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# Recreation Economic Values for Estimating Outdoor Recreation Economic Benefits From the National Forest System

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## Abstract

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Natural resource professionals are often tasked with weighing the benefits and costs of changes in ecosystem services associated with land management alternatives and decisions. In many cases, federal regulations even require land managers and planners to account for these values explicitly. Outdoor recreation is a key ecosystem service provided by national forests and grasslands, and one of significant interest to the public. This report presents the most recent update of the Recreation Use Values Database, based on an exhaustive review of economic studies spanning 1958 to 2015 conducted in the United States and Canada, and provides the most up-to-date recreation economic values available. When combined with data pertaining to recreation activities and the quantity of recreation use, the recreation economic values can be used for estimating the economic benefits of outdoor recreation. The recreation economic value estimates provided in this report, whether from past research literature or from values constructed using our meta-analysis benefit function, are average consumer surplus per person per activity day.

Keywords: Benefit transfer, economic value, ecosystem services, outdoor recreation, recreation benefits, nonmarket valuation, national forest planning and management, NEPA.

## Preface

This report was sponsored by the National Center for Natural Resource Economics Research. The center is a virtual collaborative effort of the Washington office and the regional research stations within U.S. Department of Agriculture, Forest Service, Research and Development. The center was founded to respond rapidly to emerging natural resource economic issues of national significance by leveraging expertise across the Forest Service. The center sponsors research with funding from client organizations and regional research station contributions.

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## Introduction

Outdoor recreation is one of the most widely recognized ecosystem services provided by national forests and grasslands and is identified as one of five uses under the Multiple-Use Sustained-Yield Act of 1960. The forest reserves, which would eventually become the first national forests, were originally reserved in the late 19th century to conserve timber and water. Those places also rather quickly became destinations for people seeking both primitive and developed recreation opportunities (Waugh 1918). Today's National Forest System (NFS) receives more than 148 million visits annually with visitors engaging in a variety of outdoor pursuits (USDA FS 2017). The continuing role of the Forest Service in providing sustainable recreation opportunities to the public is evident in the agency's current strategic plan. Developing and maintaining sustainable recreation opportunities is identified as one way to achieve the agency's strategic objectives: "Strengthen Communities" and "Connect People to the Outdoors" (USDA FS 2015). Meeting these objectives requires understanding what recreation activities occur on national forests and grasslands, who is involved in that recreation, and how much do they value their recreation experiences. Recreation activities and numbers of participants on national forests are tracked by the National Visitor Use Monitoring (NVUM) program (English et al. 2002). Other federal and state agencies have their own monitoring programs that also provide estimates of recreation use and activity participation. The economic values that people hold for specific recreation activities are primarily tracked through periodic updates to the Recreation Use Value Database (RUVD) (e.g., Rosenberger and Loomis 2001) and in the scientific literature.

**Natural resource professionals are often tasked with weighing the benefits provided by natural resources against the costs of management.**

Natural resource professionals are often tasked with weighing the benefits provided by natural resources against the costs of management to produce those benefits. Although the social and economic values of ecosystem services, including outdoor recreation opportunities, are widely recognized, they can be difficult to quantify. Yet in many circumstances, federal regulations require land managers and planners to account for those values explicitly. Within the Forest Service, for example, the Renewable Resources Planning Act of 1974 (superseded by the Government Performance and Results Act of 1993), which informs management of national forests and grasslands, includes an assessment phase and a program analysis phase (USDA FS 2000). The assessment phase identifies the supply of, and demand for, renewable resources on the nation's forests and grasslands. The program analysis phase evaluates the benefits and costs associated with the Forest Service's various programs. These requirements demand credible benefit estimates for key ecosystem

services associated with Forest Service management and planning. More broadly, the need for credible benefit estimates is underscored by the President Barack Obama administration's 2015 memorandum directing federal agencies to factor the values of ecosystem services into all federal planning and decisionmaking (Office of Management and Budget 2015).

The economic benefits of recreation use of NFS lands can be estimated for given locations using original studies or information transferred from prior studies conducted elsewhere. The latter method—known as "benefit transfer"—applies benefit estimates obtained through primary research for one location to other unstudied locations of interest. Benefit transfer is used by public agencies and other practitioners when (1) available time, funding, or expertise for conducting original studies are limited; (2) there are available data from existing studies conducted elsewhere; and (3) the application of benefit transfer, given the available studies and location of interest, is deemed reasonable by analysts. Benefit transfer and published recreation economic values can also be used to meet the needs of state and local resource management agencies, as well as nongovernment organizations and private consultants.

**The economic value of any given recreation activity is a monetary measure of the economic benefits received by an individual or group doing that activity.**

This report is intended to meet the continuing need for current recreation benefit information by updating the Rosenberger and Loomis (2001) and Loomis (2005) databases of recreation economic values. This update reflects the most recent version of the RUVD, based on an exhaustive review of economic studies spanning 1958 to 2015 conducted in the United States and Canada. The report thus provides the most current and comprehensive set of recreation economic values available. Specifically, this report provides (1) a brief review of economic concepts and benefit transfer methods, (2) estimates of recreation economic values by primary recreation activity and Forest Service region, and (3) additional context and guidance for analysts using these estimates. The appendix provides technical information about benefit transfer and nonmarket values, and an overview of the RUVD itself. Additional information about the RUVD can be found online at: http://recvaluation.forestry.oregonstate.edu/.

## Recreation Economic Value

The economic value of any given recreation activity is a monetary measure of the economic benefits received by an individual or group doing that activity. For any one individual, the net economic value of a given recreation activity is measured as the maximum amount the individual is willing to pay to participate in the activity, less the actual cost incurred by the individual to participate in that activity. The economic value of recreation differs from the economic impact of recreation.

Economic impact (or economic contribution) measures how spending by recreationists affects economies within a given geography (e.g., community, region, state, or nation) by virtue of the influence that spending has on employment and income. Economists typically use an analytical method called economic impact (or input/output) analysis to evaluate economic impacts. In this report, we are focused only on the economic value of recreation benefits and not recreation economic impacts. The economic impacts associated with national forest recreation are reported by other sources (e.g., White et al. 2016).

Benefit-cost analysis is a common method for evaluating the potential influence that planning and management alternatives and decisions might have on outdoor recreation. For example, benefit-cost analysis can be used to address such questions as: What is the relative worth (i.e., benefits generated) from investments in recreation opportunities, settings, and resources? Benefit-cost analysis can include both market and nonmarket values. Market values are those that are readily identifiable and addressed in typical market transactions and usually involve observable prices or the transfer of money, such as the construction costs and entrance fees. Nonmarket values are those that are not addressed or represented in typical market transactions and can include things such as the value someone has for the opportunity to view nature or the loss of well-being from residents who must endure more traffic from people engaging in recreation. Benefit-cost analysis can be used to consider present benefits and costs as well as those that might be experienced in the future. In this report, we focus on the computation of recreation economic values by developing "direct use values" representing the benefits to individual recreationists directly engaged in outdoor recreation activities. These values represent "access" to a recreation site or to an activity, relative to that location or activity not being available or accessible to recreationists. Thus, these economic values measure the total net benefits of doing the recreation activity rather than the total net benefits from changes in the quality or characteristic of that recreation. The resulting recreation economic values enable scientists, resource analysts, and other practitioners to apply benefit transfer methods to compute the economic value of recreation benefits based on recreation participant numbers reported or projected for a location or activity over a given period. The application of these average values to economic assessments is discussed further in the appendix.

## Benefit Transfer Methods

Benefit transfer methods include value transfer and function transfer. Value transfer is the use of a single estimate of value or a weighted average of multiple estimates of value obtained from previously published studies and research literature. Value

transfer can be an attractive method for estimating recreation economic benefits when time, funding, and expertise are insufficient to conduct an original study. Moreover, new estimates of economic value based on original or primary research are not needed if resulting value estimates are unlikely to statistically differ from estimates derived from benefit transfer methods. However, original or primary research may provide additional information necessary to evaluate or assess management implications at a site—how values relate to changes in resource or site quality, proposed management options, or other attributes held constant in the benefit transfer estimation process, for example.

Function transfer is the use of a statistical model to derive recreation economic values. The model is estimated from participant or survey data available from one or more previously published studies and is adjusted for characteristics of the site or collection of sites being considered. Function transfers can also rely on data summarizing value estimates reported in a body of literature (such as the RUVD), using a technique known as meta-analysis. Function transfer using meta-analysis can be a more statistically rigorous and robust method for conducting benefit transfer, but is dependent on the availability of information about the characteristics of a specific site, or collection of sites, being considered. Rosenberger and Loomis (2001, 2017) provide a thorough conceptual background for different benefit transfer methods. Additional information about the mechanics of benefit transfer methods can be found in the appendix of this report.

**Research studies have tested the validity and reliability of benefit transfer methods, and all methods generally do well.**

Many research studies have tested the validity and reliability of benefit transfer methods, and all methods generally do well. Function transfers typically outperform value transfers in terms of validity and reliability. A summary of related literature shows median benefit transfer error for function transfers at 36 percent compared to value transfers at 45 percent (Rosenberger 2015). There is significant variability around both median transfer error estimates, which may in part be due to the experimental nature of these evaluations in academic (or research) settings. In actual benefit transfers conducted by economists and analysts, we feel that good judgment will help to avoid excessive transfer errors. The smallest transfer errors are generally found in benefit transfer applications where the study site and the policy site are similar.

## How Economic Values for NFS Recreation Were Estimated

We developed estimates of the economic values of recreation benefits for 14 outdoor recreation activity sets (table 1). These recreation activity sets are based on outdoor recreation activities currently recognized by the Forest Service NVUM program

**Table 1—Definitions and National Visitor Use Monitoring categories of primary recreation activities represented in the Recreation Use Values Database**

| Primary activity | Definition | National Visitor Use Monitoring activity represented |
|---|---|---|
| Backpacking | Camping at primitive or dispersed backcountry sites | Primitive camping, backpacking |
| Biking | Mountain and leisure biking | Bicycling |
| Cross-country skiing | Cross-country skiing | Cross-country skiing and snowshoeing |
| Developed camping | Camping at sites with developed amenities such as fire pits, electricity, toilets, picnic tables, and parking | Developed camping |
| Downhill skiing | Downhill skiing and snowboarding | Downhill skiing and snowboarding |
| Fishing | Freshwater fishing: all species, bodies of water, and angling techniques | Fishing |
| Hiking | Hiking, walking, jogging, and trail running that does not include backcountry camping | Hiking and walking |
| Hunting | Big game, small game, and waterfowl hunting | Hunting |
| Motorized boating | All types of motorized boating | Motorized water activities |
| Nature related | Nature watching and visitor center use | Nature center activities, nature study, viewing wildlife, viewing natural features, visiting historic sites |
| Nonmotorized boating | Floating, kayaking, rafting, and all types of nonmotorized boating | Nonmotorized water activities |
| Off-highway vehicle use, snowmobiling | Snowmobiling and off-road and all-terrain vehicle riding | Off-highway vehicle use, motorized trail activity, snowmobiling, other motorized activity |
| Other recreation | Primary and general recreation activities not accounted for in other categories | Relaxing, horseback riding, gathering forest products, resort use, other nonmotorized activities, other activities |
| Picnicking | Picnicking | Picnicking |

(USDA Forest Service 2017). Several of the activity sets represent a narrow group of activities (e.g., downhill skiing and snowboarding) while others correspond to a mix of outdoor recreation activities (e.g., off-highway vehicle motorized trail use including snowmobiling). The 14 activity sets also correspond well to recreation activity groupings typically included in the Forest Service's Resource Planning Act (RPA) assessments for recreation (e.g., Bowker et al. 2012), as well as Statewide Comprehensive Outdoor Recreation Plan (SCORP) reports completed for individual states (e.g., California State Parks 2014, Oregon Parks and Recreation Department 2013, Washington State Recreation and Conservation Office 2013).

Data for estimating recreation economic values for the NFS were drawn from the RUVD. The RUVD is based on an exhaustive review of recreation economic value studies spanning 1958 to 2015 conducted in the United States and Canada.

The data were developed following recommended best practices for meta-analysis practitioners (Stanley et al. 2013). The current version of the RUVD contains 3,194 individual recreation economic value estimates from 422 individual studies. For our purposes, we narrowed these estimates to the 14 NVUM recreation activity sets (table 2) by (1) eliminating 180 estimates for Canada; (2) eliminating 231 estimates for irrelevant activities (e.g., saltwater fishing and beach activities); and (3) removing 74 outlier estimates (i.e., unreasonably small or large values, which significantly affect average values) as less than $5 or greater than $500 per person per activity day. These changes resulted in the 2,709 estimates from 342 studies summarized in table 2. It is common for a single study to report several recreation economic value estimates, hence the disparity in the number of estimates and studies.

**Table 2—Summary statistics for average recreation economic value estimates of consumer surplus[a] per primary activity day per person from recreation demand studies, 1958 to 2015**

| Activity | Number of studies[b] | Number of estimates[c] | Mean value estimate | Median value estimate | Standard error of the mean | Range of value estimates | |
|---|---|---|---|---|---|---|---|
| | | | | | | Minimum | Maximum |
| Backpacking | 6 | 41 | $17.04 | $9.83 | 2.44 | $6.30 | $60.16 |
| Biking | 13 | 36 | $98.94 | $63.48 | 17.43 | $11.78 | $499.34 |
| Cross-country skiing | 3 | 5 | $36.84 | $31.43 | 6.93 | $20.12 | $60.18 |
| Developed camping | 22 | 82 | $22.99 | $16.12 | 2.47 | $5.08 | $166.11 |
| Downhill skiing | 5 | 13 | $77.63 | $30.54 | 25.62 | $7.85 | $277.86 |
| Fishing | 120 | 913 | $72.59 | $53.27 | 2.22 | $5.36 | $464.82 |
| Hiking | 37 | 111 | $78.19 | $47.17 | 7.97 | $5.02 | $451.64 |
| Hunting | 64 | 618 | $76.72 | $63.12 | 2.38 | $5.04 | $419.60 |
| Motorized boating | 20 | 83 | $42.48 | $19.72 | 6.63 | $5.02 | $437.18 |
| Nature related | 47 | 431 | $63.46 | $47.10 | 2.79 | $5.04 | $441.26 |
| Nonmotorized boating | 23 | 83 | $114.12 | $48.95 | 13.54 | $5.18 | $473.02 |
| Off-highway vehicle use, snowmobiling | 14 | 49 | $60.61 | $51.19 | 9.58 | $9.06 | $462.96 |
| Other recreation | 66 | 220 | $62.06 | $30.33 | 5.02 | $5.12 | $390.74 |
| Picnicking | 8 | 24 | $31.98 | $23.62 | 6.62 | $5.03 | $149.13 |

[a] All value estimates in 2016 dollars. These figures are general descriptive statistics from studies contained in the Recreation Use Values Database. These figures are intended to give information about the range and central tendencies of values in the research literature for recreation activities common to national forests and grasslands. The values in this table should not be used for benefit transfer purposes; instead use the values in table 3.

[b] Total number of studies is 342 (some studies report separate value estimates for two or more primary activities).

[c] Total number of estimates is 2,709.

The distribution of study numbers across the 14 activity sets reflects the relative numbers of scientific studies focused on different recreation activities and does not reflect the relative popularity or importance of any one activity set over another. Wildlife-related activities, such as fishing and hunting, have historically been the focus of much recreation benefit research, for example. Conversely, downhill skiing and backpacking have received relatively less attention in the research literature. Most studies included in the database focused on recreation in rural, rather than urban, places. There are wide ranges of recreation economic value estimates across most activities. The range of value estimates reflects variation across individual study sites (e.g., site quality, attributes, and recreation facilities) and study participants, as well as differences in study methods. Accounting for this variation is one reason why meta-analysis is especially attractive for developing economic estimates of recreation values.

**We developed estimates of the average recreation economic values per person per day for each Forest Service region and the NFS as a whole.**

We developed estimates of the average recreation economic values per person per day for each Forest Service region and the NFS as a whole. We developed the estimates by fitting a meta-regression statistical model to the economic estimates of values for recreation activities that are relevant to national forests, and associated data contained in the RUVD. The regression measured the effect or relationship of select independent variables from the RUVD to the recreation economic value data characterizing the standardized consumer surplus per person per day as:

$$\text{Value/person/primary activity day} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_k X_k$$

where there are k explanatory variables (k = 1…K). The βs measure the statistical relationship between the variation in the explanatory variable to the variation in the value estimates, also known as partial effects. The estimates of economic value for all primary recreation activities and regions were then constructed by weighting the measured partial effect (coefficient) of relevant policy site features by database fixed values—the nonactivity and nonregion variables were held constant at their representation in the data (i.e., at their mean value). We then summed across these weighted partial effects to derive recreation economic value. This produces a recreation economic value estimate that adjusts the baseline estimate (by holding all other nonactivity and nonregion effects constant at their mean value) by activity- and region-specific partial effects.

For example, a recreation economic value for developed camping in Region 1 (Northern Region) was derived by setting the partial effects for developed camping and Region 1 at their full level (weights = 1) and removing the partial effects of other recreation activities and regions (weights = 0), while holding all the effects of all other variables at their mean value. We repeated the process for all activities

for all regions and the NFS as a whole. The recreation economic values estimated in this manner are intended to be used only to represent the value associated with recreationists' **primary** recreation activities; they do not represent the value for ancillary, or secondary, activities and should not be used to estimate economic benefits for those activities. The recreation economic values we report are robust to the uniqueness of any single study given they rely on contributions from all related studies in the metadata and are systematically adjusted based on measurable differences across the sites being studied. Additional details on this meta-analysis function, along with example applications, are provided in the appendix.

We stress that the recreation economic value estimates provided in this report are average values of consumer surplus per person, per primary activity day. Consumer surplus, or net willingness to pay (i.e., total willingness to pay minus cost to engage in the activity), is a measure of the welfare an individual gains by engaging in an activity or purchasing a good. This measure is commonly used for benefit-cost analysis or economic efficiency analysis by federal agencies such as the U.S. Army Corps of Engineers, Bureau of Reclamation, U.S. Environmental Protection Agency, and the Forest Service (see Forest Service Handbook SFH 1909.17). Additional technical notes on this concept are provided in the appendix.

## Economic Values of Recreation Benefit

Average recreation economic values are reported for each of the 14 primary recreation activities for each Forest Service region, and the NFS as a whole in table 3. Nationally, recreation economic values range from about $45 per person per day for camping and backpacking to about $120 per person per day for nonmotorized boating. On average, a day of recreating on national forest lands provides about $80 in benefit to the recreationist. Average recreation economic values across all activities for individual Forest Service regions were calculated as the weighted average of the share of each region's recreation use in each primary activity. Region-level recreation use was drawn from current NVUM estimates (USDA FS 2017). Average recreation economic values for Forest Service regions range from about $63/day for Region 5 (Pacific Southwest Region) national forests to about $77/day for Regions 1 and 4 (Intermountain Region) national forests to $103 for Region 10 (Alaska Region) national forests. The regional-level recreation economic values are influenced by the types of activities popular in each region and the underlying values for those activities.

Analysts need to pay attention to units of measure when applying the recreation economic values reported here to compute aggregate recreation benefits. We report the recreation economic values on an "activity day" basis (i.e., benefit per

**Table 3—Estimates of the average economic value of recreation benefits (use value) by primary activity and Forest Service region (average consumer surplus per person per primary activity day)**

| | Forest Service region | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Primary activity** | **R1** | **R2** | **R3** | **R4** | **R5** | **R6** | **R8** | **R9** | **R10** | **National** |
| Backpacking | 39.59 | 32.81 | 40.89 | 42.81 | 26.64 | 33.15 | 32.61 | 21.10 | 65.09 | 44.00 |
| Biking | 93.18 | 86.40 | 94.48 | 96.40 | 80.23 | 86.74 | 86.20 | 74.70 | 118.69 | 97.60 |
| Cross-country skiing | 62.96 | 56.18 | 64.26 | 66.18 | 50.01 | 56.52 | 55.98 | 44.47 | 88.46 | 67.37 |
| Developed camping | 42.06 | 35.28 | 43.36 | 45.27 | 29.11 | 35.61 | 35.07 | 23.57 | 67.56 | 46.47 |
| Downhill skiing | 88.67 | 81.89 | 89.97 | 91.88 | 75.72 | 82.23 | 81.68 | 70.18 | 114.17 | 93.08 |
| Fishing | 77.96 | 71.18 | 79.26 | 81.18 | 65.01 | 71.52 | 70.98 | 59.47 | 103.46 | 82.37 |
| Hiking | 90.90 | 84.12 | 92.20 | 94.12 | 77.95 | 84.46 | 83.91 | 72.41 | 116.40 | 95.31 |
| Hunting | 83.86 | 77.08 | 85.16 | 87.07 | 70.90 | 77.41 | 76.87 | 65.37 | 109.36 | 88.27 |
| Motorized boating | 64.82 | 58.04 | 66.12 | 68.03 | 51.87 | 58.37 | 57.83 | 46.33 | 90.32 | 69.23 |
| Nature related | 66.57 | 59.79 | 67.87 | 69.79 | 53.62 | 60.13 | 59.59 | 48.09 | 92.08 | 70.99 |
| Nonmotorized boating | 115.37 | 108.59 | 116.67 | 118.59 | 102.42 | 108.93 | 108.38 | 96.88 | 140.87 | 119.78 |
| Off-highway vehicle use/snowmobiling | 56.89 | 50.11 | 58.19 | 60.11 | 43.94 | 50.45 | 49.91 | 38.40 | 82.39 | 61.30 |
| Other recreation | 71.45 | 64.67 | 72.75 | 74.66 | 58.49 | 65.00 | 64.46 | 52.96 | 96.95 | 75.86 |
| Picnicking | 55.62 | 48.84 | 56.92 | 58.83 | 42.67 | 49.17 | 48.63 | 37.13 | 81.12 | 60.03 |
| Weighted average | 76.24 | 71.88 | 76.20 | 77.04 | 63.19 | 68.64 | 66.70 | 55.93 | 103.00 | 79.96 |

Note: All value estimates are in 2016 dollars. These estimates are computed using a statistical meta-regression model. They represent the average value of the economic benefit to recreationists using national forests and grasslands. These figures represent the value only for those recreationists who engage in the listed activities as their primary activity; these values should not be applied to secondary or ancillary activities done by recreationists. These values do not represent the economic activity generated by national forest recreation.

person per day). An activity day is one person recreating for some portion of a day. For example, an individual whose primary recreation activity is picnicking and who engages in that activity for 2 hours on one day is one primary activity day of picnicking. Six people with the primary activity of picnicking who each spent 2 hours on one day doing that activity is six primary activity days of picnicking. One individual with the primary activity of camping who camps overnight for one night would equal two primary activity days of camping.

Currently, recreation use estimates for most federal agencies managing outdoor recreation opportunities are reported in terms of "visits." For the Forest Service, a national forest visit is defined as "one person participating in one or more recreation activities on a national forest or grassland for an unspecified period of time" (USDA FS 2017). A visit begins when someone enters the national forest and ends when the individual leaves the national forest for the last time that day. A national forest visit may last 1 hour or several days. Analysts will need to convert visits to primary activity days to obtain a quantity of recreation use with which to multiply by the recreation economic values. We provide conversion factors for doing this in

table 4 and example computations in the next section of this report. The conversion factors were computed using the NVUM data by estimating the average number of calendar days per visit reported by visitors engaged in each NVUM recreation activity. The values presented here should only be applied to the primary activities of visitors. For instance, recreationists whose primary activity is hiking likely participate in other activities (e.g., viewing nature, viewing wildlife, and photography) during their hikes. However, for those visitors, only the recreation economic value of "hiking" counts for their visit.

## Guidance for Analysts

The recreation economic values provided in table 3 may be used in a variety of ways. By themselves, the values show the average economic value of recreation benefit (i.e., consumer surplus) per activity day that accrues to an individual engaged in a type of recreation activity within a Forest Service region. These average value estimates are what we would **expect** the economic benefit to be, conditional on available information and holding all else constant. This expected, or average, value is an estimate within the distribution of all estimates with the highest likelihood of being observed. Thus, these recreation economic value estimates may be multiplied by the number of activity days a location receives to derive the aggregate benefit of recreation. Applications at national, regional, and forest-level aggregations include a mix of recreation sites with different qualities and characteristics, and the use of average values is typically most appropriate at this level of analysis.

To apply the recreation economic values, analysts will multiply the value per person per day by the estimated annual activity days in that primary activity. For national forests under current conditions, the number of activity days can be estimated using visit estimates by activity provided by NVUM reports and conversion factors to translate visits into activity days reported in table 4. Other reliable information on the number of recreation visits can also be used. Reliable information on visits may include counts of recreation use (in per-person activity days) estimated from fee envelopes or permits where all use is covered by those measures, studies by university or agency scientists where the methods are clearly described and replicable, and "engineered" estimates that clearly show assumptions and describe data sources.

We urge users to **not** interpret the relative economic values of activities as indicative of which activities are "best" to promote through management. Just because the average economic value for nonmotorized boating is larger than the average economic value for picnicking, for example, does not necessarily mean

**Table 4—Activity days per national forest visit, by primary activity and Forest Service region**

| | Forest Service region | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Primary activity** | **R1** | **R2** | **R3** | **R4** | **R5** | **R6** | **R8** | **R9** | **R10** | **National** |
| Backpacking | 2.4 | 2.5 | 2.1 | 2.7 | 2.8 | 2.6 | 2.4 | 2.5 | 2.7 | 2.4 |
| Bicycling | 1.1 | 1.1 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 |
| Cross-country skiing | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 2.0 | 1.0 |
| Developed camping | 2.7 | 2.7 | 2.6 | 2.5 | 2.8 | 2.8 | 2.8 | 2.9 | 2.5 | 2.7 |
| Downhill skiing | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.1 | 1.0 |
| Driving for pleasure | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.1 |
| Fishing | 1.3 | 1.2 | 1.3 | 1.5 | 1.3 | 1.3 | 1.1 | 1.3 | 1.3 | 1.3 |
| Gathering forest products | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.1 |
| Hiking, walking | 1.1 | 1.1 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Horseback riding | 1.3 | 1.3 | 1.1 | 1.4 | 1.2 | 1.4 | 1.6 | 1.4 | 1.0 | 1.3 |
| Hunting | 1.3 | 1.3 | 1.6 | 1.6 | 1.5 | 1.5 | 1.2 | 1.2 | 1.5 | 1.3 |
| Motorized trail activities | 1.3 | 1.3 | 1.2 | 1.4 | 1.3 | 1.3 | 1.1 | 1.1 | 1.0 | 1.3 |
| Motorized water activities | 1.3 | 1.1 | 1.1 | 1.2 | 1.3 | 1.4 | 1.2 | 1.1 | 1.1 | 1.3 |
| Nature center activities | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 |
| Nonmotorized water activities | 1.7 | 1.1 | 1.2 | 1.7 | 1.4 | 1.3 | 1.2 | 1.3 | 1.1 | 1.7 |
| Off-highway vehicle use | 1.2 | 1.2 | 1.2 | 1.5 | 1.2 | 1.3 | 1.2 | 1.2 | 1.0 | 1.2 |
| Other motorized activities | 1.5 | 1.2 | 1.1 | 1.0 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.5 |
| Other nonmotorized | 1.1 | 1.2 | 1.0 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Picnicking | 1.2 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.1 | 1.1 | 1.2 | 1.2 |
| Primitive camping | 2.8 | 2.4 | 2.4 | 2.5 | 2.3 | 2.6 | 2.3 | 2.7 | 2.0 | 2.8 |
| Relaxing | 1.6 | 1.5 | 1.4 | 1.5 | 1.5 | 1.5 | 1.3 | 1.4 | 1.4 | 1.6 |
| Resort use | 2.5 | 2.1 | 2.6 | 2.5 | 3.2 | 2.3 | 3.1 | 2.2 | 3.1 | 2.5 |
| Snowmobiling | 1.0 | 1.2 | 1.0 | 1.1 | 1.2 | 1.2 | 1.0 | 1.1 | 1.1 | 1.0 |
| Viewing natural features | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.1 | 1.1 |
| Viewing wildlife | 1.1 | 1.1 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 |
| Visiting historic sites | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 2.9 | 1.1 |
| Other activities | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.1 | 1.0 | 1.2 | 1.1 | 1.1 |
| No activity reported | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Weighted activity average | 1.2 | 1.1 | 1.2 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |

Conversion coefficients are the average number of calendar days per national forest visit. These figures can be used to convert Forest Service national forest visits into activity days. The values in the weighted activity average row are average values for each region weighted by the percentage of visits for each primary activity for each region as estimated from National Visitor Use Monitoring. Those values can be used to convert aggregate regional or national level visit estimates to activity days without needing to account for primary activity type.

that management efforts should focus on nonmotorized boating at the expense of opportunities for picnicking. Additionally, managers should also consider the supply of different recreation opportunities. There may be many nonmotorized boating opportunities, and few or no picnic facilities, implying that the incremental benefit from additional picnic sites may be relatively high compared to adding boating sites. Further, there may be numerous people who picnic compared to people who participate in nonmotorized boating activities, meaning that, in aggregate, the total benefit from picnicking is much great than that of boating, despite the average recreation economic value for boating being comparatively large.

These average recreation economic values may not always be appropriate for site-level analyses (e.g., those focused on a specific lake, campground, or trail), but they can be a starting point. The average values here are computed from a wide range of studies conducted in actual recreation settings with varying characteristics and quality. These average economic values may not always be representative of the conditions (including quality) at an individual recreation site or specific recreation setting. The average recreation economic values reported here could be reasonably applied for site-specific analyses if that site was similar to an "average" site studied in the RUVD. In cases where greater specificity is required in the economic value estimate, analysts may want to scale up or down the average value. We recommend that analysts considering rescaling of average values lean toward making conservative alterations, as very low and very high estimates of recreation economic values are the rarest kinds estimated from primary research. An alternative approach would be to use a single point estimate transfer by matching specific studies in the RUVD with the policy site of interest (see the appendix for a description of the steps for conducting point estimate transfers).

The average recreation economic values reported here are likely inappropriate for analyses that involve changes in the quality of recreation sites and settings or the cost of accessing them. For example, the recreation economic values reported here would not be helpful in estimating the benefits to recreationists from a project to increase the screening between campsites that improved the quality of the camping experience. To do that analysis, a primary study would have to be done, or the analyst would need to find a study in the RUVD that covered a comparable site. The recreation economic values reported here might be appropriate for a study focused on added benefit from increasing the number of sites in a campground that was at full capacity (and therefore increases the number of visits) if the addition of sites did not change the quality or cost of camping there. Finally, the recreation economic values here are likely inappropriate to estimate the benefit (or loss) to visitors from a change in fees to access a recreation site.

## Example Applications

We provide two examples of how the recreation economic values reported in table 3 can be used to compute aggregated economic benefits of recreation. The first example is an estimate of the aggregated economic benefits of recreation provided collectively by the national forests in each Forest Service region; the second is an estimate of the aggregated economic benefit of recreation provided by a single national forest.

### Estimating the Economic Benefit of Recreation for a Single Forest Service Region

We use Forest Service Region 2 (Rocky Mountain Region) as an example for computing aggregated economic benefits for an entire Forest Service region. The aggregate benefit to users who recreate on national forests in Region 2 can be computed by multiplying the number of recreation visits by the conversion coefficient from table 4 and by the average recreation economic value estimate for the region from table 3 as:

| Region 2 NVUM 2015 use estimate (1,000s) | X | Conversion coefficient (table 4) | X | Economic value (table 3) | = | Aggregated recreation benefit value ($1,000s) |
|---|---|---|---|---|---|---|

or:

| | | | | | | |
|---|---|---|---|---|---|---|
| 28,291 visits | X | 1.1 | X | $71.88 | = | $2,236,913 |

Given these inputs, the economic benefit to individuals who recreated on Region 2 national forests in 2015 is computed as $2.24 billion. That means that the money spent by federal agencies to provide recreation opportunities in Region 2 national forests provided $2.24 billion in well-being to those people who recreated. The $2.24 billion figure does **not** represent the economic contribution or economic activity generated by recreation at Region 2 national forests; computing economic contribution would require an economic impact analysis.

### Estimating the Economic Benefit of Recreation for a Single National Forest

We use the Medicine Bow National Forest to show the procedure for estimating the aggregate economic benefit of recreation for an individual national forest (table 5). The computation begins with the estimate of total annual recreation use on the Medicine Bow National Forest (534,871 visits) and the percentage distribution of that use by primary activity. Both the recreation use figure and the distribution of use by recreation activity are drawn from NVUM estimates (USDA FS 2017).

**Table 5—Estimate of the annual, aggregate economic benefits accruing to individuals recreating on the Medicine Bow National Forest**

| Primary activity | Primary activity | National forest visits | Conversion coefficient (table 4) | Primary activity days | Use value (table 3) | Economic benefit[a] |
|---|---|---|---|---|---|---|
| | *Percent* | | | | *- - - - - Dollars - - - - -* | |
| Backpacking | 0.0 | 161 | 2.5 | 403 | 32.81 | 13,209 |
| Bicycling | 2.5 | 13,372 | 1.1 | 14,709 | 86.40 | 1,270,853 |
| Cross-country skiing | 16.8 | 90,034 | 1.0 | 90,034 | 56.18 | 5,058,131 |
| Developed camping | 0.9 | 4,804 | 2.7 | 12,972 | 35.28 | 457,654 |
| Downhill skiing | 9.6 | 51,105 | 1.0 | 51,105 | 81.89 | 4,185,002 |
| Driving for pleasure | 6.0 | 32,092 | 1.1 | 35,301 | 64.67 | 2,282,947 |
| Fishing | 2.6 | 14,072 | 1.2 | 16,887 | 71.18 | 1,201,981 |
| Gathering forest products | 0.2 | 919 | 1.1 | 1,010 | 64.67 | 65,343 |
| Hiking/walking | 15.0 | 80,231 | 1.1 | 88,254 | 84.12 | 7,423,903 |
| Horseback riding | 1.9 | 9,976 | 1.3 | 12,969 | 64.67 | 838,724 |
| Hunting | 7.2 | 38,767 | 1.3 | 50,397 | 77.08 | 3,884,575 |
| Motorized trail activities | 1.7 | 9,253 | 1.3 | 12,029 | 50.11 | 602,786 |
| Motorized activities | 0.2 | 918 | 1.1 | 1,010 | 58.04 | 58,633 |
| Nature center activities | 0.0 | 0 | 1.0 | 0 | 64.67 | 0 |
| Nature study | 0.1 | 501 | 1.1 | 551 | 64.67 | 35,605 |
| No activity reported | 0.2 | 1,303 | 1.0 | 1,303 | 64.67 | 84,258 |
| Nonmotorized water activities | 0.2 | 964 | 1.1 | 1,061 | 108.59 | 115,183 |
| Off highway vehicle use | 4.1 | 22,094 | 1.2 | 26,512 | 50.11 | 1,328,540 |
| Other motorized activities | 0.2 | 856 | 1.2 | 1,027 | 50.11 | 51,461 |
| Other nonmotorized activities | 0.6 | 3,170 | 1.2 | 3,804 | 64.67 | 246,023 |
| Picnicking | 1.0 | 5,286 | 1.1 | 5,814 | 48.84 | 283,971 |
| Primitive camping | 0.8 | 4,258 | 2.4 | 10,220 | 32.81 | 335,302 |
| Relaxing | 4.3 | 22,999 | 1.5 | 34,499 | 64.67 | 2,231,062 |
| Resort use | 0.0 | 0 | 2.1 | 0 | 64.67 | 0 |
| Snowmobiling | 9.0 | 48,138 | 1.2 | 57,766 | 50.11 | 2,894,658 |
| Other activities | 6.0 | 32,092 | 1.2 | 38,511 | 64.67 | 2,490,488 |
| Viewing natural features | 8.0 | 42,790 | 1.1 | 47,069 | 59.79 | 2,814,234 |
| Viewing wildlife | 0.9 | 4,716 | 1.1 | 5,187 | 59.79 | 310,145 |
| Visiting historic sites | 0.0 | 0 | 1.1 | 0 | 59.79 | 0 |
| Total | 100.0 | 534,871 | | 620,404 | | 40,564,669 |

[a] Economic benefit values are in 2016 dollars. Visitation figures are from National Visitor Use Monitoring round 3 (fiscal years 2009 to 2014).

Practitioners should focus on the primary recreation activity of visits rather than any secondary (or "participating") activities.

The number of visits by recreation activity is computed by multiplying the appropriate primary activity percentage by the estimate of total use on the national forest. The visits-by-activity figure is then multiplied by the conversion coefficient for each activity for Region 2 (where the Medicine Bow National Forest is located) drawn from table 4 to compute the number of activity days for each activity. The appropriate economic benefit estimate for each activity is drawn from table 3 using the crosswalk to NVUM activities shown in table 2. The economic benefit for each activity is calculated by multiplying activity days by the use value figure. The aggregate economic benefit of recreation on the entire Medicine Bow National Forest is the sum of all the benefit values for each primary activity.

**Characterizing and understanding recreation use will continue to be a necessary step in managing national forests.**

Recreationists on the Medicine Bow National Forest receive in total $40.6 million in economic benefits from recreating there. Again, that figure does **not** represent the economic impact or economic activity generated from recreation on the national forest, but rather the economic value of the benefit to those who recreated.

## Conclusions

Outdoor recreation has been, and likely will continue to be, an important use of national forests, and one that connects the U.S. public and international tourists with the many benefits that public forest lands have to offer. Characterizing and understanding recreation uses of national forests thus will continue to be a necessary step in managing national forests to meet their multiple-use mandate. The economic value estimates reported here thus provide a critical resource for forest planners, managers, and policymakers charged with developing and implementing the stewardship of U.S. public forest lands.

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# Appendix

**The RUVD summarizes recreation economic value estimates from more than 50 years of economic research.**

This appendix provides additional technical information about the methods and techniques described in this document. It begins with a history of the Recreation Use Value Database (RUVD), and then summarizes key economic concepts. A more detailed discussion of benefit transfer methods and how to conduct them is provided, followed by the technical details of the meta-analysis function transfer used in constructing table 3.

## History of the Recreation Use Values Database

The RUVD summarizes recreation economic value estimates from more than 50 years of economic research (work published from 1958 to 2015) characterizing the value of outdoor recreation in the United States and Canada. The RUVD includes all documented estimates of recreation economic values published in journal articles, technical reports, book chapters, working papers, conference proceedings, or graduate theses (Stanley 2001). Included studies encompass a variety of methods, regional and activity foci, sample sizes, and site characteristics.

The RUVD is the result of seven separate literature reviews, although it was completely reconstructed in 2006. The first review covered literature on outdoor recreation and forest amenity use values from the 1960s to 1982, with 93 benefit estimates (Sorg and Loomis 1984). The second literature review covered 1968 to 1988, (Walsh et al. 1988) increasing the benefit estimate count to 287. A third literature review, conducted by MacNair (1993), covered estimates from 1968 to 1993 and formally coded information on study attributes. A fourth literature review, conducted by Loomis and others (1999), used an expanded coding protocol and merged with the MacNair database. Kaval and Loomis (2003) updated this expanded database, with emphasis on underrepresented recreation activities. In 2006, the RUVD was rebuilt using an expanded coding protocol with new variables and the database was again updated with new and overlooked valuation studies. Finally, in 2015 the RUVD was updated to include studies from 2006 to 2015. This effort, following the best practice guidelines established by Stanley et al. (2013), brought the number of studies included to 422 and estimates to 3,194.

Primary studies were included if (1) they estimated access values (i.e., with vs. without access to the resource or activity); (2) they followed well-established economic practices for stated or revealed preference, or mixed estimation models (e.g., Champ et al. 2017); (3) they were conducted in the United States or Canada; and (4) they reported an economic value that could be converted into a standardized

consumer surplus dollar value per person per day. The RUVD includes the standardized economic value as well as identified information on the document source and study, site, activity, and methodology attributes of each study. Additional information about the RUVD, including studies and coding protocol, can be found at http://recvaluation.forestry.oregonstate.edu/.

## Consumer Surplus

Consumer surplus is the economic value of a recreation activity above what must be paid by the recreationist to enjoy the activity (fig. 1). Looking at conditions when demand is $D_0$, consumer surplus is the area below the demand function ($D_0$) and above the price or expenditure line (B), or area BCD. Consumer surplus is also referred to as net willingness to pay, or willingness to pay in excess of the cost of the good. Total economic use value is consumer surplus plus the costs of participation, or area 0ACD in figure 1 when demand is $D_0$ and A is the number of days of participation. Consumer surplus is generally estimated in primary research by inferring it from revealed preference data (i.e., generate the demand function and then calculate consumer surplus), or directly estimated using stated preference data (i.e., where people state their maximum net willingness to pay within constructed market conditions). For more information on nonmarket valuation methods, see Champ et al. (2017).

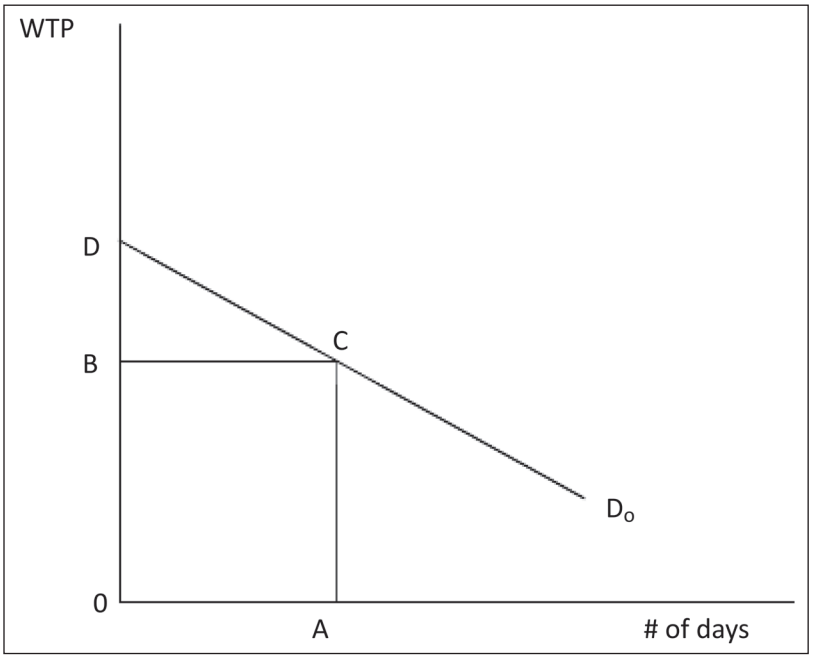


Figure 1—Consumer surplus in demand.

## Benefit Transfer

There are two broad approaches to benefit transfer: (1) value transfer and (2) function transfer (fig. 2). Value transfers encompass the transfer of (1-a) a single benefit estimate from a study site, or (1-b) a measure of central tendency (e.g., average or median) for several benefit estimates from a study site or sites, or (1-c) administratively approved estimates. Administratively approved value estimates are discussed in conjunction with the measure of central tendency discussion (hereafter average value transfer will refer to both (1-b) and (1-c)). Function transfers are the transfer of (2-a) a benefit or demand function from a study site, or (2-b) a meta regression analysis function derived from several study sites. Function transfers are adapted to fit the context of the policy site with respect to socioeconomic characteristics, extent of market and environmental impact, and other measurable characteristics that may capture or define the differences between sites with this information and the one where it is needed (i.e., being transferred to). The adapted function is then used to construct a benefit measure for the policy site.

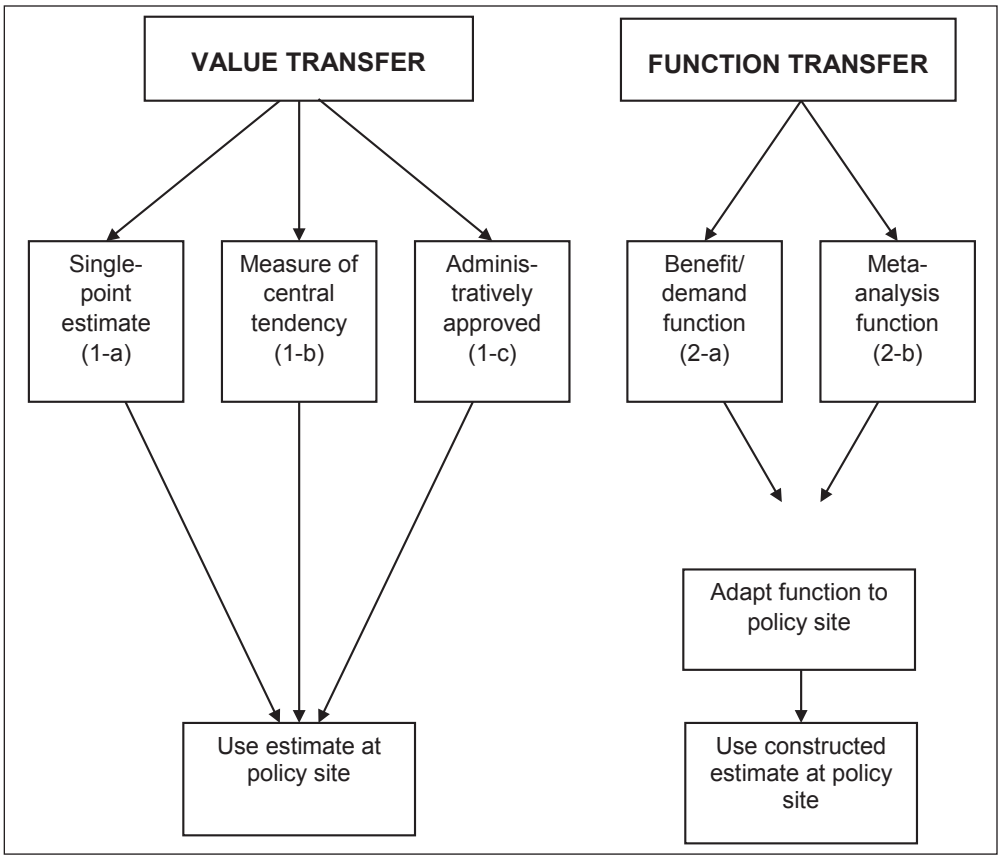


Figure 2—Benefit transfer approaches (adapted from Rosenberger and Loomis 2001).

Applications of benefit transfer methods may or may not be structurally (i.e., directly) related to underlying utility theoretic approaches. The continuum of structural linkages is identified in Bergstrom and Taylor (2006). Additional discussions and comprehensive information on benefit transfers are found in Johnston (2015) and others, including Johnston and Rosenberger (2010), and Rosenberger and Loomis (2017).

**Value transfer methods—**

***Single-point-estimate transfer***—A single-point-estimate benefit transfer uses an estimate from a single relevant primary research study (or range of point estimates if more than one study is relevant). The steps to performing a single-point-estimate transfer include identifying and quantifying the management or policy-induced changes on recreation use, and locating and transferring an appropriate "unit" consumer surplus measure. The following is a more detailed list of the steps involved in single-point-estimate transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
1. Assess relevance and applicability of study site data.
5. Select a benefit measure from a single relevant study or a range of benefit measures if more than one study is relevant.
6. Multiply benefit measure by total change in recreation use.

**The context surrounding each benefit transfer can be unique, meaning there is no universal protocol that can be objectively followed in any situation.**

The simplicity with which these steps are presented may be misleading. Finding a valid and reliable benefit measure can be complex and require the analyst to make many judgments on the comparative structure between two or more sites. These judgments often rely on limited available information about the original study context and may require additional information be gathered about the sites and study methods.

Similarity of sites is a key element in the defense of point-transferred values. Defensibility can be defined on two feasibility dimensions–technical and political. Technical feasibility is inversely related to the degree of technical and theoretical consistency between the study site context and the policy site context. Political feasibility is highly context- and scale-dependent, accounting for an array of social and cultural factors. The context surrounding each benefit transfer can be unique, meaning there is no universal protocol that can be objectively followed in any situation. However, quite often information can be transferred with varying levels of confidence (Johnston and Rosenberger 2010).

***Average value transfer methods***—An average value transfer is based on using a measure of central tendency of all or subsets of relevant and applicable studies as the transfer measure for a policy site issue. The primary steps to performing an average value transfer include identifying and quantifying the management or policy-induced changes on recreation use, and locating and transferring a "unit" average consumer surplus measure. The following is a more detailed list of the steps involved in average value transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
5. Assess relevance and applicability of study site data.
6. Use average value for the region or use an average of a subset of study measures.
7. Multiply benefit measure by total change in recreation use.

Federal public land agencies commonly use administratively approved average values in assessing management and policy actions. The U.S. Department of Agriculture Forest Service has used Resources Planning Act (RPA) values since 1980 (USDA FS 1991). These RPA values have been provided for groups of activities and Forest Service regions of the country. Similarly, the U.S. Bureau of Reclamation and U.S. Army Corps of Engineers have relied on U.S. Water Resources Council (1973, 1979, 1983) "unit day values" for decades. Although some of the unit day values may not have been based directly on the emerging literature on outdoor recreation economic values and measures, they have all been influenced to a certain degree by this literature. Average value estimates, however, are no better than the data on which they are based. All the issues that could be raised concerning the credibility of any single measure are also relevant for an average value based, in part, on that measure.

***Benefit-function-transfer methods***—Benefit-function transfers use a model to statistically relate benefit measures to study factors, such as characteristics of the user population and the resource being evaluated. Benefit-function transfers usually come from two sources. First, a benefit function or demand function has been estimated and reported for a recreation activity in a geographic location through primary research. Second, a meta-analysis function can be estimated from several independent primary research projects. In either case, the transfer process entails adapting the function to the characteristics and conditions of the policy site, constructing a benefit measure based on this adaptation of the function, and using the measure for evaluating the policy site.

***Demand-function transfer***—The transfer of an entire demand function is conceptually more sound than value transfers, because recreation benefit estimates and use rates are a complex function of site and user characteristics, and spatial and temporal dimensions of recreation site quality and site choice. When transferring a point estimate from a study site to a policy site, it is assumed or implied that the two sites are identical across the various factors that determine benefit derived in recreational use of the two sites. An average value transfer assumes the benefits of the policy site are around the mid-level of benefits measured for the study sites incorporated into the average value calculation. However, this is not always the case. The invariance surrounding the transfer of benefit measures alone makes these transfers insensitive or less robust to significant differences between the study site(s) and the policy site. Therefore, the main advantage of transferring an entire demand function to a policy site is the increased relevance of tailoring a benefit measure to fit the characteristics of the policy site. It is in the adaptation stage of constructing a benefit measure from a study site demand function that the additional value of the transfer method is realized. The following is a more detailed list of steps for demand- and benefit-function transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
5. Assess relevance and applicability of study site data and whether demand or benefit function is specified.
6. Adapt demand or benefit function to policy site characteristics and construct benefit measure.
7. Multiply constructed benefit measure by total change in recreation use.

Disadvantages of the method are primarily due to data collection and model specification in the original research effort. Factors in the demand function may be relevant to the study site but not to the policy site. Also, factors that influence demand at the policy site may not have been collected at the study site or were not significant in determining demand at the study site. These factors significantly affect the constructed benefit measures at a policy site.

The specification of demand functions can significantly affect the reliability of their use under varying circumstances. To employ a demand function transfer, the analyst must use insight and judgment concerning the applicability and transferability of demand functions, the details of which are beyond the scope of this report.

**Meta-regression analysis is the statistical summarizing of relationships between benefit measures and quantifiable characteristics of studies.**

The adaptation of a demand function from a study site to a policy site can be complex and lead to a large error. This error can be influenced by dissimilarities between site and user population characteristics of the study site and policy site. Critical demand/benefit-function transfer requires strong knowledge of economic methodology and estimation of consumer surplus. Therefore, it is highly recommended that when attempting to perform a demand-function transfer you either have the requisite knowledge or solicit the aid of someone who does.

***Meta-regression analysis benefit-function transfer***—Meta-regression analysis is the statistical summarizing of relationships between benefit measures and quantifiable characteristics of studies. The data for a meta-analysis are generally summary statistics from study site reports and include quantified characteristics of the user population, study site's environmental resources, and valuation methodology used. Coding of the studies included in the literature review lends itself directly to the estimation of a meta-analysis benefit function. However, interpretation of original study results can be a source of error in meta-analysis databases (Stanley et al. 2013).

Meta-analysis has been traditionally concerned with understanding the influence of methodological- and study-specific factors on research outcomes and providing summaries and syntheses of past research. A more recent use of meta-analysis is the systematic use of the existing value estimates from the literature for benefit transfer. Essentially, meta-analysis regression models can be used to construct benefits at policy sites. Meta-analysis has several conceptual advantages over other benefit-transfer methods such as point-estimates and demand-function transfers, which generally revolve around the advantages of broader and more diverse data for adapting meta-regression models to specific policy site valuation needs. The specific steps to conducting a meta-regression analysis function transfer are as follows:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Adapt meta-regression analysis benefit function to policy site characteristics and construct benefit measure.
5. Multiply constructed benefit measure by total change in recreation use.

Meta-analysis has many advantages over unit transfer: it uses information from many studies, providing more rigorous value measures sensitive to the underlying distribution of estimates; multiactivity, multisite meta-analyses can construct estimates for regions in which no studies were conducted for an activity; and methodological differences can be controlled when calculating a value. An example of this

method is provided in this report. It is the method used to construct the economic values in table 3.

## Meta-Regression Analysis Detailed Methods

**Panel data and model specification**—
Quantitative literature reviews such as meta-analysis may utilize pools of data with panel characteristics (Rosenberger and Loomis 2000). The RUVD includes many empirical studies (e.g., single observations) that provide several estimates of recreation economic value, fewer studies that provide only one estimate, and a handful of studies that provide many (greater than 20) estimates of value. Using a fixed-effects model to correct for intrastudy panel effects, or a random-effects model to correct for interpanel effects is one option. However, these options can add complexity to modeling and decrease degrees of freedom. Random-effects models assume the random error associated with each panel (e.g., primary study) is uncorrelated with other variables, for example region or valuation method. Past meta-analysis has also elected to use only one estimate per study or to average all estimates into one weighted estimate per study (Nelson and Kennedy 2009). However, this approach leaves a lot of information out of the meta-regression. Where individual studies publish multiple estimates, these estimates generally represent different activities at one site, different user groups at one or more sites, or the same activity at multiple sites.

Identification of panel effects or stratification within any panel data can be difficult. In this case, we use a simple correction to identify potential panel effects by publication. A cluster-robust covariance estimator with pooled ordinary least squares (OLS) corrects for potential nonindependence without requiring any assumptions about the error. Clustering covariances by activity, region, or document (individual publication) increased the standard error (SE) of some variables and decreased SE of others but made little difference in the significance of most variables. This indicates there may be some within-group correlation by region, activity, or even publication but not enough to prevent the use of OLS.

**Meta-regression**—
Ordinary least-squares linear regression is a widely used method for relating the distribution of a dependent variable, here the estimates of use value in the RUVD, with the variation in one or more independent variables. Conventional OLS assumes the dependent variable has similar variance across the range of independent variable values; observations of the dependent variable are independent from one another; and the explanatory variables have no linear relationship. The independent variables included in the model are described in table 6 and include aspects of survey methodology and site characteristics. Our OLS model uses a linear-linear

**Table 6—Meta-regression analysis variables definitions**

| Variable name | Description |
|---|---|
| Dependent variable: | |
| Value | Consumer surplus per person per activity day (2016 dollars) |
| Sample characteristics variables: | |
| Nonresidents | = 1 if sample contains nonresident visitors only; = 0 otherwise |
| **Residents**[a] | = 1 if sample contains local resident visitors only; = 0 otherwise |
| **Mixed residents/nonresidents** | =1 if sample contains a mix of resident and nonresident visitors; = 0 otherwise |
| **User sample** | =1 if sample derived from user list (e.g., fishing/hunting license holders); = 0 otherwise |
| **Onsite sample** | =1 if visitors sampled on-site; = 0 otherwise |
| **General population sample** | =1 if sample derived from a general population (e.g., random sample of state residents); = 0 otherwise |
| Methodology variables: | |
| Revealed preference | =1 if revealed preference valuation method used; = 0 otherwise |
| **Stated preference** | =1 if stated preference valuation method; = 0 otherwise |
| Substitutes modeled | =1 if substitute sites included in valuation model; = 0 otherwise |
| Zonal travel cost | =1 if zonal travel cost method used; = 0 otherwise |
| **Individual travel cost** | =1 if individual travel cost method used; = 0 otherwise |
| Resource/site variables: | |
| Lake | =1 if value reported for a lake/reservoir environment; = 0 otherwise |
| Forest | = 1 if value reported for a forested environment; = 0 otherwise |
| Wetland | = 1 if value reported for a wetland environment; = 0 otherwise |
| **River** | = 1 if value reported for a river/stream environment; = 0 otherwise |
| Regional variables: | |
| Forest Service (FS) Region 1 | = 1 if value reported for FS Region 1; = 0 otherwise |
| FS Region 2 | = 1 if value reported for FS Region 2; = 0 otherwise |
| FS Region 3 | = 1 if value reported for FS Region 3; = 0 otherwise |
| FS Region 4 | = 1 if value reported for FS Region 4; = 0 otherwise |
| FS Region 5 | = 1 if value reported for FS Region 5; = 0 otherwise |
| FS Region 6 | = 1 if value reported for FS Region 6; = 0 otherwise |
| FS Region 8 | = 1 if value reported for FS Region 8; = 0 otherwise |
| FS Region 9 | = 1 if value reported for Forest Service Region 9; = 0 otherwise |
| FS Region 10 | = 1 if value reported for FS Region 10; = 0 otherwise |
| National | = 1 if value reported for national level; = 0 otherwise |
| Multiple regions | = 1 if value reported for multiple FS Regions; = 0 otherwise |

**Table 6—Meta-regression analysis variables definitions (continued)**

| Variable name | Description |
|---|---|
| NVUM primary recreation activity variables | |
| Developed camping | = 1 if value reported for developed camping; = 0 otherwise |
| Backpacking | = 1 if value reported for backpacking; = 0 otherwise |
| Picnicking | = 1 if value reported for picnicking; = 0 otherwise |
| Nature related | = 1 if value reported for nature-related; = 0 otherwise |
| Cross-country skiing | = 1 if value reported for cross-country skiing; = 0 otherwise |
| Fishing | = 1 if value reported for fishing; = 0 otherwise |
| Hunting | = 1 if value reported for hunting; = 0 otherwise |
| Off-highway vehicle use/snowmobiling | = 1 if value reported for off-highway vehicle use use/snowmobiling; = 0 otherwise |
| Nonmotorized boating | = 1 if value reported for nonmotorized boating; = 0 otherwise |
| Motorized boating | = 1 if value reported for motorized boating; = 0 otherwise |
| Hiking | = 1 if value reported for hiking; = 0 otherwise |
| Biking | = 1 if value reported for biking; = 0 otherwise |
| Downhill skiing | = 1 if value reported for downhill skiing; = 0 otherwise |
| Other recreation activity | = 1 if value reported for other recreation activity; = 0 otherwise |

Note: Omitted variables are bold.

NVUM = National Visitor Use Monitoring.

functional form to relate the dependent and independent variables as follows.

$$\text{Equation:} \quad CS/Day = \sum \beta X_{ik} = \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots \beta_J X_{iK} + \varepsilon_i \qquad (2)$$

where there are i estimates, j individual studies and k explanatory variables (k = 1…K) that explain consumer surplus per day (CS/Day). The meta-regression follows the simple equation above where i = 2,709, j =342, and K = 32, where regional and activity comprised 23 of the explanatory independent variables. All statistical analysis was performed in Stata (SE version 14).

**Data coding and independent variable selection—**

The RUVD includes a master coding sheet with 126 fields. The main coding categories include study, benefit measure, methodology specifics, activity, site characteristics, and user demographics. Table 6 lists and defines the variables from this pool that were included in the meta-regression. Most of the variables are qualitative dummy variables coded as 0 or 1, where 0 means the study does not have a characteristic and 1 means that it does. Independent variables were included in the optimized meta-regression if they were significant at an 80 percent level of confidence or better. A general-to-specific process was used, which began with the full specification of the

model using all coded variables. Least significant variables were removed sequentially until remaining variables were significant at the 80 percent confidence level or better ($p \leq 0.20$). The choice of the minimum significance level is arbitrary, but it does reduce the risk of not detecting a difference even though Type I errors are increased at an equal rate. This optimization reduces overspecification of the model when retaining variables whose coefficients are not significantly different than zero. Regional and activity category variables were retained regardless of significance as the purpose of this meta-regression is to construct values for benefits transfer by region and activity, not to study the influence of region and activity on consumer surplus values. The results of this model are presented in table 7.

**Outliers**—
Outliers are a common occurrence in metadata (Nelson 2015) and the economic values within the RUVD vary widely. Outliers can become influential data points, affecting the meta-regression and weighted means in ways that cloud inference. Based on examination of the methods behind these outliers, and some reasonable assumptions about daily recreation economic values, consumer surplus per day estimates below $5 and above $500 were removed from the meta-analysis

**Results**—
Table 7 provides results of the meta-regression model fit to the data and used in constructing the values in table 3. The next section provides examples of how average values are constructed, with particular attention to treatment of the region and activity-specific variables. However, as noted elsewhere, the first eight variables, measuring partial effects of study methods and modeling assumptions, population, and site characteristics, are held constant at their mean values. In general, the model accounts for more than 20 percent of the observed variation in the benefit estimates, which is consistent with prior meta-analyses of recreation benefits (Rosenberger and Loomis 2001).

The meta-regression analyzes information on all studies in the database and relates independent variables of interest, such as activity, region, or survey methodology, to the dependent variable, estimated recreation benefit (measured as consumer surplus). Theoretically, when a variable helps explain the variation in recreation benefit measures, its regression coefficient will be significant in the model. Combining these significant variables in a multivariate model provides a transparent and consistent way to estimate average values based on a policy site's specific characteristics. Given the large sample size, the overall model performance has a grand mean—that is, the mean of the sample means—with ±2.5 percent margin of error. Thus, the meta-regression analysis model provides more robust estimates than an average value transfer (e.g., table 3 values).

**Table 7–Optimized meta-analysis benefit-transfer model**

| Variable | Coefficient | Robust SE[a] | Mean of variable |
|---|---|---|---|
| Nonresidents | 45.05[b] | 9.94 | 0.07 |
| User sample | 22.25[b] | 8.27 | 0.21 |
| Revealed preference | 28.06[b] | 8.83 | 0.48 |
| Substitutes modeled | -15.95[b] | 6.25 | 0.25 |
| Zonal travel cost | -47.78[b] | 9.53 | 0.21 |
| Lake | -23.15[b] | 7.13 | 0.19 |
| Forest | -11.84 | 8.85 | 0.16 |
| Wetland | 187.47[b] | 8.87 | 0.01 |
| Forest Service (FS) Region 1 | 15.50 | 11.87 | 0.04 |
| FS Region 2 | 8.72 | 9.51 | 0.09 |
| FS Region 3 | 16.80 | 12.53 | 0.07 |
| FS Region 4 | 18.72 | 12.96 | 0.09 |
| FS Region 5 | 2.55 | 12.04 | 0.04 |
| FS Region 6 | 9.06 | 12.65 | 0.06 |
| FS Region 8 | 8.52 | 8.74 | 0.19 |
| FS Region 9 | -2.98 | 8.59 | 0.31 |
| FS Region 10 | 41.01 | 22.87 | 0.03 |
| National | 19.92 | 13.13 | 0.03 |
| Developed camping | -29.39[b] | 10.22 | 0.02 |
| Backpacking | -31.85[b] | 10.63 | 0.03 |
| Picnicking | -15.83[b] | 7.90 | 0.01 |
| Nature related | -4.87 | 9.02 | 0.16 |
| Cross-country skiing | -8.48 | 9.96 | 0.01 |
| Fishing | 6.51 | 9.00 | 0.34 |
| Hunting | 12.41 | 10.10 | 0.23 |
| Off-highway vehicle use/snowmobiling | -14.55 | 13.45 | 0.02 |
| Nonmotorized boating | 43.92 | 30.99 | 0.03 |
| Motorized boating | -6.63 | 16.15 | 0.03 |
| Hiking | 19.45 | 12.63 | 0.04 |
| Biking | 21.74 | 27.72 | 0.01 |
| Downhill skiing | 17.22 | 35.75 | 0.01 |
| Constant | 54.77[b] | 12.89 | 1 |

Summary statistics: N = 2,709, adjusted $R^2$ = 0.20, Root mean squared error = 61.44.

[a] Cluster robust standard error computed in Stata 14.1 using individual study as cluster (n = 342).

[b] Variable is statistically significant at the $p < 0.05$ level or better. Overall margin of error is ±2.5 percent.

Also keep in mind that many qualitative variables reflecting other attributes of the study, site and resource, methods, and values estimates do not exceed the 80 percent significance threshold when specifying the meta-regression model. Empirically these variables are not related to variations in consumer surplus for this set of data, but they may be theoretically significant. Unfortunately, retaining all variables would result in increased multicollinearity and overspecification of the model. Please keep this in mind when conducting single-study transfers where assessing the degree of similarity between sites depends greatly on their characteristics regardless of their significance in the meta-regression model.

**Total aggregate benefits are likely greater for locals than nonlocals.**

The estimated parameters show the partial effect of each variable on the variation in the dependent variable—value per person per day. For example, people who travel greater distances (nonresidents) from home to recreation sites have higher values, ceteris paribus, than local residents. However, the total aggregate benefits to local residents are likely higher owing to the ability to visit more often at lower overall cost, but people who generally travel greater distances have selected their destination over other sites and activities that are generally closer to home. Also along this same line of reasoning, studies that incorporate substitute sites (substitutes modeled) generally produce lower estimated values, ceteris paribus, as economic theory would expect (see Loomis and Walsh 1997, Rosenthal 1987).

**Additional detail and application**—
The meta-analysis function is used to construct values by holding all independent or explanatory variables constant at their mean values (last column, table 7), except for the relevant regional and activity variables. These effects are weighted by their mean values—each variable's coefficient is multiplied by its weight, providing the partial consumer surplus owing to that variable. These partial values are then summed along with the constant (intercept) to construct values. To construct estimates for a particular region, that region's variable would be equal to 1, and the full value of its coefficient would be summed into the constructed value.

This procedure is illustrated in the examples presented in table 8 where we calculate the average value of a day of hiking in California (FS Region 5 [Pacific Southwest Region]) and a day of camping in Georgia (FS Region 8 [Southern Region]). The example predictions in table 8 may look simplistic—this is because we have averaged out the many other nonregion and nonactivity variables in the model. However, note that the data behind the meta-analysis is not all specific to hiking or camping, or California or Georgia. Therefore, each of the constructed average values is an estimate for a generic activity similar to hiking in California or to camping in Georgia. There is often a direct correlation between the degree of specificity in the constructed value and the overall representation of a variable

**Table 8—Example adaptation of meta-analysis benefit function**

| | | Hiking in California | | Camping in Georgia | |
|---|---|---|---|---|---|
| Variable | Coefficient | Adaption value | Partial CS | Adaption value | Partial CS |
| FS Region 1 | 15.50 | 0 | 0 | 0 | 0 |
| FS Region 2 | 8.72 | 0 | 0 | 0 | 0 |
| FS Region 3 | 16.80 | 0 | 0 | 0 | 0 |
| FS Region 4 | 18.72 | 0 | 0 | 0 | 0 |
| FS Region 5 | 2.55 | 1 | 2.55 | 0 | 0 |
| FS Region 6 | 9.06 | 0 | 0 | 0 | 0 |
| FS Region 8 | 8.52 | 0 | 0 | 1 | 8.52 |
| FS Region 9 | -2.98 | 0 | 0 | 0 | 0 |
| FS Region 10 | 41.01 | 0 | 0 | 0 | 0 |
| Developed camping | -29.39 | 0 | 0 | 1 | -29.39 |
| Backpacking | -31.85 | 0 | 0 | 0 | 0 |
| Picnicking | -15.83 | 0 | 0 | 0 | 0 |
| Nature related | -4.87 | 0 | 0 | 0 | 0 |
| Cross-country skiing | -8.48 | 0 | 0 | 0 | 0 |
| Fishing | 6.51 | 0 | 0 | 0 | 0 |
| Hunting | 12.41 | 0 | 0 | 0 | 0 |
| OHV use/snowmobiling | -14.55 | 0 | 0 | 0 | 0 |
| Nonmotorized boating | 43.92 | 0 | 0 | 0 | 0 |
| Motorized boating | -6.63 | 0 | 0 | 0 | 0 |
| Hiking | 19.45 | 1 | 19.45 | 0 | 0 |
| Biking | 21.74 | 0 | 0 | 0 | 0 |
| Downhill skiing | 17.22 | 0 | 0 | 0 | 0 |
| Constant | 54.77 | 1 | 54.77 | 1 | 54.77 |
| Net of all other variables | NA | NA | 1.17 | NA | 1.17 |
| Total | | | $77.94 | | $35.07 |

CS = consumer surplus, FS = Forest Service, NA = not applicable, and OHV = off-highway vehicle.

in the database. This is due to the statistically discovered variability across these activities, or lack thereof. For example, there are 111 estimates for hiking and 82 estimates for camping included in the database, not all of which are in Region 5 or Region 8. Therefore, the constructed averages take into account the distribution of all values for hiking or camping relative to all values for Regions 5 and 8. These example applications illustrate the degree to which these constructed values are generic estimates when holding everything in the model constant except for region and activity.

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