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The Economic Value of Derby Fishing: An Application of Travel-Cost Methodology in Lake Superior

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Introduction

This study is part of a larger effort to assess the total recreational benefits derived from the western tip of Lake Superior. A large component of these benefits are those derived from recreational fishing. Several valuation methodologies are being considered to assess these benefits including the commonly-used travel-cost and contingent-valuation approaches. Before sampling the entire user population, it was considered desirable to test several of these methodologies on a smaller but more easily identified and surveyed group. Thus, information from a survey dealing with the fishing behavior of entrants in a fishing derby held on the lake was utilized. Although contingent valuation questions were included in this survey, the discussion here will be limited to the application of the travel-cost methodology.

The travel-cost approach uses information on the time and monetary expenses incurred by visitors to a recreational site (or by participants in a site-specific event) in traveling to and from the site in order to estimate a demand curve for visitation or participation. This demand curve is then used to calculate the total benefit (actual amount paid plus consumer surplus) enjoyed by the visitors or participants. Unlike several other travel-cost applications, this study uses respondent-reported expenditures and time costs to determine a travel-cost measure as opposed to using a priori determined per-mile cost figures.

Background

In the summer of 1987, the Lake Superior Steelhead Association sponsored its 12th annual Lake Superior Trout and Salmon Derby. The derby was run over nine days (June 20-28). Those registering paid an entry fee of \$10. Cash prizes were awarded to those catching the largest trout and salmon (by weight). The registration forms for the derby were used to mail out surveys to all 691 of the entrants. Of these, 450 were returned for a response rate of 65 percent. However, only 388 of these were complete enough to be used indicating perhaps some difficulty

understanding the survey questions or impatience with the survey's length.

Theoretical Framework

Despite some limitations (see Bishop and Heberlein [1] and Fisher [8]), the travel-cost methodology is perhaps the most widely accepted valuation methodology used by resource economists to value environmental resources and activities related to them (Burt and Brewer [2], Cicchetti, Fisher, and Smith [5], Freeman [9], and Krutilla and Knetsch [11]). It is most often associated with Clawson and Knetsch [6], although some of the basic elements of the procedure appear in a suggestion made by Harold Hotelling in 1947 in an unpublished letter to the U.S. National Park Service. It has been applied specifically to evaluate fisheries and recreational fishing by Ellefson [7], Pearce [14], and Smith and Kavanagh [16], Steinnes and Raab [15], and Hansen [10].

The basic assumption of this approach is that the cost in money and time spent travelling to a particular site or participating in a site-specific event is a reflection of individuals' additional willingness to pay above the established entry or admission fee. In addition, it is assumed that participants will react to changes in these travel costs in the same manner that they would to changes in the entry or admission fees. Thus, if a relationship between visitations (or participation) and travel cost can be determined, it can then be used to estimate the demand for visitations to the site or participation in the event. Freeman [9] provides a simple summary of the basic steps and assumptions of this methodology.

Typically "zones" of comparable travel cost are established and the participation rate from the zones is determined as a function of such factors as the entry or admission fee, travel expenditures, time spent in travel, and socioeconomic variables such as income, median educational attainment, age and the like:

$$PR(i) = f\{A(i), E(i), T(i), Y(i), S(i)\} \quad (1)$$

where:

$PR(i)$ = participation rate from zone i (expressed here as participation days per 10,000 population)

$A(i)$ = admission or entry fee

$E(i)$ = travel expenditures between zone i and the site

$T(i)$ = round-trip travel time from zone i to the site

$Y(i)$ = average income of participants from zone i
 $S(i)$ = other socioeconomic variables related to zone i
 i = zones around the site.

When it is assumed that participants react to changes in their travel costs as they do to changes in admission or entry fees and when time spent traveling is converted into a monetary value (as it must be to insure results are not biased, see Cesario and Knetsch [3]), the first three dependent variables may be collapsed into a single travel-cost variable, $TC(i)$. The exact formulation of this variable will be described in detail below. Thus, (1) becomes:

$$PR(i) = f\{TC(i), Y(i), S(i)\} \quad (2)$$

Once the above relationship has been estimated, it can then be used to estimate the demand for participation by varying $TC(i)$ and noting the total change in participation across all zones.

The Specifics

The initial step was to identify travel zones with internally similar travel-cost characteristics and with reasonably obtainable population statistics. Using reported travel time information as a guide, ten zones were determined as depicted on the map in Figure 1. Generally, zone boundaries were chosen to follow city and county boundaries so that population figures from the 1980 Census could be used. These figures are shown in column 1 of Table 1. Constraints on sample size and population information prohibited a finer division of zones.

A participation day is defined as any day of the nine derby days the respondent spent at least some time fishing in Lake Superior. Of the 388 surveys considered, 34 respondents indicated that although they had entered the derby, they did not actually participate. The remaining 354 respondents generated 1147 participation days. The distribution of these days by the zone of residence of the respondent is shown in column 2 of Table 1. To estimate the total number of participation days in the derby, these sample figures were scaled up as noted in Table 1. Finally, Table 1 presents the participation rate by zone expressed in total participation days per 10,000 population.

The next task was to develop an appropriate travel-cost measure for each zone. For each respondent a travel-cost per participation day was defined as:

$$\text{TCPD} = \{\text{TVC} + \text{TLC} + \text{RTT}(\text{NT})(\text{W}^*)\} / \text{NDAYS} \quad (3)$$

where:

TCPD = total travel cost per participation day

TVC = total reported vehicle expenses

TLC = total reported lodging expenses

RTT = round-trip travel time from residence to Lake Superior

W* = per hour value of travel time

NT = total number of trips from residence to Lake Superior

NDAYS = total number of reported participation days

Several points are noteworthy about this definition. The numerator attempts to capture all travel costs (monetary and time) associated with the respondent's participation in the entire derby. This figure is divided by the number of days the respondent actually participated to yield an average travel cost per participation day.

The expenditures or monetary costs consist of two types: vehicle and lodging expenses. The travel-cost methodology considers all costs which must be expended by the participant due to the fact that the activity does not take place at his or her residence (or conversely, all the costs that are saved by those living at or very near the site at which the activity is taking place). Thus, while the above expenses should be considered, other expenses reported by the respondents concerning food, fishing equipment, boat fuel, licenses, etc. would not be relevant and so were not included.

To determine a monetary value for the time cost of travel requires first a determination of the total time spent travelling to and from the site (Lake Superior) and some measure of the value of a unit (hour) of travel time. For respondents who reported that they had stayed at their own residence while participating in the derby, the total round-trip travel time from their residence to the site was multiplied by the number of days they participated ($\text{NT} = \text{NDAYS}$). For all others it was assumed that only one trip between their residence and the site occurred so that the total round-trip travel time from their residence to the site was multiplied by one ($\text{NT} = 1$). These respondents were assumed to be lodging at or very near the site (either at a motel or campground or with friends).

The value of an hour of travel time, W*, is based largely on the theoretical work summarized by Wilman [18] and the empirical findings of Cesario [3]. Upon reviewing several empirical studies in an effort to

determine a reasonable shadow price for the value of recreational travel time, Cesario concludes that the evidence suggests it lies somewhere between one-fourth and one-half of the wage rate. Estimates by Nelson [13] fall in the same range while McConnell and Strand [12] report a method which yields a higher proportion (around .61 for sportfishing). For conservative estimates the lower bound of .25 was utilized. Thus, for each respondent W^* was determined by taking his or her annual reported income, dividing it by 2,000 (the approximate number of work hours per year: fifty 40-hour weeks) to obtain an hourly wage rate, and then dividing by 4 to obtain W^* .

The travel-cost per participation day figures for all individuals in a particular zone were then summed and averaged to obtain the zone estimates shown in the last column of Table 2. Because the distribution of these costs tended to be skewed so that neither the mean or median figures provided very representative information, the average of the two was used as a measure of the central tendency of these costs. The remaining figures in Table 2 show illustrative averages by zone for the other variables described above.

Using participation rate as the dependent variable and travel-cost per participation day, average zone income, and mean zone age as independent variables, regression estimates of equation (2) were made. The income and age variables were not significant in any of these estimates as would be expected from their lack of significant variation across zones. Linear, quadratic, and exponential specifications of the relationship between the remaining variable, TCPD, and participation rate were assessed. A "weighted" (i.e., each zone observation weighted by the number of individual observations upon which it was based) exponential relationship provided the most reasonable "fit" in that the percentage of the variation in PR explained by TCPD was greater than in the linear case (.668 versus .514) while the quadratic specification yielded unusable negative values for PR for a relevant range of TCPD values. The estimated relationship was thus:

$$\text{LOG}(\text{PR}) = 2.70454 - .065337(\text{TCPD}) \quad (4)$$

where all coefficients are significant beyond the 99 percent level.

Equation (4) was used to determine the expected change in participation rate resulting from changes in travel cost for each zone. This change in turn was multiplied by the population of the zone to yield the total change in participation days generated from that zone. Adding

these together yielded the total change in participation days resulting from a change in travel costs. Table 3 presents the results of increasing travel costs in \$3 increments.

Since participants are assumed to react to increases in the admission or entry fee as they would to increases in travel cost, the participation figures of Table 3 may be used to derive the demand curve for derby participation. This demand is shown in Figure 2. Calculation of the total benefits (the sum of what actually was paid and consumer surplus) is straight-forward. The estimated 2,043 participation days were purchased for \$6,304.50 (\$10 entry fee times an estimated 630.45 active participants). The consumer surplus (the area under the demand curve but above the amount actually paid) meanwhile amounts to \$14,173.50 for a total benefit of \$20,478. Given 2,043 participation days this implies an average per day value of \$10.02.

Concluding Remarks

The principal advantages of the travel-cost methodology are that it is based on observed behaviors (expenditures incurred, time taken, visits or participation days enjoyed) as opposed to hypothetical questions and that, given the validity of the assumptions made, this information can readily be used to generate demand and total benefit estimates. However, it should be noted that there is some evidence that people cannot or do not report their actual behavior very well (see Bishop and Heberlein [1, p. 928], for some examples). To the extent that respondents were not completely aware of their actual expenditures, the results of this study would of course be biased. One may also raise a question on the validity of the assumption that recreationists view changes in their travel costs as equivalent to changes in admission or entry fees. To the authors' knowledge, this assumption has not yet been empirically tested.

With respect to other qualifications and limitations in the use of the travel-cost approach, the particular application here fares quite well. In particular, biases are to be expected when there are differences in the availability of substitutes across zones, if "higher prices" alter the quality of the "good" by reducing congestion or if the trip to the site had multiple purposes (see Bishop and Heberlein [1]).

For derby fishing on Lake Superior these biases would appear to be small. Congestion is not a factor given the size of the lake and the number of "good" fishing spots. In addition, 83 percent of those

participating reported that their participation in the derby was not part of a vacation trip indicating that the derby was the principal or sole reason for their trip(s) to Lake Superior. Finally, there does not appear to be any reason to expect the availability of substitutes to differ across zones even with different definitions of exactly what the "good" is. If defined generally as "derby fishing," many opportunities exist across the entire upper Midwest in all zones. If defined narrowly as "derby fishing on Lake Superior," few if any substitutes exist in any of the zones (only two other major derbies are held on the western end of Lake Superior but neither of these is held at the same time).

Endnote

*This paper was presented at the Mid-Continent Regional Science Association meeting, St. Louis, Missouri, June 2-4, 1988. The authors are assistant professor of economics, MBA student, professor of economics, and associate professor of sociology respectively at the University of Minnesota-Duluth.

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Table 1
Participation Rate by Zone

Zone	Zone Population	Participation Days (Sample)	Participation Days (Total)*	Participation Rate**
1	102,750	539	960	93.431
2	17,135	142	253	147.651
3	30,404	60	107	35.193
4	31,936	63	112	35.070
5	27,839	57	102	36.639
6	117,479	85	151	12.853
7	150,375	25	45	2.993
8	871,600	23	41	0.470
9	1,985,873	132	235	1.183
10	(7,000,000)	<u>21</u>	<u>37</u>	0.053
	TOTALS	1,147	2,043	

*Of a sample of 388 respondents, 34 indicated no days of participation. Given that 691 individuals actually registered for the derby, this suggests that 630.45 would be expected to have actually participated. Thus, the figures in this column were calculated by scaling those of the sample up by a factor of 1.781 (i.e., 630.45/354).

**Number of participation days per 10,000 population.

Table 2
Travel Cost Statistics by Zone

Zone	Number of Days	Income	Travel Time*	Total Vehicle Costs	Total Lodging Costs	Travel Cost Per Day**
1	3.000#	35,000	1.000	10.00	0.00	8.906
	3.164	34,823	1.252	16.80	2.64	(13.157)
	3.327	34,645	1.504	23.60	5.28	17.407
2	4.000	35,000	0.600	0.00	0.00	4.750
	4.029	34,536	0.909	4.22	3.43	(6.505)
	4.057	34,071	1.217	8.43	6.86	8.259
3	3.000	45,000	0.600	5.00	0.00	5.625
	3.265	40,515	0.700	8.24	15.59	(11.297)
	3.529	36,029	0.800	11.47	31.18	16.969
4	2.000	35,000	2.000	20.00	0.00	15.250
	2.500	36,131	2.929	24.12	9.71	(25.549)
	3.000	37,262	3.857	28.24	19.43	35.847
5	3.500	27,500	2.000	20.00	2.50	19.167
	3.532	29,063	1.950	26.31	7.81	(20.107)
	3.563	30,625	1.900	32.63	13.13	21.046
6	3.000	35,000	3.000	20.00	20.00	17.813
	3.074	33,750	2.897	20.45	18.82	(17.974)
	3.148	32,500	2.793	20.89	17.63	18.134
7	3.000	35,000	3.000	30.00	0.00	16.875
	2.889	34,445	2.866	34.11	5.00	(22.754)
	2.778	33,889	2.733	38.22	10.00	28.633
8	2.000	35,000	7.000	40.00	14.00	46.250
	2.046	37,387	7.209	37.27	14.00	(46.851)
	2.091	39,773	7.418	34.55	14.00	47.451
9	2.000	45,000	7.000	26.00	2.50	37.453
	2.320	46,000	6.572	27.03	14.99	(42.722)
	2.640	47,000	6.144	28.06	27.48	47.990
10	4.000	45,000	11.500	45.00	30.00	48.891
	3.750	45,417	12.084	47.50	32.00	(46.893)
	3.500	45,833	12.667	50.00	34.00	44.894

Table 2 (continued)

*Round-trip travel time from residence to Lake Superior.

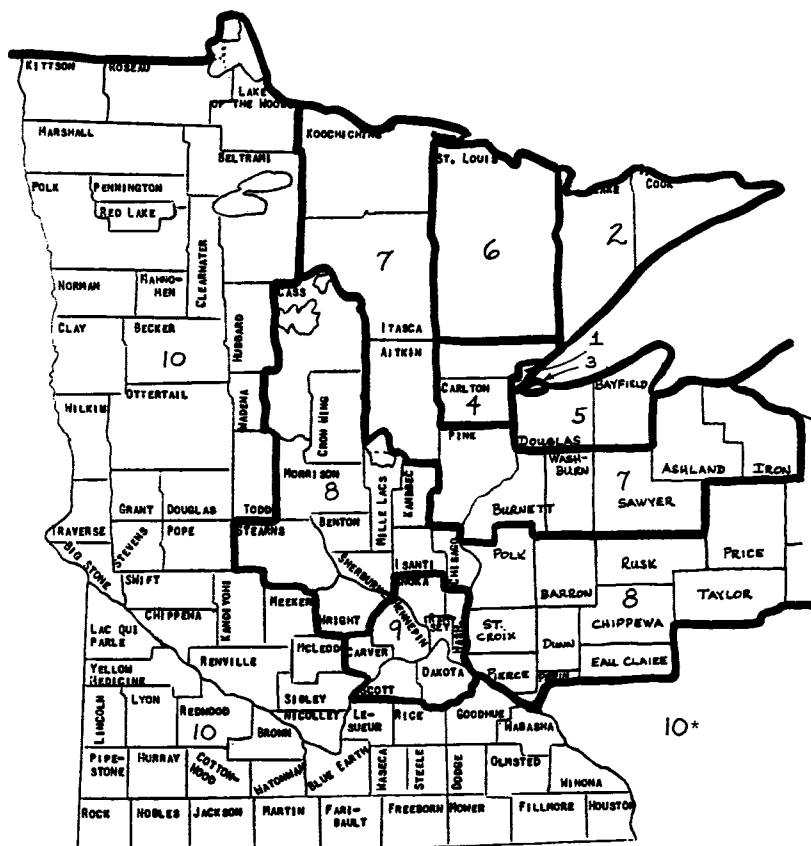
**Zone average of the individual values calculated from equation (3).

#Upper figure in each cell is the median, lower is the mean, and middle figure is the average of these two. Sample observations (number of respondents) for each zone are 162, 35, 17, 21, 16, 27, 9, 11, 50, and 6, respectively.

Table 3
Number of Participation Days
with Various Additions to Travel Cost

Added Travel Cost Per Day	1	2	3	4	5	6	7	8	9	10	Total Participation Day
+3	457.8	207.7	179.2	22.1	43.6	253.6	158.1	--	103.6	--	1,42
+6	291.5	132.3	114.1	14.0	27.	161.5	100.7	--	--	--	842
+9	185.6	84.2	72.7	8.9	17.7	102.8	64.1	--	--	--	356
+12	118.2	53.6	46.3	5.7	11.3	65.5	40.8	--	--	--	341
+15	75.3	34.2	29.5	3.6	7.2	41.7	26.0	--	--	--	218
+18	47.9	21.7	18.8	2.3	4.6	26.6	16.6	--	--	--	139
+21	30.5	13.9	12.0	1.5	2.9	16.9	10.5	--	--	--	88
+24	19.4	8.8	7.6	--	1.9	10.8	6.7	--	--	--	55
+27	12.4	5.6	4.8	--	--	6.9	--	--	--	--	30
+30	7.9	3.6	3.1	--	--	--	--	--	--	--	15
+33	5.0	2.3	2.0	--	--	--	--	--	--	--	9
+36	--	1.4	-1.3	--	--	--	--	--	--	--	3
+39	--	0.9	--	--	--	--	--	--	--	--	1

Figure 1



*Zone 10 includes the rest of the Upper Midwest (the easterly portions of North and South Dakota, Iowa, Northern Wisconsin, and the westerly portions of the Upper Peninsula of Michigan).

Figure 2
Demand for Participation Days in the Lake Superior
Trout and Salmon Derby

