
Volume 40
March 2014
ISSN 1389-9341
ELSEVIER
Forest Policy and Economics
A companion journal to Forest Ecology and Management

Forest Policy and Economics 40 (2014) 21–30

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Effects of travel cost and participation in recreational activities on national forest visits

Seong-Hoon Cho [a,*], J.M. Bowker [b], Donald B.K. English [b], Roland K. Roberts [a], Taeyoung Kim [a]

[a] University of Tennessee, Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, Knoxville, TN 37996-4518, United States
[b] USDA Forest Service, Southern Station, 320 Green Street, Athens, GA 30602-2044, United States

A R T I C L E I N F O

Article history:
Received 16 March 2013
Received in revised form 25 November 2013
Accepted 15 December 2013
Available online 16 January 2014

JEL classification:
D12
Q26

Keywords:
National forest visits
Recreational activities
Travel cost
Consumer welfare

A B S T R A C T

In the face of higher travel costs due to rising gasoline prices and scarce budget resources, we explored differences in the impacts of travel costs on recreational demand for visitors participating in various recreational activities. Five individual travel cost models were estimated, one for each of 5 national forests (i.e., Allegheny, Coconino, Mount Baker-Snoqualmie, Ouachita, and Wenatchee). Travel cost had a consistently negative effect on the number of visits (and thus caused losses in aggregate consumer surplus) across all recreational activities and national forests, although the magnitudes of the effects varied significantly. For example, decreased visit numbers (and thus the aggregate loss of consumer surplus) resulting from hypothetical increases in travel costs are greater for non-trail and backpacking-activity participants than for trail and backpacking-activity participants in the Allegheny national forest. This finding implies that increases in funds allocated towards improving non-trail and backpacking-based recreational activities may stem the loss of consumer surplus due to the decline in visits to the Allegheny national forest caused by the increase in travel cost more than similar increases in funds allocated to trail and backpacking-activities. These results are important because many national-forest managers are facing declining visits resulting from the effects of higher gasoline prices on travel costs. Thus, they can use our results in making decisions about allocating scarce budget resources to recreational activities that have the greatest potential to stem the decline in national-forest visits.

1. Introduction

1.1. Background

The gasoline price, a major component of travel cost, has remained historically high since 2004 (see Fig. 1 for the average retail gasoline price during 1994–2012). The U.S. average gasoline price for all grades and all formulations has increased by 94% from \$1.90 per gallon to \$3.68 per gallon during 2004–2012 (average increase of more than 10% per year). A rise in the gasoline price, triggering increased travel cost, affects recreational travel decisions negatively (Fantazzini et al., 2011). The recreation and leisure literature has shown that higher gasoline prices lead to decreased recreation demand (e.g., Clawson and Knetsch, 1966; Kamp et al., 1979). Earlier studies have focused on the comparison between the impacts of gasoline rationing and higher gasoline prices on recreational travel (e.g., Corsi and Harvey, 1979; Kamp et al., 1979; William et al., 1979), and the impacts of rising travel cost on visitors' travel mode, length of trip, destination, time spent traveling and frequency of trips (Aronsson and Brännäs, 1996; Brännäs and Laitila, 1992; Bhat, 1995; Hausman et al., 1995; Gurmu and Trivedi, 1996; Morgan, 1986). More recent literature has focused on the effects of gasoline price on travel participation and behavioral adaptations such as willingness to substitute alternative recreation sites (e.g., Oh and Hammitt, 2011), and the effects of travel cost on the number of trips to different regions by different income groups (e.g., Lundevaller, 2009).

Although the abovementioned literature has explored the effects of gasoline prices on travel participation from different perspectives, little, if any, research has explicitly suggested solutions to stem the decline in visits resulting from rising travel costs related to gasoline prices. From among the many travel cost analyses that could suggest solutions to declining recreational visits, we focus on the impacts of rising travel costs on travel decisions made by visitors participating in different types of recreational activities. Our research is motivated by the need to distribute increasingly scarce budget resources for national forest management to curtail the decline in visits to recreational sites. Thus, if rising travel costs have different impacts on travel decisions by visitors participating in different types of recreational activities, budget resources can be allocated to stimulate recreation demand for those activities with the greatest impact on visits.

Previous studies have explored market segmentation using participation in various types of recreational activities in relation to visitor benefits or motivations, preferences, use patterns, and recreational specializations (e.g., Galloway, 2002; McCool and Reilly, 1993; Donnelly et al., 1996; Fredman and Emmelin, 2001; Ryan and Sterling, 2001; McFarlane and Boxall, 1996; Warzecha and Lime, 2001; Lai et al., 2007; Poudyal et al., 2009; Bhubaneswor et al., 2012). These studies commonly used a demand-oriented approach to categorize recreation-activity participants by demand characteristics, and found that preferences

* Corresponding author. Tel.: +1 865 974 7408; fax: +1 865 974 9492.
E-mail address: scho9@utk.edu (S.-H. Cho).

1389-9341/\$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.forpol.2013.12.004

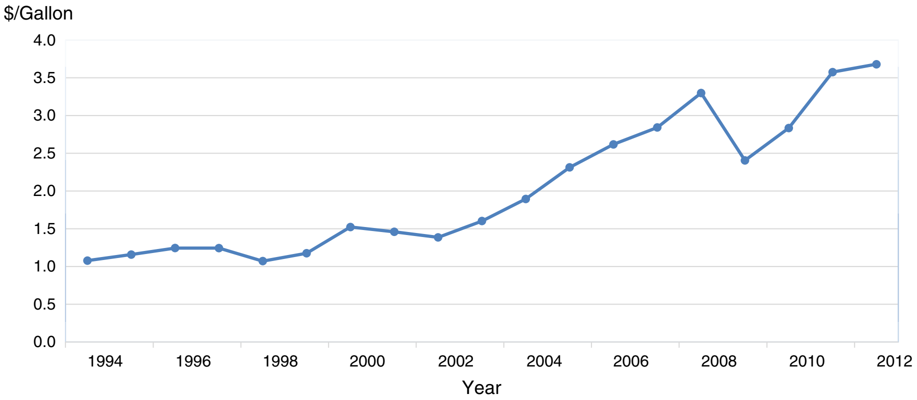

Fig. 1. Trend in average retail gasoline price (nominal values) for all grades in the United States.

about recreational activities differentiate recreational participants. Although this branch of research has emphasized the heterogeneity in recreational activities in relation to recreational demand, little, if any, research has explicitly considered this heterogeneity in regard to rising travel costs with a focus on the implications for mitigating the decline in visits.

1.2. Objective and significance of our analysis

The objective of our research is to evaluate the effects of travel costs on recreational demand by visitor participation in various types of recreational activities, and to determine the implications for slowing the decline in visits. We test the hypotheses that (1) the impact of travel cost on visits is lower for individuals who participate in specific recreational activities than those who do not participate in the specific activities and (2) the impact of travel cost on visits varies by participation in different types of recreational activities.

We tested the hypotheses with travel cost models for 5 national-forest cases in the United States (i.e., Allegheny, Coconino, Mount Baker-Snoqualmie, Ouachita, and Wenatchee). Using the estimates from the travel cost models, we predicted the number of visits for recreational-activity participants and non-recreational-activity participants under the *status quo* travel cost and hypothetical increases in travel cost of 30%, 60%, and 90%, *ceteris paribus*. The hypothetical increases in travel cost were loosely based on increases in the U.S. average gasoline price in recent years (e.g., 94% increases during 2004–2012). The predicted numbers of visits for recreational-activity participants and non-recreational-activity participants were used to examine the effects of higher gasoline prices on visits and consumer welfare from participation in various types of recreational activities.

Our research contributes to the travel cost literature in two ways. First, our empirical finding of the heterogeneity in the impacts of travel cost on number of visits to national forests by recreation activities has a direct and explicit implication for mitigating declining visits due to higher gasoline prices. Participation in recreational activities has recently become a prominent theme among researchers, policymakers, and managers involved with forest and nature-based recreation and tourism (Elands and van Marwijk, 2012). Although such research has emphasized the heterogeneity among recreational activities in relation to recreational demand, it has neglected the potential implications for curtailing the decline in visits. Our research fills this gap by evaluating implications and solutions for stemming the tide of declining visits through simulated changes in visits and consumer welfare based on participation in alternative recreational activities under hypothetical increases in travel cost.

For example, our finding of a more price-elastic demand for non-water-activity participants relative to water-activity participants suggests that higher gasoline prices trigger a greater decline in visits for non-water-activity participants relative to water-activity participants. Correspondingly, *ex ante* simulations suggest that aggregate consumer welfare declines more for non-water-activity participants than for water-activity participants when the gasoline price increases. These findings imply that increases in funds allocated to improving non-water-based recreational activities may stem the decline in visits (and the decline in consumer welfare) to the Coconino national forest by more than similar increases in funds allocated to more price-inelastic water-based activities.

Second, we evaluate the robustness of our impacts by evaluating travel cost models for 5 national forests across the United States. This 5-case analysis is a significant contribution to the literature because previous empirical studies have relied on estimates using one recreational site (or sites) in a limited geographic area. For example, Galloway (2002) examines park-related attitudes and behaviors of visitors to parks in Ontario, Canada. McCool and Reilly (1993) explore forest and recreation management preferences of forest recreationalists in Alberta, Canada. Donnelly et al. (1996) recognize the diversity of benefits visitors seek from a particular recreation engagement in Colorado State Parks. Thus, the robustness of the heterogeneity in recreational activities in relation to recreational demand has never been established because of the limited diversity in recreational sites studied in previous literature. In contrast, our evaluation is based on 5 diverse national forests using survey data from the USDA Forest Service's National Visitor Use Monitoring (NVUM) program that adopts a nationally consistent and statistically valid sampling approach (White and Wilson, 2008).

The remainder of the paper is organized as follows: The study area, NVUM survey methods, and data are described in Section 2; methods and procedures for selecting the empirical model and predicting visit numbers and consumer welfare are presented in Section 3; the empirical results are discussed in Section 4; and Section 5 offers conclusions.

2. Study area and NVUM survey

2.1. Study area

Five national forests with different characteristics (i.e., Allegheny, Coconino, Mount Baker-Snoqualmie, Ouachita, and Wenatchee) were chosen for the analysis. (See Fig. 2 and Table 1 for the locations and brief descriptions of the 5 national forests.) These national forests represent recreational sites with different climate zones and landscapes (hence various recreational opportunities) and different demographics and local cultures of visitors (hence various recreational demands). While the Mount Baker-Snoqualmie and the Wenatchee National Forests are adjacent each other, the Allegheny, Coconino, and Ouachita National Forests are far apart geographically. By examining national forests that are both geographically dispersed and adjacent, we test our hypotheses with national forests that share similar and different visit characteristics, visitor characteristics, and visitor preferences, while

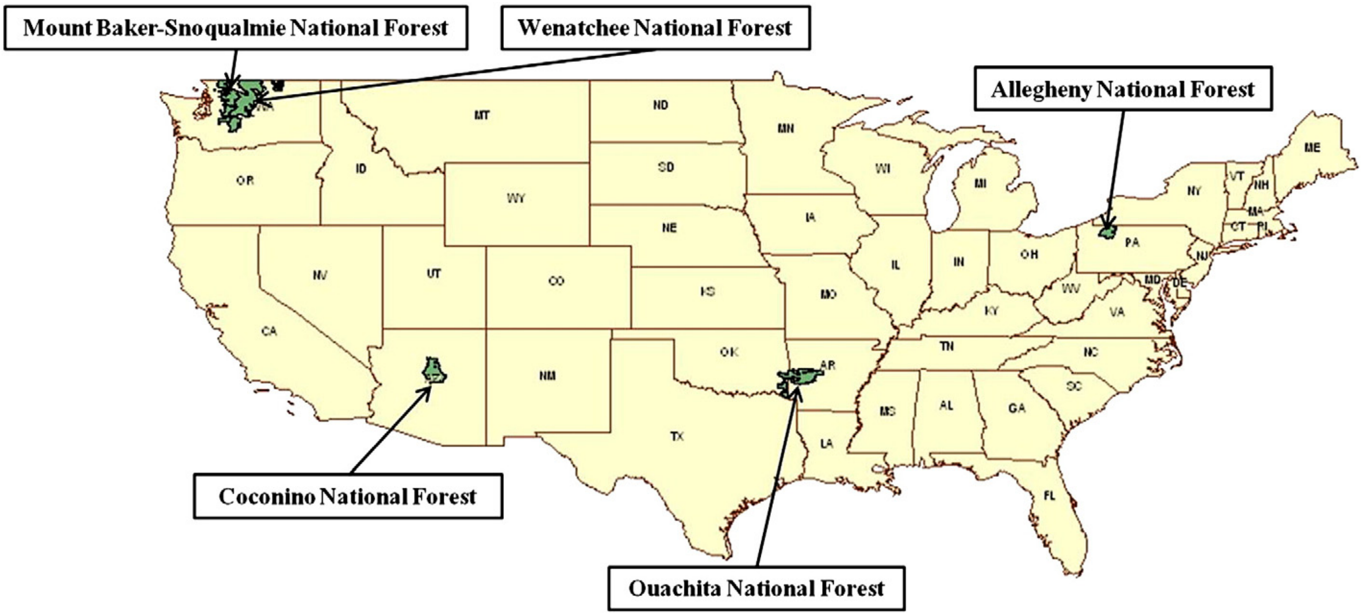

Fig. 2. Locations of the 5 national forests.

evaluating the robustness of the heterogeneity in impacts of recreational activities on recreational demand.

The Allegheny National Forest is located in the northwest corner of Pennsylvania and 86% (443,850 acres of 513,175 acres) of the national forest is covered by forest. Since the development of the Allegheny Reservoir in 1965, recreation has diversified into 14 different activities using campgrounds, boat launches, beaches, picnic areas, hiking trails, and overlooks around the reservoir. Sixty-six trails (879 total miles) and 598 camping sites on 24,145 acres of recreational area were available for 683,000 annual visitors in 2005 (USDA Forest Service, 2013a).

The Coconino National Forest in northern Arizona consists of 1.86 million acres with 3.25 million visitors annually, making it the largest and the most popular national forest among the 5 national forests. The Forest has diversified landscapes ranging from the Red Rocks of Sedona to Ponderosa Pine Forests, to alpine tundra. Only 63% of the Forest (1.17 million acres of 1.86 million acres) is covered by forest. The remaining area includes deserts, flatlands, mesas, alpine tundras, and ancient volcanic peaks. The Forest includes 517 camping sites, 177 trails (1214 total miles), and 15 different recreational activities available on 13,500 acres of recreational area (USDA Forest Service, 2013b).

The Mount Baker-Snoqualmie National Forest in Washington is composed of 1.72 million acres located along the western slopes of the Cascade Range with glacier-covered peaks, mountain meadows, and old-growth forests. The Forest attracts 1.90 million visitors annually, consists of 683 camping sites, 393 trails (1625 total miles), and has facilities for 14 recreational activities on 8473 acres of recreational area (USDA Forest Service, 2013c). The National Forest is a popular recreational destination with easy road access coupled with 62% of Washington State's population (3.63 million people) living within a 70-mile drive (LLC Books, 2010).

The Ouachita National Forest is the oldest national forest in the Southern United States and lies in western Arkansas. The Forest encompasses 1.78 million acres, including most of the Ouachita Mountains and it also contains hiking, mountain biking, and horseback riding trails. Canoeing and fishing are popular activities on 25,890 acres of recreational area. The Forest includes 293 camping sites and 188 trails (911 total miles). The most extensive trail is Ouachita National Recreation Trail, which traverses 223 mi across the region (USDA Forest Service, 2013d).

The Wenatchee National Forest is located southwest of the Mount Baker-Snoqualmie National Forest and encompasses 1.74 million acres. While the Wenatchee National Forest neighbors the Mount Baker-Snoqualmie National Forest, the Wenatchee National Forest receives considerably less rainfall and experiences more extreme temperatures than the Mount Baker-Snoqualmie National Forest, because the

Table 1
Brief description of the 5 national forests.

Lists	Allegheny	Coconino	Mt Baker-Snoqualmie	Ouachita	Wenatchee
Number of visitors[a]	683,000	3,250,600	1,899,100	1,321,500	2,130,800
Size of national forest (acre)[b]	513,175	1,856,038	1,724,229	1,784,457	1,739,057
Distance to the nearest major city (miles)[c]	29.9	46.6	48.4	27.4	48.2
Number of camping site[d]	598	517	683	293	1294
Number of recreation activities[e]	14	15	14	15	16
Size of recreation area(acre)[e]	24,145	13,538	8473	25,890	15,000
Number of trails[f]	66	177	393	188	1018
Total length of trails (miles)[f]	879	1214	1615	911	4076
Proportion of forested area[g]	0.864	0.629	0.755	0.856	0.603

[a] 2006 NVUM survey results (USDA Forest Service, 2006a,b,c,d,e).
[b] USDA Forest Service (2012).
[c] We estimated based on distance from each national forest to the nearest major city with population more than 100,000 is calculated using "Near analysis" tool in ArcGIS 10.0 (Environmental Systems Research Institute, 2013).
[d] US National Forest Campground Guide (2013).
[e] The official websites of the 5 national forests (USDA Forest Service, 2013a,b,c,d,e).
[f] The official websites of Coconino (USDA Forest Service, 2013b), and direct phone call contact with Allegheny, Mt. Baker Snoqualmie, Ouachita, and Wenatchee national forest services.
[g] We estimated based on 2006 National Land Cover Database (MRLC, 2013) using ArcGIS 10.0.

Wenatchee National Forest extends along the eastern slopes of the Cascade Range while the Mount Baker-Snoqualmie National Forest is located along the western slopes of the Cascade Range. The Forest offers hiking, camping, fishing, hunting, horseback riding, mountain biking, snowmobiling and sightseeing activities, 1294 camping sites and 1018 trails (4076 total miles) in 15,000 acres of recreational area to more than 2.13 million annual visitors (2005 estimates) (USDA Forest Service, 2013e).

2.2. NVUM survey

Much of the data, including annual numbers of visits (as the dependent variable in the travel cost model) and visitors' characteristics (except income) and participation in different recreational activities (as explanatory variables in the travel cost model), were collected from the survey conducted during Round 1 of the USDA Forest Service's National Visitor Use Monitoring (NVUM) program (USDA Forest Service, 2007). The objectives of the NVUM program are (1) to estimate the number of recreation visits to national forests and (2) to produce descriptive information about visitation, including activity participation, demographics, visit duration, measures of satisfaction, and trip spending connected to the visit (USDA Forest Service, 2007, 2010). The survey was conducted for over 155,000 visitors at 7532 different sites across 120 national forests during 1368 days of sampling between January 2000 and September 2003 (Bowker et al., 2005; USDA Forest Service, 2005). The survey database from the USDA Forest Service contains the records of 154,987 visitors. Among the recorded visitors, 136,584 visitors agreed to be interviewed (88% participation rate).

Interviewers (typically Forest Service employees), trained by attendees of the national training and certification program, conducted face-to-face, on-site interviews using 3- or 4-page National Visitor Use Survey forms. Three versions of the Survey form were used. All three versions had the same 27 questions about demographics and visit descriptions on pages 1–3.[1] One-third of the forms had these 27 questions on 3 pages, one-third of the forms had 4 pages with 6 economic questions on page 4, and one-third of the forms had 4 pages with 16 satisfaction questions on page 4 including 14 satisfaction elements, overall satisfaction, and crowding rate.[2] The questionnaires contained 3 questions with multiple sub-questions and 37 multiple choice questions that were shown on flashcards. The flashcards were used to provide potential answers to more lengthy or confidential questions, helping the visitor see all potential choices and allowing them to take time to consider all potential answers. The duration of the interview varied between 8 min and 12 min depending on the Survey form (USDA Forest Service, 2007).

The surveys used a double sampling method with a two-step approach (James, 1967). In the first step, the survey days and sites were randomly selected from a stratified set of days and recreational sites, with strata defined by site type and daily exit volume. The exact survey location was determined by road/weather conditions, type of road, and stopping distance. Interviews were given to randomly selected vehicles or groups that stopped at the randomly selected sites. In the second step, an interview was conducted with the individual who had the most recent birthday among the individuals in the randomly selected vehicle exiting the selected recreational site. For each selected site-day, 6 h of exit interviews was conducted. Site-visit estimates were acquired for each sample day, averaged by strata, and then expanded by a stratified-sampling weight (English et al., 2002). Results from the NVUM program were used to construct NVUM data. The NVUM quality-assurance-check procedure was implemented to ensure the quality of the survey data (USDA Forest Service, 2007).

2.3. Data

The annual number of visits was obtained from the NVUM question, “Including this visit, about how many times have you come to this National Forest for recreation in the last 12 months?” (USDA Forest Service, 2007). The visitors' characteristics, except income, were collected from the NVUM demographic questions. The number of accompanying people in the vehicle and the number of accompanying people under 16 years old were collected from the questions, “How many people (including you) traveled here in the same vehicle as you?” and “How many of those people are less than 16 years old?”. Dummy variables for gender, age, and race were created from information gathered using the flash cards. Although annual household income is an important factor in the decision to visit a national forest, an income question was not asked in Round 1 of the NVUM survey, and thus income was not included in the model. This missing variable may create omitted-variable bias; nevertheless, gender, age and race, which are correlated with income, were included in the model to minimize the potential bias.

All interviewed visitors were asked to circle the numbers associated with 26 types of recreational activities. Participants could choose more than one activity from among the 26 activities shown on a flashcard followed by the question, “In which of the following activities have you participated or will you participate in during this national forest visit?” (USDA Forest Service, 2007).[3] We subgrouped the 26 activities into 8 major recreational activities and created 8 dummy variables (hereafter referred to as “activity dummy variables”). See Table 2 for a detailed description of the activities included in each dummy variable.

The activity dummy variables capture the effects on the number of visits from participating in each major recreational activity. For example, the water activity dummy variable captures the difference in the numbers of visits between participants and non-participants in water-related recreational activities. Significance tests for the dummy variables of the pooled-data model provided a test of whether the explanatory variables have different effects across national forests.

We included interaction variables between travel cost and the 8 activity dummy variables (that were not mutually exclusive because participants could choose more than one activity) to capture differences in the effects of travel cost on visits for individuals who did or did not participate in the specified recreational activities. For example, the interaction between travel cost and the water activity dummy variable captures the difference in the impact of travel cost on visits for those who did or did not participate in water-related recreational activities.

A visitor's travel costs to the destination national forest and to substitute sites (i.e., the nearest state park from visitor's area of origin) were created by multiplying the estimated travel distances in miles, obtained from ArcGIS 9.2 (Environmental Systems Research Institute, 2009), by the 2003 mileage reimbursement rate ($0.36 per mile), obtained from the U.S. General Services Administration (GSA, 2013). The GSA estimated the mileage reimbursement rate based on the average cost of gasoline and oil, depreciation, maintenance, accessories, parts, tires, insurance, and state and federal taxes for privately owned vehicles. It is worth to note that the opportunity cost of travel to the site was not

[1] Demographic questionnaires include questions on the topics such as gender, age group, race/ethnicity, and number of people in the vehicle. Visit description questionnaires include questions on the topics such as length of stay, purpose of trip, types of lodging, and distance from home (USDA Forest Service, 2007).

[2] Economics questionnaires include questions on the topics such as the amount of money spent for this entire trip by market segment and spending categories such as gas, food, and lodging. Satisfaction questionnaires include questions on the topics such as satisfaction of accessibility of facilities, crowding rates given the satisfaction, satisfaction/importance on recreation services, and quality of recreation facilities (USDA Forest Service, 2007).

[3] The 26 activities include backpacking, bicycling, cross-country skiing, developed camping, downhill skiing, driving for pleasure, fishing, gathering forest products, hiking/walking, horseback riding, hunting, motorized water activities, nature center activities, nature study, non-motorized water activities, off-highway vehicle use, other motorized activities, other non-motorized activities, picnicking, primitive camping, relaxing, resort use, snowmobiling, viewing natures features, viewing wildlife, and visiting historic sites (USDA Forest Service, 2005).

Table 2
Variable names, definitions, and summary statistics.

Variables	Description	Allegheny	Coconino	Mt. Baker-Snoqualmie	Ouachita	Wenatchee
		Mean (std. dev.)	Mean (std. dev.)	Mean (std. dev.)	Mean (std. dev.)	Mean (std. dev.)
Dependent variable						
Number of visit	Number of visits during the past 12 months for a last exiting individual group in a vehicle	19.98 (36.07)	45.97 (84.07)	15.63 (26.54)	32.06 (66.52)	21.79 (25.73)
Variables of characteristic of visiting group						
Accompanying people	Number of accompanying people in the same vehicle	2.64 (1.45)	2.46 (1.51)	2.92 (4.03)	2.74 (1.74)	2.76 (1.32)
Under 16 years old	Number of accompanying people under 16 years old	0.48 (0.98)	0.52 (1.01)	0.58 (1.83)	0.73 (1.28)	0.63 (1.02)
Gender	Dummy variable for gender (1 if a survey respondent is male, 0 otherwise)	0.77. (0.42)	0.68 (0.47)	0.66 (0.48)	0.79 (0.41)	0.68 (0.47)
Senior	Dummy variable for over 60 or older (1 if a survey respondent is ≥60, 0 otherwise)	0.15 (0.36)	0.09 (0.28)	0.06 (0.24)	0.11 (0.32)	0.05 (0.22)
White	Dummy variable for Caucasian (1 if a survey respondent is Caucasian, 0 otherwise)	0.95 (0.21)	0.93 (0.25)	0.93 (0.25)	0.99 (0.10)	0.79 (0.41)
Dummy variables for participant activities						
Water	Participation of water-related recreational activities (i.e., non-motorized water travel such as canoeing, sailing, and rafting, motorized water travel such as boating, and water ski sledding, and fishing) (1 if yes, 0 otherwise)	0.19 (0.39)	0.17 (0.38)	0.08 (0.27)	0.18 (0.38)	0.14 (0.34)
Trail	Participation of trail and backpacking-related recreational activities (i.e., backpacking, camping in unroaded areas, bicycling including mountain biking, hiking, walking, and horseback riding) (1 if yes, 0 otherwise)	0.56 (0.50)	0.61 (0.49)	0.61 (0.49)	0.74 (0.44)	0.49 (0.50)
Viewing	Participation of viewing and relaxing-related recreational activities (i.e., viewing and photographing natural features such as scenery, flowers, wildlife, birds, and fish, driving for pleasure on paved, gravel, and dirt roads, relaxing, hanging out, and escaping from heat and noise) (1 if yes, 0 otherwise)	0.85 (0.36)	0.74 (0.44)	0.74 (0.44)	0.95 (0.21)	0.77 (0.42)
Picnicking	Participation of picnicking and camping-related recreational activities (i.e., picnicking and family day gatherings in developed sites, resorts, cabins, and other accommodations on Forest Service managed lands, and camping in developed and primitive sites) (1 if yes, 0 otherwise)	0.38 (0.49)	0.35 (0.48)	0.24 (0.43)	0.51 (0.50)	0.34 (0.47)
Education	Participation of education-related recreational activities (i.e., visiting historic and prehistoric sites, a nature center, nature trail, and visitor centers) (1 if yes, 0 otherwise)	0.11 (0.31)	0.23 (0.42)	0.27 (0.44)	0.40 (0.49)	0.12 (0.32)
R-vehicle	Participation of recreational motor vehicle-related recreational activities (i.e., riding in designated non-snow off-road vehicle areas, non-snow motorized trails, other motorized activities including endure events, games, and plane) (1 if yes, 0 otherwise)	0.06 (0.24)	0.09 (0.29)	0.08 (0.27)	0.05 (0.23)	0.03 (0.18)
Winter	Participation of winter sports-related recreational activities (i.e., downhill skiing or snowboarding, cross-country skiing, snowshoeing, snowmobiling) (1 if yes, 0 otherwise)	0.01 (0.10)	0.12 (0.32)	0.22 (0.41)	– –	0.31 (0.46)
Gathering	Participation of gathering and hunting-related recreational activities (i.e., gathering mushrooms, berries, firewood, or other natural products and hunting) (1 if yes, 0 otherwise)	0.19 (0.40)	0.05 (0.21)	0.05 (0.23)	0.27 (0.45)	0.10 (0.30)
Travel cost variables						
Travel cost	Travel cost for round trip based on privately owned vehicle mileage rates in 2003 ($0.36 per mile) by the U.S. General Services Administration, which was calculated based on gasoline and oil, depreciation of original vehicle cost, maintenance, accessories, parts, and tires, insurance, and state and federal taxes	40.95 (32.69)	50.67 (29.98)	33.88 (13.70)	66.35 (42.83)	51.04 (24.40)
Travel cost × water	Interaction term between travel cost and water	42.73 (26.5)	54.44 (30.72)	29.81 (10.96)	66.06 (34.56)	46.01 (23.56)
Travel cost × trail	Interaction term between travel cost and trail	42.87 (34.8)	50.16 (30.86)	33.49 (13.81)	71.26 (44.67)	53.32 (24.9)
Travel cost × viewing	Interaction term between travel cost and viewing	41.2 (34.03)	52.01 (30.41)	34.26 (13.81)	67.47 (43.04)	48.03 (25.01)
Travel cost × picnicking	Interaction term between travel cost and picnicking	44.86 (33.33)	60.82 (28.28)	33.14 (14.39)	78.55 (39.69)	55.51 (25.14)
Travel cost × education	Interaction term between travel cost and education	55.27 (33.43)	57.58 (33.19)	34.05 (12.57)	72.89 (47.37)	44.7 (25.93)
Travel cost × R-vehicle	Interaction term between travel cost and R-vehicle	60.94 (26.36)	59.09 (28.43)	35.75 (10.26)	75.41 (44.83)	58.54 (19.01)
Travel cost × winter	Interaction term between travel cost and winter	15.61 (8.62)	43.20 (23.8)	35.32 (12.52)	– –	52.87 (23.75)
Travel cost × gathering	Interaction term between travel cost and gathering	43.31 (29.09)	52.38 (28.45)	29.95 (13.78)	86.04 (36.68)	61.31 (30.5)
Characteristics of alternative site						
Travel cost to nearest state park	Travel cost for round trip to nearest state park based on privately owned vehicle mileage rates	8.78 (5.94)	118.47 (25.09)	8.44 (4.10)	16.65 (13.66)	7.61 (4.98)
Size of nearest state park	Size of nearest state park in square mile	15.79 (27.53)	90.75 (114.82)	15.45 (38.59)	8.05 (7.06)	14.49 (24.54)

considered, because income information was not available from survey respondents. Travel distances are represented by the distances between centroids of a visitor's zip code of origin and either the centroid of the visitor's destination national forest or the nearest state park.

3. Empirical model

3.1. Model selection

The dependent variable is count data so we first considered Poisson regression (Cameron and Trivedi, 1986; Greene, 2008). The hypothesized Poisson distribution is:

$$\Pr[Y = y_i|x_i] = \frac{\exp(-\lambda_i)\lambda_i^{y_i}}{\Gamma(1+y_i)}, \quad \lambda_i = \exp\left(\alpha + x_{ii}^{'}\beta\right), y_i = 0, 1, \ldots, i = 1, \ldots, N, \tag{1}$$

where $Y = y_i$ is the annual number of visits to a national forest, x_i is a vector of covariates including the travel cost to the site, the travel cost of visiting a substitute site (i.e., travel cost to the nearest state park) and its scale (i.e., size of the nearest state park), visitors' characteristics (i.e., gender, age, race, and characteristics of accompanying people in the same vehicle), participation in different types of recreational activities and their interactions with the travel cost to the site, α and β are the parameter estimates, $i = 1, \ldots, N$ is the number of observations, $E[y_i|x_i] = \lambda_i$, and $Var[y_i|x_i] = \lambda_i$.

A Pearson goodness-of-fit, chi-squared test suggested that the Poisson model did not fit the data well (test results reported below), so we performed a negative binomial regression as an alternative for count data. The negative binomial distribution is:

$$\Pr[Y = y_i|x_i] = \frac{\exp(\theta + y_i)\gamma_i^{\theta}(1-r_i)^{y_i}}{\Gamma(1+y_i)\Gamma(\theta)} y_i = 0, 1, \ldots, \theta > 0, \quad r_i = \theta/(\theta + \lambda_i). \tag{2}$$

We performed a zero-truncated negative binomial regression as an alternative to the negative binomial regression, because zero visits to a national forest cannot occur in survey data collected at the site of a national forest. The zero-truncated negative binomial distribution is:

$$\Pr(Y = y_i|x_i) = \frac{\Gamma(Y_i + 1/\alpha)}{\Gamma(Y_i+1)\Gamma(1/\alpha)}(\alpha\mu)^{Y_i}(1+\alpha\mu)^{-(Y_i+1/\alpha)}\left(\frac{1}{1-(1+\alpha\mu)^{-1/\alpha}}\right), \tag{3}$$

where μ is the intensity or rate parameter. We used the lower of the Akaike Information Criteria to choose between the negative binomial and the zero-truncated negative binomial regressions.

We used the maximum likelihood method to estimate models for the 5 national forests and a pooled-data model with dummy variables for the national forests. Because the 5 national forests provide a variety of examples with different characteristics and draw from different populations, we tested the hypothesis that the travel cost models are different. We used a likelihood ratio (LR) test to evaluate the hypothesis that all slope parameters are equal. Rejection of the null hypothesis suggests that separate regressions for the 5 national forests would be one of the appropriate options.

3.2. Predicting visit numbers and consumer welfare

We calculated the marginal effects of travel-cost increases on the demand for visits by participants in each recreational activity. These marginal effects were calculated from the selected models when the interactions between travel cost and the activity dummy variables were statistically significant at the 5% level. Using these marginal effects, we predicted the numbers of visits for recreational-activity participants and non-recreational-activity participants under the *status quo* travel cost and hypothetical increases in travel cost by 30%, 60%, and 90%, *ceteris paribus*.

The predicted number of visits was multiplied by the stratified-sampling weight discussed in the data section to expand each prediction to the number of visits that represents a given stratum. The sampling weight was calculated by [(average existing traffic count per day for the stratum) × (the ratio of number of vehicles interviewed that day to the total vehicle count that day) × (number of persons per vehicle for recreation vehicles sampled)] / [(total number of sites visited by the individual during the current national forest visit)] (English et al., 2002). The "ratio of number of vehicles interviewed that day to the total vehicle count that day" was included in the sampling weight calculation to correct for overrepresentation in the sample for those who visited more sites per national forest and to avoid a downward bias for those who visit just one site.

We calculated the change in average individual consumer welfare. We used the changes in weighted predicted number of visits for recreational-activity participants and non-recreational-activity participants and marginal effects of travel-cost on the demand for recreational-activity participants and non-recreational-activity participants. The values were calculated conditioned on recreational-activity participants $\Delta CS|_r$, where $r = 0$ for a non-participant and 1 for a participant based on Heberling and Templeton (2009):

$$\Delta CS|_r = \sum_{i=1}^{N}\left(\hat{y}_{i,hypothetical|r} - \hat{y}_{i|r}\right) \times \frac{\left(-1/\beta_{travel\,cost|r}\right)}{NP_i} \times \frac{1}{N}, \tag{4}$$

where $\beta_{travel\ cost|r}$ is the coefficient of travel cost conditioned on recreational-activity participants, $\hat{y}_{i|r}$ is the weighted predicted number of visits for interviewee i under the *status-quo* travel cost conditioned on recreational-activity participants, $\hat{y}_{i,hypothetical|r}$ is the weighted predicted number of visits for observation i conditioned on recreational-activity participants under the 3 hypothetical increases in travel cost, NP_i is the number of people in the vehicle of observation i, and N is the number of observations.

We compared percentage changes in the weighted numbers of visits predicted for recreational-activity participants and non-recreation-activity participants and their corresponding percentage changes in consumer welfare under the *status-quo* travel cost and the 3 hypothetical increases in travel cost. These comparisons were used to evaluate differences in the impacts of travel cost on visits by individuals who did or did not participate in the 8 major recreational activities.

4. Empirical results

4.1. Model selection

The Pearson goodness-of-fit, chi-squared statistics are 10,644, 31,318, 13,154, 18,621, and 15,543 for the Allegheny, Coconino, Mount Baker-Snoqualmie, Ouachita, and Wenatchee national forests, respectively. These statistics are statistically significant at the 5% level, indicating that the data do not fit the Poisson model for any of the 5 national forests. The AICs (Akaike Information Criteria) for the negative binomial regressions are 7.5, 8.6, 7.4, 7.6, and 8.0 for the Allegheny, Coconino, Mount Baker-Snoqualmie, Ouachita, and Wenatchee national forests, respectively, and they are 3545, 4562, 5120, 3982, and 7904, respectively, for the zero-truncated negative binomial regressions. The lower AICs suggest that the negative binomial regressions fit the data better than the zero-truncated negative binomial regressions for all 5 national forests. An LR statistic of 786.6 (df = 102, p-value < 0.001), calculated from the negative binomial regressions, suggests rejection of the null hypothesis that all slope parameters are equal across the 5 national forests. The coefficients and marginal effects of the 5 negative binomial regressions are discussed below. (See Table 3.)

Table 3
Coefficients and marginal effects of the negative binomial regression.

Variables	Allegheny		Coconino		Baker		Ouachita		Wenatchee	
	Coef	ME	Coef	ME	Coef	ME	Coef	ME	Coef	ME
Intercept	4.340*		6.699*		2.765*		6.388		3.952	
	(0.345)		(1.203)		(0.399)		(0.687)		(0.281)	
Variables of characteristic of visiting group										
Accompanying people	−0.124*	−1.747*	−0.089	−2.339	−0.014	−0.195	−0.095*	−1.382	−0.034	−0.675
	(0.036)	(0.505)	(0.053)	(1.397)	(0.012)	(0.165)	(0.049)	(0.707)	(0.031)	(0.607)
Under 16 years old	0.028	0.394	−0.039	−1.033	−0.022	−0.310	0.057	0.832	−0.012	−0.229
	(0.052)	(0.728)	(0.085)	(2.241)	(0.019)	(0.269)	(0.066)	(0.959)	(0.039)	(0.767)
Gender	−0.089	−1.279	−0.171	−4.662	0.172*	2.347*	−0.099	−1.480	0.211*	4.017*
	(0.118)	(1.748)	(0.119)	(3.342)	(0.084)	(1.125)	(0.129)	(1.98)	(0.062)	(1.148)
Senior	−0.251	−3.242	−0.021	−0.539	−0.245	−3.091	0.259	4.155	−0.127	−2.380
	(0.143)	(1.698)	(0.213)	(5.526)	(0.172)	(1.954)	(0.162)	(2.883)	(0.128)	(2.263)
White	−0.023	−0.325	0.128	3.181	0.51*	5.798*	−0.631	−12.674	−0.195*	−4.085*
	(0.234)	(3.365)	(0.226)	(5.333)	(0.163)	(1.494)	(0.501)	(13.506)	(0.073)	(1.631)
Dummy variables for participant activities										
Water	−0.533*	−6.435*	−1.123*	−21.579*	−0.342	−4.167	−0.446	−5.654*	0.206	4.397
	(0.237)	(2.469)	(0.326)	(4.733)	(0.445)	(4.691)	(0.253)	(2.815)	(0.190)	(4.380)
Trail	−0.143	−2.030	0.114	2.978	0.039	0.544	0.457*	5.994*	−0.449*	−8.876*
	(0.161)	(2.317)	(0.276)	(7.102)	(0.281)	(3.906)	(0.22)	(2.641)	(0.172)	(3.449)
Viewing	−0.060	−0.857	−0.334	−9.591	−0.527*	−8.493	−1.002*	−23.864	−0.291	−6.251
	(0.235)	(3.440)	(0.264)	(8.278)	(0.264)	(4.906)	(0.449)	(16.486)	(0.215)	(5.003)
Picnicking	−0.583*	−7.769*	−0.067	−1.756	−0.006	−0.088	−1.199*	−18.624*	−0.038	−0.751
	(0.175)	(2.276)	(0.255)	(6.593)	(0.255)	(3.562)	(0.200)	(3.615)	(0.146)	(2.851)
Education	−0.606*	−6.834*	0.388	11.418	0.042	0.602	0.349	5.271	0.043	0.862
	(0.293)	(2.643)	(0.274)	(9.021)	(0.291)	(4.158)	(0.187)	(2.974)	(0.185)	(3.787)
R-vehicle	−1.352*	−11.357*	−0.648	−13.346	−0.513	−5.868	−0.340	−4.255	1.926*	108.215
	(0.597)	(2.845)	(0.484)	(7.732)	(0.565)	(5.214)	(0.396)	(4.254)	(0.531)	(65.288)
Winter	0.387	6.612	0.276	8.113	0.795*	14.305	–	–	0.392*	8.403
	(1.018)	(20.928)	(0.416)	(13.594)	(0.405)	(9.309)	–	–	(0.197)	(4.602)
Gathering	0.133	1.958	0.116	3.230	0.308	4.970	−0.381	−5.102	−0.157	−2.922
	(0.192)	(2.942)	(0.611)	(17.878)	(0.409)	(7.558)	(0.211)	(2.623)	(0.194)	(3.376)
Travel cost variables										
Travel cost	−0.021*	−0.299*	−0.041*	−1.085*	−0.024*	−0.338*	−0.037*	−0.537*	−0.009*	−0.185*
	(0.006)	(0.081)	(0.008)	(0.224)	(0.01)	(0.146)	(0.010)	(0.142)	(0.005)	(0.092)
Travel cost × water	0.008	0.113	0.019*	0.49*	0.007	0.094	0.008*	0.122*	−0.004	−0.079
	(0.005)	(0.068)	(0.005)	(0.144)	(0.014)	(0.196)	(0.003)	(0.050)	(0.004)	(0.074)
Travel cost × trail	0.007*	0.099*	0.000	0.000	0.010	0.135	−0.003	−0.045	0.004	0.070
	(0.003)	(0.047)	(0.005)	(0.122)	(0.008)	(0.111)	(0.003)	(0.048)	(0.003)	(0.066)
Travel cost × viewing	0.001	0.009	0.009	0.235	0.015*	0.214*	0.007	0.103	0.003	0.062
	(0.005)	(0.071)	(0.005)	(0.135)	(0.008)	(0.108)	(0.009)	(0.133)	(0.004)	(0.070)
Travel cost × picnicking	−0.001	−0.008	−0.005	−0.131	−0.005	−0.069	0.011*	0.159*	−0.005*	−0.102*
	(0.003)	(0.045)	(0.004)	(0.111)	(0.007)	(0.102)	(0.003)	(0.038)	(0.002)	(0.049)
Travel cost × education	−0.004	−0.056	−0.008	−0.199	−0.013	−0.182	−0.002	−0.024	−0.002	−0.048
	(0.005)	(0.069)	(0.004)	(0.117)	(0.008)	(0.114)	(0.002)	(0.036)	(0.003)	(0.068)
Travel cost × R-vehicle	0.016	0.232	0.015	0.384	0.012	0.167	0.013*	0.181*	−0.034*	−0.666*
	(0.010)	(0.138)	(0.008)	(0.207)	(0.015)	(0.212)	(0.005)	(0.066)	(0.009)	(0.182)
Travel cost × winter	−0.039	−0.546	0.001	0.023	0.001	0.011	–	–	−0.007	−0.145
	(0.057)	(0.809)	(0.008)	(0.218)	(0.012)	(0.162)	–	–	(0.004)	(0.075)
Travel cost × gathering	0.002	0.023	−0.001	−0.021	0.007	0.098	−0.001	−0.012	0.000	0.000
	(0.004)	(0.055)	(0.01)	(0.265)	(0.011)	(0.16)	(0.003)	(0.041)	(0.003)	(0.067)
Characteristics of alternative site										
Travel cost to nearest state park	−0.018	−0.251	−0.013	−0.331	−0.016	−0.227	0.002	0.029	−0.001	−0.018
	(0.012)	(0.162)	(0.007)	(0.191)	(0.01)	(0.135)	(0.006)	(0.082)	(0.006)	(0.112)
Size of nearest state park	0.004*	0.049*	0.004*	0.092*	0.003*	0.045*	0.010	0.141	0.000	−0.001
	(0.002)	(0.025)	(0.001)	(0.016)	(0.001)	(0.018)	(0.008)	(0.119)	(0.001)	(0.025)
N	491		549		710		551		995	

Note: Numbers in parentheses are standard errors, and * indicates the significance at the 5% level.

4.2. Control variables

The number of accompanying persons in a vehicle had negative effects (only results that are significant at the 5% level are discussed unless otherwise indicated) on the total number of visits for 2 of the 5 national forests (Allegheny and Ouachita), while the number of accompanying persons under 16 years of age was not significant for any of the national forests. These results suggest that smaller traveling parties tend to visit more often than larger parties in two cases, whereas the number visits is not affected in any case by having children in the traveling party.

The number of visits was greater for male survey respondents than female respondents for the Mount Baker-Snoqualmie and Wenatchee national forests. Caucasian respondents visited the Mount Baker-Snoqualmie national forest more than non-Caucasian respondents, while the opposite was the case for the Wenatchee national forest. The conflicting marginal effects for Caucasians between these two national forests suggest that they draw from different populations. Although these two national forests are adjacent to each other on the western (Mount Baker-Snoqualmie) and eastern (Wenatchee) slopes of Cascade Range, 662 of 710 (93%) of visitors were Caucasian in the

Table 4
Predicted number of visits and welfare changes for hypothetical increases in travel cost.

National forests	Activity participation		Predicted number of visits (1000 visits)				Welfare/visit/person	Aggregate annual welfare (1,000,000 dollars)			
			Base	30%	60%	90%		Base	30%	60%	90%
Allegheny	Trail	Yes	956	813	701	612	25.9	24.74	21.03	18.13	15.82
		No	1931	1615	1375	1186	18.7	36.08	30.18	25.69	22.17
Coconino	Water	Yes	670	326	162	81	15.5	10.40	5.06	2.51	1.26
		No	11,200	4704	2052	921	10.2	114.51	48.09	20.98	9.41
Baker	Viewing	Yes	2777	2573	2398	2249	40.1	111.48	103.28	96.28	90.29
		No	3355	2583	2012	1581	12.9	43.44	33.44	26.05	20.47
Ouachita	Water	Yes	379	293	230	183	12.2	4.63	3.59	2.81	2.23
		No	4339	2997	2151	1592	9.9	43.12	29.79	21.38	15.82
	Picnicking	Yes	734	574	462	379	12.4	9.09	7.11	5.72	4.70
		No	3984	2716	1919	1395	11.3	45.20	30.82	21.77	15.83
	R-vehicle	Yes	356	301	256	219	18.0	6.40	5.42	4.61	3.95
		No	4362	2989	2125	1555	9.7	42.53	29.14	20.72	15.16
Wenatchee	Picnicking	Yes	2288	1836	1490	1220	23.0	52.66	42.27	34.30	28.09
		No	3386	2823	2386	2042	40.7	137.66	114.75	96.99	83.02
	R-vehicle	Yes	112	76	56	43	8.6	0.97	0.66	0.48	0.37
		No	5562	4583	3820	3219	38.8	215.80	177.82	148.22	124.90

former national forest, whereas 791 of 995 (79%) of visitors were Caucasian in latter national forest. These findings imply that visitor characteristics and preferences may be different even for sites sharing similar geographical locations.

The numbers of visits were lower for participants than non-participants in (1) water-related activities in the Allegheny, Coconino, and Ouachita national forests, (2) trail-related activities in the Wenatchee national forest, (3) viewing-related activities in the Mount Baker-Snoqualmie and Ouachita national forests, (4) picnicking-related activities in the Allegheny and Ouachita national forests, (5) education-related recreational activities in the Allegheny national forest, and (6) R-vehicle-related recreational activities in the Allegheny national forest. In contrast, participants in trail-related activities in the Ouachita national forest, participants in R-vehicle-related recreational activities in the Wenatchee national forest, and participants in winter-related activities in the Mount Baker-Snoqualmie and the Wenatchee national forests visited more often than non-participants. These results imply that the effects of participation in recreational activities on national forest visits vary across national forests and types of recreational activities.

Although travel cost to the nearest state park did not affect the number of visits to any of the national forests, the size of the nearest state park positively affected the number of visits to the Allegheny, Coconino, and Mount Baker-Snoqualmie national forests. These results imply that close-by state parks are not substitutes for recreational opportunities in national forests, but may imply complementarity in some cases. For example, residents of regions with a larger total area offering outdoor recreational opportunities may participate in more of those activities during a year, increasing demand for visits to both state parks and national forests. At least in these three cases, visits to national forests increased for individuals close to larger state parks. Nevertheless, the positive effect of the nearest state-park's size requires further investigation.

4.3. Travel cost variables

The travel cost had a consistently negative effect on the number of visits across all recreational activities and national forests, although the magnitudes of the effects varied considerably. An increase in travel cost by $1 decreased the number of visits between 0.19 and 1.09 depending on the national forest. These estimates seem higher than those reported in the literature for visits to recreational sites for a specific purpose. For example, an increase in travel cost by $1 decreased the number of visits for ice climbing in the Hyalite Canyon of the Gallatin national forest by 0.02–0.03 (Anderson, 2010). The lower marginal effects are understandable, because specific rare-amenity recreational activities, such as ice climbing, have fewer substitutes relative to the broad activity categories used in our models. The lower substitutability implies more inelastic demand and, hence, a lower impact on visits due to higher travel cost—visitors who like ice climbing are reluctant to sacrifice visits when travel cost increases.

The interaction variables suggest significant differences in the impacts of travel cost on visits between participants and non-participants in recreational activities, depending on the national forest. An increase in travel cost by $1 decreases the number of visits by (1) 0.60 for participants and 1.09 for non-participants, and 0.42 for participants and 0.54 for non-participants in water-related activities in the Coconino and Ouachita national forests, respectively, (2) 0.20 and 0.30, respectively, for participants and non-participants in trail-related activities in the Allegheny national forest, (3) 0.12 and 0.34, respectively, for participants and non-participants in viewing-related activities in the Mount-Baker Snoqualmie national forest, (4) 0.38 for participants and 0.54 non-participants, 0.29 for participants and 0.19 for non-participants in picnicking-related activities in the Ouachita and Wenatchee national forests, respectively, and (5) 0.36 for participants and 0.54 for non-participants, and 0.86 for participants and 0.19 for non-participants in R-vehicle-related activities in the Ouachita and Wenatchee national forests, respectively.

4.4. Predicted visits and welfare changes

Table 4 shows the predicted annual numbers of visits, individual consumer surplus per visit, and annual aggregate consumer surplus for the *status quo* travel cost (Base) and hypothetical 30%, 60%, and 90% increases in travel cost, *ceteris paribus*, for recreational-activity participants and non-participants in cases with significant activity/travel-cost interactions. Compared with the Base, hypothetical 30%, 60%, and 90% increases in travel cost decrease visit numbers for trail-activity participants by 143,000 (15.0%), 255,000 (26.7%), and 345,000 (36.0%), respectively, while those for non-trail-activity participants decrease by 316,000 (16.4%), 556,000 (28.8%), and 744,000 (38.6%), respectively, in the Allegheny national forest. The consumer surplus per visit for trail-activity participants and for non-trail-activity participants was $26 and $19, respectively. Although the loss in consumer surplus per visit due the decline in visit numbers is greater for trail-activity participants than for non-trail-activity participants, the decline in visit numbers is greater for non-trail-activity participants than for trail-activity participants. Because of the larger negative impact of the greater decline in visit numbers than the decline in consumer surplus per visit, the aggregate loss in consumer surplus from hypothetical increases (30%, 60%, 90%) in travel cost is greater for non-trail-activity participants ($5.9 million, $10.4 million, and $13.9, respectively) than for trail-activity participants ($3.7 million, $6.6 million, and $8.9 million, respectively) in the Allegheny national forest.

By the same token, the aggregate loss in consumer surplus from hypothetical 30%, 60%, and 90% increases in travel cost is greater (1) for non-water-activity participants ($66.4 million, $93.5 million, and $105.1, respectively) than for water-activity participants ($3.7 million, $6.6 million, and $8.9 million, respectively) in the Coconino national forest, (2) for non-water-activity participants ($13.3 million, $21.7 million, and $27.3, respectively) than for water-activity participants ($1.0 million, $1.8 million, and $2.4 million, respectively) in the Ouachita national forest, (3) for non-viewing-related recreational activity participants ($10.0 million, $17.4 million, and $23.0, respectively) than for viewing-related recreational activity participants ($8.2 million, $15.2 million, and $21.2 million, respectively) in the Mount-Baker Snoqualmie national forest, (4) for non-picnicking-related recreational activity participants ($14.4 million, $23.4 million, and $29.4, respectively) than for picnicking-related recreational activity participants ($2.0 million, $3.4 million, and $4.4 million, respectively) in the Ouachita national forest, and (5) for non-R-vehicle-related recreational activity participants ($13.4 million, $21.8 million, and $27.4, respectively) than for R-vehicle-related recreational activity participants ($1.0 million, $1.8 million, and $2.5 million, respectively) in the Ouachita national forest.

Compared with the *status quo*, hypothetical 30%, 60%, and 90% increases in travel cost cause a decrease in visit numbers for picnicking-related recreational activity participants by 451,000 (or 19.7%), 798,000 (or 34.9%), and 1,067,000 (or 46.7%), respectively, while those for non-picnicking-related recreational participants decreased by 564,000 (or 16.6%), 1,000,000 (or 29.5%), and 1,344,000 (or 39.7%), respectively, in the Wenatchee national forest. The consumer surplus per visit for picnicking-related recreational activity participants and for non-picnicking-related recreational activity participants was $23 and $41, respectively. Both the loss of consumer surplus per visit and the decline in visit numbers were greater for non-picnicking-related recreational activity participants than for picnicking-related recreational activity participants. Thus, the aggregate loss in consumer surplus from the hypothetical increases in travel cost is greater for non-picnicking-related recreational activity participants ($22.9 million, $40.7 million, and $54.6 million) than for picnicking-related recreational activity ($10.4 million, $18.4 million, and $24.6 million) in the Wenatchee national park. By the same token, the aggregate loss in consumer surplus from the hypothetical increases in travel cost is greater for non-R-vehicle-related recreational activity participants ($38.0 million, $67.6 million, and $90.9) than for R-vehicle-related recreational activity ($0.3 million, $0.5 million, and $0.6 million) in the Wenatchee national park.

5. Conclusions

In the face of higher travel costs due to rising gasoline prices and scarce budget resources, we explored differences in the impacts of higher travel costs on recreational demand for visitors (and hence on their consumer welfare) for participants and non-participants in various recreational activities. Across all recreational activities and the 5 national forests, travel cost had a consistently negative effect on the number of visits, although the magnitudes of the effects varied considerably. Differences in magnitudes of the effects of travel cost increases on visits between recreational-activity participants and non-participants across the 5 national forests vary. Thus, the decision-making implications about allocating funds for maintenance and improvement of facilities and services differ.

Below is a summary of the implications based on our findings, highlighting differences among the 5 national forests. In the Allegheny national forest, the aggregate loss in consumer surplus from hypothetical increases in travel cost is greater for non-trail-activity participants than for trail-activity participants. This finding implies that increases in funds allocated towards improving non-trail-related recreational activities may stem the loss in consumer surplus from higher travel cost more than similar increases in funds allocated to improving trail-related activities. For example, increased funding for maintenance and improvement of overlooks of the forest's main attraction, the Allegheny Reservoir, may stem the loss in consumer surplus more effectively than using the funds to improve trail-related infrastructure.

In the Coconino and Ouachita national forests, the aggregate loss in consumer surplus from increases in travel cost is greater for non-water-activity participants than for water-activity participants. In the Ouachita and Wenatchee national forests, the aggregate loss in consumer surplus is greater (1) for non-picnicking-related activity participants than for picnicking-related activity participants and (2) for non-R-vehicle-related recreational activity participants than for R-vehicle-related recreational activity participants. These findings imply that (i) increases in funds allocated towards improving non-water-based recreational activities may stem the loss in consumer surplus due to increases in travel cost by more than using the funds to improve water-based activities and (ii) increases in funds allocated towards improving non-picnicking-related and non-R-vehicle-related recreational activities may mitigate the loss in consumer surplus due to increases in travel cost by more than similar increases in funds allocated to picnicking-related and R-vehicle-related recreational activities. For example, although canoeing and fishing are popular activities in the Ouachita national forest, increased funding for maintenance and improvement of the Ouachita National Recreation Trail may curtail the loss in consumer surplus due to the decline in visits from increased travel cost more effectively than using funds for improving canoeing and fishing experiences.

In the Mount Baker-Snoqualmie national forest, the aggregate loss in consumer surplus from increased travel cost is greater for non-viewing-related recreational activity participants than for viewing-related recreational activity participants. This finding implies that increases in funds allocated towards improving non-viewing-related recreational activities may slow the loss in consumer surplus due to increased travel cost by more than similar increases in funds allocated to viewing-related recreational activities. For example, given the attraction of the long trails in the national forest, increased funding for maintenance and improvement of the trails may curtail the loss in consumer surplus due to increased travel cost more effectively than using the same amount funding for improving viewing-related recreational activities.

Our modeling methods and findings can be adopted by persons interested in predicting recreational-site visits based on participants' recreational activities. For instance, we could modify the Microsoft (MS) Access database application, originally developed to predict the numbers of visits to national forests, to simulate alternative future demand scenarios (Bowker et al., 2008), assuming the impacts of travel cost on visits vary by visitor participation in various recreational activities under alternative assumptions about rising gasoline prices. Such a modified predictor can help national forest managers make decisions about allocating funds for maintenance and improvement of facilities and services associated with visitors' participation in recreational activities.

References

Anderson, D.M., 2010. Estimating the economic value of ice climbing in Hyalite Canyon: an application of travel cost count data models that account for excess zeros. J. Environ. Manag. 91 (4), 1012–1020.

Aronsson, T., Brännäs, K., 1996. Household work travel time. Reg. Stud. 30 (6), 541–548.

Bhat, C., 1995. A heteroscedastic extreme value model of intercity travel mode choice. Transp. Res. B 471–483.

Bhubaneswor, D., Yao, R.T., Turner, J.A., Barnard, T., 2012. Recreational users' willingness to pay and preferences for changes in planted. For. Policy Econ. 17, 34–44.

Bowker, J.M., English, D., Bergstrom, J.C., Starbuck, C.M., 2005. Valuing national forest recreation access: using a stratified on-site sample to generate values across activities for a nationally pooled sample. Selected Paper Prepared for Presentation at the American Agricultural Economics Association Annual Meeting, Providence Rhode Island, July 24–27, 2005.

Bowker, J.M., Starbuck, C.M., Souter, R.A., 2008. The Feasibility of Utilizing NVUM Survey Results and US Census Bureau Data to Estimate and Forecast Recreation Demand on National Forests: A Case Study. Report prepared for the USAD Forest Service.

Brännäs, K., Laitila, T., 1992. Modeling and prediction of travel distance by car. Transp. Plann. Technol. 16, 129–143.

Cameron, A.C., Trivedi, P.K., 1986. Econometric models based on count data: comparison and applications of some estimations and tests. J. Appl. Econ. 1, 29–53.

Clawson, M., Knetsch, J.L., 1966. Economics of Outdoor Recreation. Johns Hopkins University Press, Baltimore, MD.

Corsi, T., Harvey, M., 1979. Change in vacation travel in response to motor fuel shortages and higher prices. J. Travel Res. 17 (4), 7–11.

Donnelly, M.P., Vaske, J.J., DeRuiter, D.S., King, T.B., 1996. Person–occasion segmentation of state park visitors. J. Park. Recreat. Adm. 14 (2), 95–106.

Elands, B.H.M., van Marwijk, R.B.M., 2012. Policy and management for forest and nature based recreation and tourism. For. Policy Econ. 19, 1–3.

English, D.B.K., Kocis, S.M., Zarnoch, S.J., Arnold, J.R., 2002. Forest Service National Visitor Use Monitoring Process: Research Method Documentation. SDA National Forest.

Environmental Systems Research Institute, 2009. ArcGIS Desktop 9.2.

Environmental Systems Research Institute, 2013. ArcGIS Resources: ArcGIS Help 10.1 — Near Analysis.

Fantazzini, D., Höök, M., Angelantoni, A., 2011. Global Oil Risks in the Early 21st Century. Energy Policy 39 (12), 7865–7873.

Fredman, P., Emmelin, L., 2001. Wilderness purism, willingness to pay and management preferences: a study of Swedish mountain tourists. Tour. Econ. 7 (1), 5–20.

Galloway, G., 2002. Psychographic segmentation of park visitor markets: evidence for the utility of sensation seeking. Tour. Manag. 23, 581–596.

Greene, W.H., 2008. Econometric Analysis, 6th edition. Prentice Hall, Englewood Cliffs, NJ.

GSA, 2013. Privately Owned Vehicle (POV) Mileage Reimbursement Rates. Available at http://www.gsa.gov/portal/content/104206.

Gurmu, S., Trivedi, P., 1996. Excess zeros in count models for recreational trips. J. Bus. Econ. Stat. 14, 469–477.

Hausman, J., Leonard, G., McFadden, D., 1995. A utility-consistent, combined discrete Choice and count data model assessing recreational use losses due to natural resource damage. J. Public Econ. 56, 1–30.

Heberling, M., Templeton, J., 2009. Estimating the economic value of national parks with count data models using on-site, secondary data: the case of the great sand dunes national park and preserve. Environ. Manag. 43 (4), 619–627.

James, G.A., 1967. Recreation Use Estimation on Forest Service Lands in the United States. USDA Forest Service, Southeastern Forest Experiment Station.

Kamp, B.D., Crompton, J.L., Hensarling, D.M., 1979. The reactions of travelers to gasoline rationing and to increases in gasoline prices. J. Travel Res. 18, 37–41.

Lai, P.H., Cheng, C.K., Scott, D., 2007. Building Stewardship With Recreation Users: An Approach of Market Segmentation to Meet the Goal of Public-Lands Management.

L.L.C. Books (Ed.), 2010. National Forests of Washington (U.S. State): Mount Baker-Snoqualmie National Forest, Umatilla National Forest, Gifford Pinchot National Forest.

Lundevaller, E.H., 2009. The effect of travel cost on frequencies of shopping and recreational trips in Sweden. J. Transp. Geogr. 17, 208–215.

McCool, S.F., Reilly, M., 1993. Benefit segmentation analysis of state park visitor setting preferences and behavior. J. Park. Recreat. Adm. 11 (4), 1–14.

McFarlane, B.L., Boxall, P.C., 1996. Exploring forest and recreation management preferences of forest recreationists in Alberta. For. Chron. 72 (6), 623–629.

Morgan, J.N., 1986. The impact of travel costs on visits to US national parks: intermodal Shifting among Grand Canyon visitors. J. Travel Res. 24, 23–28.

Multi-Resolution Land Characteristics Consortium (MRLC), 2013. National Land Cover Database (NLCD) 2006. Available at http://www.mrlc.gov/nlcd2006.php.

National Forest Campground Guide, U.S., 2013. National Forests and Campgrounds. Available at http://www.forestcamping.com/dow/list/nflist.htm.

Oh, C.O., Hammitt, W.E., 2011. Impact of increasing gasoline prices on tourism travel patterns to a state park. Tour. Econ. 17 (6), 1311–1324.

Poudyal, N.C., Hodges, D.G., Merrett, C.D., 2009. A hedonic analysis of demand for and benefit of urban recreation parks. Land Use Policy 26, 975–983.

Ryan, C., Sterling, L., 2001. Visitors to Litchfield National Park, Australia: a typology based on behaviours. J. Sustain. Tour. 9 (1), 61–75.

USDA Forest Service, 2005. National Forest Visitor Use Monitoring Program National Project Results January 2000 through September 2003.

USDA Forest Service, 2006a. National Visitor Use Monitoring Results for Allegheny National Forest.

USDA Forest Service, 2006b. National Visitor Use Monitoring Results for Coconino National Forest.

USDA Forest Service, 2006c. National Visitor Use Monitoring Results for Mt. Baker-Snoqualmie National Forest.

USDA Forest Service, 2006d. National Visitor Use Monitoring Results for Ouachita National Forest.

USDA Forest Service, 2006e. National Visitor Use Monitoring Results for Wenatchee National Forest.

USDA Forest Service, 2007. National Visitor Use Monitoring Handbook July 2007. (Washington D.C. Available at http://www.fs.fed.us/recreation/programs/nvum/reference/july07_handbook.pdf).

USDA Forest Service, 2010. National Visitor Use Monitoring Results. National Summary Report. (Available at http://www.fs.fed.us/recreation/programs/nvum/nvum_national_summary_fy2009.pdf).

USDA Forest Service, 2012. Land Areas of the National Forest System.

USDA Forest Service, 2013a. Allegheny National Forest — Recreation. Available at http://www.fs.usda.gov/recmain/allegheny/recreation.

USDA Forest Service, 2013b. Coconino National Forest — Recreation. Available at http://www.fs.usda.gov/recmain/coconino/recreation.

USDA Forest Service, 2013c. Mt Baker-Snoqualmie National Forest — Recreation. Available at http://www.fs.usda.gov/recmain/mbs/recreation.

USDA Forest Service, 2013d. Ouachita National Forest — Recreation. Available at http://www.fs.usda.gov/recmain/ouachita/recreation.

USDA Forest Service, 2013e. Okanogan-Wenatchee National Forest — Recreation. Available at http://www.fs.usda.gov/recmain/okawen/recreation.

Warzecha, C.A., Lime, D.W., 2001. Place attachment in Canyonlands National Parks: visitors' assessment of setting attributes on the Colorado and Green Rivers. J. Park. Recreat. Adm. 19 (1), 59–78.

White, E.M., Wilson, J.B., 2008. National visitor use monitoring implementation in Alaska. Gen. Tech. Rep. PNW-GTR-740. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR (52 pp.).

William, P.W., Burke, J.F., Dalton, M.J., 1979. The potential impact of gasoline futures on 1979 vacation travel strategies. J. Travel Res. 18 (1), 3–7.