Staff Papers Series

Staff Paper P87-19 June 1987

TIME IN RECREATION MODELING AND DECISION MAKING

by

Wiktor L. Adamowicz
and
Theodore Graham-Tomasi

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

TIME IN RECREATION MODELING AND DECISION MAKING[1]

BY

Wiktor L. Adamowicz[2]
and
Theodore Graham-Tomasi[3]

June 1987

[1]This research was supported by the Minnesota Agricultural Experiment Station Project 14-88 and the Department of Agricultural and Applied Economics, University of Minnesota. Some data were provided by the Minnesota Department of Natural Resources; no endorsement of the research findings by them is implied.

[2]Assistant Professor, Department of Rural Economy, University of Alberta and Research Assistant, Department of Agricultural and Applied Economics, University of Minnesota.

[3]Assistant Professor, Department of Agricultural and Applied Economics and Department of Forest Resources, University of Minnesota, and Visiting Assistant Professor, School of Natural Resources, University of Michigan.

TIME IN RECREATION MODELING AND DECISION MAKING

The interest in modeling recreation decision making has risen rapidly in the past two decades. Valuing the effects of environmental quality changes has become a major research effort for economists. However, one of the most troublesome aspects of this effort has been the value and role of time in the decision making process. A variety of approaches have been suggested for the valuation of travel and site time in recreation studies (see Smith, Desvousges and McGivney, Wilman, Cesario and Knetsch, and McConnell). None of these approches are entirely satisfactory.

Firstly, most rely on time as a constraint in the recreation decision process while in fact it may be an argument in the utility function (see Zeckhauser for an interesting approach to modeling time as the main source of utility in economic life). Secondly, the question of the value of time seems to be an unanswerable one in general. Most economic models assume that time is valued at the wage rate, however, many empirical studies value recreational time at some fraction of the wage rate. Which is correct? Manoch has formulated a model by which the value of time differs from the wage rate on non-work days however this model has not been used in recreation studies as of yet. Economic theory appears to provide little definitive guidance as to how to value time. Thirdly, most data gathering efforts have not included consideration of the variables required for an empirical examination of the role and value of time on recreation decisions; thus most research into this question is either theoretical in nature or uses weak proxies in the empirical analyses. It would seem that empirical examination is the only avenue left to explore the value of time in an issue as complex as recreation decision making.

This paper reports the results of a project to collect information on the role and value of time in recreation decisions. The data collected are based on several models formulated in the recreation decision making literature. The next section will outline the construction of the questionnaires and the underlying theoretical models. The third section of the paper presents the results of the survey research and some of the findings. The fourth section contains an analysis of various time value models and their results given our more complete data structure. The fifth section presents our conclusions.

Theory and Questionnaire Design

Two major techniques are utilized for the valuation of recreational activities using market data as the source of information (as opposed to contingent valuation which uses direct questions). These techniques are the travel cost model (TCM) and the hedonic price model (HPM). While other techniques exist, these are the most popular empirical approaches to valuing non-market goods. The TCM bases estimates of consumers surplus on how travel costs affect site use (see McConnell). Time enters the TCM both in terms of the opportunity cost of travel to the site (as travel and time costs) as well as through the way time spent in recreation is modeled in the demand system. Early studies utilized a fraction of the wage rate times travel time as a measure of the opportunity cost of travel time and added this amount to the travel cost, thus raising estimates of consumers surplus relative to estimates which ignore the value of time (Cesario and Knetsch). Wilman describes a theoretical model in which travel and on-site time are measured, each with a different price, and are added to the opportunity cost of the trip. This also would result in an increase in the consumers surplus estimate. Most approaches to including the value of time in TCM studies have either made somewhat ad hoc estimates of the value of time or have not performed empirical work (Wilman is an example of the latter while Smith, Desvousges and McGivney is an example of the former, McConnell and Strand is an example of a study with theoretical and empirical analysis). We are interested in collecting data that allow us to better determine the value of time in recreation and to examine the various time value models and estimate them with these data.

Hedonic travel cost models (HTCM) are a new approach to valuing not sites themselves, but rather site characteristics and changes in them. Brown and Mendelsohn developed the HTCM model as a variant of the hedonic price models popular in the environmental literature. The HTCM does not possess a strong theoretical basis; nevertheless it has been utilized in a variety of studies of the economic effects of water quality (Brown and Mendelsohn, Bockstael, Hanemann and Kling). The HTCM is estimated by regressing the travel costs or travel time on the characteristics of various sites for each population zone. The basis is that recreationists are willing to pay, through travel or time costs, for higher characteristic levels. The coefficients of such a regression make up the "hedonic prices" which are then used to derive a demand function for chracteristics. Clearly, time costs are an integral part of the HTCM. Similar studies that fall under the hedonic price category estimate expenditure on recreation activities as a function of characterisitcs, analogous to the Ladd and Suvannunt analysis of food characteristics. Both approaches yield implicit prices and demand functions for characteristics.

Papers by Wilman and Smith, Desvousges and McGiveny have shown that under certain assumptions both travel time and site time should be valued at some rate in a TCM. These papers utilize a traditional utility maximizing model with either household production components or time constraints. However, often consumers are interested in spending time in a certain activity rather than consuming a "unit" of that activity. Utility may be an increasing function of the time spent. This type of model, inspired by the analysis by Zeckhauser, is employed below.

Let us examine a consumer who chooses to maximize utility as a function of the time spent recreating T_s, the time spent travelling to the recreation site T_d, and the time spent in other activities T_w (note that appropriate definitions of T_s will return us to a traditional travel cost framework where T_s is a trip. The present approach allows more flexibility in the defintion of travel and site time) . The consumer must purchase market goods in order to participate in each of these activities. Let $\gamma(T_z)$, $\eta(T_d)$ and $\alpha(T_x)$ be the functions that convert recreation, travel and other activity time into dollar units. For example, $\eta(d)$ is the money cost of travel as a function of travel time. Let S be non-wage income, w the wage rate, T_w the time spent working regular time, ω the constant multiple that converts the regular time wage rate into an overtime rate, and T_o the time spent working overtime. The basic model is

$$\text{MAX } U = U(T_z, T_d, T_x) \tag{1}$$

$$\text{subject to: } S + wT_w + \omega wT_o \geq \gamma(T_z) + \eta(T_d) + \alpha(T_x) \tag{2}$$

$$T \geq T_w + T_o + T_z + T_d + T_x \quad . \tag{3}$$

One specification which will consider time constraints explicitly will include the constraints:

$$T_x \geq \xi(T_x) \tag{4}$$

$$Td \geq \delta(T_d) \tag{5}$$

$$Tz \leq \zeta(T_z) \quad . \tag{6}$$

Constraint (4) indicates that there is some minimum time required to consume each unit of activity x, while constraint (5) is a similar minimum time required to travel to the recreation site. Constraint (6) indicates that the time on site may be less than or equal to the maximum possible length of stay. For example, if the recreation activity is constrained by daylight hours (or the fact that the recreationist must return to work), there is a limit on the number of hours that can be spent in the activity. Maximizing the system above yields a series of Kuhn-Tucker conditions and 5 Lagrange Multipliers. Let λ_1 be the multiplier on the private good time requirement, λ_2 the multiplier on travel time, λ_3 the multiplier on site time, λ_5 the multiplier on total time and λ_4 the multiplier on the budget constraint. The Lagrangian is

$$\begin{aligned} L = {} & U(T_x, T_z, T_d) + \lambda_1(T_x - \xi(T_x)) + \lambda_2(T_d - \delta(T_d) \\ & + \lambda_3(T_z - \zeta(T_z)) + \lambda_4(\; S + wT_w + \omega w T_o \\ & - \gamma(T_z) - \eta(T_d) - \alpha(T_x) \;) + \lambda_5(T - T_w - T_o - T_z - T_d - T_x). \end{aligned} \quad (7)$$

The K-T conditions include the relations that if the travel time constraint is binding (that is, is the shortest route to the site is chosen), then the multiplier λ_1 is non-zero, and if the site time constraint is binding, λ_3 is non-zero. These multipliers, in addition to the multiplier on the budget constraint, can be rearranged to form the value of travel time and the value of site time as ratios between the multipliers. In particular, differentiation with respect to T_z and T_d yields

$$\partial L/\partial T_z = U'_{Tz} - \lambda_4 \; \gamma'(T_z) - \lambda_3 - \lambda_5 \leq 0 \quad (8)$$

$$\partial L/\partial T_d = U'_{Td} - \lambda_4 \; \eta'(T_z) - \lambda_2 - \lambda_5 \leq 0 \quad (9) \; .$$

Equating (8) and (9) via λ_5 (assuming T_d and T_z are positive) and dividing through by λ_4 yields an expression in the value of travel time (λ_2/λ_4) and the value of site time (λ_3/λ_4). Alternately we can form;

$$U'_{tz} - U'_{td} = \lambda_2 - \lambda_3 + \lambda_4(\; \gamma'(_{Tz}) - \eta'(T_d)) \quad (10)$$

This condition is very similar to equation 10 in Wilman. The right hand side of (10) is the marginal cost of recreation time including the marginal utility of additional site time, the marginal utility of saving travel time and the marginal utility of income times marginal time costs. The typical travel cost model results from assuming $\lambda_2=\lambda_3=0$ and ignoring U'_{td}. The formulation in (10) results in travel time and site time being valued at different rates. The posited constraints result in such a form. The travel time constraint is similar to DeSerpa's formulation of time constraints and the site time constraint is similar to Wilman's trip constraint. Of course, this is not the only model that might be plausible for recreation decisions.

If travel time is not binding or site time is not binding, a different time value is possible since these multipliers are zero. In such a case the value of time is obtained from the K-T conditions of the wage time variable.

$$\partial L/\partial T_w = \lambda_4 w - \lambda_5 \leq 0 \quad (11)$$

$$\partial L/\partial T_o = \lambda_4 \omega w - \lambda_5 \leq 0 \quad (12)$$

Equation (11) states that the value of time is the wage rate if individual is working (regular hours, $T_w > 0$) and the value of time is the overtime premium wage if $T_o > 0$. Note that the ratio of λ_5 over λ_4 is the ratio of the marginal utility of income over the marginal utility of time, or the value in income of time. Therefore, depending on what constraints are binding and what the individual's alternate activity is, the value of time differs from some factor times the wage rate to an unknown ratio of Lagrange multipliers.

If we remove the site time constraint (6) we return to a situation where site time is valued at the wage rate and only travel time can potentially be valued at a rate different than the wage rate. Manipulation of these constraints and models can also result in the model of Smith, Desvousges and McGivney, in which travel time and on site time are valued at some non-linear function of the wage rate.

Let us manipulate the model one last time by adding a constraint which requires that wage time and overtime time must be less than of equal to some constant factor. This constraint will illustrate the binding effect of work hours on the recreation issue. Let the Lagrange multiplier on this constrant be λ_6. Equations (11) and (12) become:

$$\partial L/\partial T_w = \lambda_4 w - \lambda_5 - \lambda_6 \leq 0 \quad (11)$$

$$\partial L/\partial T_o = \lambda_4 \omega w - \lambda_5 - \lambda_6 \leq 0 \quad (12)$$

Upon rearrangement these equations imply that the value of time (λ_5/λ_4) is less that the wage rate (or the overtime rate) by the ratio λ_6/λ_4, the shadow value of the work time constraint over the marginal utility of income.

Clearly, alternate versions of the model above can be formed to model work time constraints and other aspects of the recreation decision. However, this model suggests that several variables that have not typically been collected in recreation activity surveys need to be included in questionnaires. In particular, we require more information on the constraints affecting the recreationists and their travel and on-site time use. Our attempt to collect such data through a survey instrument is described below. Before turning to the issue of data collection and questionnaire design we discuss the hedonic price model of recreation use and the role of time in this model.

An alternate version of the time value issue, which results directly from the inclusion of time in the utility function, is a hedonic price formulation of the recreation decision. Let the consumer maximize utility as a function of recreation time (T_x) and a site characteristic (C). In this case we treat time in the activity as a characteristic since it is produced by a combination of travel and other purchased goods and time on site. In the form of a hedonic price model the consumer maximizes:

$$U = U(T_x, C, X)$$

$$\text{subject to: } M \geq P_x X + V(T_x, C),$$

where X is a vector of other market goods, P_x is the price of X, M is income and V(.) is the cost function for activity characteristics. It is hypothesized that recreationists will spend more to yield more units of time in the activity or more units of the activity characteristic (see Brown and Mendelsohn) . An estimate of trip costs as a function of activity time and site characteristics will yield the price of site time and the prices of the characteristics. Such a model can be used to estimate the demand for characteristics. It is important that the time used as the characteristic be the desired "characteristic". For example, the desired time may be fishing time and not travel or other related onsite time. We use such a specification in the empirical model below.

Our analysis shows that the value of on-site time and the value of travel time may differ. In applications it will be difficult to determine the value of on-site and travel time. The opportunity cost of time may be the wage rate for persons who are employed and who would work as an alternate activity. However, for those who are constrained from working either by institutional or physical constraints the value of time may differ from the wage rate. Most researchers have argued that the value of time should be less than or equal to the wage rate, but if there is a constraint on the amount of time required in the recreation activity, it is possible to envision a value of travel time higher than the wage rate (consider the individual who leaves work early to beat the rush hour; the value of time saved appears to be greater than the wage rate). The data required to determine the value of travel and on site time include: (1) how much time was spent traveling to the recreation site, (2) what alternate activity would be pursued if the individual was not recreating (eg. working), (3) whether the shortest route to the site taken (eg. was travel time a binding constraint), (4) accurate estimates of wages for the individual and the household, (5) accurate estimates of travel costs and on-site expenditures, (6) accurate estimates of miles travelled and travel time , and (7) information on whether the trip was taken during a regular work day, holiday or weekend.

Survey Design and Results

The collection of these data as well as various socioeconomic and recreational attitude variables was the goal of the Phase 1 of this project. Phase 2 was designed to collect detailed time use and recreational activity data on the respondents. There are no examples in the literature of the collection of such a data set or the examination of the various alternate models of time value in recreation decisions execpt for ad hoc measures of time value (see Wilman and Pauls; Smith, Desvousges and McGivney).

The data requirements described above led to the construction of two questionnaires, one to yield general information on a sample of recreationists and non-recreationists, and a second to collect information relevent to our model of time value for a recreation activity. Sport fishing in Minnesota was chosen as the recreational activity. The general population survey was performed to collect socioeconomic and general recreation participation information on a sample of the Minnesota population. This sample was also chosen to determine the probability of participation in recreational fishing, since a survey of anglers alone would suffer from self selection bias (for a discussion of the truncated nature of recreation models see Kealy and Bishop).

The general (Phase 1) sample was drawn from the Minnesota Public Safety Name and Address Listing, provided by the Minnesota Department of Natural Resources. One thousand names were provided. The survey (in Appendix 1) elicited information on the individual's perception of environmental problems in the state, the participation of the individual in various recreation activities as well as detailed bigraphical information on the individual and his/her family. Notably, income class information was collected for the various part of the family unit in order to obtain a more detailed breakdown of the most important variable in determining the value of time, the wage rate.

Of the 1,000 surveys mailed out on July 8, 1986, 348 were returned completed, 120 were returned unopened due to improper addressing or lack of forwarding, for a net percentage return of 39.5%. The high return of unusable surveys led us to believe that the mailing list may have been somewhat dated. Follow up cards were sent on July 31, 1986 but there was no large increase in the response. Descriptive statictics of some of the more important variables are in Table 1. The Phase 1 survey provided the participants in recreational fishing required for the Phase 2 survey.

The Phase 2 survey elicited information on four fishing trips taken during the 1986 fishing season (See Appendix 2). One hundred anglers were chosen from the 74% of the respondents to the Phase 1 survey who indicated that they would participate in recreational fishing in 1986. Of the 100 surveys mailed on October 2, 1986, 31 were returned and 8 were returned unusable, for a net response rate of 33.7%. While the return percentages are rather disappointing, they are not surprising given the complex nature of the data requested and the apparent problems in the mailing list. The Phase 2 data were organized on a per trip basis in order to analyze the data on a trip basis rather than an individual basis, similar to the approach of Bockstael, Hanemann and Kling. Descriptive statistics on the trip data are summarized in table 2.

Descriptive statistics from the phase 2 sample provide some significant information on the alternate activities and the time use decisions made by the angler. In particular, on nearly 90% of the trips the recreationists took the shortest route to the site, thereby indicating that the Lagrange multiplier on travel time is zero. We also found that travel time was nearly 2 hours on average and trip length was about 100 miles, total costs over $100 per trip and travel costs about 15% of total costs, fishing time made up about 45% of total site time and average fishing time was about 15 hours per trip. Some 28.9% of the trips were on a regular work day. However, it is not clear whether this question picked up respondent's vacation periods or time after work, or both. Closer examination of the data indicates that many of the longer trips were taken on "regular working days" indicating that the respondent may have considered a vacation a regular working day. The variable "alternate activity" may provide more information on this issue.

Table 3 contains a frequency distribution for each of the alternate activity categories for the 77 trips. Working and working overtime make up a large proportion of the total, although gardening and relaxing seem to be the major alternate choices. The value of time estimates should be based, at least in some part, on the alternate activity the individual would particiapte in. This variable will be utilized in the time models below.

It is interesting to note that all recreation analyses that the authors are aware of assume that recreators have complete information (a possible exception is the work of Smith et al, 1986 where the variance of water quality is an important parameter, but there is no explicit modeling of this attribute). We included a question about the recreator's information regarding whether or not they changed their mind about how much time to spend at the site. Nearly 24% of respondents changed their mind. Table 4 contains crosstabulations of water quality, site quality and crowding effects with the decision to stay on site the desired amount of time ("Did you change you mind about how much time to spend on this site?"). The only quality variable which seems to be related to the decision to change the trip length is fishing quality. The majority of respondents who changed their mind about trip length indicated that fishing quality was a serious problem. This suggests that quality and expectations play a role in recreation decisions. The authors intend to explore this further in another paper.

Table 5 indicates that the decision to choose the shortest route is positively correlated with the number of individuals in the fishing party. Table 6 crosstabulates the alternate activity with the decision to change the length of stay, the decision to choose the shortest route and the variable indicating if the trip was taken on a regular work day. The results of the crosstabs suggests that when work is the alternate acvtivity the shortest route is more likely to be chosen, as one would expect. There does not appear to be a pattern between the alternate activity and the desicion to change the length of the trip. Finally, the alternate activity variable and the regular work day variable are compared to examine if working is always the alternate activity on a regular work day. This does not appear to be the case. Four respondents indicated that work was the alternate activity even though the trip was not on a regualr work day and many respondents indicated that work was not the alternate activity even though the trip was on a regular work day. This suggests that time valuation studies which value the opportunity cost of time at the wage rate may be incorrect. Of course it may also suggest that respondents did not understand the question very well.

Valuation Models

Two types of valuation models are estimated in this section. Firstly, a modified travel cost model is estimated using the method of Kealy and Bishop devised to estimate travel cost models with days at the site as the dependent variable. Secondly, 2 hedonic price models are estimated to determine the implicit price of trip characteristics and time. The first of these hedonic price models is estimated on the basis of the value of time as a function of the characteristics, somewhat like the HTCM of Brown and Mendelsohn.

The travel cost model estimates days to a site as a function of travel costs, socioeconomic characteristics and recreation quality variables. Prior to estimation of the TCM the self-selection bias problem inherent in recreation activity must be treated. Because the respondents to the phase 2 survey are anglers while the other non-anglers have zero demand for fishing days, the result is a self-selection problem in that only individuals with non-zero fishing days are in the demand for days sample. The Heckman procedure provides a solution to this bias by first estimating the probability that someone will participate in recreational fishing and then using the ratio of the ordinate of the normal PDF at this probability over 1 minus the normal CDF value for this probability as a variable in the demand regressions. This ratio, known as the inverse Mill's ratio, eliminates the bias associated with the truncated sample (Wilman and Pauls). The probability of participation in recreational fishing was estimated as a function of fishing experience and income. The results of this probit estimation are in table 7.

The demand functions, estimated as a function of travel cost, water quality and the Mill's ratio are presented in table 8. There are four separate travel cost regressions. The first is estimated with no value placed on travel time, the second values travel time at the wage rate and adds this value to the travel cost, the third adds one third of the wage rate to the travel cost while the fourth forms an index which adds 1.5 times the wage rate for individuals who responded that overtime was their alternate activity, one times the wage rate for individuals who chose work as their alternate activity and one third times the wage rate for those choosing some non-work item as the alternate activity. This was an attempt to use the additional information gathered in our survey to estimate the value of time. Both linear and semi-log forms of the demand function were estimated. The approach taken here is clearly an ad hoc one in that the specific time valuations chosen are arbitrary. Due to deficiencies in the data, no attempt was made to measure time values for different classes of recreators. However, we do feel that our approach of distinguishing groups of recreators with different time values based on the nature of their recreation trips yields some insight into the time valuation issue.

The consumer surplus estimates are presented in table 9. These estimates indicate that the value of time is a very important contributor to the value of recreation. However, which one of these estimates is correct? Incorrect valuation could result in an overstatement or understatement of benefits by a factor of 10 . Thus, the correct modeling of the value of time is crucial. The formulation with the value of time priced at the wage rate for those whose alternate activity is working and 1/3 the wage rate for those not working seems to be a reasonable, yet still ad hoc, method of valuing time. The consumer surplus results for this value of time are still nearly 10 times the value without any time costs but with travel costs relatively low (an average of about $15 per trip) and income relatively high (average income for the sample is $30,000) this result is not surprising. However, it is interesting to note that the consumers surplus for the full wage rate value of time and the consumers surplus for the alternate activity value are not very different, relative to the difference between these values and the 1/3 wage rate and no time value estimates. This suggests that it may not be unreasonable to use the full wage rate as the value of time in studies that do not have data on the alternate activities.

The final empirical investigation into the value of time specifications is an hedonic price function. Two types of hedonic price functions are estimted. Firstly, a more traditional function with the value of travel time as a function of site characteristics is estimated. Secondly, the model presented above with activity time as a characteristic is estimated.

The results of the estimation of travel time as a function of site characteristics are presented in table 10. The same value estimates are applied to this model, i.e., no value of time, time times the wage, 1/3 the wage and the alternate activity indicator times the wage rate. The most significant finding is that the best fit is provided by the alternate activity model (on the basis of R-squared). The hedonic prices estimated from these models are of the expected sign, a positive price for additional fish catch and a negative price for additional "problems" in water quality.

The second form of the hedonic price model is estimated as expenditures as a function of fishing time and catch. Fishing time is chosen as the appropriate activity time variable and catch is the other site characteristic. In order to maintain flexibility in the functional form in this model a generalized Box-Cox form was estimated. This form is

$$(Y^a-1)/a = \alpha_0 + \alpha_1 \ (X^b{}_1-1)/b + \alpha_2 \ (X^c{}_2-1)/c \ ,$$

where a,b and c are the Box-Cox parameters. If all the parameters equal zero, the model is double log. The results of this procedure are in Table 11. The coefficients of this model, combined with the functional form, provide the implicit price of each characteristic as the first derivative of expenditures with respect to the characteristic. The implicit price of fishing time was correlated with the wage rate and the value of time estimated using the alternate activity index to determine if this measure of the value of time was related to the more typical indicators (Table 12). There is little relationship between the value of time measured at the wage rate and the hedonic price of fishing time (a correlation of about .1). However, there is a stronger relationship (.22) between the value of time using the alternate activity and the hedonic price. While these results are from a limited data set they are interesting in an exploratory sense. They suggest that the alternate activity index may be a better valuation of time than the wage rate or some fraction of it. Hence the value of time may be less than or greater than the wage rate.

Conclusions

This paper has presented a theoretical model that is moderately different from others in the recreation area. Specifically, the model presents value of site and travel time as well as the consumption of activity time as the source of utility producing activity. Based on this model an effort was undertaken to obtain data to estimate the relationships. Also, in order to concentrate on time value and more micro level behavioral decisions the survey was designed to collect detailed data on the alternate activities and time uses of the recreationists.

Although exploratory in nature the tentative results indicate that time value is a very complex issue. The use of data such as alternate activities may help in identifying a more appropriate model and estimate of time value. There are many avenues for additional research. This paper suggests that more effort is required in the empirical estimation of recreation decision models in the face of time and activity constraints.

REFERENCES

Bockstael, N.E., W.M. Hanemann and C.L. Kling, Modeling Recreational Demand in a Multiplie Site Framework. Paper Presented at the AERE Workshop on Recreation Demand Modeling. Boulder, Colorado. May 1985.

Brown, G.M. and R. Mendelsohn, "The Hedonic Travel Cost Method", **Review of Economics and Statistics.** (1984):427-433.

Cesario, F.J. and J.L. Knetsch, "Value of Time in Recreation Benefit Estimates", **Water Resources Research** 6, (1970):700-704.

DeSerpa, A.C. "A Theory of the Economics of Time." **Economic Journal** (Dec. 1971):828-846.

Hanoch, G. "Hours and Weeks in the Theory of Labor Supply", in, J.P. Smith ed., **Female Labor Supply.** pp. 119-165. Princeton University Press. 1980.

Kealy, M.J. and R.C. Bishop, "Theoretical and Empirical Specifications Issues in Travel Cost Demand Studies." **American Journal of Agricultural Economics.** (1986):660-667.

Ladd, G.W. and V. Suvannunt, "A Model of Consumer Goods Characteristics" **American Journal of Agricultural Economics.** (August 1976): 504-510.

McConnell, K.E. "Economics of Outdoor Recreation", in A.V. Kneese and J.L. Sweezy eds. **Handbook of Energy and Natural Resource Economics.** pp. 677-722. North Holland 1986.

Smith, V.K., W.H. Desvousges and M.P.McGivney, "The Opportunity Cost of Travel Time in Recreational Demand Models." **Land**

Economics (August 1983): 259-278.

Smith, V.K., W.H. Desvousges and A. Fisher, "A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits." **American Journal of Agricultural Economics** (May 1986): 280-290.

Wilman, E.A. "The Value of Time in Recreation Benefit Studies." **Journal of Environmental Economics and Management" (1980):272-** 286.

Wilman, E.A. and R.J. Pauls, "Sensitivity of Consumers' Surplus Estimates to Variation in the Parameters of the Travel Cost Model." **Canadian Journal of Agricultural Economics** (March 1987):197-212.

Zeckhauser, R. "Time as the Ultimate Source of Utility", **Quarterly Journal of Economics** Symposium on Time in Economic Life. 1972.

TABLE 1: DESCRIPTIVE STATISTICS PHASE 1

	MEAN	STD DEV
Years living in MN	37.68	18.46
Percent who fished in MN previously	96.5%	
Percent who fished in 1986	74.1%	
Fishing experience (years)	23.57	17.97
Age	43.88	15.37
Sex (% female)	26.3%	

TABLE 2: DESCRIPTIVE STATISTICS PHASE 2

	MEAN	STD DEV
Travel cost per trip	14.50	15.27
Food cost per trip	33.56	65.66
Equipment cost per trip	10.43	27.45
Lodging cost per trip	34.63	98.75
Other costs per trip	11.49	37.86
Total cost per trip	104.62	183.96
Fishing Time (minutes)	886.84	850.92
Site Time (minutes)	1993.42	2489.27
Travel Time (minutes)	119.21	104.68
Miles Traveled	100.93	94.09
Percent of trips on a regular work day	28.9%	
Percent of trips which shortest route is chosen	88.2%	
Percent of trips where respondent changed mind about time to spend on site	23.7%	
Percent of trips with spouse	31.6%	
Party size	4.10	3.40
Fish catch	21.47	31.80

TABLE 3: FREQUENCY OF ALTERNATE ACTIVITIES

WORK	WORK O.T.	GARDEN	WORK/HOME	GOLF	READ	TV	OTHER REC.	RELAX	STUDY
14	5	29	8	1	1	1	6	10	2

TABLE 4: CROSSTAB OF QUALITY VARIABLES VERSUS DECISION TO STAY AT SITE

CROWDING

STAY AT SITE		0(NO PROBLEM)	1	2	3	4	5	6	7(SERIOUS PROB)
	NO	24	8	10	5	4	3	5	0
	YES	7	2	1	2	0	2	4	0

WATER QUALITY

STAY AT SITE		0(NO PROBLEM)	1	2	3	4	5	6	7(SERIOUS PROB)
	NO	20	7	9	8	7	3	1	4
	YES	9	0	0	2	2	2	2	1

FISHING QUALITY

STAY AT SITE		0(NO PROBLEM)	1	2	3	4	5	6	7(SERIOUS PROB)
	NO	13	8	5	9	6	9	7	2
	YES	2	0	2	1	5	0	1	7

TABLE 5: CROSSTAB OF PARTY SIZE VERSUS DECISION TO TAKE SHORTEST ROUTE TO SITE

PARTY SIZE

SHORT ROUTE CHOSEN		1	2	3	4	5	6	8	10	12	14	22
	YES	1	22	16	12	3	4	4	2	2	1	1
	NO	4	1	2	0	0	2	0	0	0	0	0

TABLE 6: CROSSTAB OF ALTERNATE ACTIVITY VERSUS:

(1) CHANGE MIND ABOUT LENGTH OF STAY AT SITE
(2) DECISION TO CHOOSE SHORTEST ROUTE TO SITE
(3) REGULAR WORKING DAY

(1) DECISION TO STAY AT SITE

		WORK	WORK O.T.	GARDEN	WORK/HOME	GOLF	READ	TV	OTHER REC.	RELAX	STUDY
STAY AT SITE	NO	11	5	25	6	1	0	1	3	6	1
	YES	3	0	4	2	0	1	0	3	4	1

(2) DECISION TO CHOOSE SHORTEST ROUTE TO SITE

		WORK	WORK O.T.	GARDEN	WORK/HOME	GOLF	READ	TV	OTHER REC.	RELAX	STUDY
SHORT ROUTE CHOSEN	NO	1	0	4	2	0	0	1	0	1	0
	YES	13	5	25	6	1	1	0	6	9	2

(3) REGULAR WORKING DAY

		WORK	WORK O.T.	GARDEN	WORK/HOME	GOLF	READ	TV	OTHER REC.	RELAX	STUDY
WORKING DAY	NO	4	5	26	4	1	1	1	2	9	2
	YES	10	0	3	4	0	0	0	4	1	0

TABLE 7: PROBIT ESTIMATE: PARTICIPATION IN FISHING

DEPENDENT VARIABLE: PARTICIAPTION IN FISHING
OBSERVATIONS: 348
LOG-LIKELIHOOD: -169.62

VARIABLE	COEFFICIENT	STD.ERR.	T-STAT	P-VALUE
CONSTANT	-.219050	0.169694	-1.293525	0.1958
EXPERIENCE	.033644	0.004894	6.939099	0.0000
INCOME (RESPONDENT)	.040358	0.026164	1.542499	0.1229

TABLE 8: OLS ESTIMATES OF TRAVEL COST DEMANDS

DEPENDENT VARIABLE: DAYS
FUNCTIONAL FORMS: L=LINEAR, SL=SEMI-LOG
TRAVEL TIME VALUE: 0=NO TRAVEL TIME VALUE, 1=WAGE RATE, 2=1/3WAGE RATE 3=ALTACT INDICATOR * WAGE RATE (SEE TEXT)

FORM	TIME VALUE	REGRESSION RESULTS				
L	0	Observations: 76		Degrees of freedom: 72		
		R-squared : 0.288		Rbar-squared : 0.258		
		Var	Coef	Std. Error	t-Stat	P-Value
		CONST	3.889430	1.225194	3.174543	0.002
		WQUAL	-0.663110	0.148722	-4.458710	0.000
		TCOST	-0.579369	0.135320	-4.281466	0.000
		MILLS	1.046139	0.673545	1.553184	0.125
L	1	R-squared : 0.223		Rbar-squared : 0.191		
		Var	Coef	Std. Error	t-Stat	P-Value
		CONST	3.668801	1.276232	2.874713	0.005
		WQUAL	-0.596580	0.153144	-3.895551	0.000
		TCOST	-0.048760	0.014807	-3.292985	0.002
		MILLS	0.934631	0.704332	1.326975	0.189
L	2	R-squared : 0.244		Rbar-squared : 0.213		
		Var	Coef	Std. Error	t-Stat	P-Value
		CONST	3.746997	1.260122	2.973520	0.004
		WQUAL	-0.622712	0.152170	-4.092222	0.000
		TCOST	-0.136772	0.037733	-3.624781	0.001
		MILLS	1.001125	0.696121	1.438148	0.155
L	3	R-squared : 0.159		Rbar-squared : 0.124		
		Var	Coef	Std. Error	t-Stat	P-Value
		CONST	3.343802	1.320884	2.531489	0.014
		WQUAL	-0.529314	0.157462	-3.361536	0.001
		TCOST	-0.058614	0.027414	-2.138057	0.036
		MILLS	0.858291	0.744107	1.153450	0.253

SL 0 R-squared : 0.402 Rbar-squared : 0.377

Var	Coef	Std. Error	t-Stat	P-Value
CONST	1.477544	0.289799	5.098516	0.000
WQUAL	-0.217757	0.035178	-6.190185	0.000
TCOST	-0.167722	0.032008	-5.240051	0.000
MILLS	0.050009	0.159316	0.313897	0.755

SL 1 R-squared : 0.336 Rbar-squared : 0.308

Var	Coef	Std. Error	t-Stat	P-Value
CONST	1.420256	0.304717	4.660907	0.000
WQUAL	-0.200868	0.036565	-5.493443	0.000
TCOST	-0.014798	0.003535	-4.185539	0.000
MILLS	0.025138	0.168168	0.149483	0.882

SL 2 R-squared : 0.361 Rbar-squared : 0.334

Var	Coef	Std. Error	t-Stat	P-Value
CONST	1.442399	0.299142	4.821791	0.000
WQUAL	-0.208232	0.036124	-5.764423	0.000
TCOST	-0.041112	0.008957	-4.589688	0.000
MILLS	0.043592	0.165253	0.263789	0.793

SL 3 R-squared : 0.252 Rbar-squared : 0.220

Var	Coef	Std. Error	t-Stat	P-Value
CONST	1.322740	0.321835	4.109996	0.000
WQUAL	-0.181237	0.038366	-4.723922	0.000
TCOST	-0.018237	0.006680	-2.730220	0.008
MILLS	0.005442	0.181303	0.030015	0.976

TABLE 9: CONSUMERS' SURPLUS ESTIMATES

FORM	TIME	CONSUMERS' SURPLUS
L	0	7.36
L	1	87.49
L	2	31.19
L	3	72.78
SL	0	5.96
SL	1	67.58
SL	2	24.32
SL	3	54.83

FUNCTIONAL FORMS: L=LINEAR, SL=SEMI-LOG
TRAVEL TIME VALUE: 0=NO TRAVEL TIME VALUE, 1=WAGE RATE,
2=1/3WAGE RATE 3=ALTACT INDICATOR * WAGE RATE (SEE TEXT)

TABLE 10: ESTIMATES OF HEDONIC REGRESSIONS WITH TRAVEL TIME

TIME VALUE

0

Observations:	76	Degrees of freedom:	73	
R-squared :	0.356	Rbar-squared :	0.338	

Var	Coef	Std. Error	t-Stat	P-Value
CONST	2.526791	0.276319	9.144468	0.000
CATCH	0.013794	0.005304	2.600597	0.011
WQUAL	-0.376026	0.075034	-5.011393	0.000

1

Observations:	76	Degrees of freedom:	73	
R-squared :	0.422	Rbar-squared :	0.406	

Var	Coef	Std. Error	t-Stat	P-Value
CONST	40.441911	7.728612	5.232752	0.000
CATCH	0.790699	0.148360	5.329611	0.000
WQUAL	-7.514631	2.098696	-3.580619	0.001

2

Observations:	76	Degrees of freedom:	73	
R-squared :	0.422	Rbar-squared :	0.406	

Var	Coef	Std. Error	t-Stat	P-Value
CONST	·13.480637	2.576204	5.232752	0.000
CATCH	0.263566	0.049453	5.329611	0.000
WQUAL	-2.504877	0.699565	-3.580619	0.001

3

Observations:	76	Degrees of freedom:	73	
R-squared :	0.523	Rbar-squared :	0.510	

Var	Coef	Std. Error	t-Stat	P-Value
CONST	10.855282	6.535641	1.660936	0.101
CATCH	1.014137	0.125459	8.083402	0.000
WQUAL	-3.170710	1.774746	-1.786571	0.078

TRAVEL TIME VALUE: 0=NO TRAVEL TIME VALUE, 1=WAGE RATE,
2=1/3WAGE RATE 3=ALTACT INDICATOR * WAGE RATE (SEE TEXT)

TABLE 11: RESULTS OF BOX-COX HEDONIC REGRESSIONS

BOX-COX PARAMETERS

OPTIMIZATION RESULTS

Date : 5/23/1987   Time : 20:26

*** Value of Objective Function: 274.516401 ***

Parameter Name	Parameter Value	Relative Gradient
X1	0.035719	0.000000
X2	0.556979	0.000000
X3	0.240098	0.000000

Computation Time: 4 minutes 36.16 seconds   Iterations: 10

REGRESSION PARAMETERS

Dependent Variable: EXPEN

Date : 5/23/1987   Time : 2:23

Observations:	74	Degrees of freedom:	79
R-squared :	0.465	Rbar-squared :	0.450
Residual SS :	121.673	Std error of est :	1.309
Total SS :	227.557	F(3 ,71)=30.8933	P-value=0.00

Durbin-Watson Statistic: 1.544

Var	Coef	Std. Error	t-Stat	P-Value
CONST	2.144168	0.270364	7.930671	0.000
FTIME	0.281536	0.048617	5.790893	0.000
CATCH	0.063529	0.052900	1.200927	0.234

TABLE 12: CORRELATION MATRIX: HEDONIC PRICE OF TIME, WAGE, ALTACT*WAGE

	HEDONIC	WAGE	ALTACT
HEDONIC PRICE	1.000000	0.101769	0.223823
WAGE	0.101769	1.000000	0.728293
ALTACT*WAGE	0.223823	0.728293	1.000000

1986 MINNESOTA RECREATION SURVEY

1. We would like to know whether you feel the following environmental problems are affecting lakes and rivers in Minnesota. Please circle one number on the scale from zero to seven (0 - 7) for each condition listed below.

	NO PROBLEM						SERIOUS PROBLEM	
Water surface crowding	0	1	2	3	4	5	6	7
Shoreland crowding	0	1	2	3	4	5	6	7
Declining water quality	0	1	2	3	4	5	6	7
Unsightly development	0	1	2	3	4	5	6	7
Excess algae, aquatic weeds	0	1	2	3	4	5	6	7
Acid Rain	0	1	2	3	4	5	6	7
Declining fishing quality	0	1	2	3	4	5	6	7

2. Do you own or have the use of any of the following items? Place a check in the YES column if you do or check NO if not. If you checked YES, please indicate if you use this item for fishing or during a fishing trip by placing a check in the USE FOR FISHING column.

	YES	NO	USE FOR FISHING
Cabin near a recreation site			
Motorhome			
Trailer			
Motor Boat			
Canoe			

3. Have you ever fished in Minnesota before? (please check yes or no) YES _____ NO _____

   If you answered YES, how many years have you been fishing in Minnesota? _____ years

4. Have you fished or do you intend to go fishing in Minnesota this year (1986)? (please check yes or no) YES _____ NO _____

5. Do you participate in any other water-based forms of recreation other than fishing (for example, swimming, camping)? Please place a check in front of front of the recreation activities you participate in.

   ______ swimming ______ boating ______ sailing
   ______ waterskiing ______ camping ______ canoeing
   ______ picnicing ______ birdwatching ______ other ________________

We would like to have some information about you and your family. Please answer questions 6 through 11 about yourself and questions 12 and 13 about your family.

6. Residence (please fill in nearest city or town) ______________________________

7. Age ______________

8. Sex M_____ F_____

9. How long have you lived in Minnesota? _________ years

(please turn over)

10. Please indicate where you spent the majority of your youth (check one):

_______ Rural area (population less than 1,000)
_______ Small town (population less than 25,000)
_______ Urban area (population greater than 25,000)

11. Please indicate the LAST grade of school you completed by checking the appropriate category below:

_______ Grade School or less (0-8)
_______ High School Graduate (12)
_______ College Graduate
_______ Some High School (9-11)
_______ Some College
_______ Postgraduate Work

12. For classification purposes, we would like to know the general category which best describes the income that you and your family earned in 1985. Please place a check on the appropriate line for yourself, your spouse and the rest of your family (if applicable).

YOU	SPOUSE	REST OF FAMILY		YOU	SPOUSE	REST OF FAMILY	
___	___	___	under $5,000	___	___	___	$5,000-$9,999
___	___	___	$10,000-$14,999	___	___	___	$15,000-$19,999
___	___	___	$20,000-$24,999	___	___	___	$25,000-$29,999
___	___	___	$30,000-$34,999	___	___	___	$35,000-$39,999
___	___	___	$40,000-$44,999	___	___	___	$45,000-$49,999
___	___	___	$50,000-$99,999	___	___	___	$100,000 or more

13. We would like to have some information about your immediate family and their participation in recreational fishing. Please fill in the following table with this information: place age in the first column, indicate sex with an M or F in the second column, and write YES or NO in the third column if the individual participates in fishing or not. (If you are single or have no children, please leave the appropriate spaces blank in the table below. If you have more than 5 children, please fill in the information in the space at the bottom of this page.)

	AGE	SEX	PARTICIPATE IN FISHING (Yes or No)
Spouse			
Child #1			
Child #2			
Child #3			
Child #4			
Child #5			

14. Please share with us your opinion about water-based recreation and the most serious issues you feel affect Minnesota's recreation resources today.

Thank you for participating in our survey and sharing your concerns about Minnesota's environment with us. Please return this survey in the envelope provided.

1986 MINNESOTA FISHING SURVEY
FISHING TRIP SURVEY

PLEASE ANSWER THE FOLLOWING QUESTIONS FOR THE LAST FOUR FISHING TRIPS YOU TOOK THIS SEASON.

TRIP #1

1. Date of Trip: DATE LEFT____________________ DATE RETURNED____________________ 2. Miles to the site __________
3. Did you choose the shortest route to the site? _____ YES _____ NO

4. Fishing Site (name of lake or nearest landmark):____

5. How long did it take you to travel to the site? __________________ HOURS
6. How much did you spend on each of the following:

Travel costs (gas, oil, etc.) $__________ Food costs $__________ Lodging Costs $__________
Equipment costs $__________ Other costs $__________

7. Time spent at the site: HOURS SPENT AT THE SITE __________ hours
HOURS SPENT FISHING __________ hours

8. How many people were in your fishing party ? __________ PERSONS Was your spouse in the fishing party? _____ YES _____ NO
How many of your children were in the fishing party ? __________ CHILDREN

9. Please write the names of the fish species you sought and the number you caught below.

	Fish Species Sought	Number Caught		Fish Species Sought	Number Caught
1.	___________________	_____________	2.	___________________	_____________
3.	___________________	_____________	4.	___________________	_____________

10. Please circle a number indicating how serious you feel each of the following conditions is at this fishing site.

	NO PROBLEM ... SERIOUS PROBLEM
Crowding	0....1....2....3....4....5....6....7
Declining fishing quality	0....1....2....3....4....5....6....7
Overall water quality	0....1....2....3....4....5....6....7

11. Did you change your mind about how much time to spend at this site after reaching it? _____ YES _____ NO
12. If you had not taken this trip what would you have been doing instead?
(eg. working overtime, working at another job, gardening, reading) ________________________

13. Was this trip taken on one of your regular working days? _____YES _____ NO.

TRIP #2

1. Date of Trip: DATE LEFT____________________ DATE RETURNED____________________ 2. Miles to the site __________
3. Did you choose the shortest route to the site? _____ YES _____ NO

4. Fishing Site (name of lake or nearest landmark):____

5. How long did it take you to travel to the site? __________________ HOURS
6. How much did you spend on each of the following:

Travel costs (gas, oil, etc.) $__________ Food costs $__________ Lodging Costs $__________
Equipment costs $__________ Other costs $__________

7. Time spent at the site: HOURS SPENT AT THE SITE __________ hours
HOURS SPENT FISHING __________ hours

8. How many people were in your fishing party ? __________ PERSONS Was your spouse in the fishing party? _____ YES _____ NO
How many of your children were in the fishing party ? __________ CHILDREN

9. Please write the names of the fish species you sought and the number you caught below.

	Fish Species Sought	Number Caught		Fish Species Sought	Number Caught
1.	___________________	_____________	2.	___________________	_____________
3.	___________________	_____________	4.	___________________	_____________

10. Please circle a number indicating how serious you feel each of the following conditions is at this fishing site.

	NO PROBLEM ... SERIOUS PROBLEM
Crowding	0....1....2....3....4....5....6....7
Declining fishing quality	0....1....2....3....4....5....6....7
Overall water quality	0....1....2....3....4....5....6....7

11. Did you change your mind about how much time to spend at this site after reaching it? _____ YES _____ NO
12. If you had not taken this trip what would you have been doing instead?
(eg. working overtime, working at another job, gardening, reading) ________________________

13. Was this trip taken on one of your regular working days? _____YES _____ NO.
