change that shifts the recreation demand curve (e.g., change in fish catch) by using the average consumer surplus times a change in visitor days resulting from the change in quality may not always result in an accurate estimate of the economic value of this quality change. Ideally the incremental value is calculated as the change in consumer surplus from the change in area between the improved and existing demand curve.

However, the use of average consumer surplus per visitor day times the change in visitor days may be a good approximation of the change in recreation value under certain circumstances. First, several commonly used recreation demand models do in fact imply a constant value per day. These include a discrete choice model such as a multinomial logit model (Morey, 1994), a semi-log functional form where the dependent variable (trips) of the Travel Cost Model is logged (Adamowicz et al., 1989) or a count data travel Travel Cost Model (Creel and Loomis, 1990). Second, if there is non-price rationing of hunting permits, boating permits, or access to the site (e.g., lottery), then the average consumer surplus is an accurate measure of the expected value of an additional recreational opportunity (Mumy and Hanke, 1975). Nonetheless, the user should be aware of the approximate nature of using average consumer surplus as a measure of value. The use of meta analyses for benefit function transfer can sometimes avoid this problem.

Total Economic Value: Use + Passive Use Values

It is important for the user to keep in mind that some of the benefit transfer studies provide estimates of just on-site recreation use values such as hunting or viewing. These direct use values may often reflect the majority of societal benefits for abundant game species such deer or bass or hatchery trout. However, for some rarer species or rare habitats (e.g., old growth forests, wetlands, free flowing rivers), people who do not actually hunt or view these species or visit their habitat still may receive benefits from preservation of these species or habitats. Economists refer to these off-site benefits by a variety of names including existence value (Krutilla, 1967; Randall and Stoll, 1983) or non-use values. Some economists disaggregate existence value into existence and bequest values (Walsh et al., 1984). More recently the federal courts have labeled these existence values as a passive use value, and require federal agencies within Department of Interior and National Oceanic and Atmospheric Administration to include these values when calculating compensable values for natural resource damage assessments or oil spills (U.S. Court of Appeals, 1989).

Passive use values are also measured using what a person would pay for a change in rare species abundance or protection of a given area of habitat. As such, the units of value for passive use value are often annual willingness to pay per household. Since no one can be denied the enjoyment from knowing a particular species or habitat is protected, passive use values can potentially accrue to millions of households simultaneously. Thus, applying values per household requires the analyst to decide how many households may benefit from protection of a given area of habitat. There are no hard and fast rules on this. However, there have been several studies on the spatial extent of WTP for preservation of several endangered species, that can provide some guidance on this topic. Loomis (2000) presents a graph that shows how WTP falls off with distance for preservation of salmon, wetlands and T&E species in the southwest US. Generally, about 80% of the local WTP is received by those living within 300 miles of the habitat or species. About 60% of the local WTP is received by those living within 1500 miles. (See Loomis [2000] for more details). Nonetheless, there is still a significant WTP for salmon and wetlands, since anadromous species migrate great distances up rivers and wildlife using wetlands migrate hundreds of miles along flyways. Thus, the spatial distribution of benefits across large areas for such wide-ranging species or habitats to wide ranging species is quite plausible.

For some resources such as wetlands, the original studies performed the calculations of the number of households affected and, therefore, report values per acre that reflect the spatial market for the natural resource. In this case, the analyst can simply transfer the value per acre to their study area. This implicitly assumes that their wetland is of equivalent regional significance as the ones studied in the literature. This may not always be the case, as Hoehn (2006) has found that studied wetlands may be "priority wetlands" that have higher values than generic wetlands, due to characteristics such as the proximity of the wetlands to population centers. If the wetlands being analyzed using the benefit transfer approaches are not as regionally significant as the ones studied in the literature, the benefit transfer estimates using values per acre may slightly over state the values of more generic wetlands (3-19% in Hoehn's analysis).

It is also important for the user to carefully decide if the management action or policy primarily affects just visitor use values (e.g., hunters, viewers or anglers) or has a significant passive use value for the general population. It is important to avoid the temptation to "pile on" passive use value benefits to recreation use values in order to make benefit estimates larger. However, in many cases, if the species is sufficiently abundant that hunting, fishing or viewing takes place, it will not be rare enough to generate significant passive use values. As pointed out by Randall and Stoll (1983), existence values become empirically significant when the species or environment is quite scarce. By this same logic, species that are not abundant enough to support hunting, fishing or viewing may well generate significant passive use values which should be counted. However, there are species or habitats that provide both use values and passive use values. Species such as whales (Loomis and Larson, 1994) and whooping cranes (Stoll and Johnson, 1984) and natural environments such as wetlands (Woodward and Wui, 2000; Brander et al., 2006), wilderness (Walsh et al., 1984) and free flowing rivers (Sanders et al., 1990) are examples where both use and passive use values are relevant. Nonetheless the analyst should document the rationale for applying use and/or passive use values to their particular study.

One last concern relates to avoiding double counting of the same benefits using different benefit transfer methods. For example, using a value per acre of wetland that includes waterfowl hunting, along with a separate estimate of waterfowl hunting benefits clearly would double count these values.

2. Types of Benefit Transfer

As illustrated in Figure 2, there are two broad types of benefit transfer (a) value transfer and (b) Function Transfer (Rosenberger and Loomis, 2001).

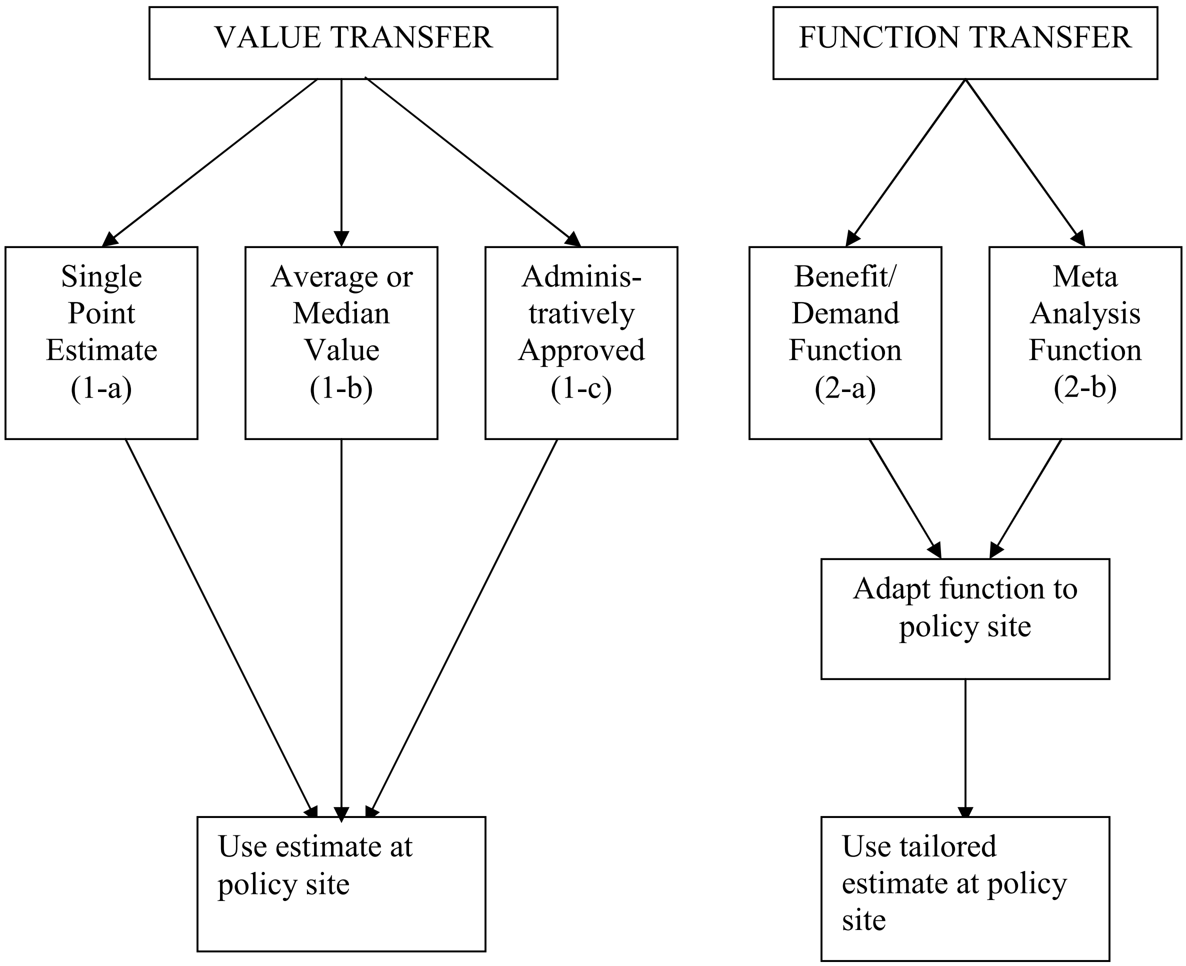

Figure 2. Benefit transfer approaches (From Rosenberger and Loomis, 2001)

Value Transfers

Single Point Estimates: Within value transfer an analyst may be lucky enough to find a study that matches the species and general geographic location to the one they need. As such they can simply transfer that an inflation adjusted point estimate from that study to theirs. As part of the CD provided, there are several databases of recreation values of fishing, hunting and viewing, as well as databases of T&E species values, wetland values, etc., that the analyst can search to determine if there is a good match between their policy site and an existing study site.

Average Value Estimates: However, many times there is not a perfect match between the species and the specific geographic location of the available studies and the policy site. For example, one may need a value of wildlife viewing for Riverside County in California. However, all that may be available is an average value in the table for wildlife viewing in California as a whole, or the west coast. In this case use of such an average value is a reasonable approach to arriving at a benefit estimate for the study site in Riverside County. Alternatively, a search of the database may uncover multiple existing studies of the species at the policy site. For example, if an average value for big game hunting in Montana is needed, there are several studies using multiple methods for both deer and elk. In this case, rather than selecting just one study, a more accurate measure of benefits may be obtained by averaging the values from the several studies.

Benefit Function Transfer

There are two types of benefit function transfer: (a) benefit/demand function transfer; and (b) meta-analysis function transfer. This report will focus on meta-analysis function transfer as such a function is literally a study of all the available empirical studies, and therefore, is more comprehensive and broadly applicable for benefit transfer. From the standpoint of expediency, a single meta-analysis function can be applied to many more activities and species than is usually the case with any single individual demand function from the empirical literature. However, if a review of the databases does provide an indication of a good match between the policy site and a site with an individual demand function or site specific willingness to pay function, such an individual function transfer is likely to be more accurate than that obtained from a meta-analysis. However, the analyst will require greater effort to gather the necessary means of the independent variables and program the spreadsheet for these individual benefit functions. Given the widespread applicability of meta-analysis benefit functions, these have been pre-programmed in this project for a wide variety of resources including recreation, T&E species, wetlands and aquatic resources. Meta-analyses have received qualified support as a technique for benefit transfer by a number of economists (Boyle et al., 1999; Brander and Florax, 2007; Johnston et al., 2005) and agencies (U.S. Environmental Protection Agency, 2000).

Ideal Criteria for a valid benefit transfer

There are three criteria that have been proposed for an ideal benefit transfer. These are ideal criteria provided by Boyle and Bergstrom in the 1992 special issue on benefit transfer in Water Resources Research (page 659) as:

a. The nonmarket commodity valued at the study site must be identical to the nonmarket commodity to be valued at the policy site.

b. The human populations affected by the nonmarket commodity at the study site and the policy site have identical characteristics.
c. The assignment of property rights at both sites must lead to the same theoretically appropriate benefit measure (e.g., original study uses WTP and a measure of WTP is desired for the policy site).

As a practical matter most adherents to benefit transfer recognize that it is unlikely that all three of these can be met exactly. This is particularly true of condition (a) and (b). For example, in terms of (a), available studies on antelope hunting may unavailable in the state needing the policy analysis. The analyst might be faced with two choices: either apply a value of antelope hunting study from another state or apply a value of deer hunting from the same state. This is essentially a trade-off between meeting condition (a) by having identical species (antelope), but departing from condition (b) since the antelope values are from a different state. If the other state is an adjacent western state, with similar human population demographics, this might be acceptable. If the two states are quite different (e.g., California versus Nevada), then it may be better to take the value of hunting deer from the same state and apply it to antelope. While this departs from condition (a), the error in WTP values might be less than from departing from condition (b) if the state where the original values came from are quite different than the policy state where the values would be applied. The advantage of using a benefit-transfer function approach as compared to transferring point estimates is that it may be possible to adjust WTP for differences in socio-demographics between the two states using a benefit function transfer approach. Thus in this case, the value of antelope hunting could be estimated for the state of interest using a benefit transfer function with values of demographic set at those for the state of interest, and therefore better meet conditions (a) and (b).

3. Brief Definitions of Valuation Methods

Since the individual study values, average values and several of the meta-analyses that the user might apply were derived from one or more non-market valuation methods, it is important for the user to understand some basic concepts and terminology associated with each valuation method. For more details on these methods see (Champ et al., 2003; Haab and McConnell, 2002).

Contingent Valuation Method and other Stated Preference Methods

Contingent valuation is a survey based approach that constructs a hypothetical market or simulated referendum to value a public good. The public good may be a public program to protect a species or protect a habitat. *Attribute-based* methods, also called conjoint or choice analysis methods, typically ask respondents about a series of similar multi-attribute goods or services that differ in the levels of their common attributes. One of the attributes can be the a particular wildlife species or habitat at issue. Like contingent valuation, attribute-based approaches are quite flexible in the kinds of goods or services they can be used to value, but require a realistic payment scenario.

Travel Cost Method

The *travel cost* method uses differences in travel costs to recreation sites, and the corresponding number of trips taken to trace out a recreation site demand curve, from which the WTP for the recreation visits can be calculated. Having data for multiple sites that differ in their site quality allows for estimating the value of site characteristics such as fishing quality or scenic beauty.

Hedonic methods

The *hedonic* method typically uses data on property sales to isolate WTP for the attributes of the properties. Among the attributes may be environmental attributes such as the distance to open space, access to scenic vistas, or ambient air quality. Of course, all relevant attributes must be represented in the data in order to avoid incorrectly estimating the value of the attributes that are included.

4. Benefit Transfer Data: Updating Literature Reviews and Meta-Analyses

a. Recreation Use Values: Hunting, Fishing and Viewing

In order to produce updated the tabular values of fishing, hunting and viewing, we started with Loomis (2005) recent U.S. Forest Service database and publication. The completeness of this database for fishing studies was checked by comparing it to the Boyle et al. (1998) Sport Fishing Database since this database is believed to have the most complete coverage of fishing valuation studies. This database was kindly provided by Industrial Economics Inc. (We appreciate the cooperation of IEC in providing this to us). To ensure we had the most recent studies on fishing, hunting and viewing, we also obtained both a recently updated database from Dr. Randall Rosenberger at Oregon State University. By the end of 2006, he had updated the Loomis (2005) database for an EPA project on benefit transfer. The Rosenberger database was checked against the Loomis (2005) database to reconcile issues like a study of bird-watching that was only listed in wildlife viewing but not in bird watching in the Rosenberger database. Further Rosenberger provided a listing of very recent studies up to and including January 2007 that had not been entered into his database. This listing was inspected for fishing, hunting and wildlife viewing studies. New studies were acquired, coded, and added to the database in order to have the most updated values per hunter day, angler day and viewer day tables by geographic region. In addition, all the database studies were disaggregated into three types of fishing (cold, warm, anadromous - i.e., steelhead and salmon), three types of hunting (big game, small game and waterfowl), and two types of viewing (general wildlife viewing and bird viewing). Thus, the tables of values presented in the user manual and on the CD are up to date in terms of studies available as of the beginning of 2007.

b. Salmon Values

Given the relatively few studies on the total economic value of salmon, we provide a table of dollars values per household and dollar values per thousand fish along with location of the study and the percentage change in fish the study valued. These values are also used in the meta-analysis described below. We decided to present the individual study values rather than an average so as to facilitate individuals performing point value transfers by matching their policy site to a particular study site. Thus, using the salmon value table, an individual can attempt to as closely match the location (e.g., primarily states of Oregon or Washington), order of magnitude of the increment in fish valued and the expected percentage change in fish between their policy site and the five studies that have been performed. Of course the closer the match, the more accurate the benefit transfer is likely to be.

c. Wetland Values

Values per acre by region of the country are summarized in table to allow users only interested in a "back of the envelope" point estimate transfer of such values. This table utilizes the publicly available wetland data of Woodward and Wui (2001). More recent raw data to summarize in a table was not available but more recent meta-analyses of wetland values was used and is discussed below.

d. T&E Species Values

To arrive at the most complete and up to date tabular values for Threatened, Endangered and rare species we started with the Loomis and White (1996) database and updated this. The first source of updates was the work of Saloio (2002) who added studies to the Loomis and White database. However, in reviewing his study, we limited ourselves to additional study values that were in the U.S. or Canada (i.e. North America). Additional recent studies and values were located for a variety of species. A table of values by species was developed and then summarized for the users interested in making species specific point estimate transfers.

5. META-ANALYSES

If a recently done meta-analysis was available from the literature, we frequently utilized it, as these studies had access to the original raw data and often put an extraordinary amount of effort into their meta-analyses. This was the case for sport fishing, wetlands, terrestrial wildlife habitat and aquatic habitat. In cases where an original meta-analysis could not be found, we performed such an analysis for hunting, T&E species, and salmon. All of these meta-analysis regression equations are programmed into spreadsheets models. Per discussions with Dr. Randall Rosenberger at Oregon State University, we set the methodology variables to the means of the raw data that went into the meta-analysis. Thus the user needs to only tailor the study using geographically or species specific variables, without worrying about the valuation methodology variables. However, if the user has a strong prior preference on the appropriate valuation method for a particular species or ecosystem service, they can modify the valuation methodology variable in the spreadsheet accordingly.

a. Sport Fishing Meta-Analysis

We chose to adopt the original meta-analysis equation of Boyle, et al for sport fishing. Their analysis represented a very thorough analysis of their database. They tested several different specifications and ran numerous robustness scenarios to investigate the relative accuracy of their models. Their consumer surplus per day model had the largest number of observations (n=461, about double the observations available for the per trip model). Boyle et al. (1999) point out that in their verification of the estimated models, those with larger sample sizes yield models that give more accurate predictions of WTP. Further, the verification scenarios run by Boyle, et al (1999) for bass and salmon fishing showed that the per day consumer surplus model yielded all positive estimates of value (in accordance with economic theory and common sense), while the per trip models yielded several negative consumer surplus estimates when the methodological variable was set to the travel cost model. Therefore, we have selected their consumer surplus per day model for the sport fishing meta-analysis. With the available time and resources available to us, we did not feel we could improve upon this model, and devoted our efforts to estimating meta-analyses models for hunting and wildlife viewing instead.

b. Hunting Meta-Analysis

Using the more than 500 hunting values we estimated a meta-analysis for hunting that is reported below in Table 1.

The variables are defined as follows:

Data Year	Year of the data (e.g. 1995)
Inter Mtn	Intermountain Region Intercept Shifter
North East	North Eastern U.S. Region Intercept Shifter
Pacific	Pacific Coast Region Intercept Shifter
South East	South Eastern U.S. Region Intercept Shifter
Land Ownership	Land Ownership (=1 Public; 0= private or mixed ownership)
Unit Conversion	Methodology variable for whether values had to be converted from season or trips to days; =1 Yes
Value Method	1 if method is TCM and 2 if CVM
Waterfowl	1 if species hunted is waterfowl.

The regional values are relative to the omitted region which is Alaska. We found no statistical difference for studies involving big game hunting, but these were the vast majority (about 70%) of the studies in the database.

Table 1. Results of Hunting Meta-Analysis

Dependent Variable: Consumer Surplus Per Day
Included observations: 554

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1409.956	593.8087	2.3744	0.0179
Data Year	-0.641987	0.298028	-2.1541	0.0317
Inter Mtn	-32.20362	9.476563	-3.3982	0.0007
North East	-43.69774	9.597475	-4.5530	0.0000
Pacific	-30.41689	11.38787	-2.6709	0.0078
South East	-46.35317	10.38775	-4.4622	0.0000
Land Ownership	-12.99613	4.382956	-2.9651	0.0032
Unit_Conversion	-14.57622	4.640093	-3.1413	0.0018
Value Method	-18.20684	5.265460	-3.4577	0.0006
Waterfowl	-24.76600	5.459601	-4.5362	0.0000
R-squared	0.130467	Mean dependent var		61.33909
Adjusted R-squared	0.116082	F-statistic		9.069268
S.E. of regression	46.63584	Prob(F-statistic)		0.000000

Wildlife Viewing Meta-Analysis

There were relatively few wildlife viewing studies, and the resulting meta-analysis had very few statistically significant variables. Only land ownership differences were statistically significant and none of the geographic regions were. Therefore, we suggest analysts use the table of values provided since the meta-analysis does not add much utility for benefit transfer.

c. Wetland Meta-analysis

There have been at least three meta-analyses of the many studies on the multitude of wetland values. The first was by Woodward and Wui (2001) which found 39 studies that either estimated or calculated an annual value per acre. In total, their meta-analysis had 65 estimates of values for ten ecosystem services of wetlands (flood control, water quality, water quantity, recreational fishing, commercial fishing, bird hunting, bird watching, amenity, habitat values, and storm protection). This analysis has been updated and expanded by Brander et al. (2006) and by Brander and Florax (2007). We investigated the Brander and Florax (2007) study as it focused on North American and European wetland studies, whereas Brander et al. (2006) included studies from Southeast Asia and Africa. As discussed above, given the differences not only in the wetland type but also the socio-demographic conditions in Africa and Southeast Asia, we believe more accurate benefit transfer to U.S. wetlands would occur by focusing only on values from developed countries like the U.S, Canada and Europe. We should also note, the variable for Europe in the Brander and Florax (2007) meta-analysis is not statistically significant suggesting that European values are not all that different from U.S. and Canadian values of wetlands. Besides having additional more recent studies, the Brander and Florax meta-analysis also expands upon Woodward and Wui's (2001) list of wetland services that are valued.

In addition, we obtained a recent meta-analysis of wetlands from Ohio State University that reflects Borrisova-Kidder dissertation research prepared under the guidance of Alan Randall. Like Brander and Florax, this meta-anlaysis includes a measure of income. One advantage of the Borrisova-Kidder, meta-model is that it includes variables for geographic location within the United States. The regions are USDA Farm regions. These regional dummy variables allow the user to better geographically tailor the transferred wetland values to their study site. This meta-analyses had some similarities and differences to those of Brander and Florax and Woodward and Wui, and so we developed spreadsheets to compare them. In general, the values per acre and patterns of values for the Borrisova-Kidder and Woodward Wui are quite similar. In particular, the values per ecosystem service per acre are in the $100 to $600 per acre range in Borrisova-Kidder, much closer to Woodward and Wui, which is in the $200 to $2,000 per ecosystem service per acre range. The Brander and Florax provide values that are in the tens of thousands of dollars per acre, which seems quite high and inconsistent with much of the underlying literature values. These values were checked against estimates in the Brander and Florax book chapter and appear correct. Further, the pattern of values across ecosystem services in the Borrisova-Kidder and Woodward and Wui have a very high correlation of 0.78. Thus to err on the conservative side and to provide meta-values consistent with the tabular wetland service values (which area based on Woodward and Wui), we have decided to rely upon the wetland meta-spreadsheets by Borrisova-Kidder.

d. Freshwater Aquatic Resource Improvements Meta-Analysis

Johnston et al. (2005) provide a meta-analysis of per household WTP for improvements in water quality, aquatic habitat and recreational fishing conditions in the United States. The WTP reflects total economic value comprising both use and non-use (Johnston et al., 2005: 223). The studies include lakes, rivers, estuaries as well as salt ponds/salt marshes. Since total economic values are estimated, the contingent valuation method is the primary methodology.

The model yields the change in WTP that results from moving from the current baseline water quality as measured by a numeric score on the Resources for the Future (RFF) water quality ladder (this ladder, taken from Mitchell and Carson [1989: 345] is provided on a tab of the aquatic resource improvements Excel file). The bottom of the ladder has a value of zero indicating the water is neither safe to boat, fish nor swim. At a score of 2.5 it is considered safe for boating. At 5.0, it considered safe for most game fish such as bass and, at 4.0, it is considered safe for shellfish (Johnston et al. 2005: 229). Based on the current uses, the analyst enters the current level of water quality from the RFF ladder. Then, for water quality improvements that target fish (WQ_fish) or shellfish (WQ_shell) or both (WQ_many species) or are not specified (WQ_non), the analyst enters the numerical **increase** in water quality from the baseline to the new level on the RFF water quality ladder. Some judgment is obviously required as the levels on the RFF water quality ladder cannot be objectively mapped to water quality measurements such as dissolved oxygen or pH.

e. Salmon Economic Meta-Analysis

We conducted an additional literature review to update our prior analysis of salmon total economic values. Prior studies included Olsen et al. (1989) on salmon in the Columbia River system; Loomis' (1996) Elwha dam removal in Washington; Layton et al. (2001) for salmon in Washington; and Hanemann et al. (1991) for salmon in the San Joaquin Valley. In addition to these prior studies we found a new study by Bell et al. (2003) that valued salmon in Oregon and Washington. From these studies we developed a table of values. To facilitate benefit transfer, we expressed the study results on the basis of willingness to pay per household per thousand salmon. We also report the corresponding magnitude of change in the relevant salmon population. This should aid field users in trying to match the context of their policy site to the existing study sites.

Of course if there is not a good match between the change in salmon numbers in the policy site and the study site, an alternative approach is to use our meta-analysis equation developed from these estimates. A relatively simple meta-analysis equation explained 30% of the variation in a household's annual WTP per 1000 salmon. This dependent variable was related to the percentage change in number of salmon/steelhead.

Table 2. Salmon Meta-Analysis

Dependent Variable: Real Per Household WTP for Salmon
Sample=19

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Percent Change	0.843577	0.1101	7.661	0.0000
Percent Change Sq	-0.001182	0.0001	-6.115	0.0000
R-squared	0.3388	Mean dependent variable		63.179
Adjusted R-squared	0.2999	S.E. of regression		32.411

The basic equation has reasonable explanatory power and statistically significant coefficients. The equation also appears to yield sensible results. That is, annual household WTP goes up with the percentage increase in salmon, but as the number of salmon increases, the rate of increase moderates, reflecting diminishing marginal value. The function has increasing values per household up to a 350% increase, which is within the range of the percentage increases found in the data set. The WTP function is relatively flat in the +300% to +350% range. The model will accommodate negative values for percentage change. In fact, due to the quadratic functional form, a 50% loss (-50%), results in a larger loss in value per household than a 50% gain. This is consistent with a given magnitude of loss having a larger reduction in utility than a gain of equal size for most people who are not completely risk neutral.

Once the value per household is determined the analyst multiplies this by the number of households affected by the decision or project. Typically, state fish and game biologists will take a state perspective and use the state number of households. However, if the species is a federally listed species, a more national valuation would be appropriate using a multi-state regional population. The analyst can see Loomis (2000) for guidance on extending values from state to national levels.

f. Terrestrial Habitat Meta-Analysis

A meta-analysis of habitat values was conducted by Borisova-Kidder (2006) as part of his dissertation at Ohio State University under the direction of Alan Randall, Timothy Haab and Brent Shongen. The meta-analysis included eleven U.S. studies that produced 23 observations. Species and habitats included spotted owls in old growth forests, piping plovers and nesting beaches, agricultural land as well as wilderness.

The resulting meta-analysis equation is given in Table 3.

Table 3: Meta-Analysis of Terrestrial Habitat.

Variable **Dependent Variable is Natural Log of benefits per acre**	**Mean**	**Coefficient**	**Std. Error**
Constant	1	-10.3666	6.238
YEAR OF STUDY (1982=1, …)	**9.26**	**0.465**	**0.185**
LNACRE (Natural Log of Acres)	10.27	0.344	0.369
CVM (1 if CVM study)	0.91	1.514	2.262
PUBLISH (1= published in journal article)	0.83	-0.272	2.09
VIEWING (1 if habitat provided viewing)	**0.61**	**6.669**	**2.059**
OS (open space)	**0.26**	**5.331**	**2.073**
OSHABMULT (open space + habitat for multiple species)	0.39	2.014	1.555

The overall equation had an adjusted R square of 0.388, and the F statistic was 2.99, statistically significant at the 0.05 level. Based on comparison of coefficient to the standard errors, the year of the study, Viewing and Open Space were statistically significant variables.

This equation is programmed into the Excel spreadsheet to allow the user to estimate the value in dollars per acre for protecting a user-specified number of acres. It also allows the user to choose whether these acres provide wildlife viewing and open space.

g. T&E Species Total Economic Value Meta-Analysis

To arrive at the most complete and up to date values for Threatened, Endangered and rare species we started with the Loomis and White (1996) database and updated this. The first source of updates was the work of Saloio (2002) who added studies to the Loomis and White database. However, in reviewing his study, we limited ourselves to additional study values that were in the U.S. or Canada (i.e. North America). For the purposes of benefit transfer we were reluctant to include studies from Europe or Asia as the demographics and preferences of users as well as the substitute species may be somewhat different than in the U.S. Since the intent of this study is to provide tabular values and meta-analysis equations for benefit transfer in the U.S. we wanted to come as close to the three conditions laid out by Boyle and Bergstrom. As noted above, the second condition for an ideal benefit transfer is to have similarity between the characteristics of the human populations (e.g., demographics) at the existing study site where the values come from and the policy site where the values will be applied. This is most likely met within the same country rather than across countries (see Ready et al. [2004] for more discussion of this issue). Nonetheless, we found 10 additional studies that valued one or more threatened, endangered or rare species in the U.S. that were published since the Loomis and White (1996) meta-analysis.

General T&E model specification and purpose

The purpose of this model is to relate household willingness to pay for threatened and endangered species to the species type, the change in the size of the species population, as well as various aspects of the study, such as contingent valuation format, payment frequency, study year, and whether households or visitors are valuing the species. This meta-analysis finds the best model to predict willingness to pay for threatened and endangered species. This is a predictive model that can be used by field biologists and planners and will be programmed into an excel spreadsheet.

Data Sources

Studies valuing threatened and endangered species prior to 1996 were taken from Loomis and Whites' "Economic benefits of rare and endangered species: summary and meta-analysis," published in Ecological Economics (1996). Studies published after 1996 were obtained by searching various databases, such as Econlit, as well as by locating a few unpublished studies. A total of six new usable studies valuing threatened and endangered species in the United States were found, consisting of 21 willingness to pay estimates. Three of these studies value a type of fish, one values the riverside fairy shrimp, one values the stellar sea lion, and the last values the gray wolf. Table 4 outlines all 39 studies included in the meta-analysis with details about each one.

Table 4: List of T&E valuation studies

Species	STATE	CHANGE SIZE	LOSS	PAY FREQ	CV FORM	VISITOR	YEAR	WTP
Mammal	-							
Bighorn Sheep	AZ	100	1	0	0	0	1985	$16.99
Wolf	WY (YNP)	100	0	1	1	1	1990	$93.92
Wolf	WY (YNP)	100	0	1	1	1	1991	$162.10
Wolf	ID, MT, WY	100	0	1	1	0	1992	$37.43
Wolf	ID, MT, WY	100	0	1	1	0	1993	$28.37
Wolf	ID, MT, WY	100	0	1	1	0	1993	$21.59
Wolf	MN	100	1	1	1	0	2001	$22.64
Marine Mammal	-							
Gray-blue Whale	CA	100	1	0	0	0	1984	$45.94
Sea Otter	CA	100	1	0	0	0	1984	$39.80
Dolphin	CA	100	1	0	0	0	1984	$36.41
Seal	CA	100	1	0	0	0	1984	$34.50
Monk Seal	HI	100	1	1	1	0	1986	$165.80
Humpback Whale	HI	100	1	1	1	0	1986	$239.53
Gray Whale	CA	50	0	0	0	0	1991	$23.65
Gray Whale	CA	100	0	0	0	0	1991	$26.53
Gray Whale	CA	50	0	0	0	1	1991	$36.56
Gray Whale	CA	100	0	0	0	1	1991	$43.46
Sea Lion	AK & US	100	1	0	1	0	2000	$70.90
Bird	-							
Whooping Crane	TX & US	100	1	0	1	0	1983	$43.69
Whooping Crane	TX & US	100	1	0	1	1	1983	$68.55
Bald Eagle	WI	100	1	0	1	0	1984	$21.21
Northern Spotted Owl	WA	50	1	0	0	0	1987	$38.61
Northern Spotted Owl	WA	75	1	0	0	0	1987	$39.99
Northern Spotted Owl	WA	100	1	0	0	0	1987	$60.84
Turkey	New Engl.	100	1	0	1	0	1989	$11.38
Turkey	New Engl.	100	1	0	0	0	1989	$15.36
Bald Eagle	New Engl.	100	1	0	1	0	1989	$45.21
Bald Eagle	New Engl.	100	1	0	0	0	1989	$31.85
Bald Eagle	WA	300	0	1	1	1	1989	$349.69
Bald Eagle	WA	300	0	1	0	1	1989	$244.94
Northern Spotted Owl	US	100	1	0	1	0	1990	$130.19
Woodpecker	SC & US	99	1	0	0	0	1992	$14.69
Woodpecker	SC & US	99	1	0	1	0	1992	$20.46
Woodpecker	SC & US	99	1	0	0	0	1992	$13.14
Mexican Spotted Owl	US	100	1	0	1	0	1996	$68.84
Mexican Spotted	US	100	1	0	0.5	0	1996	$51.52

Owl								
Falcon	ME	87.5	0	1	1	0	1997	$32.27
Fish	-							
Striped Shiner	WI	100	1	0	1	0	1984	$8.32
Salmon/Steelhead	Pacific NW	100	0	0	0	0	1989	$42.97
Salmon/Steelhead	Pacific NW	100	0	0	0	0.5	1989	$95.86
Salmon/Steelhead	Pacific NW	100	0	0	0	1	1989	$121.40
Atlantic Salmon	MA	100	1	0	1	0	1989	$10.00
Atlantic Salmon	MA	100	1	0	0	0	1989	$11.12
Arctic Grayling	US	33	1	1	0	1	1991	$26.47
Arctic Grayling	US	33	1	1	0	1	1991	$19.84
Squawfish	NM	100	1	0	0	0	1994	$11.65
Salmon/Steelhead	WA	600	0	0	1	0	1994	$79.53
Salmon/Steelhead	WA	600	0	0	1	0	1994	$98.41
Salmon/Steelhead	US	600	0	0	1	0	1994	$91.67
Minnow	NM	100	1	0	1	0	1995	$37.77
Col Riv Freshwater Fish	WA	50	0	0	1	0	1998	$210.84
Col Riv Migratory Fish	WA	50	0	0	1	0	1998	$146.57
Seattle Freshwater Fish	WA	50	0	0	1	0	1998	$229.31
Seattle Migratory Fish	WA	50	0	0	1	0	1998	$307.76
Seattle Saltwater Fish	WA	50	0	0	1	0	1998	$311.31
Salmon	WA	100	0	0	1	0.5	2000	$138.64
Salmon	WA	100	0	0	1	0.5	2000	$91.55
Salmon	WA	100	0	0	1	0.5	2000	$141.27
Salmon	WA	100	0	0	1	0.5	2000	$90.64
Salmon	OR	100	1	0	1	0.5	2000	$57.99
Salmon	OR	100	1	0	1	0.5	2000	$47.70
Salmon	OR	100	1	0	1	0.5	2000	$91.99
Salmon	OR	100	1	0	1	0.5	2000	$28.39
Salmon	OR	100	1	0	1	0.5	2000	$134.00
Salmon	OR	100	1	0	1	0.5	2000	$87.84
Other	-							
Sea Turtle	NC	100	1	0	1	0	1991	$19.01
Riverside Fairy Shrimp	CA	100	1	0	0	0	2001	$28.38

Variable Definitions for the Meta-Analysis

We generally followed the model specification and variable definitions used by Loomis and White, with slight refinements and additions.

Dependent Variables

WTP2006 – The willingness to pay per household for the particular species being valued, in 2006 dollars.

<u>Independent Variables</u>

Changesize- Change in the size of the population of the species. A doubling would be 100% change and avoiding extinction would also be 100% change. Less than 100% is the percentage chance of survival.

CV Format- Contingent valuation format- binary variable coded 1 for dichotomous choice, 0 for open-ended and payment card.

Bird- Binary variable coded 1 if the species being valued is a bird, 0 otherwise.

Fish- Binary variable coded 1 if the species being valued is a fish, 0 otherwise.

Mammal- Binary variable coded 1 if the species being valued is a mammal, 0 otherwise.

Marine- Binary variable coded 1 if the species being valued is a marine mammal, 0 otherwise.

Other- Binary variable coded 1 if the species being valued is not a mammal, fish, bird, or marine mammal (e.g., species is an amphibian, crustacean, etc.)

Payment frequency- Frequency of the payment outlined in the study- binary variable coded 1 for a one-time payment or purchase of a lifetime membership, 0 for an annual payment amount.

Response rate- Survey response rate.

Study year- Year the study was performed.

Visitor- Binary variable coded 1 if the sample frame was visitors, 0 if households/residents.

New independent variables include:

Loss- Binary variable coded 1 if the change in the size of the species population represents avoiding a loss, coded 0 if it represents a gain in the species population.

Choice Experiment- Binary variable for choice experiment studies.

New study- Binary variable coded 1 if the study was performed in or after 1995, 0 otherwise.

Results

Table 5 is the best new model that helps explain household willingness to pay for threatened and endangered species. A dummy variable called 'Choice Experiment' was added for the one new study that uses a choice experiment format instead of the typical contingent valuation method format. A paper by Stevens et al. concludes that even when choice experiment studies and contingent valuation studies use the same questions to elicit willingness to pay, choice experiments often result in higher willingness to pay estimates (Stevens et al., 2000).

Table 5: Updated T&E Species Meta-Analysis estimation model

Dependent Variable: WTP2006
Method: Least Squares
Included observations: 67

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-23.0109	16.426	-1.400	0.1665
Changesize	0.1928	0.058	3.324	0.0015
Payment Frequency	35.4734	16.765	2.115	0.0386
CV Format	32.7929	14.447	2.269	0.0269
Visitor	77.4726	18.146	4.269	0.0001
Marine	45.3756	18.999	2.388	0.0201
Bird	33.1836	15.126	2.193	0.0322
Choice Experiment	221.7361	26.161	8.475	0.0000

R-squared	0.6382	Mean dependent var	78.6082
Adjusted R-squared	0.5952	S.D. dependent var	78.9802
S.E. of regression	50.2473	F-statistic	14.8661
Log likelihood	-353.2453	Prob(F-statistic)	0.0000

Based on the adjusted R squared, 60% of the variation in willingness to pay for threatened and endangered species is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Since this is a linear model, there is a constant relationship between the independent variables and willingness to pay. Therefore, if the size of the species population increases by 1%, annual household WTP increases by $0.19. If incremental or marginal values of a change in species population are desired, the user can run the meta-analysis benefit transfer function twice: once with all variables set at current values (and *change size* set at zero) and then again with *change size* set to the policy-induced population change that is being evaluated. Negative percentage change in species population can be entered, up to a –50% change (the model is most valid within that range). The difference between the estimated value per household with the particular percent change and the baseline value per household (with a zero percent change) will provide an estimate of the change in value per household with the percentage change in species population.

If payment takes the form of a one-time payment or the purchase of a lifetime membership, WTP increases by $35.47 compared to annual payments. However, since we have standardized the meta-benefit transfer function to predict ***annual*** household WTP, this one time payment variable is set to zero.

If the contingent valuation survey format was dichotomous choice, WTP increases by $32.79. If a visitor is valuing the species, WTP increases by $77.47. In the meta-analysis benefit function transfer, the user can set visitor to 1 or zero. If a marine mammal is being valued, WTP increases by $45.38. If a bird is being valued, WTP increases by $33.18. If the study is a choice experiment, WTP increases $221.74. The influence of this choice experiment variable is moderated by the fact that only 7.5% of the value estimates come from choice experiments. Thus, in the meta-benefit transfer function, the net effect of this variable is just $16.63 on the overall annual household WTP.

6. NATIONAL WILDLIFE REFUGE (NWR) VISITOR USE MODELS

The purpose of these models is to relate National Wildlife Refuge visitation to refuge acres, natural features of the refuge (e.g., lakes, rivers, ocean), population and income in the surrounding area. This is a predictive model that can be used by field biologists and planners.

a. Data Sources

A sample of National Wildlife Refuges, their location, and the visits per activity (non-consumptive visits, fishing visits, hunting visits) for each refuge was obtained using "Banking on Nature 2004: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" by James Caudill, Ph.D. and Erin Henderson in the Division of Economics, U.S. Fish and Wildlife Service, Washington, D.C.

Refuge acres (total, upland, wetland) as well as natural features within the refuge (lakes, rivers, oceans) were found in Refuge brochures, as well as Refuge planning documents, such as Comprehensive Conservation plans and Environmental Impact Statements prepared by the U.S. Fish and Wildlife Service. This data was also verified with the "Banking on Nature 2004" report and refuge websites.

Per-capita income was obtained using the "Banking on Nature 2004" report. County population is based on the population of all counties within a 60 mile radius surrounding the particular Refuge.

b. Model Variable Definitions

Dependent Variables

Big Game Hunting Visits- Includes antelope, bear, deer, elk, moose, wild turkey, and similar large animals which are hunted (U.S. Fish and Wildlife Service, 2002).

Freshwater Fishing Visits- Includes fishing visits to reservoirs, lakes, ponds, and the nontidal portions of rivers and streams (U.S. Fish and Wildlife Service, 2002).

Migratory Bird Hunting Visits- Includes birds that regularly migrate from one region or climate to another, including band-tailed pigeons, coots, ducks, doves, gallinules, geese, rails, and woodcocks (U.S. Fish and Wildlife Service, 2002).

Non-consumptive Visits- Recreational activities that enjoy wildlife without consuming it, such as birding, photography, picnicking, etc. The "Banking on Nature 2004" report categorizes these as nature trails, observation platforms, other wildlife observation, beach/water use, and other recreation.

Saltwater Fishing Visits- Includes fishing visits to oceans, tidal bays and sounds, and the tidal portions of rivers and streams (U.S. Fish and Wildlife Service, 2002).

Small Game Hunting Visits- Includes grouse, partridge, pheasants, quail, rabbits, squirrels, and similar small animals and birds for which many states have small game seasons and bag limits (U.S. Fish and Wildlife Service, 2002).

Total Hunting Visits- All hunting visits, including migratory bird, small game, and big game hunting visits.

Independent Variables
County Population- For each National Wildlife Refuge, population data was aggregated for all counties within a 60 mile radius.

Lake- Open water such as lakes, reservoirs, or ponds within the refuge boundary.

Ln- takes the natural log of the variable.

Ocean- Coastal, salt water.

Per Capita Income- "Banking on Nature 2004" reports the 2003 per capita income of the counties which make up the area economy surrounding the refuge.

River- Running water such as rivers or streams within the refuge boundary.

Total Acres- Current acres within the refuge boundary.

Upland Acres- Includes cropland, grassland, dry forests, woodlands.

Wetland Acres- Includes fresh/brackish marsh, swamps, bogs, bottomland forests.

c. Statistical Results

Generally we retained explanatory variables that were statistically significant at the 10% or higher level in the following models.

Non-consumptive Visits:
Dependent Variable: Ln Nonconsumptive Visits
Method: Least Squares
Included observations: 87

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-12.1170	8.325	-1.455	0.1494
Ocean	1.1012	0.357	3.083	0.0028
Ln Per Capita Income	1.4553	0.802	1.813	0.0734
Ln Total Acres	0.4601	0.124	3.692	0.0004
Ln County Population	0.2550	0.146	1.742	0.0852
R-squared	0.2466	Mean dependent var		10.8888
Adjusted R-squared	0.2099	S.D. dependent var		1.6165
S.E. of regression	1.4369	F-statistic		6.7114
Log likelihood	-152.4105	Prob(F-statistic)		0.0001

Based on the adjusted R squared, 21% of the variation in non-consumptive visits is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

The presence of an ocean has a positive effect on non-consumptive visits to the refuge and is significant at the 1% level.

Per capita income of the area economy surrounding the refuge has a positive effect on non-consumptive visits and is significant at the 10% level. Due to the double log functional form, the per capita income coefficient can also be interpreted as the percent change in non-consumptive visits. A 1% change in per capita income causes a 1.46% change in non-consumptive visits.

Total acreage of the refuge has a positive effect on non-consumptive visits and is significant at the 1% level. Due to the double log functional form, the total acre coefficient can also be interpreted as the percent change in non-consumptive visits. A 1% change in total acres causes a 0.46% change in non-consumptive visits. As total acres increase, non-consumptive visits increase at a decreasing rate (diminishing marginal effect).

County population surrounding the refuge also has a positive effect on non-consumptive visits and is significant at the 10% level. Due to the double log functional form, the county population coefficient can also be interpreted as the percent change in non-consumptive visits. A 1% change in county population causes a 0.26% change in non-consumptive visits. As county population increases, non-consumptive visits increase at a decreasing rate (diminishing marginal effect).

The remaining variable 'lake' was not found to be significant.

Consumptive Visits:
All consumptive visit models below were applied to refuges with positive hunting or fishing visitation. The model is conditional on the refuge offering the consumptive activity.

Variables omitted from the models were not statistically significant at conventional levels (e.g. 10%).

Total Hunting Visits:

Dependent Variable: Ln Total Hunting Visits
Method: Least Squares
Included observations: 73

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3.9600	1.4714	2.6913	0.0089
Lake	0.9435	0.5183	1.8203	0.0730
Ln Total Acres	0.3037	0.1431	2.1216	0.0374
R-squared	0.1059	Mean dependent var		7.7794
Adjusted R-squared	0.0803	S.D. dependent var		1.5851
Log likelihood	-132.6237	F-statistic		4.1438
		Prob(F-statistic)		0.0199

Based on the adjusted R squared, 8% of the variation in total hunting visits is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 5% level.

The presence of a lake has a positive effect on total hunting visits to the refuge and is significant at the 10% level.

Total acreage of the refuge has a positive effect on total hunting visits and is significant at the 5% level. Due to the double log functional form, the total acre coefficient can also be interpreted as the percent change in total hunting visits. A 1% change in total acres causes a 0.3% change in total hunting visits. As total acres increase, total hunting visits increase at a decreasing rate (diminishing marginal effect).

Migratory Bird Hunting Visits:

Dependent Variable: Ln Migratory Bird Hunting Visits
Method: Least Squares
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2.8937	1.8100	1.5987	0.1264
Ln Wetland Acres	0.5051	0.2047	2.4679	0.0233
R-squared	0.2427	Mean dependent var		7.2918
Adjusted R-squared	0.2029	S.D. dependent var		1.6266
S.E. of regression	1.4523	F-statistic		6.0906
Log likelihood	-36.5825	Prob(F-statistic)		0.0233

Based on the adjusted R squared, 20% of the variation in migratory bird hunting visits is explained by the independent variables.

Wetland acreage of the refuge has a positive effect on migratory bird hunting visits and is significant at the 5% level. Due to the double log functional form, the wetland acre coefficient can also be interpreted as the percent change in migratory bird hunting visits. A 1% change in wetland acres causes a 0.5% change in migratory bird hunting visits. As wetland acres increase, migratory bird hunting visits increase at a decreasing rate (diminishing marginal effect).

Small Game Hunting Visits:

Dependent Variable: Ln Small Game Hunting Visits
Method: Least Squares
Included observations: 13

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.9364	2.9960	-0.3125	0.7605
Ln Upland Acres	0.9152	0.3324	2.7533	0.0188
R-squared	0.4080	Mean dependent var		7.2395
Adjusted R-squared	0.3542	S.D. dependent var		1.7854
S.E. of regression	1.4348	F-statistic		7.5806
Log likelihood	-22.0536	Prob(F-statistic)		0.0188

Based on the adjusted R squared, 35% of the variation in small game hunting visits is explained by the independent variables.

Upland acreage of the refuge has a positive effect on small game hunting visits and is significant at the 5% level. Due to the double log functional form, the upland acre coefficient can also be interpreted as the percent change in small game hunting visits. A 1% change in upland acres causes a 0.92% change in small game hunting visits. As upland acres increase, small game hunting visits increase at a decreasing rate (diminishing marginal effect).

<u>Big Game Hunting Visits:</u>

Dependent Variable: Ln Big Game Hunting Visits
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1.8293	3.1071	0.5888	0.5661
Ln Upland Acres	0.6279	0.3541	1.7731	0.0996
R-squared	0.1947	Mean dependent var		7.2754
Adjusted R-squared	0.1328	S.D. dependent var		1.9514
S.E. of regression	1.8172	F-statistic		3.1439
Log likelihood	-29.1707	Prob(F-statistic)		0.0996

Based on the adjusted R squared, 13% of the variation in big game hunting visits is explained by the independent variables.

Upland acreage of the refuge has a positive effect on big game hunting visits and is significant at the 10% level. Due to the double log functional form, the upland acre coefficient can also be interpreted as the percent change in big game hunting visits. A 1% change in upland acres causes a 0.63% change in big game hunting visits. As upland acres increase, big game hunting visits increase at a decreasing rate (diminishing marginal effect).

County population did not come in significant in any of the hunting models. This may be due to the fact that while there is a higher population in the mid and south Atlantic regions, there may be less interest and/or less opportunity for hunting activities. The decreased participation rate may be offsetting the higher population rate, resulting in a zero effect of population on hunting. Likewise, in the less populated north central and intermountain regions, there may be more interest and/or opportunity for hunting activities, resulting in the same zero net effect of population on hunting.

Freshwater Fishing Visits:

Dependent Variable: Ln Freshwater Fishing Visits
Method: Least Squares
Included observations: 62

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	35.7585	15.7470	2.2708	0.0269
Ln Total Acres	0.4908	0.2184	2.2472	0.0284
Ln Per Capita Income	-4.0377	1.5078	-2.6779	0.0096
Ln County Population	0.6538	0.2326	2.8113	0.0067
R-squared	0.2721	Mean dependent var		7.9249
Adjusted R-squared	0.2344	S.D. dependent var		2.1325
S.E. of regression	1.8658	F-statistic		7.2262
Log likelihood	-124.5770	Prob(F-statistic)		0.0003

Based on the adjusted R squared, 23% of the variation in freshwater fishing visits is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Total acreage of the refuge has a positive effect on freshwater fishing visits and is significant at the 5% level. Due to the double log functional form, the total acre coefficient can also be interpreted as the percent change in freshwater fishing visits. A 1% change in total acres causes a 0.49% change in freshwater fishing visits. As total acres increase, freshwater fishing visits increase at a decreasing rate (diminishing marginal effect).

Per capita income of the area economy surrounding the refuge has a negative effect on freshwater fishing visits and is significant at the 1% level. Due to the double log functional form, the per capita income coefficient can also be interpreted as the percent change in freshwater fishing visits. A 1% change in per capita income causes a 4% change in freshwater fishing visits.

County population surrounding the refuge has a positive effect on freshwater fishing visits and is significant at the 1% level. Due to the double log functional form, the population coefficient can also be interpreted as the percent change in freshwater fishing visits. A 1% change in population causes a 0.65% change in freshwater fishing visits. As population increases, freshwater fishing visits increase at a decreasing rate (diminishing marginal effect).

Saltwater Fishing Visits:

Dependent Variable: Ln Saltwater Fishing Visits
Method: Least Squares
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-96.4928	35.3252	-2.7316	0.0162
Ln Total Acres	1.3814	0.4421	3.1246	0.0075
Ln Per Capita Income	8.9709	3.2234	2.7831	0.0147
R-squared	0.4674	Mean dependent var		9.3155
Adjusted R-squared	0.3913	S.D. dependent var		2.4384
S.E. of regression	1.9024	F-statistic		6.1435
Log likelihood	-33.4042	Prob(F-statistic)		0.0122

Based on the adjusted R squared, 39% of the variation in saltwater fishing visits is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the near 1% level.

Total acreage of the refuge has a positive effect on saltwater fishing visits and is significant at the 1% level. Due to the double log functional form, the total acre coefficient can also be interpreted as the percent change in saltwater fishing visits. A 1% change in total acres causes a 1.38% change in saltwater fishing visits.

Per capita income of the area economy surrounding the refuge has a positive effect on saltwater fishing visits and is significant at the 5% level. Due to the double log functional form, the per capita income coefficient can also be interpreted as the percent change in saltwater fishing visits. A 1% change in per capita income causes a 9% change in saltwater fishing visits.

The remaining independent variable, 'county population,' was not significant.

7. STATE-LEVEL VISITOR USE MODELS

The purpose of this model is to relate state-level wildlife related recreation activity days (hunting, fishing, and wildlife viewing) to acres habitat and land access for that state, as well as population and median income for that state. This is a predictive model that can be used by field biologists and planners to estimate changes in wildlife related recreation with changes in habitat and state demographics.

a. Data Sources

Days of hunting (big game, small game, and migratory bird), days of fishing (freshwater and saltwater), as well as days of nonresidential wildlife-watching activity by state were obtained from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Fish and Wildlife Service. This was the most recent data from the U.S. Fish and Wildlife Service at the time of our study.

Habitat and land characteristics, including surface area of nonfederal land, federal land, and water areas, land cover/use of nonfederal rural land (cropland, CRP land, pastureland, rangeland, and forestland), as well as wetland acres for each state were obtained from the U.S. Department of Agriculture's1997 National Resources Inventory Summary Report.

Acres of National forest and state forest land by state were found in the United States Department of Agriculture's "Forest Resources of the United States, 1992."

Acres of land by state under the jurisdiction of the Bureau of Land Management were found in the Bureau of Land Management's 1996 online edition of Public Lands Statistics. This type of federal land was tested in all models where applicable but was not found to be statistically significant.

Acres of National parks by state were found through the National Park Service. This type of federal land was tested in all models where applicable but was not found to be statistically significant.

Population and median income by state were taken from the U.S. Census Bureau, Census 2000, to match visitation data.

b. Model Variable Definitions

<u>Dependent Variables</u>
Big Game Hunting Days- Days of big game hunting by state in the continental U.S. in 2001; includes antelope, bear, deer, elk, moose, wild turkey, and similar large animals which are hunted (U.S. Fish and Wildlife Service, 2002).

Freshwater Fishing Days- Fishing days by state in the continental U.S. in 2001 which took place in reservoirs, lakes, ponds, and the nontidal portions of rivers and streams, excluding the Great Lakes (U.S. Fish and Wildlife Service, 2002).

Migratory Bird Hunting Days- Days of migratory bird hunting by state in the continental U.S. in 2001; includes birds that regularly migrate from one region or climate to another. The survey focused on migratory birds which may be hunted, including bandtailed pigeons, coots, ducks, doves, gallinules, geese, rails, and woodcocks (U.S. Fish and Wildlife Service, 2002).

Saltwater Fishing Days- Fishing days by state in the continental U.S. in 2001 which took place in oceans, tidal bays and sounds, and the tidal portions of rivers and streams (U.S. Fish and Wildlife Service, 2002).

Small Game Hunting Days- Days of small game hunting by state in the continental U.S. in 2001; includes grouse, partridge, pheasants, quail, rabbits, squirrels, and similar small animals and birds for which many states have small game seasons and bag limits (U.S. Fish and Wildlife Service, 2002).

Total Hunting Days- Days of big game, small game, and migratory bird hunting by state in the continental U.S. in 2001.

Wildlife-Watching Activity Days- Days of an activity engaged in primarily for the purpose of feeding, photographing, or observing fish or other wildlife by state in the continental U.S. in 2001. In previous years, this was also termed nonconsumptive activity (U.S. Fish and Wildlife Service, 2002).

<u>Independent Variables</u>

Cropland – A land cover/use category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland, for example, hayland or pastureland that is in a rotation with row or close-grown crops. Noncultivated cropland includes permanent hayland and horticultural cropland (National Resources Inventory, 1997).

CRP Land – A land cover/use category that includes land under a Conservation Reserve Program contract, which is a federal program established under the Food Security Act of 1985 to assist private landowners to convert highly erodible cropland to vegetative cover for 10 years (National Resources Inventory, 1997).

Estuarine Wetlands – Wetlands occurring in the Estuarine System, one of five systems in the classification of wetlands and deepwater habitats. Estuarine wetlands are tidal wetlands that are usually semi-enclosed by land, but have open, partly obstructed or sporadic access to the open ocean. In estuarine wetlands, the ocean water also is at least occasionally diluted by freshwater runoff from the land. The most common example is where a river flows into the ocean (National Resources Inventory, 1997).

Federal Land - A land ownership category designating land that is owned by the federal government. It does not include, for example, trust lands administered by the Bureau of Indian Affairs or Tennessee Valley Authority (TVA) land (National Resources Inventory, 1997).

Ln- takes the natural log of the variable.

Median Income- 1999-2000 two-year moving average of household median income by state taken from the U.S. Census Bureau.

National Forests- Timberland area designated by Executive Order or statute as National forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands (Powell et al, 1992).

Other Private Rural Land – A land cover/use category that includes farmsteads and other farm structures, field windbreaks, barren land, and marshland (National Resources Inventory, 1997).

Palustrine Wetlands – Wetlands occurring in the Palustrine System, one of five systems in the classification of wetlands and deepwater habitats. Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergent plants, or emergent mosses or lichens, as well as small, shallow open water ponds or potholes. Palustrine wetlands are often called swamps, marshes, potholes, bogs, or fens (National Resources Inventory, 1997).

Population- State population taken from the 2000 Census.

Private – A type of ownership pertaining to land belonging to an individual person or persons, a partnership, or a corporation (all of which are persons in the legal sense), as opposed to the public or the government; private property (National Resources Inventory, 1997).

Private Forest land – A land cover/use category that is at least 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cut over forest or abandoned farmland) and not currently developed for nonforest use (National Resources Inventory, 1997).

Private Pastureland – A land cover/use category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding or renovation, and control of grazing. For the NRI, includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether or not it is being grazed by livestock (National Resources Inventory, 1997).

Private Rangeland – A land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland (National Resources Inventory, 1997).

State Forests- Public timberland area owned by states or leased by states for more than 50 years (Powell et al., 1992).

Total Wetlands – Palustrine and Estuarine wetlands.

Water Areas – A land cover/use category comprising water bodies and streams that are permanent open water (National Resources Inventory, 1997).

c. Statistical Results

All non-highly correlated independent variables that were sensible explanatory variables were tested in the following models. Variables omitted from the models were not statistically significant at conventional levels (e.g. 10%).

Big Game Hunting Days:

Dependent Variable: Big Game Hunting Days per Capita
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.0299	0.0060	4.9826	0.0000
Ln Federal Land	8.98E-05	5.22E-05	1.7212	0.0926
Ln State Forest Land	0.0001	6.53E-05	1.8148	0.0767
Ln Private Forest Land	-0.0001	9.07E-05	-1.1461	0.2582
Ln Private Rangeland	-5.67E-05	2.55E-05	-2.2245	0.0315
Ln Median Income	-0.0027	0.0005	-5.0847	0.0000
R-squared	0.4599	Mean dependent var		0.0008
Adjusted R-squared	0.3956	S.D. dependent var		0.0006
S.E. of regression	0.0005	F-statistic		7.1520
Log likelihood	302.1791	Prob(F-statistic)		0.000064

Based on the adjusted R squared, 40% of the variation in big game hunting days per capita is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Federal land has a positive effect on big game hunting days per capita and is significant at the 10% level.

State forest land has a positive effect on big game hunting days per capita and is significant at the 10% level.

Despite private forest land's low level of significance, sensitivity analysis of alternative specifications suggest that controlling for acres of private forest land is important to avoid omitted variable bias. Its negative sign may reflect the large amount of private forest land in commercial plantations and limited public access.

Private rangeland has a negative effect on big game hunting days per capita and is significant at the 5% level. The negative sign on the coefficient may be due to the fact that it is **private** rangeland, and thus has limited hunting access. It could also be due to the fact that rangeland is considerably drier than other types of land, thereby offering less habitat value for big game. It could also be that ranching fencing makes it difficult for some big game to access the ranch.

Median income has a negative effect on big game hunting days per capita and is significant at the 1% level.

Small Game Hunting Days:

Dependent Variable: Ln Small Game Hunting Days
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	8.4253	0.8226	10.2427	0.0000
State Forest Land	0.0003	0.0001	2.2418	0.0305
Cropland	4.26E-05	1.53E-05	2.7806	0.0082
Private Pastureland	0.0001	4.70E-05	2.5406	0.0149
Private Rangeland	-1.95E-05	7.41E-06	-2.6235	0.0122
Population	4.54E-08	1.88E-08	2.4170	0.0202
Median Income	-5.52E-05	1.73E-05	-3.2014	0.0026

R-squared	0.5815	Mean dependent var	6.7201
Adjusted R-squared	0.5203	S.D. dependent var	1.0503
S.E. of regression	0.7274	F-statistic	9.4964
Log likelihood	-49.0499	Prob(F-statistic)	0.000002

Based on the adjusted R squared, 52% of the variation in small game hunting days is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

State forest land has a positive effect on small game hunting days and is significant at the 5% level.

Cropland has a positive effect on small game hunting days and is significant at the 1% level.

Private pastureland has a positive effect on small game hunting days and is significant at the 5% level.

Private rangeland has a negative effect on small game hunting days and is significant at the near 1% level. This negative sign could be due to the fact that rangeland is considerably drier than other types of land. Another reason may be that the average ownership size of ranches tends to be greater than the average ownership size of other types of land, such as farms. Hence this could result in fewer owner user days compared with the same areas split up in numerous small farms. This, in turn, could result in a decrease in small game hunting days when there is an increase in rangeland.

Population has a positive effect on small game hunting days and is significant at the 5% level.

Median income has a negative effect on small game hunting days and is significant at the 1% level.

Migratory Bird Hunting Days:

Dependent Variable: Ln Migratory Bird Hunting Days per Capita
Method: Least Squares
Observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-7.5023	1.2280	-6.1091	0.0000
Ln Federal Land	0.0914	0.0469	1.9496	0.0593
Ln Cropland	0.2488	0.0765	3.2524	0.0025
Ln Private Forest Land	-0.3271	0.0769	-4.2515	0.0001
Ln Total Wetlands	0.1492	0.0799	1.8677	0.0702
Median Income	-5.62E-05	1.36E-05	-4.1385	0.0002
R-squared	0.6325	Mean dependent var		-9.0302
Adjusted R-squared	0.5800	S.D. dependent var		0.8263
S.E. of regression	0.5355	F-statistic		12.048
Log likelihood	-29.3235	Prob(F-statistic)		0.000001

Based on the adjusted R squared, 58% of the variation in migratory bird hunting days per capita is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Federal land has a positive effect on migratory bird hunting days per capita and is significant at the 10% level. Due to the double log functional form, the federal land coefficient can also be interpreted as the percentage change in migratory bird hunting days per capita. A 1% change in federal land causes a 0.09% change in migratory bird hunting days per capita. As federal land increases, migratory bird hunting days per capita increase at a decreasing rate (diminishing marginal effect).

Cropland has a positive effect on migratory bird hunting days per capita and is significant at the 1% level. Due to the double log functional form, the cropland coefficient can also be interpreted as the percentage change in migratory bird hunting days per capita. A 1% change in cropland causes a 0.25% change in migratory bird hunting days per capita. As cropland increases, migratory bird hunting days per capita increase at a decreasing rate (diminishing marginal effect).

Private forest land has a negative effect on migratory bird hunting days per capita and is significant at the 1% level. The negative sign on the coefficient may be due to the fact that forest land is not suitable habitat for many migratory bird species. Due to the double log functional form, the forest land coefficient can also be interpreted as the percentage change in migratory bird hunting days per capita. A 1% change in forest land causes a 0.33% change in migratory bird hunting days per capita. As forest land increases, migratory bird hunting days per capita decrease.

Total wetlands has a positive effect on migratory bird hunting days per capita and is significant at the 10% level. Due to the double log functional form, the total wetlands coefficient can also be interpreted as the percentage change in migratory bird hunting days per capita. A 1% change in total wetlands causes a 0.15% change in migratory bird hunting days per capita. As total wetlands increase, migratory bird hunting days per capita increase at a decreasing rate (diminishing marginal effect).

Median income has a negative effect on migratory bird hunting days per capita and is significant at the 1% level.

<u>Total Hunting Days:</u>

Dependent Variable: Total Hunting Days per Capita
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.0058	0.0012	4.8392	0.0000
Ln Federal Land	0.0001	6.95E-05	2.0669	0.0449
Ln Private Rangeland	-7.66E-05	3.41E-05	-2.2479	0.0299
Ln Private Forest Land	-0.0003	0.0001	-2.6953	0.0101
Ln Total Wetlands	0.0002	7.88E-05	2.6593	0.0110
Median Income	-9.34E-08	1.52E-08	-6.1359	0.0000
R-squared	0.5189	Mean dependent var		0.0012
Adjusted R-squared	0.4616	S.D. dependent var		0.0009
S.E. of regression	0.0006	F-statistic		9.0584
Log likelihood	288.2962	Prob(F-statistic)		0.000007

Based on the adjusted R squared, 46% of the variation in total hunting days per capita is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Federal land has a positive effect on total hunting days per capita and is significant at the 5% level.

Private rangeland has a negative effect on total hunting days per capita and is significant at the 5% level. The negative sign on the coefficient may be due to the fact that it is private rangeland, and thus has limited hunting access. It could also be due to the fact that rangeland is considerably drier than other types of land or that typical ranch lands ownership size is quite large, limiting the number of owner users.

Private forest land has a negative effect on total hunting days per capita and is significant at the 1% level. The negative sign on the coefficient may be due to the land being in private commercial plantation forests with limited public access.

Total wetlands has a positive effect on total hunting days per capita and is significant at the near 1% level.

Median income has a negative effect on total hunting days per capita and is significant at the 1% level.

Please see the Appendix for an alternative model of total hunting days per capita that splits out public land into Federal National Forests and State-owned public forest land.

Freshwater Fishing Days:

Dependent Variable: Ln Freshwater Fishing Days
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1.7043	0.9123	-1.8683	0.0685
Ln State Forest Land	0.1027	0.0470	2.1845	0.0344
Ln National Forest	0.0650	0.0220	2.9602	0.0050
Ln Water Areas	0.1990	0.0797	2.4969	0.0164
Ln Population	0.5504	0.0674	8.1646	0.0000
R-squared	0.8056	Mean dependent var		8.8166
Adjusted R-squared	0.7875	S.D. dependent var		0.8825
S.E. of regression	0.4069	F-statistic		44.5348
Log likelihood	-22.3041	Prob(F-statistic)		0.0000

Based on the adjusted R squared, 79% of the variation in freshwater fishing days is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

State forest land has a positive effect on freshwater fishing days and is significant at the 5% level. Due to the double log functional form, the state forest land coefficient can also be interpreted as the percentage change in freshwater fishing days. A 1% change in state forest land causes a 0.10% change in freshwater fishing days. As state forest land increases, freshwater fishing days increase at a decreasing rate (diminishing marginal effect).

National forest land has a positive effect on freshwater fishing days and is significant at the 1% level. Due to the double log functional form, the national forest land coefficient can also be interpreted as the percentage change in freshwater fishing days. A 1% change in national forest land causes a 0.065% change in freshwater fishing days. As national forest land increases, freshwater fishing days increase at a decreasing rate (diminishing marginal effect).

Water areas has a positive effect on freshwater fishing days and is significant at the 5% level. Due to the double log functional form, the water areas coefficient can also be interpreted as the percentage change in freshwater fishing days. A 1% change in water areas causes a 0.199% change in freshwater fishing days. As water areas increases, freshwater fishing days increase at a decreasing rate (diminishing marginal effect).

Population has a positive effect on freshwater fishing days and is significant at the 1% level. Due to the double log functional form, the population coefficient can also be interpreted as the percentage change in freshwater fishing days. A 1% change in population causes a 0.55% change in freshwater fishing days. As population increases, freshwater fishing days increase at a decreasing rate (diminishing marginal effect).

Please see the Appendix for an alternative model of freshwater fishing days that may be more applicable to states dominated by private pastureland and having few, if any, National and State Forests.

Saltwater Fishing Days:

Dependent Variable: Saltwater Fishing Days per Capita
Method: Least Squares
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.0147	0.0074	1.9775	0.0655
Ln Cropland	-0.0002	6.01E-05	-3.0173	0.0082
Ln Estuarine Wetlands	0.0001	5.01E-05	2.1150	0.0505
Ln Median Income	-0.0012	0.0007	-1.8240	0.0869
R-squared	0.4011	Mean dependent var		0.0006
Adjusted R-squared	0.2888	S.D. dependent var		0.0004
S.E. of regression	0.0004	F-statistic		3.5712
Log likelihood	131.9450	Prob(F-statistic)		0.0377

Based on the adjusted R squared, 29% of the variation in saltwater fishing days per capita is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 5% level.

Cropland has a negative effect on saltwater fishing days per capita and is significant at the 1% level.

Estuarine wetlands has a positive effect on saltwater fishing days per capita and is significant at the 5% level.

Median income has a negative effect on saltwater fishing days per capita and is significant at the 10% level.

Wildlife-Watching Activity Days:

Dependent Variable: Ln Wildlife-Watching Activity Days
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3.7016	0.8926	4.1472	0.0002
Ln State Forest Land	0.2021	0.0640	3.1583	0.0029
Ln Private Forest land	0.1886	0.0892	2.1143	0.0403
Population	5.67E-08	1.26E-08	4.4995	0.0001
Median Income	4.09E-05	1.12E-05	3.6592	0.0007
R-squared	0.7465	Mean dependent var		8.6082
Adjusted R-squared	0.7229	S.D. dependent var		0.8684
S.E. of regression	0.4571	F-statistic		31.6553
Log likelihood	-27.8934	Prob(F-statistic)		0.0000

Based on the adjusted R squared, 72% of the variation in nonresidential wildlife-watching activity days is explained by the independent variables.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

State forest land has a positive effect on wildlife-watching activity days and is significant at the 1% level. Due to the double log functional form, the state forest land coefficient can also be interpreted as the percentage change in wildlife-watching activity days. A 1% change in state forest land causes a 0.2% change in wildlife-watching activity days. As state forest land increases, wildlife-watching activity days increase at a decreasing rate (diminishing marginal effect).

Private forest land has a positive effect on wildlife-watching activity days and is significant at the 5% level. Due to the double log functional form, the private forest land coefficient can also be interpreted as the percentage change in wildlife-watching activity days. A 1% change in private forest land causes a 0.19% change in wildlife-watching activity days. As private forest land increases, wildlife-watching activity days increase at a decreasing rate (diminishing marginal effect). We suspect that private forest land may provide habitat for some watchable wildlife species, some which (e.g., birds) may be seen without physically accessing the private land.

Population has a positive effect on wildlife-watching activity days and is significant at the 1% level.

Median income has a positive effect on wildlife-watching activity days and is significant at the 1% level.

The variables 'National forests,' 'cropland,' 'CRP land,' 'private pastureland,' and 'private rangeland' were not statistically significant.

8. CONCLUSIONS

Within the limits of the available literature and data, we have provided up to date benefit transfer values and estimated meta-analysis equations for benefit function transfer. This has been done for both wildlife recreation use values for hunting, fishing and viewing. This has also been done for total economic values of habitats (e.g., wetlands, aquatic resources and terrestrial) and species (e.g., salmon and T&E species). We have also estimated wildlife recreation use estimation models for National Wildlife Refuges that are applicable to state Wildlife Management Areas. Finally, we have estimated state-level wildlife recreation use estimation models for the lower 48 states that can be applied to privately owned and public lands that represent potential habitat for game and non-game species.

Appendix: Alternative State-Level Hunting and Freshwater Fishing Visitor Use Models

Total Hunting Days:

Dependent Variable: Total Hunting Days per Capita
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.0072	0.0013	5.7159	0.0000
Ln State Forest	0.0001	8.81E-05	1.5269	0.1345
Ln National Forest	0.0001	4.58E-05	2.2764	0.0281
Ln Private Rangeland	-5.67E-05	2.62E-05	-2.1614	0.0366
Ln Private Forest Land	-0.0005	0.0001	-3.6434	0.0007
Ln Total Wetlands	0.0002	7.88E-05	2.5596	0.0143
Median Income	-9.51E-08	1.48E-08	-6.4261	0.0000
R-squared	0.5719	Mean dependent var		0.0012
Adjusted R-squared	0.5093	S.D. dependent var		0.0009
S.E. of regression	0.0006	F-statistic		9.1293
Log likelihood	291.1007	Prob(F-statistic)		0.000002

This variation of the original model for total hunting days per capita tests the effects of State Forest and National Forest land on total hunting days per capita rather than simply the effects of federal land as a whole on total hunting days per capita. This model may be more useful in eastern states with significant State Forest acreage and minimal Federal lands.

Based on the adjusted R squared, 51% of the variation in total hunting days per capita is explained by the independent variables, justly slightly higher than the original Total Hunting Days model.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

State forest land has a positive effect on total hunting days per capita and is significant at the near 10% level.

National forest land has a positive effect on total hunting days per capita and is significant at the 5% level.

Private rangeland has a negative effect on total hunting days per capita and is significant at the 5% level. The negative sign on the coefficient may be due to the fact that it is private rangeland, and thus has limited hunting access. It could also be due to the fact that rangeland is considerably drier than other types of land offering less habitat value.

Private forest land has a negative effect on total hunting days per capita and is significant at the 1% level. The negative sign on the coefficient may be due to the acreage being in private commercial plantation forests with limited public access.

Total wetlands has a positive effect on total hunting days per capita and is significant at the 5% level.

Median income has a negative effect on total hunting days per capita and is significant at the 1% level.

Freshwater Fishing Days:

Dependent Variable: Freshwater Fishing Days
Method: Least Squares
Observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2661.975	919.4431	2.8952	0.0059
Private Pastureland	0.8148	0.2233	3.6481	0.0007
Water Areas	1.6336	0.7349	2.2230	0.0314
Population	0.0005	0.0001	4.6850	0.0000

R-squared	0.6626	Mean dependent var	9186.229
Adjusted R-squared	0.6396	S.D. dependent var	6550.533
S.E. of regression	3932.685	F-statistic	28.7995
Log likelihood	-463.3205	Prob(F-statistic)	0.0000

This variation of the original model for freshwater fishing days looks at the effects of private pastureland (no federal land) on freshwater fishing days whereas the original model looked at the effects of state forest and national forest land, rather than any private land, on freshwater fishing days. Thus, this model may be useful in states with predominantly private land.

Based on the adjusted R squared, 64% of the variation in freshwater fishing days is explained by the independent variables, somewhat less explanatory power than the original models.

Based on the F statistic, the independent variables as a group are statistically different from zero at the 1% level.

Private pastureland has a positive effect on freshwater fishing days and is significant at the 1% level.
Water areas has a positive effect on freshwater fishing days and is significant at the 5% level.
Population has a positive effect on freshwater fishing days and is significant at the 1% level.

9. REFERENCES

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