Modeling Recreation Decisions and Estimating the Benefits of North Dakota River Recreation

Steven Piper
Economics Group, D-8270
U.S. Bureau of Reclamation
Denver, Colorado 80225 USA

ABSTRACT: North Dakota is a state with a wide variety of recreational opportunities but limited resources for developing recreational facilities. As a result, positive benefits from recreation must be demonstrated to justify public expenditures for recreational facilities. This paper presents estimates of the benefits from North Dakota river recreation and identifies the primary characteristics that influence those benefits. Three separate models are examined: (1) a survey participation model that is used to correct for nonresponse bias, (2) a recreation participation model that estimates the factors affecting the decision of an individual to participate in river recreation, and (3) a travel cost model that estimates the factors affecting the number of trips an individual will take to a river recreation area. The benefits of North Dakota river recreation are estimated by the travel cost model to average about $32.50 per visit and about $114 million annually. The three models are also used to demonstrate the potential recreational benefits from improved North Dakota river water quality.

KEY WORDS: Probit, tobit, travel cost method, water quality.

INTRODUCTION

North Dakota is a state with a wide variety of recreational opportunities but limited resources for developing recreational facilities. The 1991-1995 North Dakota Outdoor Recreation Plan indicated a need for improved river recreation access throughout the state (North Dakota Parks and Recreation Department, undated). However, the relatively small population and slow growth rate in North Dakota limit potential tax revenues. As a result, the North Dakota Parks and Recreation Department must be able to demonstrate measurable benefits from the development of recreational facilities to justify public expenditures for these facilities. Consumer data are needed to estimate the impacts of recreational expenditures on the local economy and the value (benefits) North Dakota residents place on North Dakota river recreation.

Several studies have estimated impacts of recreational spending on the North Dakota economy (Mittleider and Leitch 1984; Baltezore and Leitch 1988; North Dakota Parks and Recreation Department 1996). The primary focus of the North Dakota Parks and Recreation Department has been to measure recreational expenditures and their impacts on local economies, which are fundamentally different than recreational benefits. Recreational benefits represent the value of recreational activities to participants whereas expenditures and impacts represent the influence of recreational activities on local sales, income, and employment. The economic benefits of North Dakota river recreation and the factors that influence river recreation have not been previously measured.

In this paper, I analyze a three-step modeling process to evaluate the factors that influence an individual's decision to respond to a mail survey, an individual's decision to participate in North Dakota river recreation, and

the costs that visitors incur when they recreate at various sites. These models are then used to estimate the economic benefits of North Dakota river recreation. Although only North Dakota residents are included in the travel costs analysis of recreational benefits, it is recognized that these benefits also accrue to nonresidents. In addition, the analysis identifies important characteristics that influence benefits; emphasizes the need to target facility development toward these dominant characteristics to maximize recreational benefits; and provides a method for estimating recreational demand at different sites. The estimates for recreational benefits can be useful to the North Dakota Parks and Recreation Department to help justify expenditures for recreational facilities as well as to recreation agencies in other states to help develop procedures for estimating similar models.

STUDY AREA

Six North Dakota rivers are considered in this analysis: the Missouri, Red, Little Missouri, James, Sheyenne, and Souris–all of which represent a wide variety of site characteristics and various recreational opportunities. Primary types of recreation include fishing, sightseeing, boating, and swimming. Of the six rivers, the Missouri is the most visited river in the state.

MODEL

The demand for recreational services is based on consumer demand theory, where individuals purchase goods and services in quantities that maximize utility (enjoyment) given their level of available income. The utility obtained from consuming different quantities of recreation and other goods and services can be described using a utility function, where utility is a function of the quantities of various goods and services. The consumption decision can be represented as:

$$Z = U(Q_r, Q_a)$$

subject to:

$$P_rQ_r + P_aQ_a = M$$

where Z is total utility, Q_r is the quantity of recreation, Q_a is the quantity of all other goods and services, P_r is the price of recreation, P_a is the price of all other goods and services, and M is available income. Solving this optimization problem results in first order conditions that require the marginal utility of recreation and other goods to be equal at the quantities purchased:

$$U'_{Qr} = P_r\lambda$$
$$U'_{Qa} = P_a\lambda$$

where U'_{Qr} and U'_{Qa} are measures of the utility an individual receives from purchasing the last unit of the good, or marginal utility. The lambda (λ) represents the marginal utility of income. Therefore, price multiplied by lambda is the opportunity cost of purchasing the good. The first order conditions indicate that an individual will purchase each type of good until the marginal utility of the last unit purchased is equal to the marginal utility given up to purchase the good. The quantity of the different goods are purchased such that the value of the enjoyment associated with each purchase, at the margin, is equal to its price.

Most recreational activities are not traded in markets that reflect the true value of recreation (although there is some movement in this direction). As a result, the variable cost of gaining access to a site (travel cost) can be used as a proxy for the price of obtaining recreation. The cost of access includes the variable cost of transportation (gasoline, oil, tires) and the opportunity costs associated with the time spent to travel to the site. By measuring the cost of gaining access at various distances, a recreation demand model reflecting the quantity demanded at various prices can be derived that is consistent with consumer demand theory.

The relation between the quantity of recreation trips demanded by an individual to each of J=1,...,n sites and the factors that affect demand can be expressed as:

$$Q_j = f(P,S,Z_1,...,Z_n)$$

where P is a vector of access prices for each site, S is a vector of individual socio-economic characteristics, and Z_j is a vector of site characteristics.

Several different types of travel cost models can be estimated, depending on the type of data available (see Walsh 1986). Zonal travel cost models are based on aggregated visitation data and can be used to estimate changes in visits per capita as a function of travel cost and other relevant social and site characteristics. Individual models are based on detailed individual recreational behavior over a period of time and can be used to estimate representative recreation visitation decisions. This analysis uses data from North Dakota river recreation users and nonusers to estimate an individual data recreation model.

SOURCES OF DATA

The source of recreation visitation data for this analysis is a mail survey of North Dakota households that was conducted by the North Dakota Parks and Recreation Department (1997). The survey was a general population survey that was designed to estimate a resident's recreational use of North Dakota rivers and expenditures associated with that use. The survey, which was sent to river recreation users as well as nonusers, included questions about the importance of river recreation to the respondent, recreation expenditures, number of days spent recreating at specific rivers in North Dakota, and socio-economic characteristics.

A random sample of 2,500 North Dakota residents, ages 18 years or older, was obtained from the 1996 population of 428,588 drivers license holders. In August 1996, the Parks and Recreation Department initiated the survey by mailing an introductory letter to residents, which indicated that a questionnaire was forthcoming. The first questionnaire was mailed on 30 October 1996, followed by a postcard reminder on 12 November. A second questionnaire was mailed on 20 November 1996. Responses could not be obtained from 276 of those sampled, due to undeliverable addresses or a change to an out-of-state address; death; or poor health. Of the 2,224 deliverable surveys, 1,193 surveys were returned for a response rate of 53.6%.

Data were also obtained from the U.S. Bureau of the Census (1997) and the U.S. Geological Survey (USGS 1997). The Census data were combined with the North Dakota survey data to estimate household income and age associated with nonrespondents as part of a survey response model. Data from the USGS (1997) were used to estimate water quality in each of the six rivers considered in this analysis.

NORTH DAKOTA RIVER RECREATION TRAVEL COST MODEL

This analysis is based on individual recreation data obtained from a sample of the general North Dakota population. Therefore, several different kinds of information are available that can be used to model recreational behavior. First, the households included in the randomly selected group that were sent questionnaires can be compared to the households that actually provided responses to determine if there are characteristics that affect the probability of returning a survey. Second, those who returned surveys included river recreation participants and nonparticipants. Therefore, the river recreation participation decision can be modeled. Third, a travel cost model for recreation participants can be modeled.

Survey Response Model

A probit model was estimated and the results used to account for nonresponse bias in the mail survey. This step is required because some factors that influence the likelihood of an individual returning a survey may also influence recreation decisions. If this occurs, then using the responses from river recreation users without adjustment will result in biased travel cost estimates. Those who respond to the survey may have characteristics that also influence the value of their response; therefore, the sample would not be representative of the entire North Dakota population. Modeling the survey response decision is important because intuitively nonrespondents would be expected to have a lower level of visitation than respondents.

The procedure used to correct for nonresponse bias generally followed the procedures used by Cameron et al. (1996). A probit model of the probability of responding to the river recreation survey was estimated and inverse mills ratios (IMR's) were calculated. The IMR's were then included in the participation and travel cost regressions as explanatory variables. These IMR's, which have unique values for each observation, represent the conditional probabilities associated with providing North Dakota river recreation behavior information and provide a statistical correction for any systematic response bias in the recreation demand equations.

The estimated North Dakota survey response model is:

Probability of responding = f(Inc, Age, Miles), where:

Inc = annual household income,
Age = age of the respondent,
Miles = miles to the nearest river recreation site.

Income and age are general socio-economic variables that indicate overall wealth and, possibly, the health of the respondents as well as general attitudes about requests for household information. Distance to the nearest river recreation is an indication of the familiarity and importance of river recreation to the questionnaire recipient. Income and distance to river recreation were both included as variables in the survey response/nonresponse model in Cameron et al. (1996). It is expected that the greater the number of miles to river recreation, the less likely the recipient will return the questionnaire. Age is an important explanatory variable in the decision to participate in recreational activities (Walsh 1986) and is hypothesized to be an important variable in the decision to participate in a recreational survey as well.

The response and nonresponse data were used to estimate a survey response model. Identification numbers from the survey responses were matched with addresses in the database to determine who returned or did not return a questionnaire. The only information available for the nonrespondents was their location (mailing address and zip code), which is not useful in itself for determining factors influencing the decision to return a survey. However, the location data can be combined with secondary data from the U.S. Bureau of the Census (1997) to derive values for socio-economic variables that influence the probability of returning a survey. The income and age estimates were based on U.S. Bureau of the Census (1997) data at the most detailed level possible. For example, if the address was a city or place for which detailed data were available (such as Bismarck or Fargo) then city or place data were used. If detailed city or place data were not available, then county level data were used. The survey response model was estimated using 2,224 observations.

River Recreation Participation Model

The second model is a recreation participation model that estimates the factors affecting the decision of an individual to participate in river recreation. This model represents the number of people who would participate in recreation at different North Dakota river sites. Factors that could influence the decision to recreate or not recreate include: water quality at the home site and nearby adjacent sites, whether or not the individual lives in an urban or rural setting, and socio-economic characteristics. Water quality measures based on total suspended sediment (TSS), total Kjeldahl nitrogen (TKN), and total phosphorus (TP) in rivers and lakes at local and adjacent regions were included in a study of fishing participation by Ribaudo and Piper (1991). The water quality variables represent associated biological impacts that could affect the attractiveness of a river for recreation. The urban and rural distinction was also included in the study by Ribaudo and Piper (1991). As mentioned above, the IMR's from the first model were included as an independent variable in the participation model.

The estimated North Dakota river recreation participation model is:

Probability of participation = f(HTKN, HTP, ATKN, ATP, Urban, Sex, Age, Inc, IMR) where:

HTKN = total Kjeldhal Nitrogen at the nearest river recreation area,
HTP = total phosphorous at the nearest river recreation area,
ATKN = total Kjeldhal Nitrogen at the second nearest river recreation area,
ATP = total phosphorous at the second nearest river recreation area,
Urban = does the respondent live in an urban area (1=yes, 0=no),

Sex = sex of the respondent (1=male, 0=female),
Age = age of the respondent,
Inc = annual household income, and
IMR = inverse mills ratios from the survey response model.

Water quality data from 1973 to 1995 were obtained from the USGS (1997) for the six rivers included in this analysis. Total Kjeldahl nitrogen and TP are used as measures of river water quality. The urban variable was included to account for the desire of urban residents to get away from crowds that rural residents do not experience. Sex, age, and income are included as general demographic variables. The IMR variable is included to account for nonresponse bias. Data from 852 of the 1,193 returned questionnaires included all of the visitation and socio-economic information needed to estimate a visitation decision model.

River Recreation Travel Cost Model

The third model is a travel cost model that estimates the factors affecting the number of trips an individual will take to a river recreation area. The primary factor is the cost of traveling from the origination point of the trip to the stream site. Other important factors that typically influence visitation to a particular site include: the availability of substitute recreation sites, water quality at the site visited, and income. The availability of substitutes is an important variable in determining visitation to a specific site (Ward and Loomis 1986). Substitutes are accounted for in this analysis using a dummy variable, where the dummy is equal to one if a substitute site is available that is closer than the specific study site. Distance to a specific study site and the substitute site was estimated by measuring the distance from the origin of the respondent to the nearest river access point. Water quality is included as a measure of site attractiveness (Ribaudo and Piper 1991). Income is included to account for greater quantities of recreation that can be consumed at higher incomes (Walsh 1986) and age is included as a socio-economic variable (Walsh 1986). The travel cost model can be used to estimate a demand function and the benefits from recreation. The third model can be represented as:

Visits = f (Cost, Urban, Goodsub, TKN, Inc, Age, IMR2)

where:

Visits = number of visits by each respondent,
Cost = estimated travel cost per visitor,
Urban = does the respondent live in an urban area (1=yes, 0=no),
Goodsub= existence of a substitute closer than study site,
TKN = water quality measured by total Kjeldhal nitrogen,
Inc = annual household income,
Age = age of the respondent, and
IMR2 = inverse mills ratios from the river participation model.

Of the 852 observations used in the probability of river recreation model, 381 individuals indicated that they participated in North Dakota river recreation. A total of 29 observations were discarded because of missing trip information, leaving 352 observations for estimating the final travel cost model.

Travel costs were estimated using a variable cost of 10.5 cents per mile (American Automobile Manufacturers Association Inc. 1996), the household income estimates from the survey, and the distance from the origin of the respondent to the nearest access point for the specific river. Hourly income rates were estimated by dividing household income by the number of household members and dividing per capita income by 2,080 hours (52 weeks multiplied by 40 hours per week). The cost of time was determined on a per capita basis due to the lack of information on the number of working adults earning income in each household. The income rates were then divided by three to estimate the time cost of travel. The rate used for determining the cost of time is generally between 1/4 and 1/2 the income rate. The 1/3 rate was used as a compromise value for time spent traveling (Cesario 1976; Cesario and Knetsch 1976).

The travel cost model requires an estimate of the number of trips taken by each recreation participant to a specific site. However, the questionnaire from which the data were gathered asked for visitation estimates in terms of total days spent recreating at each of the six North Dakota rivers. Each respondent provided information on the number of days spent at each of the six rivers considered in this analysis. Estimates of the number of recreation days per trip in the northern region of the United States were used to convert river recreation days into trips (U.S. Forest Service

1990). The number of trips will be overestimated using this method if a significant number of trips are multiple purpose. However, the potential for over-estimating trips is mitigated somewhat by the fact that approximately 30% of the respondents participating in river recreation participated in only one type of activity and about 70% of the respondents spent one-half or more of their recreation days on one type of activity.

MODELING RESULTS

The three models used to estimate the benefits of North Dakota river recreation were estimated using LIMDEP Version 7.0 (Greene 1995). A probit model was run for the survey response model to enable the calculation IMR's for use in the other two regressions. A probit model was also estimated for the river recreation participation model.

The travel cost model was initially estimated using ordinary least squares. The estimated travel cost model was tested for normality of the residuals using a Lagrange Multiplier test and heteroskedasticity was tested using the Park test. Both of these tests indicated that ordinary least squares was not an appropriate estimation technique. The number of visits for each observation in the travel cost model has a lower limit of one. Therefore, the model was re-estimated using the tobit model, which accounts for a large number of observations at an observation limit (Maddala 1983). A moment-based test indicated that heteroskedasticity was a problem for the tobit model. Therefore, a weighted tobit model was estimated using the square root of travel cost as a weight. The modeling results are presented in Table 1.

All of the variables except income had the expected sign in the survey response model, and the income variable is not significant at the 5% level. The likelihood ratio test for each model is a chi-square based test that indicates the overall significance of the estimated equation. The likelihood ratio (LR) tests indicate that the independent variables as a group included in the survey response and participation models have a significant effect on the probability of responding to the survey or participating in river recreation. The LR test also indicates that the independent variables included in the travel cost model have a significant impact on the number of visits. The individual t-ratios indicate all of the coefficients that are different from zero at the 10% level of significance or better are of the expected sign.

BENEFITS

The river participation model, adjusted for survey response bias, indicates a participation rate of approximately 41.3%. This is a fairly high rate, which was expected given the results from previous recreation surveys (North Dakota Parks and Recreation Department, undated). Based on a July 1996 North Dakota population of 643,539 people, this translates into 265,780 North Dakota river recreation participants in 1996. The travel cost model estimates about 13.25 visits per participant based on mean values for each of the model variables. This results in an estimated 3.52 million visits per year.

The travel cost model can be used to estimate a recreation demand curve, where price varies from zero to the price where visits equal zero (choke price). Average river recreation benefits per visit can be estimated by taking the area under the curve and dividing by the number of visits per participant. The benefits are estimated to equal about $32.50 per visit. Multiplying the average benefit by the estimated number of visits by North Dakota residents results in total benefits of about $114 million annually. These benefits represent only North Dakota residents. Additional benefits would be expected from nonresidents. However, benefits to instate residents would be the greatest concern of state parks and recreation officials.

CONCLUSIONS

The river recreation participation model indicates that water quality, sex, age, and income all have a significant impact on the decision to participate in river recreation. The

TABLE 1.
Modeling results.

Variable	Coefficient	Asymptotic t-ratio	Expected sign
Survey Response Probit Model			
Inc	-0.0000073	-0.68	no
Age	0.0153630	3.13[a]	uncertain
Miles	-0.0036480	-2.45[a]	yes
Constant	-1.0863000	—	—
Likelihood ratio test = 39.52			
Participation Probit Model			
HTKN	-0.3322400	-2.71[a]	yes
HTP	-0.4386300	-2.52[a]	yes
ATKN	-0.1664900	-0.97	yes
ATP	-0.6196600	-2.01[a]	yes
Urban	0.2097500	1.58	yes
Sex	0.3066700	3.38[a]	uncertain
Age	-0.0173600	-6.12[a]	uncertain
Inc	0.0000072	3.13[a]	yes
IMR	-0.0028300	-0.01	uncertain
Constant	1.1809000	—	—
Likelihood ratio test = 110.3			
Travel Cost Weighted Tobit Model			
Urban	-2.7687000	-1.05	yes
Cost	-0.2865800	-4.37[a]	yes
Goodsub	-8.8073000	-3.84[a]	yes
TKN	-3.0346000	-2.61[a]	yes
Inc	0.0001177	1.71[b]	yes
Age	-0.0173800	-0.16	uncertain
IMR2	18.7110000	-3.32[a]	uncertain
Constant	38.4600000	—	—
Likelihood ratio test = 67.36			

[a] Significant at the 5% level
[b] Significant at the 10% level

location of the individual in an urban or rural setting did not have a significant effect on participation. The travel cost model indicated that water quality, income, and age also had an impact on visitation.

The importance of substitutes is an indication that river recreation opportunities should be promoted in areas that do not currently have river access. The North Dakota Parks and Recreation Department can use the results to help identify areas where improved river access could generate significant benefits. The importance of water quality in both the decision to recreate and the number of visits indicates a need to maintain or improve river water quality in order to protect river recreation benefits.

The modeling results can be used to evaluate the effect of changes in river water quality on river recreation participation, visitation, and benefits. Assume that a policy is under consideration that would improve water quality in all North Dakota rivers through a 10% reduction in TKN and TP. Based on the weighted aggregate elasticity (Hensher and Johnson 1981) for each of the water quality variables in the participation model, a 10% water quality improvement in all North Dakota rivers would increase river recreation participation from 41.3 to 44.8% of the North Dakota population.

Improved water quality will also affect the number of visits per participant. Based on the elasticity of the expected number of visits from the visitation model, a 10% water quality improvement would increase average visitation from 13.25 visits to 13.5 visits per participant. A 10% improvement in river water qual-

ity results in an increase of 22,500 river recreation participants and an increase of 370,000 river recreation visits. At an average benefit of $32.50 per visit, the total recreation benefit would increase by about $12 million annually.

The same procedure can be used to evaluate a policy that would target river water quality improvements toward regions where most river recreators live, or the home region in the estimated models. A 10% water quality improvement in home region rivers would result in a river recreation participation rate of 43.8% and an increase of 290,000 river recreation visits. This represents increased recreation benefits of $9.4 million annually.

Previous North Dakota Parks and Recreation surveys have generally been used to estimate regional impacts from recreational expenditures in North Dakota. This analysis shows that the information gathered from Parks and Recreation surveys can be used to analyze policies that influence recreation participation and visitation. The models estimated in this analysis can be used to estimate river recreation benefits from improving access to river recreation and from improving river water quality.

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