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Demand for and Economic Value of Nonmotorized Boating Access in Rivers at US National Forests

Binod P. Chapagain, Neelam C. Poudyal, J.M. Bowker, Ashley E. Askew, Donald B.K. English, and Donald G. Hodges

Binod P. Chapagain (binod.chapagain@okstate.edu), Department of Integrative Biology, Oklahoma State University, Stillwater, OK, USA. Neelam C. Poudyal (npoudyal@utk.edu), Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN, USA. J.M. Bowker (mbowker@fs.fed.us), USDA Forest Service, Southern Research Station, Athens, GA, USA. Ashley E. Askew (aaskew@uga.edu), Warnell School of Forestry and Natural Resources, University of Georgia, GA, USA. Donald B.K. English (donald.english@usda.gov), Recreation, Heritage, and Volunteer Resources Staff, USDA Forest Service, Washington DC, USA. Donald G. Hodges (dhodges2@utk.edu), Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, TN, USA.

Abstract

Nonmotorized boating (NMB) is a popular recreation activity in the US National Forest System. Previous studies on NMB were from an individual river or site, which limited aggregating benefit across the system or generalizing to rivers across the country. Further, whether and how site and river characteristics affect the use of rivers for NMB activities are unknown. This study combined trip data collected from visitor surveys across the system with spatially explicit data on river characteristics in a travel cost model, and in the analysis step, characterized the economic benefit of NMB access and evaluated the effect of site and river characteristics. Net economic benefit of NMB access was estimated to be in the range of $56 to $73 per trip, depending on the modeling assumptions used. When aggregated across visits over the country, the total annual economic value of NMB access in National Forest System ranged from $92 million to $120 million. Results further suggest that site and river characteristics including water velocity, ramp availability, and rapid level were significantly related to NMB demand. Results may be useful in highlighting the use and public value of NMB access in rivers and in understanding the importance of site and river characteristics.

Study Implications: The study provides useful findings informing managers and the public regarding the significance of NMB activities and highlighting the net benefits of nonmotorized access to rivers inside the National Forest System. Economic benefits of NMB access presented here will help planners and managers characterize the value of maintaining these resources for public use, and justify the investment and costs associated with management. Factors identified as determinants of demand for nonmotorized access help river managers understand and project potential shifts in site demand for future use. Site characteristics variables found to explain demand will help river recreation managers in prioritizing site-specific management practices to enhance visitor experiences.

Keywords: nonmotorized boating, economic valuation, travel cost, national forests, site and river characteristics

Nonmotorized boating (NMB)[1] activities (e.g., boating, canoeing, kayaking, tubing, rowing, and rafting) have been a popular outdoor recreation activity in the United States, with more than 20% of the population annually participating in such activities (Cordell 2012, p. 35–40). Rivers and streams within the US National Forest System across the country are popular destinations for NMB activities (White et al. 2016) where about 3.58 million visitors participate in NMB activities and 1.64 million visits primarily for the purpose of NMB (USDA Forest Service 2015a). Recent studies on modeling of recreation participation trends have indicated that NMB will remain a popular activity in future as well. For example, White et al. (2016, p. 7) projected positive outlooks for participation in floating activities (canoeing, kayaking, and rafting), increasing by 21.7% by 2030 from 39.8 million participants in 2008. Similarly, Bowker et al. (2012, p. 26) projected the number of adults participating in floating to increase by up to 62% by 2060 under certain scenarios of climate change.

The USDA Forest Service (USFS) invests considerable human and financial resources in managing national forests, which play important roles in providing a wide range of benefits, including ecosystem services, to the public. Outdoor recreation access is one of the recognized services from these forests where 149 million visitors engage in a variety of recreation activities annually (USDA Forest Service 2015a). The USFS has acknowledged the importance of these forests' role in providing recreational benefit to the public by incorporating "connect people to the outdoors" as one of the strategic goals (USDA Forest Service 2015b). Understanding the level of recreational use and its economic value is important from management perspective. Policy decisions regarding management of public lands including national forests can be better informed by a complete understanding of the economic benefit provided to the public.

The economic significance of recreation opportunities can be expressed in terms of economic impact of recreation expenditure or economic value of access to recreation opportunities. Economic impact shows the direct and multiplier effects of visitor spending on the regional economy in terms of jobs, labor income, wage, gross domestic product contribution, tax revenue, and other economic metrics. Economic value is an alternative measure that shows the net benefit of recreation access to the beneficiaries (i.e., visitors). The economic value is interpreted in terms of the economic welfare recreationists enjoy (or potentially lose if the recreation opportunity is no longer available) from having access to this opportunity. Although there are social, economic, and cultural benefits of recreation opportunities in the national forests, benefits such as access for NMB recreation are typically not traded in competitive markets and are therefore difficult to quantify in monetary terms.

Nonmarket valuation methods such as the travel cost method (TCM) are typically used to quantify the benefit associated with access to recreation sites for a particular recreation activity (Parsons 2017). The TCM method has been widely used in water recreation studies (Bergstrom and Cordell 1991, Siderelis and Moore 2006, Bowker et al. 2009, McKean et al. 2012, Loomis and McTernan 2014). To characterize the net benefit a recreationist derives from a taking trip, also known as consumer surplus (CS), this method relies on the relationship between demand for recreation access and the cost of traveling to the site. This measure of economic benefit represents the amount a visitor may be willing to pay above and beyond their travel cost to enjoy a site (e.g., river) for the activity (e.g., NMB) (Freeman et al. 2014).

Although many studies have examined the economic value of NMB activities (Johnson et al. 1990, Bowker et al. 1996, Siderelis et al. 2001), only two TCM studies have relied on national-level river data (Bergstrom and Cordell 1991, Bowker et al. 2009). However, the generalizability of the results is limited because of small sample size and less robust modeling techniques used. Considering the large number of NMB visitors in the National Forest System, there is a need for a credible and broadly applicable information on what factors influence the demand for and value of recreational access for NBM, as well as understanding whether and how site and river characteristics affect demand. Furthermore, literature on outdoor recreation suggests that site attributes or resource characteristics affect the demand for recreation activities (Vaughan and Russell 1982, Murdock 2006). In case of river-based recreation, studies have included few of such characteristics in demand models (Bowker et al. 1997, Siderelis and Moore 2006, Loomis and McTernan 2014, Boyer et al. 2017). Bowker et al. (1997), for example, showed that the site factors such as Wild and Scenic Rivers (WSR)[2] designation and floating time significantly affected the net economic benefit of river recreation. As the sample in that study was limited to a specific river, questions about whether and to what extent WSR designation helps to improve recreational appeal of rivers or quality of visitor experience are still unclear.

Our current understanding of the demand and economic value of nonmotorized recreation relative to site and river characteristics is limited. Therefore, this study attempts to address the knowledge gaps by combining nationwide river visitation data collected from onsite visitor surveys on rivers with spatially explicit information on river and site characteristics. The study addresses two specific objectives: to estimate the net economic benefit of river access for NMB activities in the National Forest System and to evaluate the effect of site-specific and river characteristics on demand for NMB activities. These objectives are addressed by combining NMB trip profile data collected from onsite survey of NMB visitors at all national forests[3] between 2005 and 2014, with spatially explicit data on site and river characteristics to model demand for NMB.

Existing Studies on Economic Value of Nonmotorized Boating

The majority of past whitewater recreation studies aggregated multiple outdoor activities and estimated the overall welfare for all activities along with nonmotorized boating (Bowker et al. 2009, Treiman et al. 2014, Boyer et al. 2017). In terms of methodology, TCM and contingent valuation (CV), or combination of both, are commonly used methods to estimate the economic value of recreation access. In a recent database of 421 recreational use value studies, Rosenberger (2016) reported 87 estimates from 25 different studies of nonmotorized boating from 1977 to 2014. Most of the estimates (68) were for whitewater boating (e.g., Johnson et al. 1990, Bowker et al. 1996, Siderelis et al. 2001), and the remaining were for nonwhitewater activities.

The study by Bergstrom and Cordell (1991) is the only one to estimate an economic value for NMB in rivers (of all kinds) in general on a national scale. They developed a zonal travel cost model (ZTCM) of demand using a reverse gravity approach for river recreation activities such as rafting, tubing, canoeing, kayaking, and boating. Although Bowker et al. (2009) also used national-level data to estimate the net economic value of 14 different outdoor recreation activities in the national forests and grasslands, their welfare estimates cannot be generalized because the value for nonmotorized boating were aggregated with other activities such as biking and horseback riding because of sample size restrictions.

As reported by Rosenberger (2016), there is remarkable variation in the estimates among the studies as the economic value of nonmotorized boating depends on many factors including study methodologies, travel cost assumptions, sampling methods, type of activities, the location of river, site characteristic, and river features. Bowker et al. (1996) examined per trip CS associated with guided rafting on Chattooga River and Nantahala River, two representative rivers of different rapid class in the southern United States, and found the magnitude of the net benefit from visiting these rivers depends on river quality and the modeling assumptions regarding opportunity cost of time. Most of the studies on demand and recreation value of nonmotorized boating are dated: The most recent one is Loomis and McTernan (2014), which found the per person per trip value of instream flow to noncommercial paddlers in Poudre River, the only Wild and Scenic River in Colorado, to be $115.

CV surveys have also been used to assess the economic value of nonmotorized boating (e.g., Walsh et al. 1985, Siderelis et al. 2001, Loomis and McTernan 2014). The CV study on kayakers and rafters by Loomis and McTernan (2014), for example, found a willingness to pay of $62 to $108 depending on the instream flow of the river. They found similar economic value estimations in the TCM and CV method, confirming some consistency in both methods and a level of convergent reliability. In a similar CV study, Boyle et al. (1993) estimated willingness to pay values under different water flow conditions for Grand Canyon whitewater boaters. Using a CV survey in eastern North Carolina, Siderelis et al. (2001) estimated the paddlers' willingness to pay and concluded that adding annual fees does not affect their demand.

Methods

Data

Data on NMB trips to rivers on national forests between 2005 and 2014 (survey rounds 2 and 3) were obtained from the Forest Service National Visitor Use Monitoring (NVUM) program, which was started in 2000 to estimate volume and trip characteristics of recreation visitation on the national forests and grasslands (USDA Forest Service 2007). It is important to note that number of NMB trips was reported for all waterways and waterbodies combined within a national forest, but only the trips for every river was considered in this study. Every year, in five-year cycles, NVUM surveys exiting visitors at 20% of the national forests through stratified random sampling. Data from the first five-year cycle (round 1) were not used in this study because major changes were made to the sample protocol for rounds 2 and 3 (USDA Forest Service 2006).

The survey collects a wide range of information on the visits including purpose of the visit, frequency of visits, location of recreation site, visitor origin, trip expenditures, and socioeconomic information (English et al. 2002). River and site characteristics variables are not available in the NVUM data set, so data were collected from other sources that maintained spatially explicit information using physical locations (geographic coordinates) of the river site available on the NVUM survey. The lists of data used in the model and data source information are reported in Table 1.

Conceptual Framework

The economic theory of individual preferences assumes that individuals are aware of the utility of goods and services they consume. From utility maximization point of view, an individual's utility or satisfaction from recreation partly depends on the price of the recreation activity, income, and other factors. The TCM method relies on the assumption that the demand (i.e., number of trips for a recreation activity) decreases with increase in price (i.e., cost of travel). The method is based on theoretical assumption of utility maximization and weak complementarity associated with actual travel behavior reported by the recreationist (Freeman et al. 2014). Utility maximization theory assumes that the recreationists maximize their utility by consuming the resource of interest, and the property of weak complementarity assumes that private good is a weak complement with nonmarketed good or service being valued. The TCM is a demand-based model for recreational use of a site or multiple sites (Parsons 2017), in which number of trips taken by a recreationist (count data) is modeled as a function of the cost of accessing a given site(s), substitute sites, site attributes, and other sociodemographic factors believed to influence demand. Another major assumption in this method is that cost of travel to reach the site is a proxy price for recreational access. Using the relationship between cost of travel and number of trips, the main function of this method is to estimate welfare measure. The empirical process of estimating welfare measure of access to the site(s) involves two steps: estimating parameters of the demand function and calculating welfare measure from estimated parameters (Haab and McConnell 2002, p. 159).

The utility maximization equation subject to the constraints can lead to the general demand function (Parsons 2017), which can be expressed as follows:

$$Y_i = f\,(P_i, S_i, I_i, Z_i) \tag{1}$$

where Y_i is number of trips taken by an individual i for the primary purpose of a given recreation use, P_i is cost of a trip, S_i is trip cost to the substitute sites, I_i is the individual's income, and Z_i is a vector of sociodemographic attributes of individual i that may influence the demand for a given recreation activity.

The welfare measure of benefits to recreationist from recreation opportunities can be measured in terms of CS (also known as net economic benefit). The net economic value can be derived from an individual's demand curve by integrating the demand function (equation 1) and estimating the area above the price line and below the demand curve.

Figure 1 illustrates the demand curve represented by equation (1). In the figure, price (cost per trip) is measured on the y axis and demand (number of trips for a recreation activity) is measured on the x-axis. The slope

Table 1. Data used in the model and data source information.

Item	Data	Source
1	Nonmotorized boating trips, trip characteristics, sociodemographic characteristics	USDA Forest Service National Visitor Use Monitoring Program
2	Adjusted gross household income	Internal Revenue Service
3	River designation	US government's open data (US General Services Administration 2017)
4	Rapid class (difficulty)	American Whitewater's Nationwide Whitewater Inventory (American Whitewater 2017)
5	Availability of ramp at the takeout point for each national forest site	USDA Forest Service, BoatUS (BoatUS 2017)
6	Water discharge and velocity	USGS National Water Information System (United States Geological Survey [USGS] 2017)
7	River permits and quotas	USDA Forest Service, American Whitewater's Nationwide Whitewater Inventory (American Whitewater 2017)

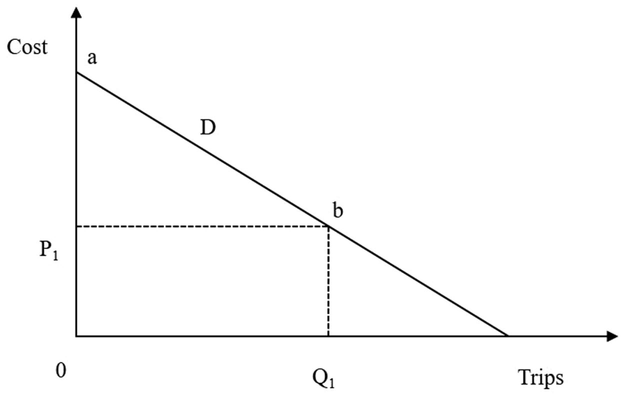

Figure 1. A demand curve illustrating the relationship between travel cost, trips, and net benefit of access to a recreation site.

"*D*" represents the individual's demand curve for recreation trips. The rectangular area, $P_1 0 Q_1 b$, represents individual's expenditure for Q_1 trips and at a cost of P_1 per trip. The triangular area, $P_1 ab$, above price line $P_1 b$ and below the demand curve represents net economic value associated with Q_1 trips. This area measures the difference between how much an individual is willing to pay and the actual cost she or he incurs (Parsons 2017). Mathematically, this area is represented by the negative inverse of the travel-cost coefficient from demand function in equation (1). Therefore, as shown in the following equation, estimated travel cost coefficient can be used to calculate CS per trip per group, and resulting CS can be divided by traveling party size to calculate CS per person:

$$CS = -\left(\frac{1}{\beta_{TCOST}}\right) \quad (2)$$

Empirical Model

Based on the theoretical foundation of demand function in equation (1) and following the existing travel cost literature (Creel and Loomis 1990, Loomis and McTernan 2014, Parsons 2017), the pooled demand model for NMB on rivers in the national forests was specified in equation (3). In TCM, pooling data across multiple related sites is often done to describe demand for an activity (e.g., hunting) in a region (Vaughan and Russell 1982, Coupal et al. 2001, Mingie et al. 2019).

$$TRIPS_{ik} = f\left(\begin{array}{l} Travel\ cost_i, Substitute\ cost_i,\ Socioeconomic_i,\ Group\ size_i, \\ Under16_i, River_k, Site_k, Days_i, Recession, Round3 \end{array}\right) + \mu_{ik} \quad (3)$$

where $TRIPS_{ik}$ represents the number of trips taken by traveling group or individual *i* to site *k* within a year; $Travel\ cost_i$ is the trip cost for unit *i*; $Substitute\ cost_i$ is the cost of traveling between unit *i*'s origin to the closest river, other than river *k*, offering a similar venue; $Socioeconomic_i$ represents socioeconomic variables (age, gender, and estimated annual income); $Group\ size_i$ is the number of people in the travel party; $Under16_i$ is the number of people under 16 years of age in the travel party; $River_k$ represents characteristics of the river such as water velocity and water discharge; $Site_k$ represents site characteristics at the takeout point of the river such as availability of ramps, availability of at least one rapid level equal or higher than level IV, WSR designation status of visited river *k*, requirement of permits and/or quotas for access to river *k*; $Days_i$ is the number of days spent during current visit; *Recession* is a binary variable denoting whether the visits were during the recession or its aftermath (December 2007 to December 2010); and *Round3* is a binary variable indicating if the visits were during third round of NVUM survey.

The dependent variable, number of visits, is a nonnegative integer; therefore, the basic approach to satisfy such count data is to employ Poisson regression or variant thereof (Parsons 2017). Because a few recreationists make many trips, while many make few trips, the trip variable is overdispersed (i.e., the mean and the variance are not equal). Therefore, a negative binomial model is used because Poisson estimator underestimates standard errors and inflates asymptotic *t*-statistics despite being consistent (Amoako-Tuffour and Martínez-Espiñeira 2012). The well-documented problems in onsite survey data such as nonnegative integer count, truncation, and endogenous stratification (Martínez-Espiñeira and Amoako-Tuffour 2008, Parsons 2017) were addressed during data analysis. The truncated negative binomial model was used to address the zero-truncated count data—that is, the dependent variable takes an integer value higher than zero only to avoid the issue of biased and inconsistent estimators (Creel and Loomis 1990). In addition, endogenous stratification occurs when the likelihood of respondents being surveyed is positively related to the frequency of their visits to the recreation site. The combined effect of truncation and endogenous stratification could result in inconsistent and biased estimation (Martínez-Espiñeira and Amoako-Tuffour 2008). To address these issues, Englin and Shonkwiler (1995) presented a truncated, endogenously stratified negative binomial model, which has been widely used in recreation demand studies with onsite data (Martínez-Espiñeira and Amoako-Tuffour 2008, Loomis and McTernan 2014).

The sample unit for NVUM is a "group," which can be a single person or a group of people traveling together. Following Sardana et al. (2016), annual number of NMB trips by an individual or group (as sampled) was used as the dependent variable, which was computed based on responses to multiple questions. First, the respondent was asked about recreation activities in which they participated during the trip, and then, the respondent was asked to identify their "primary activity" for the current trip. Next, respondents were asked to indicate number of trips (including current trip) taken during the last 12 months for the primary activity mentioned, with this study focusing on primary recreation and consumption in NMB. The details of interview process and questionnaire are available from USDA Forest Service (2007). It should be noted that trips are technically applicable to the whole national forest, but the questions in the NVUM survey are logically arranged to first identify whether the respondent used the national forest for the primary purpose of our interest (i.e., NMB) for this "representative" visit. Total visits over the 12 months for only those choosing NMB as primary activity were used to compute annual trips. In this way, we are only counting visits to the whole national forest for NMB primary purpose visitors, and we are using data that are representative (i.e., the respondent's total NMB visits, which may include other rivers in this national forest). Therefore, the reported trips are not for the particular site, but the main activity, and we feel the linked characteristics (distance, water variables, group profile) are representative given NVUM's sampling protocol.

Some adjustments were made to the original NVUM data for theoretical and empirical reasons. Because there is no systematic method to parse out travel cost for individual activities in multipurpose and multidestination trips, a standard procedure in TCM was followed by only including observations with NMB as the primary purpose of the visit (Parsons 2017). Similarly, long-distance travel is likely to be multidestination and multipurpose, which makes it difficult to separate economic values of individual activities, and long-distance travel likely includes air travel in which cost of travel varies significantly among individuals. Therefore, following Bin et al. (2005) and Hellerstein (1991), observations with 1,000 miles or more in one-way travel distance were trimmed. International visits and visits outside the conterminous United States were also dropped because the nature of these visits is expected to be different from the conterminous United States, and long-distance travel could be a multipurpose trip. The observations with annual visits greater than 52 were censored, allowing one trip per week, because censoring is typical in travel cost studies to avoid nonrecreationist visitors such as boating guides (Sardana et al. 2016).

Trip cost is sum of the expenses required to make a trip including travel cost, equipment cost, access fees to the recreation site, and opportunity cost of time (Parsons 2017). The CDXZipStream, an Excel add-in to analyze ZIP code data in Microsoft Excel, was used to calculate driving distance and time between the ZIP code of respondent's residence and the river site where she or he was surveyed. Following Parsons (2017), the mileage rate of the vehicles for respective year was estimated by adding cost of gas and upkeep (such as cost of oil, maintenance, and tires) for every year between 2004 and 2014, and following Knoche and Lupi (2007), fixed costs such as insurance and depreciation cost were not included in the mileage rate. The average vehicle operating cost per mile of a medium sedan was \$0.175 (American Automobile Association 2017). Estimating cost of travel time is the most challenging issue in computing trip cost (Parsons 2017), and the most commonly used practice is to value travel time at the full or a third of hourly wage rate (Phaneuf and Smith 2005, Knoche and Lupi 2007). Two commonly used assumptions regarding the opportunity cost of time involved in traveling are no opportunity cost of time and a portion, usually one-third of wage rate, as the opportunity cost of time (Parsons 2017). Therefore, two travel cost variables were constructed based on those two assumptions. The first travel cost variable (*TCOST1*) was the product of round-trip driving distance and mileage rate, plus reported recreation fees. The second travel cost variable (*TCOST2*) was a sum of *TCOST1* and the estimated opportunity cost of time, the product of total time (hour) spent on two-way travel and one-third of wage rate (\$/hour). Per hour wage rate was imputed by dividing annual household income by a total number of working hours (2,080) in a year (Loomis and McTernan 2014). The entry fee and equipment cost may vary by weekend or weekday, half day or full day, and age of the recreationists, and availability of discounts can range across complimentary ticket rates, promotional rate, prepurchase deals, online ticket brokers, and package deals. Because of the difficulty of accounting for variation in such fees, Parsons (2017) suggested to use perceived cost information to estimate access fees. Therefore, reported entry fees (entry, parking, or recreation use fees), equipment rental, and guide fees available in NVUM data were included in the travel cost variables.

The NVUM survey collects substitute and income information for about one-third of the respondents in the economics module, an add-on to the basic questionnaire received by all recreation visitors. In the demand model, parameter estimation and valuation of the site will be biased without substitute information (Rosenthal 1987). As different substitute variables have been used in the literature previously (Bergstrom and Cordell 1991, Loomis and McTernan 2014, Sardana et al. 2016), a heuristic rule was used wherein the nearest river (to the origin) with similar recreation opportunities, for that particular trip, was to be considered a proxy substitute site. Following past studies (Mingie et al. 2017, Chapagain et al. 2018), income[4] was estimated as a proxy to annual household income of all the observations, to use as many observations as possible but also minimize potential bias from missing income. A log-linear ordinary least squares regression of reported household income on gender, age, number of people under 16 years of age in the traveling group, and adjusted gross income was used to estimate the income. The adjusted gross household income was obtained from Internal Revenue Service for respondent's ZIP code for the respective year.

River and site characteristics along with designation data were combined with NVUM survey data in ArcGIS 10.5.1 using its Network Analyst extension and verified individually. Because rapid class information was not available for every river, it was assumed that those rivers without rapid-level information had class I rapid level. The rapid class inventory was based on different reports, so there may be some differences in rating standard used in assigning river difficulty (American Whitewater 2017). Following previous studies (Martínez-Espiñeira and Amoako-Tuffour 2008, Shrestha et al. 2000), number of days spent during the trip was included in the model. A dummy variable to represent two different NVUM data rounds was also included in the model to control for differences in demand between two data collection cycles.

Data were collected between 2005 and 2014 (rounds 2 and 3 from NVUM survey). A total of 3,917 respondents indicated that they participated in NMB as the primary purpose of their visit. Observations that did not have available data from nearby USGS water-data sites, water discharge and velocity, location of river site, and ZIP code of respondent's home were dropped. After trimming the observations (traveling distance more than 1,000 miles, total annual visits more than 52, survey site within half mile of lake, and dropping observations with missing values of important variables), only 860 observations were available for final analysis.[5] Table 2 provides the definition and descriptive statistics of variables used in the model.

Results

Regression Estimates

Results from regression model of NMB trip demand are presented in Table 3. Both zero-truncated Poisson and negative binomial models were estimated, but only results from the latter are reported because likelihood-ratio test of overdispersion rejected null hypotheses that mean and variance of the dependent variable are equal, justifying the use of negative binomial model over Poisson regression. Most variables in the model are statistically significant and have signs of coefficient that are consistent with economic theory except for substitute.[6] Calculated values of variance inflation factor (VIF) for explanatory variables was less than 1.75, suggesting that the multicollinearity among variables is not an issue. The estimated coefficient for travel cost was significant ($p < 0.01$) and negative as expected in both models, suggesting the demand for NMB decreases with increased travel cost. The substitute variable (*Substitute cost*) was found to be significant ($p < 0.01$) only in the model that does not consider the opportunity cost of time in travel cost. The coefficient on age (*Age*) was negative and significant ($p < 0.01$), suggesting older recreationists are likely to take fewer trips than younger counterparts, considering the effect of all other factors constant. The positive coefficient on male indicator (*Male*) at $p < 0.01$ suggests that males on average are likely to take more visits than females. The negative and significant coefficient on a number of people traveling in the group (*Group size*) ($p < 0.01$) suggests that the demand for NMB decreases with increased group size. The coefficient for the number of people under 16 years of age (*Under16*) was negative but not significant across the models, indicating that having children along the recreation trip would not affect the trip demand.

The positive and significant ($p < 0.1$) coefficient on the availability of boat ramp (or launching access) at takeout point (*Ramp*) suggests that demand is higher

Table 2. Definition and descriptive statistics of variables used in travel cost model of nonmotorized boating (NMB) trips to US national forests (N = 860).

Variable	Definition	Mean	Standard Deviation
Trips	Annual trips by respondent to national forest for NMB	5.60	9.4
Travel cost and socioeconomic			
Travel cost1	Travel cost with no opportunity cost of time assumed	126.71	120
Travel cost2	Travel cost with opportunity cost based on 33% of wage	203.23	185.7
Substitute cost1	Travel cost with no opportunity cost of time assumed to visit the nearest river not visited from the origin	24.70	23.3
Substitute cost2	Travel cost with opportunity cost based on 33% wage to visit the nearest river not visited from the origin	101.22	97.9
Income	Estimated mean annual income	86,270.90	29,265.2
Age	Age of the respondent	43.43	13.7
Male	Dummy variable, 1 if the respondent was male, 0 otherwise	0.66	0.5
Group size	Total number of people in the traveling group during the trip	2.93	1.6
Under16	Number of people under 16 years of age in the traveling group	0.49	1
Site and river characteristics			
Rapid4	Dummy variable, 1 if there was at least one rapid level equal or higher than level IV in the river section, 0 otherwise	0.41	0.5
Ramp	Dummy variable, 1 if boat ramp was available at takeout point, 0 otherwise	0.51	0.5
Permit	Dummy variable, 1 if a permit was required to access the river for boating, 0 otherwise	0.32	0.5
Discharge	Mean discharge in cubic meter per second	39.74	89.5
Velocity	Mean water velocity in meter per second	0.59	0.3
Designated	Dummy variable, 1 if the river was designated, 0 otherwise	0.36	0.5
Time related			
Days	Number of days spent during trip	1.77	1.8
Recession	Dummy variable, 1 if the year of the interview was between recession and aftermath period (Dec 2007–Dec 2010), 0 otherwise	0.28	0.4
Round3	Dummy variable, 1 if respondent was surveyed in round 3 (2010–2014), 0 otherwise	0.54	0.5

in the river sites with boat ramps. The coefficient on river rapid class dummy (*Rapid4*) was positive and significant ($p < 0.05$), suggesting that demand for NMB in a river with at least one rapid class of IV or higher has higher demand compared with the river with lower rapid classes. The coefficient on velocity (*VELOCITY*) was negative and significant ($p < 0.1$), suggesting that visitors at rivers of higher velocity were likely to make fewer trips than those at rivers with lower velocity. The estimated coefficient on designation (*DESIGNATED*) was negative but not significant in either of the models suggesting that, after accounting for covariates, there is no difference in NMB demand between designated and nondesignated rivers.

The negative and significant ($p < 0.01$) coefficient on a number of days spent during the current trip on NMB (*DAYS*) suggests that demand for nonmotorized boating trips is lower for those who spend more time during the trip. The coefficient on the recession and its aftermath (*RECESSION*) was negative but statistically insignificant, suggesting no difference in the demand for nonmotorized boating during the recession. The coefficient on round 3 dummy (*ROUND3*) was found to be positive and statistically significant ($p < 0.05$) across the models, suggesting that NMB demand was significantly different between different periods of NVUM's data collection cycle.

Benefit Estimates

The economic benefit of NMB trips was derived by combining the estimated travel cost coefficients in Table 3 with equation (2). Then, CS value per trip was divided by mean number of people in the traveling group (*PEOPVEH* = 2.98) to obtain CS per person per trip. With no opportunity cost of time assumed, the estimated per person per trip CS was $56.

Table 3. Regression estimates of nonmotorized boating (NMB) demand at US national forests, by alternative assumption of wage rate (N = 860).

Variables	No Wage Rate	33% Wage Rate
Travel cost and socioeconomic		
Travel cost1	–0.006** (0.000)	-
Travel cost2	-	–0.004** (0.001)
Substitute cost1	–0.011** (0.003)	-
Substitute cost2	-	–0.001 (0.002)
Income	0.000 (0.000)	0.000 (0.000)
Age	–0.011* (0.005)	–0.013** (0.006)
Male	0.488** (0.141)	0.446** (0.141)
Group size	–0.178** (0.051)	–0.198** (0.051)
Under16	–0.032 (0.083)	–0.026 (0.079)
Site and river characteristics		
Rapid4	0.268* (0.155)	0.325** (0.155)
Ramp	0.365** (0.150)	0.223 (0.149)
Permit	–0.258 (0.173)	–0.106 (0.17)
Discharge	0.000 (0.000)	0.000(0.001)
Velocity	–0.707* (0.323)	–0.641* (0.27)
Designated	–0.202 (0.001)	–0.147 (0.155)
Time related		
Days	–0.171** (0.057)	–0.145** (0.059)
Recession	–0.171 (0.057)	–0.168 (0.181)
Round3	0.147 (0.156)	0.099 (0.157)
Intercept	–20.061** (1.341)	–15.366** (0.819)
Log likelihood value	–474.121	–476.686
AIC statistics	984.241	989.373

**, * Statistical significance at α = 0.01 and α = 0.05 levels, respectively; numbers in parentheses are standard errors.

Following Kling and Sexton (1990), lower and upper bounds of confidence interval of the price coefficient were calculated through bootstrapping standard errors and the corresponding 95% confidence interval of CS per person, estimated to be $45 and $74. When the wage rate was assumed, the estimated per person per trip CS was $73 with 95% confidence interval of $59 and $90.

The estimated per person per trip CS value from this study was combined with annual estimates of NMB visits in the national forests nationwide (i.e., 1.64 million recreationists; USDA Forest Service 2015a) to derive total annual economic benefits of NMB access in the National Forest System. Therefore, nationwide net economic benefit of NMB access to rivers in the national forests and grasslands was estimated to be $91.84 million (no wage rate assumed) and $119.72 million (wage rate assumed).

Discussion

Travel Cost and Socioeconomic Variables

The inverse relation between travel cost and demand for nonmotorized boating is in line with the economic theory of demand and consistent with previous studies on recreation demand (Loomis and McTernan 2014, Mingie et al. 2019, Chapagain et al. 2020). The negative sign for substitutes appears counterintuitive, suggesting recreationists will take fewer trips to the rivers, where they were visiting, if the distance (price) to alternative river increases. Defining substitutes in recreation demand is difficult as choice of the substitutes may vary across individuals, times of the year, types of activities, and site quality attributes (Bowker et al. 2009). Therefore, literature on recreation demand finds mixed results regarding relationships between substitutes and demand, ranging from negative (Loomis and McTernan 2014) to insignificant (Amoako-Tuffour and Martínez-Espiñeira 2012) to positive (Zawacki et al. 2000). While analyzing the substitute information available in the economics module of the NVUM data, only about 47% of those respondents indicated choosing another river site if the site for their current national forest visit were unavailable. Others chose activity substitution such as staying at home, going to work, and recreating in different activities, suggesting complex nature of substitution effects in recreation demand.

The negative sign on coefficient of age seems intuitive because NMB is physically challenging, which requires a higher level of skills, energy, fitness, and quick decision-making capacity, compared with other outdoor activities such as fishing and sightseeing. Our results are in line with previous studies on river recreation demand (Loomis 2003, McKean et al. 2012). Similarly, trip demand is higher for male recreationists as implied by positive signs for male. Some nonmotorized boating activities such as rafting or canoeing are physically challenging activities, and therefore, less popular among females. The results are in line with findings of past river recreation studies (Loomis 2003, Loomis and McTernan 2014) and other outdoor recreation (Englin and Moeltner 2004, Sardana et al. 2016) that have been reported. The negative coefficient on a number of people traveling in the group was also reported in previous outdoor recreation demand studies (Chapagain et al. 2018). This result seems intuitive because travel planning for a large party is a joint decision of multiple people that may face different travel constraints such as money and/or time. Even though some of the NMB activities such as rafting may be preferred in a group, a larger group would likely take fewer trips. Similar to our finding of no effect on having children on the trip demand, Cho et al. (2014) found no difference in national park visits between traveling groups with and without children.

Variables Related to the Site and River Characteristics

NMB generally requires kinetic energy from moving water, which is only available on sloped lands. In addition, the NVUM survey does not differentiate the type of NMB activities, and preferred level of flow rate varies among different type of boating activities. The positive relation between rapid level and demand is intuitive because trip demand is likely to increase with increase with greater adventure from higher class rapids. Boating in the river with higher rapids may be considered dangerous if individuals participate with their kids, but in this study, more than 70% of the respondents did not have individuals under 16 years in their traveling group. The higher-level rapids are typically associated with better river quality for NMB activities (Bowker et al. 1996).

The estimated coefficient on discharge was insignificant although other studies have found a positive effect of this attribute on boating demand (Loomis and McTernan 2014). It is expected that increases in water flow improve the overall experience, which would increase the number of trips and benefits per trip. Loomis and McTernan (2014) found that demand for river recreation among kayakers and rafters increased substantially when the flow increased. Our results suggest boaters take fewer trips in the rivers with higher velocity. The higher water speed combined with higher rapid class may add excitement for recreationists. The NVUM data does not specify type of NMB activities, but it is possible that some activities (e.g., rafting, kayaking) are more suitable in high water speed whereas other activities (boating, sailing, and tubing) are more suitable in moderate or low-velocity rivers. A recreational trip with children and family may prefer a gentler, smoother ride than a more adventurous experience.

The demand for nonmotorized boating was not significantly different between designated and nondesignated river use, which is counterintuitive to our expectation regarding a designation signaling effect. This result is consistent with results from previous river recreation studies (Walsh et al. 1985, Moore and Siderelis 2002, 2003), although none of those studies investigated this at the national level. There could be many reasons for no significant difference in demand between designated and nondesignated rivers. First, the designation does not directly restrict or affect public access to rivers for recreation. Second, there is limited accessibility to some WSR—in particular, to Wild and Scenic categories—and boaters could prefer sites where access is easier. Third, recreationists might be unaware of the designation and scope of value of such rivers. This was the case in Farmington River (Moore and Siderelis 2002) where more than half of the respondents were unaware that the river was designated even though most of them felt designation is important for the river protection. Recreationists' knowledge about the designation could motivate them to visit the site, but conflicting reports of the awareness level of designation have been reported (Moore and Siderelis 2002, 2003). A future study may systematically analyze the difference in demand before and after the designation to accurately evaluate the effect of designation.

Time-Related Variables

The negative coefficient on number of days spent during the current trip on NMB was consistent with previous studies (Creel and Loomis 1990) but contradicted some others (e.g., Bowker et al. 1996). It is possible that long-duration boaters face more travel costs or are restricted by a working schedule that allows them to take fewer trips. The result of no difference in demand during recession may be because of many reasons. Because recession could affect participation decisions and intensity of visits, individuals who are not directly affected by recession remain in the onsite sample and visit the rivers as similar to a nonrecessionary period, whereas individuals who are directly affected with job loss or salary reductions drop out of the sample and, therefore, have no effect on the average number of participant trips. Although there is no precedent literature on effect of a recession on river recreation demand, Loomis and Keske (2012) found no significant effect of recession on visits in trail-based outdoor recreation activities. Our results found an increased demand for nonmotorized boating in round 3, which is different from Cho et al. (2015) who found no difference in national forest visits between two NVUM survey periods (rounds 1 and 2). However, large number of recreationists have been historically participating in NMB activities (Cordell 2012), and the participation rate is projected to increase in the future (Bowker et al. 2012, White et al. 2016).

Benefit Estimates

The benefit estimates from this study fall within the range of values reported in previous studies. A recently published database by Rosenberger (2016) found estimated per person per day CS of $117 for NMB activities based on 23 studies. The travel cost literature showed variation in benefits because economic value is defined by many factors including type of NMB activities, river characteristics, and recreational site characteristics, along with methodologies and assumptions used in the studies. Appendix A provides a list past studies on river recreation, their welfare estimation, study location, valuation method, and type of activities.

Only Bergstrom and Cordell (1991) have analyzed national-level data on river recreation, and they estimated per trip per person CS for different NMB separately—rafting/tubing ($67), canoeing/kayaking ($45), and rowing/other boating ($92)—using the Public Area Recreation Visitors Study (PARVS) data from 200 sites. Using nationwide visitor data from national forests, Bowker et al. (2009) estimated per person per trip CS between $118 and $194 depending on the assumption of opportunity cost of time, but the estimations were based on aggregating biking, horseback riding, and floating into a nonmotorized trail use activity. Previously, Rosenberger (2016) reported CS values as high as $512 per person per day (Middle Fork of the Salmon River, a designated river in Idaho) and lows of $5 per person per day (Salk River, Arizona), along with mean value across the estimates of $129 per person per day (for instance, $118 from Glen Canyon dam releases and downstream, Arizona). A recent study that assumed one-third of the wage rate as the opportunity cost of time found a CS per person per day trip of $115 for noncommercial whitewater kayakers (Loomis and McTernan 2014). Similarly, Bowker et al. (1996) examined per trip CS associated with guided whitewater rafting and found the values between $198 and $301 for the Chattooga WSR and the values between $147 and $206 on the Nantahala River on the zero and 25% of wage rate as the opportunity cost of time, respectively. Compared with Bowker et al. (1996), the estimates from this study are lower, partly because their estimates are for guided rafting in five rivers generally considered among the more prestigious instead of aggregate values for all type of NMB in rivers across all national forests. The study by Bergstrom and Cordell (1991) is the only one that reports the total nationwide CS values, but their estimation cannot be compared directly with results of this study because they estimated the economic value for the rivers all over the country instead of national forests. They estimated annual net economic benefits for different nonmotorized boating separately: rafting/tubing ($597.90 million), canoeing/kayaking ($1,794.32 million), and rowing/other boating ($5,693.48 million).

Conclusion

This study estimated net economic benefit of nonmotorized boating on the National Forest System and assessed the impact of site and river characteristics on boating demand. The uniqueness of this study lies in multiple aspects, including deriving benefit estimates using a rich data set that covered multiple years and hundreds of river sites across the nation, and scientifically comparing the designated and nondesignated rivers. In addition, the generality of this result is higher than previous studies because this study used more robust econometric modeling, more precise measurement of travel cost using recreation fees, different wage rate assumptions, and many characteristics in the demand model that were missing in previous studies. Findings from this study have several important implications in understanding economics of NMB demand and informing management agencies such as the USFS.

First, nonmotorized boating access in national forests has significant benefit to the public, with per trip benefit valued between $56 and $73. Aggregation of this benefit to visitation in National Forests System, the economic benefits of nonmotorized boating access to rivers inside national forests is as high as $120 million, indicating that maintaining river network for nonmotorized boating activities has enormous public value. Similar opportunities being provided in other public lands may also have substantial value. This information will be useful for resource managers and planners in characterizing the public value of nonmotorized boating opportunities on public lands, comparing the benefits with costs of maintaining such recreation opportunities, and prioritizing programs to meet recreationists' need in the future. Moreover, benefit estimations can be useful to compare economic returns from alternative land uses such as timber production and mining and to assess economic loss because of adverse land use or development, such as dams or water development projects that could alter free-flowing condition of the rivers. The information from this study contributes to an understanding of value of nonmotorized boating opportunities, a nonmarketed benefit that is usually difficult to quantify in monetary terms, associated with rivers in the national forests. Integrating such value of ecosystem services into national forest management and planning will be in between helpful and allocating resources across different uses and in evaluating the effect of that planning decisions may have on benefits to river recreationists.

Second, findings suggest that trip demand for nonmotorized boating shows significant responsiveness to site and river characteristics such as ramp availability, rapid class difficulty level, and flow velocity. The significance of these variables in our demand models indicates that failure to include these variables in the nonmotorized boating demand model may lead to omitted variable bias issues and yield biased estimates. If the managers and planners are interested in increasing visitation, focus should be placed on carefully developing site attributes because different site and river factors have different impact on demand. For instance, availability of ramps can positively affect the demand. Therefore, managers may see benefit in providing boat launch or ramp for easy access to the river. In addition, natural river factors such as water velocity and level of rapids should be considered when establishing access points.

The results related to potential differences on the demand of nonmotorized boating between designated and nondesignated rivers should be of interest to resource managers and planners. It suggests that WSR designation may not necessarily affect recreational visitation as it does for other public designations such as wilderness or national parks. One reason for no difference in demand for nonmotorized boating between designated and nondesignated river could be imperfect information about the designation (Weiler and Seidl 2004, Weiler 2006), and therefore, information on recreation values and use of the site should be appropriately disseminated to recreationists. However, further investigations with ex post analysis approach is necessary to fully understand the effect of WSR designation on demand for and value of recreation experience at designated rivers. Considering the recently observed the 50th anniversary of WSRA and looking ahead, this evidence may help inform decisions on balancing recreational demand along with protecting river values.

A few caveats of this study, mainly because of theoretical limitations of TCM and the nature of data set, should be noted. The estimate of per trip benefits are conservative because long-distance travelers and respondents beyond the conterminous United States were not considered, and data associated with other flowing water activities such as fishing, scenic viewing were not included in the analysis. Future research with data from outside the NSF may validate the results. Only one-third of respondents receive an economic module asking for income and recreational fees, and missing values of recreational fees were replaced by average values of the particular site. Moreover, reported recreational fees were used while computing travel cost variable, and variation in the fees, such as discounts and changes over the season, and changes over the season were not considered. Our results should be interpreted with caution because we included the nonmotorized boating trips data from trips to all water bodies including lakes within national forests. To avoid the possible trips to lakes, we dropped the respondents that were collected within one mile from lakes. Because recreationists were interviewed upon exiting sites within national forests, those who exited from takeout points outside the national forests were not interviewed and were thus not included in our analysis. Finally, other important variables such as length of travel, floating duration, previous experience, and dam control, which could potentially affect the visitation, could not be included because of lack of data.

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Conflicts of Interest

The authors declare no potential conflicts of interest.

Endnotes

1. Throughout the remainder of the article, "nonmotorized boating" is used as a general term for all nonmotorized boating activities, and the acronym "NMB" is used for nonmotorized boating.
2. The US Congress passed the Wild and Scenic Rivers Act (WSRA) in 1968 to protect a river or a section of a river, or even tributaries with outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar river-related values in a free-flowing condition for the benefits of present and future generations (United States Fish and Wildlife Service [USFWS] 2017a). The Wild and Scenic Rivers (WSR) System currently protects 12,709 miles of 208 rivers in 40 states and Puerto Rico (USFWS 2017b), and it includes 1.4 million acres of riparian ecosystem in the form of wetlands

and upland forests (S.M. Chesterton, Wild and Scenic Rivers program manager, USDA Forest Service, Washington Office, National Forest System, January 19, 2017, pers. commun.). Although the primary objective of the act is to protect the "outstanding values," recreationists can still enjoy a variety of outdoor activities in those rivers, which are further classified as wild, scenic, and recreational based on the level of existing impoundment and accessibility to the river.

3. USDA Forest Service National Visitor Use Monitoring (NVUM) program samples a subset of national forests every year, and each national forest within the National Forest System is surveyed once every five years. Therefore, each national forest was surveyed only twice between 2005 and 2014.
4. The models with original income variable, which is available from at most one third of the data one-third of the data, were estimated, and the sign and magnitude of coefficient of income and other variables were consistent with the models using estimated income. For brevity, only the models with estimated income are presented in this article.
5. The mean values of variables were not significantly different between the original and trimmed data, and the signs of variables were the same in both cases.
6. To investigate geographic difference in demand for NMB activities, we estimated the models with dummies for the USDA Forest Service's Resource Planning Act regions (South, North, Rocky Mountain, Pacific Coast), but coefficients for dummy variables were not significant. Because the sign and magnitude of coefficients of other variables were consistent with the models without the dummies, we only presented the models without regional dummies for brevity.

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Appendix A. Previous studies on net economic value of nonmotorized boating in the United States (2017 dollars).

Study	Study area	Consumer surplus ($)	Unit (per)	Method	Activity
Bowker and English 1994	Middle Fork Salmon River, ID	439–560	Person day	ITCM	Guided rafting
Siderelis and Moore 2006	Chattooga River, GA and SC	204	Person per trip	ITCM	Guided rafting
Siderelis and Moore 2006	Chattooga River, GA and SC	155	Person per trip	ITCM	Kayaking
Walsh et al. 1985	Rivers, CO	45	Household	CV	River recreation
McKean et al. 2012	Snake River reservoirs, WA	61	Person per trip	TCM	Boating
McKean et al. 2005	Lower Snake River, WA	27	Person per trip	TCM	Boating
Ready and Kemlage 1998	Gauley River, WV	128	Person per trip	Zonal TCM	Private paddling
Ready and Kemlage 1998	Gauley River, WV	55	Person per trip	Zonal TCM	Commercial rafting
Bergstrom and Cordell 1991	Nationwide	67	Person per trip	Zonal TCM	Rafting/tubing
Bergstrom and Cordell 1991	Nationwide	45	Person per trip	Zonal TCM	Canoeing/kayaking
Bergstrom and Cordell 1991	Nationwide	92	Person per trip	Zonal TCM	Rowing/boating
Loomis 2003	Snake River, WY	33	Person day trip	TCM	Rafting
Bowker et al. 1996	Chattooga River, GA and SC	198–301	Person per trip	TCM	Guided rafting
Bowker et al. 1996	Nantahala River, NC	147–206	Person per trip	TCM	Guided rafting
Siderelis et al. 2001	Rivers in NC	39	Annual pass	CVM	Water trail users
McKean et al. 2005	Lower Snake River reservoirs, WA	27	Person per trip	TCM	Boating
Loomis and McTernan 2014	Poudre River, CO	108	Person per trip	CVM	Boating
Loomis and McTernan 2014	Poudre River, CO	115	Person per trip	TCM	Boating