韓國林學會誌 79(3) : 231-244. 1990.
Jour. Korean For. Soc. 79(3) : 231-244. 1990.

Determining the Optimal Number of Users of a Forest-based Recreational Site : For the Case of Book Han San National Park[1]

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山林休養地의 最適 利用者數 決定에 關한 研究 : 北漢山 國立公園의 경우[1]

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ABSTRACT

As the complexity of society increases, the demand for the forest-based recreational site is also increased. This, in turn, makes congestion an ubiquitous type of externality in forest-based recreational site. Efficient resource allocation requires this congestion effect to be accounted and considered in the decision making process. In this context, this study was conducted to suggest a process which can be used to measure the congestion and determine the optimal number of users.

Willigness to pay(WTP) function obtained from Book Han San National Park users suggested that every 20,000 users increased decrease the satisfaction of users obtained from the site visit by 27.3%.

For the purpose of demonstration this WTP function is applied to determine the optimal number of users which is estimated as about 73,000 persons per day.

Key words : Optimal number of users, WTP function, Book Han San National Park, socio economic carrying capacity

要 約

産業化의 進展과 所得水準의 向上은 山林休養 需要를 급속히 增大시켰으며 이에 따라 많은 山林休養地는 과다한 利用者들로 붐비고 있다. 이러한 混雜은 山林休養地가 제공하는 service의 질을 떨어뜨릴 뿐만 아니라 休養地의 管理에도 많은 問題를 제기하고 있다.

效率的 資源의 配分을 위하여는 이러한 混雜의 效果가 의사결정 과정에서 고려되어야 한다. 이 研究에서는 混雜이 利用者들에게 주는 비효용을 測定하고 이를 이용하여 山林休養地의 最適 利用者數 결정에 適用될 수 있는 모델을 제시하고자 한다. 북한산 국립공원 이용자를 대상으로 얻어진 Willingness to pay(WTP) function에 의하면 利用者가 20,000명씩 증가할 경우 利用者들이 느끼는 滿足度는 약 27.3%가 減少하는 것으로 나타났다. 또한 이 WTP 함수를 이용하여 추산된 북한산 국립공원의 最適 利用者數는 하루에 약 73,000명으로 推定되었다.

[1] 接受 1990年 4月 9日 Received on April 9, 1990.

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INTRODUCTION

Efficient resource allocation in a competitive market requires marginal cost to equal marginal benefit. However, when an externality such as pollution or congestion exists and is not accounted for in the decision making process, this optimization requirement cannot be met.

Congestion is an ubiquitous type of externality. Highway congestion, overcrowded beaches and long queues in front of public facilities are common types of congestion externalities. When a public facility is overcrowded, the quality of service flows obtained from the particular facility by users are deteriorated (Rothenberg, 1970). This quality deterioration can reduce the satisfaction an individual can derive from the public facility. Possibly, an individual's willingness to pay for using the public facility can be reduced. In the aggregate the summation of all reductions in individual's willingness to pay due to congestion would be thought as the marginal social cost associated with the congestion (Cicchetti and Smith, 1976). For efficient and informed decision making, the congestion effect must be measured and accounted for in the decision making process.

Congestion has become an important phenomenon impacting forest-based recreational sites as many other public facilities. One reason for this congestion is the increased demand for what these facilities have to offer. National parks, forests and preserves provide recreational opportunities that include such activities as picnicking, hiking, and viewing natural surroundings. These activities allow for "a change of pace from normal workday activities, important to individual physical and mental well-being and productive activities," (Brockman and Merriam, 1973). As the complexity of society increases, the demand for the outdoor recreation and recreational sites will also increase (Wagar, 1964).

Further, forest-based recreational resources cannot be produced by man in response to increased demand for recreational sites. Accordingly, along with rapid growth in demand, the congestion problem seems to be a more serious phenomenon for forest based recreational site management due to the nonreproducible nature of the site. When use of a forest-based recreational site reaches a critical level of crowding, the quality of service flows obtained from the particular site by users deteriorate. To maximize the benefit obtained from a recreational site, the additional (marginal) user's WTP must be equal to the sum of the existing users' decreased WTP. The number of user at this point can be termed as the WTP for a particular recreational site.

This optimal carrying capacity has important implications in natural resource allocation and management. Typically, efficient land allocation requires a comparison of the net benefits a tract of land would yield between incompatible, competitive uses, for example, timber production and recreation opportunty provision. As an example, a tract of land can be used to produce an extractive industry output such as timber. Or, it can be managed to produce a collective good from the forest recreational resources. To be able to choose between these alternative uses, one has to compare the maximum net benefit each option would yield. Then, it is necessary to determine the optimal number of users of the recreational site at which recreational benefit obtained from the recreational site would be maximized.

Optimal socio-economic carrying capacity is also an important tool for evaluating various management options. As Wagar (1964) indicated, a capacity augmenting investment such as laying out additional trails, which do not intersect the existing trail system, can reduce or modify the adverse effect of congestion. To justify this management option it is necessary to estimate the maximum benefits the recreational site would yield before and after that investment. This comparison requires, in turn, defining the optimal user density of the site before and after the capacity augmenting investment.

The optimal number of users derived from socio-economic carrying capacity consideration may be different from that determined by ecological carrying capacity consideration. In this economic analysis it is assumed that the ecological carrying capacity is greater than the socio-economic carrying capacity. That is, ecological damage to the environment is negligible until congestion works as a constraint or limiting factor so that the emphasis can be placed on measuring the effect of congestion.

In this context, the purposes of this paper are (1) to develop a willingness-to-pay function for individuals visiting a high-density forest-based recreational site and (2) to determine the optimal number of user by using the willingness-to-pay function estimated.

LITERATURE REVIEW

1. Theoretical Basis

The most common criterion of efficient resource allocation is that of Pareto optimality. By supposing a two-input (L, D), two output (A, N) and two-person (X, Y) situation, Bator (1957) presented how Pareto optimal conditions are determined in a general equilibrium context.

Pareto efficiency conditions for a perfectly competitive private goods market can be summarized such as (Bator, 1957):

(1) $MRS^{X}_{AN} = MRS^{Y}_{AN}$ [Exchange Efficiency]

(2) $MRTS^{A}_{DL} = MRTS^{N}_{DL}$ [Production Efficiency]

(3) $MRS_{AN} = MRT_{AN}$ [Top-Level Condition]

In the case of public goods, however, those Pareto optimal conditions derived in the framework of private goods market are no longer relevant (Cornes and Sandler, 1986; Just et al., 1982).

Samuelson (1954) indicated that the optimal provision condition of a pure public good, which corresponds to the top-level condition above for a private good, is different from that of a private good. That is, due to the inexcludability and nonrivalry between users of a pure public good, the optimal marginal rate of transformation (MRT) should be equal to the sum of marginal valuation of that public good for the whole population of the society such as:

$$MRT = \Sigma MRS$$

Purely private goods generate utility only to the persons who consume it, therefore it can be utilized by only one person or a family. If a private good is used by one person, the same good cannot be used by others and the sum of individuals' consumption cannot exceed total product of the good (Oakland, 1972). On the other hand, a person's utilization of a public good, in a Samuelsonian sense, will not reduce the potential of other person's consumption due to the nonrivalry. Therefore, a public good can be utilized by an infinitely large number of people without reducing utilities of the person using that good (Oakland, 1972).

In the real world, there is a large array of goods that fall at any point between these two polar cases of pure private and public goods. For an example, an individual's visit to a recreational site can be thought as has two effects. The visitation increases his own utility value (a private effect) while it, at some critical point, creates or contributes to site congestion thereby reducing the utility value of other users (a social effect).

The effects of congestion externality can be accommodated rigorously in the framework of the "theory of club" which Buchanan (1965) introduced to fill the gap between the pure private goods world and the purely public goods world. Accordingly, the theory of club deals with those goods and services that belong anywhere between the two extreme pure private and pure public cases and the consumption of which have public and private effects.

The optimal number of individuals sharing those goods and services is more than one person (which is the case of the pure private good) and smaller than an infinitely large number (which is the case of the pure public good) (Buchanan, 1965). Consequently, the main concerns of the "club theory" are those of determining the optimal number of persons sharing the goods and services provided and the conditions under which an individual is voluntarily participating in the sharing group (Buchanan, 1965).

To review the club theory in depth, let us suppose a society that has a single club and consists of a homogeneous population of size, N, with the same tastes and initial endowments. It is further assumed that they consume two goods; a private good, y, and a club good, x. Only club participants of size "s" can consume the club good, and consequently (N−s) individuals are excluded. Then, a club participant's utility function will be

$$U[y_i,\ C(s,\ X)]$$

Where c(·) represents consumption of the club good with properties of $\partial C/\partial S < 0$ and $\partial C/\partial X > 0$. In other words, consumption of club good depends negatively on the size of sharing group due to congestion and positively on the club's provision.

The excluded members, (N−s), of society consume only private good, y_o, with utility function

$$U(y_o,\ 0)$$

To derive the Pareto optimal condition, both club members' and nonmembers' utilities should be taken into account. Then, a reasonable social objective function would be.

$$\max.\ s \cdot U[y_i,\ C(s,\ X)] + (N-s) \cdot U \cdot (y_o,\ 0)$$

$$\text{subject to } F\ [sy_i + (N-s)\ y_o,\ X] \leqq 0$$

Where F(·) is the society's resource constraint. The first order conditions imply[3]:

$$S \cdot C_X MRS_{cy} = MRT_{XY}\ (\text{the provision condition})$$

$$[U(\cdot)/Uy - U(\cdot)/Uy] = (y_i - y_o) - S \cdot C_S MRS_{cy}$$

(membership condition)

[3] The Lagrangian is

$$L = s \cdot U[y_i,\ C(s, X)] + (N-s) \cdot U(y_o, 0) - \lambda F[sy_i + (N-s) y_o, X]$$

with first-order conditions of

$$y_i : s \cdot (\partial U/\partial y_i) - s \cdot (\partial F/\partial y_i) = 0$$

$$y_o : (N-s)(\partial U/\partial y_o) - \lambda (N-s)(\partial F/\partial y_o) = 0$$

$$X : s \cdot (\partial U/\partial C)(\partial C/\partial X) - \lambda (\partial F/\partial X) = 0$$

$$S : U(\cdot) - U(\cdot) - \lambda F_Y (y_i - y) = 0$$

The membership condition requires that a change in utility due to club participation must be equal to the marginal (dis)utility on all existing members, due to the marginal entrant plus the difference in private consumption, which is required to maintain the marginal valuation of the private good between members and nonmembers. This is the condition by which the optimal number of users of a club good is determined.

2. Congestion Effect on Individual Willingness to Pay

When total use of a public good reaches a certain threshold, additional users impose negative effects on existing users. That is, with congestion the satisfaction of users will deteriorate even though they pay the same cost for services obtained from the public good. Therefore, an individual's valuation of their experience can be reduced. As Cicchetti and Smith (1976) properly indicated, to measure the aggregate congestion effect on a recreational site or any public facilities, a disaggregate approach, based on individual valuation, is required.

To see how congestion affects an individual's willingness to pay, suppose that the left-hand side of membership condition, derived in the previous section, equals zero. This means the marginal club entrant's utility is held constant prior to club participation. Then, the term $(y_i - y_o)$ should be equal to the sum of the congestion cost experienced by all existing members due to the marginal entrant to meet Pareto optimality condition, such as $(y_i - y_o) = S \cdot C_S MRS_{dy}$. Then, $(y_o - y_i)$ can have the interpretation of the maximum amount of willingness to pay as Hicksian compensating variation[4] of allowing to consume the club good (Hillman and Swan, 1983).

That is, the individual is indifferent between

[4] Hicksian compensating variation is defined as "the maximum of income the cosumer would be willing to pay rather than relinquish" the proposed action, in this case park use (Just et al., 1982).

two consumption combinations such as

$$U[y_0,\ 0]=U[y_0-d,\ c(\cdot)]$$

Where y_0 is initial endowment and d the club due (Hillman and Swan, 1983). Therefore, club due (d) is the maximum amount of willingness to pay for the club participation, which depends upon the total level of congestion.

3. Methods of Congestion Effect Estimation

From the preceding discussion, we know that an individual's willingness to pay is related to the quality of a recreational site which can be measured by the level of congestion. The effect of congestion, however, is not captured in the market system. Therefore, we cannot use market-oriented data to estimate the change in individual willingness to pay associated with the change in congestion for a specific recreational site.

There are two methods available to evaluate a nonmarket good ; the direct and indirect methods (Just et al., 1982). The indirect method uses the behavior of consumers in related markets to estimate the users valuation of nonmarket goods. The travel cost method, the best known method in the family of indirect methods, has been widely used for estimation of demand for outdoor recreation, a nonmarket good.

However, the travel cost method cannot be used when there is not enough variation in user origins and thus little variation in distances traveled. Insofar as there is not sufficient variation among the users' travel distance and cost, an identification problem is encountered (Just et al., 1982 ; McConnell, 1977 ; Cicchetti and Smith, 1976).

An alternative approach of measuring the benefit of nonmarket good is the direct method. This approach is to interview the individuals involved in recreation at a specific site, and by use of a survey questionnaire, have revealed their willingness to pay for the recreational site given hypothetical congestion situations (Just et al., 1982).

This approach is not free from some potential problems, either. The problems inherent to the direct method are strategic bias, information bias, and hypothetical bias (Just et al., 1982).

Despite these potential problems, the direct survey method in some situations could be the only way of estimating the value of a nonmarket good. Any alternative method, such as travel cost method, is not useful when there is not enough variation in users' travel cost to estimate the site demand function. This situation is particularly true for recreational sites located close to densely populated areas.

Cicchetti and Smith (1976) measured the effects of congestion in a low-density wilderenss area by using direct method at the Spanish Peaks Primitive Area in Montana. The number of encounters was used to describe the quality of the hypothetical wilderness experience. The use of this measure of congestion was based upon the findings of a previous study (Stanky, 1972) in which the most important attribute of wilderness recreation was solitude.

McConnell (1977) developed a model for estimating the demand for a congested recreational site and used it to estimate individual willingness to pay functions for six beaches in Rhode Island. A direct interview approach was used to obtain information on the respondent's willingness to pay for a beach visitation on the day of the interview. The revealed willingness to pay was regressed on two site quality variables : crowd size and air temperature, along with socioeconomic variables (McConnell, 1977).

More recently, Walsh et al. (1983) investigated the effects of congestion on three downhill skiing sites in Colorado and used the results to develop procedures for project evaluation. On-site interviews with 236 skiers using a contingent valuation method was conducted. Interviewees were asked to reveal the maximum amount they would be willing to pay for lift tickets under nine different combinations of lift-line wait and number of skiers per acre. Color picture examples used of the various congestion combinations (Walsh et al., 1983).

In summary, even though both direct and indirect methods generally can be employed to evaluate the site quality variable, some researchers seem to prefer the indirect method because the "indirect method is based on what people do instead of what they say they will do" (Dyer and Hof, 1979), the direct method seems to be the preferred method in measuring the effect of congestion on a recreational site located close to a densely populated area.

CONDUCT OF STUDY

1. Study Site

Book-Han-San (BHS) National Park is selected as a particular high-density recreational site for this study. This national park is 78.45km^2 in area and was designated as national park on April 2, 1982.

Visitation to the park increased from 2.05 million users in 1976 to 5.57 million users in 1982 (Ministry of Construction, Korea, 1984). Average annual rate of growth in visitation was 18.52 percent over the same period of time. The trend of increasing use is expected to continue in the future. The number of users of this national park was projected to reach 11.28 million in 1991 and 14.94 million in 1996 (Ministry of Construction, Korea, 1984). This rapid growth in use of the site causes problems of congestion for park management as well as for park users.

2. Study Design

Determining the relationship between total number of users of a recreational site and the congestion disutilities requires definition of a measure of congestion which relates crowding to decreased utility. As an example, in a highway congestion study, time taken to complete a trip of a certain length was used as a measure of congestion. This measure of congestion (additional driving time required due to congestion) links the number of vehicles to the drivers' decreased utility (Boardman and Lave, 1979). Yet as an another example, in a low-density wilderness congestion study, Cicchetti and Smith (1976) used number of trail and camp encounters with hikers as a measure of congestion which links total number of hikers in the region to the hikers' disutility (Cicchetti and Smith, 1976). A measure of congestion depends on the services provided by the public facility in question. However, none of the congestion measures used for different settings of studies seem appropriate as the measure of congestion for the BHS National Park high-density setting.

A video tape showing two representative trails of the BHS National Park with five different levels of congestion for each traill was developed during the summer, 1987, based on the corresponding different level of user density which were defined with the help of park management and experienced hikers. The video tape, then, was used to describe the hypothetical situation for which the respondents are asked about their willingness to pay.

On the video tape the potential user density of BHS National Park classified into five categories. Density 1 describes the situation which is likely to happen when the user density is at its lowest level. It shows a situation in which there is one other party or no other parties in sight and there is no noise heard.

Density 2 describes a situation which is likely to occur when the user density is at its next lowest level. It shows that there are 2-3 parties of other users in sight and the noise level is low.

Density 3 describes a situation which is likely to happen when the user density is at a moderate level. It shows that there are more than 3 parties of other users visible, and their conversations can be heard.

Density 4 describes a situation which is likely to happen when the user density is so high that a substantial degree of competition is expected to exist between users. It shows many users hiking along the trails in sing file and with considerable noise from the users.

Density 5 describes a situation which is likely to happen when the user density is at the highest level conceivable in this park. It shows that the trail is so crowed that occasionally hiking is hindered, and the level of noise is so high that conversation within a party can be difficult. It is like an urban street scene at noon in downtown Seoul. It is expected that the congestion costs associated with degradation of the recreational experience perceived by users are very high and it is obvious that some measure of management is necessary.

In addition, individual attitudes toward the natural environment are likely to have a significant effect on individual willingness to pay for use of forest based national parks. As an indicator of an individual's attitude toward the natural environment, the two factor scores obtained from the 8-item, two factor model are used. This model was derived from the New Environmental Paradigm (NEP) scale which consist of 12 items and developed by Dunlap and Van Liere (1978). Table 1 shows the items consist of each factor and factor loading of each item.

Before asking individual's for their willingness to pay, respondents were asked a series of questions about their behavior concerning forest-based recreation. In Part A of the questionnaire, they were asked about their number of annual visitations to forest-based recreational sites (not only to BHS National Park, but including other forest-based recreational sites around Seoul), their main recreational activity at the site, distance travelled from their home to the site, method of transportation used, travel time, and costs, and length of stay.

In Part B, respondents were asked to reveal their opinion about of the 12 item series of statements in the New Environmental Paradigm (NEP) Scale.

In Part C, respondents were asked to state the changes in their willingness to pay for varying levels of user density. They were shown a video tape developed with some verbal explanation, describing the situations depicted on the video tape. First, they were asked how they rate the user density of the park at the time of the interview and second, what level of density they had expected to find at the park before leaving their home for the park. These questions were included to ascertain the extent to which they understood the situations described in the video

Table 1. Factor analysis of the reduced NEP items.

Factor		Factor Loading	
		Factor 1	Factor 2
Factor 1	(Outlook on Nature)		
	Mankind was created to rule over the rest of nature.	.543	-.059
	Humans have the right to modify the environment to suit their needs.	.485	.267
	Plant and animals exist primarily to be used by humans.	.663	-.109
Factor 2	(harmony in Growth and Enviroment)		
	We are approaching the limit of the number of people the earth can support.	.031	.273
	The earth is like a spaceship with only limited room and resource.	-.040	.304
	Humans must live in harmony with nature in order to survive.	.004	.283
	There are limits to growth beyond which our industrialized society cannot expand.	-.019	.414
	Mankind is severely abusing the environment.	.066	.450

tape.

After that, they were asked to state the change in their willingness to pay for varying levels of user density. Respondents were asked to suppose that the user density at the time of the interview corresponded to Density level 4 in the video tape, which is the second highest level of user density depicted. They were then asked to state the maximum willingness to pay as an entrance fee for each visit to the park. Examples of entrance fees for some other recreational facilities such as a palace, swimming pool, or privately developed recreational sites were presented as a reference, ranging from 550 Won to 4.000 Won per visit ($ 0.70-5.00). Starting from the amount respondents were willing to pay for the user Density 4 in the video tape, the questionnaire then elicited the change in their willingness to pay for varying levels of user density, from Density 4 to Density 5, from ensity 4 to Density 3, from Density 3 to Density 2, and from Density 2 to Density 1.

If a zero willingness to pay was indicated, then the respondent was asked the reason for his/her bid. Some respondents indicated that congestion does not adversely affect their recreational experience (i.e., there was no willingness to pay more for lesser user intensity) and were recorded as zero amount of willingness to pay, otherwise his/her bid of zero amount considered as a nonresponse since it could be interpreted as a protest bid.

Part D was included to collect information on the socioeconomic status of the respondents such as : sex, age, education, occupation, family size, family income, amount of vacation, and personal health.

3. Willingness To Pay Model Specification

The theoretical model discussed in literature review section provides neither the determinants of the individual willingness to pay function, nor the functional form. However, we can infer that the utility maximizing individual's willingness to pay depends upon three groups of explanatory variables. The first group consists of variables describing the individual's resource endowment (constraint) available for the site visitation. It includes individual's money, income, time available and the price of site use. When a public recreational site such as a state and national park is provided to the public at nominal or zero entry fee, the travel cost including the time cost to reach the site can be thought as the price of the site use.

The second explanatory group consists of variables describing quality of recreational experience provided by the site. The quality of recreational experience can be defined in terms of the physical characteristics of the setting such as beauty of scenery and the crowdedness of the site.

Concerning the quality variable, we assume that characteristics of the site, other than the level of congestion, are known and invariant across the users. This assumption can be justified given that when we focus on the congestion effect of a single site, the characteristics of an area such as the beauty of scenery, flora and fauna are unaffected by the level of use of the site assuming that the level of use is under the biological carrying capacity (Cicchetti and Smith, 1976).

The third group consists of variables that hopefully capture the individual's different taste and attitude for site use. Demographic variables such as age, family size, health and education were used to capture the differing tastes for wilderness recreation (Cicchetti and Smith, 1976).

Summarizing the above discussion, the general form of individual willingness to pay function would be :

$$WTP_i = f(Y_i,\ T_i,\ TC_i,\ TT_i,\ Q_j,\ FTS_{ij},\ ED_i,\ AG_i,\ FS_i$$

were

WTP_i = willingness to pay of ith individual.

Y_i = money income of ith individual.

T_i = time constraint for site visit of ith individual.

TC_i = travel cost to the site of ith individual.

TT_i = travel time of ith individual.

Q_j = congestion measure, j = 1, ...5.

FTS_{ij} = factor score of ith individual for jth factor,

j = 1, 2.

ED_i = education of ith individual.

AG_i = age of ith individual.

FS_i = family size of ith individual.

The economic theory does not provide any specific form of individual's willingness to pay function of recreational experience. However, previous studies of recreational site congestion suggest that the linear and semi-log relationship fit well. Based on past research and given the absence of a rigorous theory both linear and semi-log specifications seem to be the most promising functional forms for the hihg-density recreational site congestion study.

4. Data Collection

The necessary information was collected by on-site interviews during October of 1987. The interviews were conducted by two survey teams at the trial head of two different hiking trails in the BHS National Park. Each survey team consisted of three members who had received three hours of training. Two members of a team carried out interviews of hikers and one member operated the video equipment.

All hiking parties passing through the interview point were contacted if either one of the two interviewers and the video equipment were available. One person from each party was randomly selected for the interview. When a hiking party consisted of members of two or more separate households, a member from each household was interviewed.

A total of 351 hikers was interviewed. Among them, results from 63 interviewees could not be used because they refused to (or were incapable of) complete the interview. Seventy-seven questionnaires were eliminated from the analysis due to the problem of a protest bid. Thus, 221 usable interviews were obtained and used for the analysis.

RESULTS

The primary variables in this study are shown in Table 2. Various combinations of these explanatory variables are regressed on individual willingness to pay (WTP) with linear and semi-log specification of the dependent variable.

Table 2. Definition of Variables

Variable	Unit	Expected Sign	Description
WTP	Won[a]	___[b]	Individual willingness to pay per use to BHS National Park
UD	1-5	-	User density in terms of video tape developed : low user density=1, high user density=5
ENVR1	*	+, ?	Factor score for "Outlook of nature" Factor
ENVT2	*	+, ?	Factor score for "Harmony in growth and environment" factor
FI	Won/Month	+	Family income per month
DA	Days/Month	—	Number of days off per month
TC	Won	—	Travel cost to the site
TT	Hour	—	Travel time to the site
NV	Days/Year	+, ?	Number of site use per year
ED	1-6	?	Education of respondent : low education=1, high education=6
FS	Person	?	Family size

[a] Monetary unit of Korean currency.

[b] Dependent variable.

*Standardized factor score

Table 3. Semi-log Willingness to Pay (WTP) Function

Variable	Coefficient	Standard Error	t
UD	-0.273	0.025	-11.114***
ENVR1	0.161	0.044	3.648***
ENVR2	0.295	0.050	5.914***
TT	0.036	0.016	2.237**
ED	-0.058	0.031	-1.885*
FS	0.069	0.022	3.144***
DA	-0.016	0.010	-1.718**

Intercept = 7.903 $R^2 = 0.15$

a Student t-ratios for the null hypothesis.

* Significantly different from zero at 90% confidence level.

** Significantly different from zero at 95% confidence level.

*** Significantly different from zero at 99% confidence level.

However, some variables such as family income and travel cost to the site were never observed to have a significant effect or have the correct signs.

Accordingly, these variables were eliminated from further analysis and the general form of individual WTP function is expressed in the following way :

WTP = f(UD, ENVR1, ENVR2, NV, TT, ED, AG, DA),

where the variables are defined as Table 2.

The results obtained from the linear model are omitted in this report. The final results of estimation with semi-log function are presented in Table 3. and used for further discussion.

The hypothesis that regression coefficients of all variables included in the equation are unrelated to willingness to pay can be rejected at 10 percent to one percent confidence level. The sign of the coefficients of most independent variables included in the equation are consistent with *a priori* expectations.

The semi-log specification implies that an increase in an independent variable has the same percentage effect on the dependent variable. Therefore, the estimated coefficient for user density, UD, implies that one unit increase of the user density reduced the individual WTP by about 27.3 percent. Thus, as the level of WTP declines, so does the absolute magnitude of the effect. This means that each additional user density has diminishing marginal effect on individual WTP (Johnston, 1984 ; Cicchetti and Smith, 1976).

The environmental factor score variables, ENVR1 and ENVR2, as indicators of an individual's attitude toward the natural environment are expected to exert a positive and direct effect on individual WTP. That is, as one is more accepting of the concepts of including man as a part of nature, that there are limits to economic growth, and there is a delicate natural balance of ecosystems, he is willing to pay more for the forest-based recreational use. WTP also depends on the time available for site use.

The independent variable of the number of off-duty days per month, DA, has a significant, negative effect on the WTP. This can be explained by assuming that if one has less time available for leisure activity, then his marginal valuation of that time will be higher than that of a person having more time available. In other words, one who spends higher valued time at a recreational site would place higher value on the recreational experience obtained from the site use, and thus would be willing to pay a higher money price.

Travel time, TT, was expected, *a priori*, to have a negative effect on WTP. Travel time can be thought of as a time price for using a recreational site in addition to the direct cost of site use and those who already pay a higher price with respect to travel would be willing to pay less for site use assuming WTP as an index of consumer surplus. However, in this study it turns out that travel time taken to reach the site has a significant positive effect on individual WTP. This can be explained with the fact that there are few available substitutes for the forest-based park recreational experience provided by BHS National Park. Persons who are willing to pay more time cost for the site visitation are also willing to pay a greater amount of money to enter the park.

The signs for demographic variables included in the equation, education (ED) and family size (FS), were difficult to anticipate. Education has a negative effect on WTP. It may be that an individual who has a higher education places less value on recreational site use. Family size has a positive effect on WTP. Individuals who come from a larger family are willing to pay more than those from a smaller family.

The coefficient of determination, R^2, adjusted for the degrees of freedom of the semi-log equation is 0.15, which is relatively low, yet "acceptable" given the cross-sectional data.

Cross-sectional data used in this study are known to be subject to the problem of heteroscedasticity of the disturbance term. That is, the constant variance assumption, $E(u^2)=\sigma^2$ is not satisfied, if heteroscedasticity exists. Accordingly, a test of homogenous variance was conducted using Glejser's test (Glejser, 1969). In the case of semi-log specification, the hypothesis of homoscedasticity cannot be rejected.

APPLICATION OF THE RESULT

To be able to use the empirically estimated results to aid in the management of BHS National Park, the relationship between total number of users and the congestion measure, the user density level, needs to be defined. Cicchetti and Smith (1976) suggested three approaches of obtaining the relationship. These are (1) relying on the experience judgement of park managers, (2) empirically estimating use congestion measure (i.e., perceived user density) relationship and (3) constructing a stochastic simulation model of use-congestion relationship (Cicchetti and Smith, 1976).

The first approach implies assuming a functional relationship between number of users and perceived user density. Even though this approach could be of limited value because it cannot be "proved" it was used in this study for the purpose of demonstration.

Several park management officers and rescue crew members staying in the park were contacted at the interview sites and the park management office. According to the information obtained from the park managers and rescue crew members, there exists a linear relationship[5] between user density level shown in the video tape and total number of users was developed. The expert opinions yielded the following linear relationship.

$$UD=0.00005N \qquad (5\text{-}2)$$

N = total number of users.

This relationship was accepted as a plausible approximation by experienced hikers who use the park frequently. Then, given this relationship it is possible to determine optimal number of users by using the estimated WTP relationship.

When we take a total-economy view point, the Pareto optimality criterion requires the total (or aggregate) WTP obtained from a recreation site to be maximized. The aggregate willingness to pay can be represented as:

$$AWTP=\Sigma f(UD,\ ENVR1,\ ENVR2,\ TT,\ ED,\ FS,\ DA) \qquad (5\text{-}3)$$

where : AWTP = aggregate willingness to pay

$f(\cdot)$ = willingness to pay of person

If we assume that all users are identical in their tastes and endowments, the aggregate process will be simplified as:

$$AWTP=N\cdot g(UD) \qquad (5\text{-}4)$$

where : N = total number of park users.

$g(\cdot)$ = representative individual's WTP function

In $g(\cdot)$, all other explanatory variables are held constant at their mean values to show the relationship between WTP and the user density variable of interest. Then, $g(\cdot)$ can be interpreted as the average or representative individual's WTP function expressed in terms of user density, UD. The park manager's objective function can be represented in the following way:

[5] This relationship implicitly assumes that the perceived user density is unvarying by the characteristics of other user and that the length of each user and that the length of stay of each user is constant.

$$\text{Max. } AWTP = N \cdot g(UD) \quad (5\text{-}5)$$

Using the relationship between total number of users, N, and user density variable, UD, as defined in equation (5-2), the first order necessary condition is given as :

$$N \cdot \partial g(\cdot)/\partial N + g(\cdot) = 0 \quad (5\text{-}6)$$

Solution of this necessary condition with respect to N gives us optimal number of users.

Using the semi-log function estimated in the previous section and the mean values for all independent variables except user density, the following condensed equation can be derived :

$$\ln(WTP) = 8.044 - 0.273UD. \quad (5\text{-}7)$$

Substituting equation (5-2) into (5-7) gives equation (5-8).

$$\ln(WTP) = 8.044 - 0.273(0.00005N) \quad (5\text{-}8)$$

Then, the aggregate willingness to pay will be :

$$AWTP = N \exp(8.044 - 0.00137N). \quad (5\text{-}9)$$

Maximizing equation (5-9) with respect to total number of users, N, gives about 73,260 persons per day as the optimal number of users for BHS National Park. The optimal user number estimated in this study falls somewhere between user density 3 and user density 4 as recorded on the video tape.

Because the level of the user density during most Sundays is higher than user density 4 shown in video tape, a substantial degree of congestion cost is involved in the use of this park. However, it must be noted that, as Wagar (1964) indicated, the optimal number of users estimated is not an absolute value inherent to the particular recreational site. The optimal number of users can be increased without adversely affecting recreational quality by management procedures that (1) reduce conflicts between competing uses, (2) reduce the destructiveness of users, (3) increase the durability of the site, or (4) provide increased opportunities for enjoyment. Wagar (1964) suggested zoning, engineering, public relations and persuasion, interpretive services and management of biotic communities as management procedures which can augment carrying capacity.

Zoning can reduce congestion disutility by reducing conflicts and efficiently using land resources. Additional trails which do not intersect existing trails and control the movements of people can increase carrying capacity without recreational quality deterioration. Publicity and other means of persuasion, such as environmental education, can also increase carrying capacity by reducing the destructive behavior of users (Wagar, 1964).

Any management procedure undertaken to augment carrying capacity can be evaluated by using an estimated WTP function. If the cost of the management procedure is less than the benefit gained from that management procedure by all the users, then it can be "justified".

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