# A METHOD FOR EXPLAINING TRENDS IN RIVER RECREATION DEMAND

George L. Peterson[1]

David W. Lime[2]

Dorothy H. Anderson[3]

Abstract.--Data being collected by The National River Recreation Study (NRRS) (U.S. Forest Service, St. Paul) includes origin-destination information for recreational visits to a variety of rivers nationwide. Such data are being collected over several years during a time of rapidly changing energy costs, economic conditions and consumer attitudes. This presents an opportunity to explain trends in river recreation demand. Methods of site choice and site demand analysis may be useful for this purpose. Appropriate mathematical models are defined and explained. It is shown how these models can be used to explain demand and predict trends.

## INTRODUCTION

The primary thesis of this paper is that while it is useful and necessary to describe and project recreation trends, it is more powerful and efficient if they can be explained and predicted.

To describe a trend is to observe it and draw a picture of it - How have things changed in the past and what changes are occurring now? To project a trend into the future is to assume a kind of uniformitarianism - that the future will march to the same drummer as the past - that the river of time on which we paddle our frail canoes has no surprises around the bend.

We are advised by voyageurs of old who paddled the Great Lakes in birchbark canoes, "If you do not wish to drown, stay close to the shore." This is good advice in planning and in paddling, but there are times when it is more efficient to cut across the bay. There are also gorges like that of the Churchill river as it flows toward Hudson Bay where, for miles on end, there is little chance of rescue or escape in the event of an upset. And, sometimes we are committed to such gorges or shortcuts before the "signs of the times" warn us of possible dangers ahead.

The strategy of watching the winds and currents of now and staying close to shore has saved many a voyageur (and many a government official). But, armed with a good map of the river and a scientific forecast of the weather, we can proceed somewhat more boldly, effectively and efficiently.

In our management of recreation resources, we cannot literally scout the rapids ahead. But, we can do some kinds of research that will allow contingency scouting. To explain a trend is to explain the data of the past and present by means of theories about the processes causing changes to occur. Such theories and models can be powerful aids to judgment.

A "trend" is "the general course or prevailing tendency or drift" of something over time. In the recreation business, public and private investors are concerned about trends in recreation demand, particularly when those trends affect the consequences of lumpy capital investments or major commitments of natural resources. Failure to recognize trends in demand may cause today's "unwise" decisions to become tomorrow's foolishness. This is particularly unfortunate when such foolishness cannot easily be undone.

[1]Professor, Department of Civil Engineering, Northwestern University, Evanston, IL 60201

[2]Research Social Scientist, USDA Forest Service, North Central Forest Experiment Station St. Paul, MN

[3]Geographer, USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN.

It is therefore understandable that so much effort goes into the description and projection of trends. But, it is better, if the trends can be explained in terms of their underlying causes. It then becomes possible to make conditional predictions, to analyze sensitivities, and, perhaps, even to control the trend rather than to chase it. The information revealed by trend explanation often leads to a double strategy which includes both modification of underlying causes of the trends and treatment of the symptoms of the trend itself.

The purpose of this paper is to discuss methods for explaining trends in river recreation. Emphasis is on the use of rivers for recreational travel by canoe, kayak, raft, innertube, etc., including the increasingly popular whitewater float trip. The framework used is generalizable, however. This kind of recreation has been increasing remarkably in recent years to the point that rationing and allocation schemes are being considered or implemented in some places. (Shelby, 1979)

The impact of increasing demand for free-flowing rivers has been complicated by another more basic trend: increasing demand for other uses of the river and its adjacent lands. The competing demands include domestic water supply, hydroelectric power, flood water retention, irrigation, industrial and manufacturing uses of water, waste disposal, and land development. Because of difficulties in demonstrating the benefits of recreation and because these competing demands for water are clearly linked to income, employment and economic development, they tend to get higher priority. This has created a trend of contracting quantity and quality of supply.

A reactionary trend based in public sentiment and political activism emerged in the late 60's and early 70's to produce 1) legislation such as the Wilderness Act, The Wild and Scenic Rivers Act, The National Environmental Policy Act, and the Wild and Endangered Species Act, 2) numerous <u>ad hoc</u> political skirmishes aimed at legislative preservation of specific free-flowing streams, and 3) a presidential call for examination of the stream-flow requirements of recreation (Carter, J. 1978).

In the midst of this exciting and perplexing ferment of contradictory demands and trends, the 1970's introduced two profound intervening factors: energy shortage and two-digit inflation, possibly leading to shrinkage of real income. Gasoline prices have quadrupled in five years. What affects are these changes having on the quantity, geographic distribution, and social distribution of demand for river recreation? What new trends, if any, are developing, and what can be predicted for the future? Can the changes reveal useful information about the demand process so that resources can be managed more effectively and future changes anticipated?

The National River Recreation Study (NRRS) being conducted by the North Central Forest Fxperiment Station (Lime, et. al. 1979) may be able to help answer such questions. Beginning in 1977 data have been collected so far on the recreational use of 39 different rivers nationwide, including origin and destination data on travel to and from the rivers. Some of the rivers have been monitored for two and three years, thus providing the possibility of analysis of trends.

## <u>Theoretical Framework</u>

A useful theoretical framework can be developed from the following assumptions:

1. The set of rivers (j=1,2,---,r) represents the nationwide spectrum of river recreation opportunities.

2. For person n residing at location i the utility or net benefit produced by a visit to river j is

$$ {}_nU(ij) = {}_nu(X_{1ij}, X_{2ij}, ---, X_{gij}, ---, X_{pij}) + {}_n\epsilon_{ij} \qquad (1) $$

Where $x_{gij}$ is the magnitude of variable g experienced by person n during a visit to river j. The x's may include travel cost, site use fees, river characteristics which influence the suitability of the site for the purpose in question (deBettencourt, 1979). ${}_nu$ is the systematic or predictable function by which utility is sensitive to x. The residual ${}_n\epsilon_{ij}$ is random "error" and is assumed to be independently and identically distributed for all rivers according to the Weibull distribution with dispersion parameter $\lambda$. (McFadden, 1978)

3. Interpersonal and inter-situational differences in ${}_nu$ can be captured effectively by a set of market segments or person types. To simplify the discussion, notation designating person or person type will be dropped. The utility function will be designated simply by

$$ U(ij) = u(x_{1ij}, x_{2ij}, ---, X_{gij}, ---, x_{pij}) + \epsilon_{ij} \qquad (2) $$

with the understanding that it may vary by market segment. The utility function may vary also by activity or purpose of visit (e.g., kayaking, canoeing, rafting), but for simplicity it may be assumed only one activity is considered.

4. When a person engages in the recreational activity in question, that river is chosen which maximizes utility.

Based on these assumptions and given participation in the specified activity, the probability that a person residing at location i will choose river j is

$$\hat{P}(j|i) = \frac{e^{\lambda U(ij)}}{\sum_{k=1}^{r} e^{\lambda U(ik)}}. \qquad (3)$$

This is a logit choice model (Domencich & McFadden, 1975). It can be estimated by maximum likelihood methods if the form of the utility function is specified and data are available on individual choices and the magnitudes of the x's experienced.

This kind of model is generally called a "site-choice" or "trip-distribution" model. It explains the proportion of total demand each site will receive, but it does not explain the magnitude of demand. The number of visits delivered by location i to river j is

$$V_{ij} = P(j|i) \sum_{k=1}^{r} V_{ik} = \frac{e^{\lambda U(ij)}}{\sum_{k=1}^{r} e^{\lambda U(ik)}} \sum_{k=1}^{r} V_{ik}, \qquad (4)$$

Where $\sum_{k=1}^{r} V_{ik}$ is the total number of visits from location i to all rivers. In order to explain the magnitude of site demand, it is thus necessary to explain $\sum_{k=1}^{r} V_{ik}$. This is a "trip-generation" problem.

There are several ways trip-generation might be approached (Stopher & Meyburg, 1975). One way is to use a simple empirical model of the type proposed by Cesario and Knetsch (1976). Assume location i is a geographic area containing a finite number of people $P_i$, of the type in question. Assume also that the average number of river trips per person is a function of the total supply of opportunities. The denominator of the trip distribution logit model (3) measures the condition of supply from the point of view of i. A plausible hypothesis is

$$\mathcal{E}(\text{River trips per person})$$

$$= \frac{\sum_{k=1}^{r} V_{ik}}{P_i} = b_o\left[\sum_{k=1}^{r} e^{\lambda U(ik)}\right]^{b_1} \qquad (5)$$

$$\text{or} \quad \sum_{k=1}^{r} V_{ik} = b_o P_i\left[\sum_{k=1}^{r} e^{\lambda U(ik)}\right]^{b_1}. \qquad (6)$$

Given this relationship, the site demand function becomes

$$V_{ij} = \frac{e^{\lambda U(ij)}}{\sum_{k=1}^{r} e^{\lambda U(ik)}} b_o P_i\left[\sum_{k=1}^{r} e^{\lambda U(ik)}\right]^{b_1}. \qquad (7)$$

An alternative approach which is conceptually more general is the nested choice model (McFadden, 1978). The choice process might be decomposable into several conditional demand allocation stages: 1) choice of recreation site given recreation activity, 2) choice of recreation activity given that time is allocated to recreation, and so on. If the utility function is separable by site variables, activity variables, etc., a logit model can be derived which explains P(j,β,---), the probability of choosing site i and activity β and --- etc. Activity variables might include "psychological outcomes" (Driver and Brown, 1975) as used by Peterson et. al., (1978) to explain activity choice. However, for use in prediction, even a two-stage model requires knowledge of all sites for all activities. In all but very simple cases of two or three choices in each stage, the model becomes impossibly complex and data hungry. With simplifying assumptions, it might be feasible to develop a model of this type which requires specific knowledge of site attributes only for river recreation. This is a subject for another paper, however. The approach used here is based on equation (7), with the understanding that more powerful models may be possible.

## The Single River Case

Equation (7) shows the demand for one river to be a function of the characteristics of all rivers with which the river competes. Consider the special case of a river with no competitors. This situation might exist, for example, when the users of a particular river include a subgroup of people whose choice set contains only that river. Some rivers, such as the Colorado River in Grand Canyon National Park and the Middle Fork of the Salmon River in Idaho may be so unique they compete with other rivers only in the sense they compete with movies or trips to Europe. A certain river may have local geographic monopoly such that virtually all the visitors use that and only that river for the activity in question. Or, we may choose to perform the analysis, given the choice of this river. In any case, the assumption of no competitors implies the parameters, models, and conclusions apply only to that river and cannot be generalized to other situations, because none comparable exist. With this understood, there are no dangers in single site analysis. For the single river case, equation (7) becomes

$$V_i = b_o P_i \, e^{b_1 \lambda U(i)} \qquad (8)$$

In general, the parameters of a single-site model such as equation (8) should not be estimated for one site and applied to another. Equation (8) derives from the assumption the rivers in question are not competitors. This may imply different utility functions and/or mutually exclusive populations for different rivers.

It is interesting to compare (8) with (7). Equation 7 can be stated as

$$V_{ij} = \left[\sum_{k=1}^{r} e^{\lambda U(ik)}\right]^{(b_1-1)} b_o P_i \, e^{\lambda U(ij)} \qquad (9)$$

or

$$V_{ij} = \gamma_i b_o P_i e^{\lambda U(ij)} = b_o P_i \, e^{[\ell n \gamma_i + \lambda U(ij)]} \qquad (10)$$

where $\gamma_i$ is a function of the condition of total supply from the point of view of i. This comparison reveals an interesting conclusion. Even if $b_o$, $b_1$, $P_i$ and U are universal for all rivers, substitutes or not, the single-site model (8) multiplies the utility function by $b_1$, the trip-generation exponent, while the multiple-site model (10) adds to the utility function an origin-specific supply function. Estimating equation (8) for one river and then applying the results to another river is an implicit assumption that $[\ell n\gamma_i + \lambda U(ij)] = b_1 \lambda U(ij)$. While this may be true under very restrictive conditions, in general the single site model clearly does not reveal generalizable information about sensitivity of demand to changes in variables in the utility function such as changes in fuel costs and site variables. While such an empirical model can explain demand and participation trends for a given river, it cannot explain or predict such trends under conditions different than those under which the data were observed. The magnitudes of the estimated "constant" parameters will change with changes in the variables.

On the other hand, using the multiple site model (7) or (10) for several non-substitutable rivers also has serious problems. As in (9) the market population from which each river draws its visitors may be different and/or the utility functions may be different. Such problems can distort the results seriously and lead to invalid conclusions if they are not recognized.

Thus, ability to predict changes in participation at specific sites requires for each river correct knowledge of a) the consumer utility function and b) the market population. If, for a given set of rivers, utility "errors" are identically and independently distributed over the market populations by the normal or Weibull distribution about a common utility function, equation (7) is an explanatory site demand function. If a river has no substitutes, equation (8) is an explanatory site demand function, but is not generalizable to other rivers.

## Simple Illustrative Models

For illustrative purposes assume the predictable portion of the utility function contains only two variables,

$D_{ij}$ = travel distance from location i to river j

$A_j$ = a measure of the site quality at river j

The functional form most often used in logit models is the simple linear combination:

$$u = bo + b_1 A_j + b_2 D_{ij} \qquad (11)$$

This function assumes a constant marginal rate of substitution, which may be reasonable for narrow ranges of variation although it does not allow estimation of the dispersion parapmeter $\lambda$. From the point of view of economic theory, a more general form is

$$u = \alpha_i A_j^{\beta_1} D_{ij}^{\beta_2}. \qquad (12)$$

Another form with properties similar to (12) is

$$u = \ell n \, \alpha + \beta_1 \, \ell n \, A_j + \beta_2 \, \ell n \, D_{ij}. \qquad (13)$$

This form produces convenient algebraic simplification of the logit model. Equations (12) and (13) are appealing because they show diminishing marginal returns, but none of these forms is satisfactory when the marginal utility function is not single valued. For example, the attractiveness of a river for white-water canoeing is low for sluggish streams. As the white-water difficulty increases, attractiveness increases to a point and then begins to decrease again as the river becomes too difficult. Perhaps this is because the variable is a composite of several more basic variables, but, in general, it has proven useful to represent such relationships by a quadratic utility function (deBettencourt, 1979):

$$u = \alpha + \beta_1 A_j^2 + \beta_2 A_j D_{ij} + \beta_3 D_{ij}^{\,2}. \qquad (14)$$

Apparently there has not been much research done on the problem of specifying the best utility function in logit models or site-demand models. Most logit modellers seem satisfied by the assumption of (11), perhaps because utility is difficult to measure and the models robust. In any case, more research is needed on utility functions. At least the robustness of the models over different utility function forms needs to be studied.

To illustrate the kinds of information revealed for trend and impact analysis, assume the utility function has the form of (13) and distance is the only variable. The multiple site-demand model (7) is

$$V_{ij} = \frac{D_{ij}^{\lambda\beta}}{\sum_{k=1}^{r} D_{ik}^{\lambda\beta}} b_o(\alpha^{\lambda b_1}) P_i \left[\sum_{k=1}^{r} D_{ik}^{\lambda\beta}\right]^{b_1} \qquad (15)$$

The single-site demand model (8) becomes

$$V_i = b_o P_i \alpha^{\lambda b_1} D_i^{\lambda b_1 \beta}. \qquad (16)$$

In estimation, the parameters cannot be decomposed and the two models are

$$V_{ij} = \frac{D_{ij}^{B_1}}{\sum_{k=1}^{r} D_{ik}^{B_1}} B_o P_i \left[\sum_{k=1}^{r} D_{ik}^{B_1}\right]^{b_1} \qquad (17)$$

and $$V_i = B_o P_i D_i^c, \qquad (18)$$

where $B_o, B_1, b_1$, and c are estimated parameters.

Given the assumptions and the multiple-site case (equation 17), the parameter $B_1$ describes the sensitivity of demand distribution to distance. The parameter $b_1$ describes the sensitivity of demand to the overall condition of supply. In the single-site case, C describes demand sensitivity to distance, but it is not generalizable to other sites.

Response of demand to changes in things like site attractiveness and fuel cost cannot be analyzed in (17) or (18). Changes in fuel cost would change the meaning of distance and would cause changes in $B_1$ and C. The impacts of changes in fuel price and other economic conditions would be better analyzed if $D_{ij}$ were replaced by variables describing travel time, travel mode, fuel price, etc. The resulting equations would be more general and would explain the response of demand to changes in these variables. Likewise, variables describing the specific site attributes to which site attractiveness is sensitive should be included in the utility function. This would explain the response of demand to specific changes at specific sites.

## Illustrative Empirical Applications

Using only distance and population, the authors used a model based on the log-linear utility function, equation (13), to do single-site analysis for the Boundary Waters Canoe Area Wilderness in Minnesota. Under the assumption of no substitutes, the purpose was to estimate

$$V_i = B_o P_i D_i^C \qquad (19)$$

for several different camping types of wilderness travelers: paddle canoeing, motor canoeing, motor boating, hiking, cross-country skiing, and snowmobiling. The purpose of the study was to describe the relative uniqueness of the site for different activity purposes by describing the geographic origins of visitors.

In order to eliminate biases resulting from possible differences in sampling rates, the equation was estimated in the following form:

$$P(ni) = P(i)P(n|i) = \alpha D_i^C e^{\epsilon_i} \qquad (20)$$

where $P(i)$ = the probability that a visit randomly observed at the site is from origin i,

$P(n|i)$ = the probability that a visit randomly observed at the site is person n from origin i, given that the visit is from origin i and assuming all persons at origin i are equally likely to visit the site.

$P(ni)$ = the joint probability that a visit observed randomly at the site is person n from origin i, assuming all persons from origin i are equally likely to visit the site.

$\epsilon_i$ = an error or residual that is assumed to be independently and normally distributed with constant variance over the range of analysis.

Estimates of these probabilities are

$$\hat{P}(i) = \frac{V_i}{\Sigma V_h},$$

$$\hat{P}(n|i) = \frac{1}{P_i}$$

$$\hat{P}(ni) = \frac{V_i}{P_i \Sigma V_h} .$$

Because equation (20) is a probability, its complete specification in the estimated form is

$$\hat{P}(ni) = \frac{D_i^{\,c}}{\Sigma P_h \; D_h^{\,c}} . \qquad (21)$$

This equation can be estimated by maximum likelihood methods. However, the simpler method of ordinary least squares applied to the log-linear form of equation (20) was used. The results are shown in Table 1.

Using National River Recreation Study data from 1977, Peterson, Lime, and Anderson (1979) estimated similar single-site equations for twelve rivers. The results are shown in Table 2.

With NRRS data for twelve rivers studied in 1978, (Ergün and Peterson 1980) estimated the following site choice model:

$$P(j/i) = \frac{e^{\beta D_{ij} + \zeta_j D_j}}{\sum_{k=1}^{r} e^{\beta D_{ik} + \zeta_j d_k}} . \qquad (22)$$

This logit model is based on the linear utility function

$$u = \beta D_{ij} + \zeta_j d_j \qquad (23)$$

Table 1
Single site Analysis for Six Uses of the Boundary Waters Canoe Area Wilderness
(Assuming no substitute sites for the respective activities)
(1974 - 1977)

| Activity | Estimated Equation $P(ni) =$ | Number of Trips in Sample | Number of Zones | Log-Linear $R^2$ | Adjusted Log-Linear $R^2$ |
|---|---|---|---|---|---|
| Paddle Canoeing | $(0.03)D_i^{-2.54}$ | 68,283 | 167 | 0.774 | 0.773 |
| Motor Canoeing | $(0.16)D_i^{-2.86}$ | 10,195 | 119 | 0.745 | 0.743 |
| Motor Boating | $(0.10)D_i^{-2.87}$ | 14,278 | 152 | 0.713 | 0.711 |
| Hiking | $(0.19)D_i^{-2.93}$ | 2,483 | 62 | 0.813 | 0.810 |
| Cross Country Skiing | $(4.13)D_i^{-3.47}$ | 365 | 14 | 0.816 | 0.801 |
| Snowmobiling | $(64.31)D_i^{-4.13}$ | 422 | 12 | 0.907 | 0.900 |

Table 2
Single-Site Analysis for Twelve Rivers
(1977 Data)

| River | Estimated Equation P(ni) = | Number of Trips in Samples | Number of Zones (i) | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|---|---|
| Main Salmon | $(0.00096)D_i^{-1.78}$ | 175 | 27 | 0.735 | 0.724 |
| Middle Fk. Salmon | $(0.0014)D_i^{-1.81}$ | 191 | 28 | 0.702 | 0.691 |
| Upper Colorado | $(0.00083)D_i^{-2.02}$ | 2169 | 52 | 0.795 | 0.791 |
| Apple | $(0.00067)D_i^{-2.03}$ | 191 | 26 | 0.753 | 0.743 |
| Nantahala | $(0.0011)D_i^{-2.08}$ | 87 | 26 | 0.697 | 0.684 |
| Chattooga | $(0.0012)D_i^{-2.26}$ | 9877 | 77 | 0.728 | 0.724 |
| Illinois | $(0.0023)D_i^{-2.27}$ | 226 | 22 | 0.789 | 0.778 |
| DesChutes | $(0.012)D_i^{-2.48}$ | 456 | 18 | 0.797 | 0.784 |
| Ocoee | $(0.0061)D_i^{-2.61}$ | 280 | 23 | 0.875 | 0.869 |
| Mohican | $(0.0028)D_i^{-2.64}$ | 444 | 21 | 0.837 | 0.828 |
| Hiwassee | $(0.035)D_i^{-2.87}$ | 128 | 12 | 0.858 | 0.844 |
| Upper Missouri | $(1.26)D_i^{-3.03}$ | 497 | 32 | 0.911 | 0.908 |

where $d_j$ is a site-specific dummy variable which takes on the value of one for river j and zero for all other rivers,
$\zeta_i$ is an estimated site-specific parameter capturing sampling and specification errors, including biases resulting from different sampling rates at different rivers.
$\beta$ is the estimated marginal utility of distance.

The analysis was based on 4524 visits to the twelve rivers from 377 three-digit zip-code zones. The estimate of $\beta$ in equation 22 is -.00167. The results clearly show distance to be an important explainer of demand distribution. A simple market share model correctly predicts 20.9% of the trips. With the addition of distance to the model, this rises to 50.7%. Assignment of equal probabilities on the basis of no information whatever gives 8.3% correctly predicted. However, Ergün also found that $\beta$ varies for the twelve rivers from region to region when the model is estimated on a regional basis. He also divided the twelve rivers into two basic types and found differences in $\beta$ by river type. This indicates the presence of effects not adequately captured by equation (21).

## Discussion of the Empirical Results

Results presented in the preceding section are illustrative only. The equations are estimated under very restrictive assumptions. The estimation procedure, while simple, does not satisfy the condition that the probabilities must sum to one over all cases, which may introduce slight biases in the exponents and major biases in the coefficients. The coefficients should, in any case, be regarded with skepticism because of their extreme sensitivity to errors in estimation.

The most interesting bit of information is the exponent of distance. Given the hypothesized functional form (20), the exponent c is the distance elasticity of trip attraction. If the equation is constrained as in (21) the elasticity is $c[1 - P(ni)]$. However, P(ni) is likely to be an extremely small number except in the unlikely situation where the origin is very close to the destination, there are few nearby origins, and the population is very small. In any case the probability will always be less than the reciprocal of the population. The elasticity estimates the percent change in P(ni) when distance changes by one percent. Assuming that any estimation biases affect all equations in the same systematic way, comparison of the exponents between equations reveals relative differences in elasticity. It does not, however, reveal reasons for the differences.

While attempting to interpret the results, it is important to recall the assumptions under which the illustrative equations were estimated, especially:

1. The distance-decay of trip attraction is insensitive to conditions of competing supply,

2. There are no differences in site quality,

3. The population from which a site attracts its visitors is homogeneous vis-a-vis the systematic or predictable portion of the utility function, and inter-personal differences are randomly, independently, and identically distributed by the Weibull distribution, and

4. The market population is the entire population of the contiguous United States.

With these assumptions in mind, the estimated elasticities lead to the following comments and conclusions:

1. Trip attraction is very sensitive to distance and is strongly explained by distance alone.

2. On the average, the explained portion of log-linear variation among zones is about the same for the BWCAW (79%) as it is for the rivers (78%). There is little variation among all the equations in the amount of variance explained. There is apparently no cause to conclude that the model is more applicable in some cases than in others.

3. The distance elasticity varies among rivers and among different uses of the BWCA. This implies some "market areas" are more local than others, for whatever reason. Generally, the more elastic the demand, the more local the resource. It is interesting that the BWCA shows very different elasticities for different uses, which suggests that a site may be geographically more unique for some purposes than for others, i.e., it tends to reach out farther for some kinds of visitors than for others.

4. Because distance is closely related to travel cost and travel time, given travel mode, it should be possible to estimate models which explain the sensitivity of site demand to these variables. This will allow prediction of the response of demand at specific sites to changes in fuel cost and transportation technology, other things being equal.

5. It is not clear from the empirical results what the reasons are for the differences in exponents. Plausible causes are

a) differences in the benefit of an activity to its participants,

b) differences in the quality of a site for the given activity,

c) differences in the quality, quantity and relative location of competing sites and activities, and

d) differences in participation costs.

It is clear that differences exist. Further experiments are needed to isolate the causes so that demand can be understood and predicted and resources wisely allocated.

6. Although details are not reported here, examination of the residuals shows nonrandom geographic patterns (Peterson, Lime & Anderson, 1979). This implies other variables may be influencing the relationships systematically and their effects may be predictable, although the magnitude of their effects is less than the effect of distance.

The distance elasticity of trip distribution in equation (23) is $\beta D_i[1 - P(j|i)]$ where $\beta = -0.00167$. This is not comparable with the trip attraction elasticity, because they are different concepts and the utility function specifications differ. It is interesting to note, however, that when $P(j|i)$ is small, the distance elasticity of trip distribution has the range of -1.78 to -4.13 when distance has the range of 1066 miles to 2473 miles.

More important, though, is that the estimate of $\beta$ is not stable when rivers are segmented by type and the population is segmented by area. This could be caused by incorrect specification of the utility function and/or aggregation error.

## REFERENCES


Carter, J. (President), Water Policy Reform Message, July 6, 1978.

deBettencourt, J.S., "Threshold Theory and Methods for Assessing Environmental Performance Capability," Ph.D. dissertation, Northwestern University, Evanston, IL., 1979.

Domeneich, J. and D. McFadden, Urban Travel Demand: A Behavioral Analysis, North Holland Publishing Co., New York, 1975.

Driver, B.L. and P.J.Brown, "A Social-Psychological Definition of Recreation Demand," in Assessing Demand for Outdoor Recreation, USDOI-BOR and NAS, Washington, D.C., 1975.

Ergün, G. and G.L.Peterson, "River Site Choice Modelling," Northwestern University, Evanston, IL., 1980.

Lime, D.W., R.C. Knopf and G.L.Peterson, "The National River Recreation Study," 2nd Conference on Research in The National Parks, Nov. 26-30, San Francisco, 1979.

McFadden, Daniel, "Modelling the Choice of Residential Location," in A. Karlquist et. al., (eds.) Spatial Interaction Theory and Planning Models, North Holland Publishing Co., New York, 1978.

Peterson, G.L., A.Anas, F.S. Koppelman, P.R. Stopher, Prediction of Urban Recreation Demand, Northwestern University, Evanston, IL, 1978.

Peterson, G.L., D.W. Lime and D.H.Anderson, "Attraction of Recreationists to Rivers: A Nationwide View," 2nd Conference on Research in the National Parks, Nov. 26-30, San Francisco, 1979.

Shelby, B. and M. Danley,"Allocating River Use," Oregon State University, 1979.

Stopher, P.R. and A.H.Mayburg, Urban Transportation Modelling and Planning, Lexington Books, Lexington, MA. 1975.