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# The Value of Sport Fishing in the Snake River Basin of Central Idaho

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**Abstract**

The value of sportfishing in the Snake River Basin in Central Idaho was measured using a two-stage/disequilibrium travel model. The two-stage/disequilibrium model does not require monetization of recreationists' travel time as required of traditional equilibrium labor market travel cost models. The model was estimated using Poisson regression, appropriate for count data when over-dispersion is absent, and adjusted for endogenous stratification (self selection bias) . Contrary to expectations that anglers living close to the sites with low values would be over represented in the sample, the endogenous stratification adjustment caused estimated consumers surplus to decline from $42 per person per trip before adjustment for endogenous stratification to $35 after adjustment. The average number of sportfishing trips per year was 6.72, resulting in an average annual willingness-to-pay of $236 per year per angler.

# The Value of Sport Fishing in the Snake River Basin of Central Idaho

The Snake River Basin is one the premier sport fisheries in the US. The region includes the main tributaries of Snake River – the Clearwater, Salmon, and Lochsa. Within this region a variety of species are sought by sport fishermen. They include warm water species such as bass, several trout species, and anadromous steelhead trout and salmon. Valuing this fishery is an important consideration in breaching the three Snake river dams as well as other management programs to enhance the sport fisheries of Central Idaho.

The travel cost method has been preferred to estimate a demand function for recreation sites because it relies on observed actual behavior of recreationists in traveling to a recreation site (Ward and Beal). A two-stage/disequilibrium model is used in this study in place of the traditional travel cost model. The model discards the assumption of competitive labor markets. It is assumed that anglers either preallocate their time among work, leisure and consumption prior to deciding among consumer goods (Shaw and Feather 1999); or work hours are fixed by employers (Bockstael et al. 1987); or they are not in the labor force. Any of these conditions imply that wage rates do not measure the value of time. Recreationists are assumed to maximize utility subject to separate constraints for time and income which results in separate pecuniary and physical time prices for a trip. Thus, the model does not require monetization of the recreationists' travel time.

## Methods

Two stage/disequilibrium demand has been applied when either the consumer (Larson 1993 a b, Shaw and Feather 1999) or the employer (Bockstael et al. 1987) sets work time versus leisure time in stage one of the allocation process. The work leisure tradeoff has been termed a long run decision

(Larson 1993b) while the second stage recreation choices are "conditioned on longer-run labor choices" (Bockstael et al. 1987).

The two stage/disequilibrium demand models consumers who desire or are forced to avoid considering the labor leisure tradeoff when allocating their time and income among goods in stage two. Persons who actually could substitute time for money income at the margin are a small part of the population. The labor market equilibrium model applies to a very small part of the population. It would be inconsistent to include work time as a consumer choice variable in stage two if consumers decide to preallocate time for work and leisure or are forced to do so by their employers. Thus, preallocation of labor time versus leisure time that determines the nature of their recreation demand curve specification.

Model Derivation

Assume that consumers combine time and goods in fixed proportions, for example, $Q_s$ is a site visit requiring $t_s$ units of time per trip. In the first stage, consumers maximize utility (U) subject to time and income constraints:[1]

$$U = u(Q, L) + \Phi_1(T - H_f - H_v - tQ - L) + \Phi_2(w_f H_f + w_v H_v + E - PQ) \qquad (1)$$

[1]First order conditions with respect to L, $H_v$ , $\Phi_1$ and a bundle of goods $Q_k$ having a composite price $P_k$ are:

$$\begin{aligned} \partial U/\partial Q_k &= 0 = \partial u/\partial Q_k - \Phi_1 t_k - \Phi_2 P_k \\ \partial U/\partial L &= 0 = \partial u/\partial L - \Phi_1 \\ \partial U/\partial H_v &= 0 = -\Phi_1 + \Phi_2 w_v \\ \partial U/\partial \Phi_1 &= 0 = T - H_f - H_v - L. \end{aligned}$$

The first constraint is time: $T = H_f + H_v + tQ + L$; where L is pure leisure time and work hours (H) are separated into fixed work hours ($H_f$) and variable work hours ($H_v$) with corresponding wages $w_f$ and $w_v$. The second constraint is the budget: $w_fH_f + w_vH_v + E = PQ$; where E is unearned income and PQ is total purchases and saving. Assume flexible work hours (i.e. $H_v>0$), so that an interior (equilibrium) solution holds in stage one. For the $j^{th}$ consumer, the combination of the first three optimization conditions yields the optimal amount of pure leisure versus a bundle of goods:

$$\frac{\partial u_j/\partial L}{\partial u_j/\partial Q_k} = \frac{w_{vj}}{(P_k + t_k w_{vj})} \qquad \textbf{(2)}$$

The optimal value for work hours, $H_v$, is determined in ($\partial Z/\partial \Phi_1 = 0$) using the optimal value of L.

The second stage consumer choice variables are restricted by the consumer or the employer to goods, $Q_1$ ... Qn:

$$U = u(Q, L^*) + \theta_1(T - H_f - H_v^* - tQ - L^*) + \theta_2(w_fH_f + w_vH_v^* + E - PQ) \qquad \textbf{(3)}$$

When work time and pure leisure is preallocated (determined in the first stage) at the level $H_v$* and L* , the second stage reduces to[2]:

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[2]First order conditions are:

$$\partial Z/\partial Q_i = 0 = \partial U/\partial Q_i - \theta_1 t_i - \theta_2 P_i$$
$$or\ \partial U/\partial Q_i = \theta_1 t_i + \theta_2 P_i \quad for\ goods\ Q_1 ... Q_n.$$

and marginal rate of substitution for any two goods are:

$$\frac{\partial U/\partial Q_1}{\partial U/\partial Q_2} = \frac{(\theta_1 t_1 + \theta_2 P_1)}{(\theta_1 t_2 + \theta_2 P_2)}$$

$$Z = U(Q, L^*) + \theta_1 (T^* - tQ) + \theta_2 (E^* - PQ) \qquad \textbf{(4)}$$

where T* includes all the fixed time components $T^* = T - H_f - H_v^* - L^*$ and E* includes all the fixed income components $E^* = w_f H_f + w_v H_v^* + E$. And both unearned and earned income are fixed in stage two. Thus, wage rate is no longer a relevant measure of the opportunity cost of time because work time and leisure time are fixed and there can be no substitution of time between consumption and work in stage two. Thus, price of time consuming goods derived in stage one ($P_k + t_k w_{vj}$) is inoperable in stage two. Physical time prices and money prices are separate entities in stage two. Time and goods can be substitutes but not goods and work or leisure time. A solution for the marginal rate of substitution in terms of the prices is not possible in stage two. The conditional demand function will contain T*, E*, P and t with no derived (full price) relationship between w, t and P. The wage rate is totally excluded from stage two demand because work and leisure hours were preallocated in stage one. The conditional travel cost demand function is the basis for empirical estimation:

$$Q_s = f(P, t, T^*, E^*) \qquad \textbf{(8)}$$

where $Q_s$ is fishing recreation trips to the Snake River Basin, P is a vector of prices for the trip and for closely related goods, t is a vector of time required for consuming the fishing recreation trips and closely related goods, T* is the total time available for combining with time-consuming goods, and E* is total household income.

Definitions for Travel Cost Demand Variables

The definitions for the variables in the disequilibrium travel cost models are shown in Table 1. The dependent variable ($Q_s$), annual reported trips from home to the fishing site. The two stage/disequilibrium model, based on the work of Bockstael et al. (1987) and Shaw and Feather

(1999), avoids the unresolved task of monetizing the value of time used in consuming goods. Traditional travel cost models generally use a “full” price as was derived in stage one above. However, most practitioners adjust the wage rate downward to account for travel time that would not have used for work or lower wages earned when moonlighting. Disagreements exist on the "correct" income proportion and wide variations in opportunity time cost have resulted. McConnell and Strand (1981, 1983) devised an empirical method to estimate time value given an interior solution in the labor market. When the technique was tested by Smith et al. (1983), estimated time value ranged from -9 to 80 times the wage rate. Thus,"... the cost of travel time remains an empirical mystery" (Randall, 1994).

Results from previous studies and this study on the Snake River Basin in Central Idaho suggest using a model specifically designed to help overcome disagreements and criticisms of the opportunity time value component of travel cost. We use a model (equation 8) that eliminates the difficult-to-measure marginal value of income from the time cost value. Instead of attempting to estimate a "money value of time" for each individual in the sample we simply enter the actual time required for travel to the fishing site as first suggested by Brown and Nawas (1973), and Gum and Martin (1975) and applied by Ward (1989), Bockstael et al. (1987) and McKean et al. (1995, 1996). Ward and Beal (2000) conclude, “In our view the most theoretically complete treatment of the travel time value problem is the work of Bockstael, et al. (1987).” Their model includes the possibility for a small part of the sample that is in an interior labor market situation to utilize the traditional wage rate time valuation. However, the two stage budgeting assumption (Shaw and Feather 1999) implies that all recreationists are at a corner labor market solution and McConnell (1999) provides yet another rationale for a disequilibrium labor market.

Ward (1983,1984) proposed that the "correct" measure of price in the travel cost model is the minimum expenditure required to travel from home to site and return because any excess of that amount is purchase of other goods and not a relevant part of the price of a trip. This own-price definition suggests other (excess) spending during the trip is associated with closely related goods whose prices are likely to be important in the demand specification. For example, time-on-site can be an important good and is often ignored in Travel Cost Model (TCM) specification. Yet time-on-site must be a closely related good because the weak complementarity principle upon which measurement of benefits from the TCM is founded implies time-on-site is essential. Weak complementarity was the term used to connect enjoyment of a site to the travel cost to reach it (Maler, 1974). It is assumed travel cost must be paid in order to enjoy time spent at the site. Without traveling to the site, the site has no recreation value to the consumer and without the ability to spend time at the site the consumer has no reason to pay for the travel. Thus the cost of travel from home to site can be used as the price associated with a particular site.

The sign of the coefficient relating trips demanded to particular time "expenditures" associated with the trip is an empirical question. For example, time-on-site or time used for other activities on the trip have prices which include both the opportunity time cost of the individual and a charge against the fixed discretionary time budget. Spending more time-on-site could increase the value of the trip leading to increased trips, but time-on-site could also be substituted for trips. Spending during a trip for goods, both on and off the site, consist of closely related goods which are expected to be complements for trips to the site. Finally, spending for extra travel, either for its own sake, or to visit other sites, can be a substitute or a complement to the site consumption. Many recreational trips combine sightseeing and the use of various capital and service items with both travel and the site visit, and include side trips (Walsh et al. 1990). Recreation trips are seldom single-purpose and travel is sometimes pleasurable and sometimes not. The effect of these "other activities" on the trip-travel cost relationship can be statistically adjusted for through the inclusion of the relevant prices paid during travel or onsite and for side trips.–

Furthermore, both trips and onsite recreation are required to exist simultaneously to generate satisfaction or the weak complementarity conditions would be violated. A relation between trips and site experiences is indicated such that marginal satisfaction of a trip depends on the corresponding site experiences. Therefore, the demand relationship should contain site quality variables, time-on-site, and goods used on-site, and other site conditions. Exclusion of these variables would violate the specification required for the weak complementarity condition which allows use of the TCM to measure benefits.

## Data

An expanded TCM survey was designed to include money and time costs of on-site time, on-site purchases, and the money and time cost of other activities on the trip. These vacation-enhancing closely related goods prices are included in the expanded survey.

The mail surveys were distributed using names and addresses collected on-site from anglers by university students in Central Idaho or reported by fishing guides in the Snake River Basin. The principal areas Idaho where respondents were contacted were near the towns of Salmon, Riggins, and Orofino. These towns were the focus of sportfishing on the upper Salmon River, main fork of the Salmon River and the Little Salmon River, and the Clearwater and Lochsa rivers, respectively.

Anglers were contacted at fishing sites from April through November 1998. Most persons contacted on-site agreed to receiving a mail questionnaire and provided their name and mailing address. Persons on guided trips were not directly accessible and thus the guides mailed or handed out surveys to their clients. The survey yielded 270 usable responses. The questionnaire used for the demand survey is similar to the sportfishing questionnaire used on the lower Snake River reservoirs and on the unimpounded Snake River above Lewiston (Normandeau Associates et al. 1998). Because of the varied ways in which survey forms were distributed for this study it was not possible to calculate response rates.

The average angler in the full sample took 6.72 trips. The full sample of 366 anglers listed rainbow trout (70%), other fish (48%), steelhead (38%), smallmouth bass (16%), white sturgeon (5%) and bull trout (4%) among the species caught[3].

**RESULTS**

The estimated regression coefficients and elasticities from the truncated Poisson regression without adjustment for endogenous stratification are reported in Table 2. The estimated regression coefficients from the Poisson regression adjusted for endogenous stratification (self selection bias) are reported in Table 3. The endogenous stratification adjustment subtracts one from the dependent variable (trips) and replaces the truncated Poisson regression with non-truncated Poisson regression (Englin and Shonkwiler 1995; Shaw 1988).

The t-ratios for all important variables to estimate the value of sportfishing are statistically significant from zero at the 5 percent level of significance or better. The tests for overdispersion (Cameron and Trivedi, 1990; Greene, 1992) for the Poisson regression were negative. Truncated negative binomial regression was also tested. The estimated coefficients for truncated Poisson and negative binomial regression are identical in all cases except on income.

The money price variable in the two stage/disequilibrium model is $P_s$, which is the out-of-pocket travel cost to the sportfishing site. Reported one-way travel distance for each party was

[3]The percentages sum to more than 100% because some anglers caught several species.

multiplied times two and times $0.076 to obtain money cost of travel per person per trip. Cost per mile was based on average cost collected from the much larger lower Snake River reservoirs angler survey (Normandeau Associates et al. 1998). Angler-perceived cost was used rather than costs constructed from Department of Transportation or American Automobile Association data. Anglers' perceived price is the relevant variable when they decide how many sportfishing trips to take. The physical time price for each individual is measured by $t_s$ which is round trip driving time in hours. Average round trip driving time was about 15 hours with an average round trip distance of 369 miles (average speed was less than 25 miles per hour).

The demand model specifies inclusion of $t_a$, round trip driving time from home to an alternate sportfishing site, as the physical time price of an alternate sportfishing site. This variable was not significant. Another alternate site price variable is $P_a$, which is the out-of-pocket travel costs to the most preferred alternate sportfishing site from the anglers home. This substitute price variable also was not significant. A price variable, $P_{md}$, measuring money travel cost for the second leg of the trip for anglers visiting a second fishing site was tested. This variable would indicate if the number of trips to the fishing site was influenced by the cost of going from the first river fishing site to the second site for those with multi-destination trips. This variable was not significant. The variable to measure time available for consuming fishing recreation and other closely related goods is T*. The discretionary time constraint variable is required for persons in a disequilibrium labor market who cannot substitute time for income at the margin. Restrictions on free time are likely to reduce the number of sportfishing trips taken. The discretionary time variable has been positive and highly significant in previous disequilibrium labor market recreation demand studies and was highly significant in this study (Bockstael et al. 1987; McKean et al. 1995, 1996, Normandeau Associates et al. 1998). The average number of days that anglers in the survey were "free from other obligations" was 91days per year. The income constraint variable (E*) is defined as average annual family income. The relation of quantity demanded to income can indicate differences in tastes among income groups. Although restrictions on income should reduce overall purchases, it may also cause a shift to low-cost types of consumer goods such as fishing. Thus, the sign on the income coefficient conceptually can be either positive or negative. The estimated coefficient on income was negative for this data set. Four other closely related goods prices were tested in the model: $t_{os}$, time spent at the primary fishing site at the river; $P_{os}$, money purchases at the primary fishing site at the river; $P_{as}$, money spent during the trip at alternate sportfishing sites in Central Idaho during the fishing trip ($26 per trip); and other recreation time spent at the primary fishing site (5.7 hours), $t_{or}$. Only the latter two variables were significant in this data set. The presence of alternate site spending during the trip tended to increase the number of trips taken. Anglers that spent more time onsite recreating, rather than fishing, tended to take fewer trips.

The expected sportfishing success rate variable, E(Catch) is the individual's previous average catch per day in the Snake River Basin. Anglers average catch was reported at nearly eight fish per day and varied from 0.2 to 70. Trips from home to site per year were hypothesized to relate positively to expected sportfishing success based on the individuals past experience fishing in the Snake River Basin. However, the expected catch variable was not significant for this data set. The strength of an angler's preferences for sportfishing to other activities should positively influence the number of sportfishing trips taken per year. The variable, TASTE, is defined as the number of hours fished per 24 hour day. The average hours fished per day was 6.68 hours. A second indicator of taste related particularly to the study region is the number of years that the angler has visited the Snake River basin in Central Idaho. The variable EXP measures this second aspect of taste. Anglers had an average of 9.8 years experience fishing in the Snake River Basin. The estimated coefficients on both taste variables were significant and had the expected positive signs. Age has often been found to influence the demand for various types of sportfishing activity. The average age of anglers in the survey was 49.5 years. Age of the angler was not significant. About 38% of the anglers in the survey used a boat at least part of the time. However, a dummy variable (BOAT) that identified anglers that used a boat for fishing either all or part of the time was not significant. Anglers with a boat did not visit the fishing site any more often than shore anglers.

Consumers surplus was estimated as shown in Hellerstein and Mendelsohn (1993) for consumer utility maximization subject to an income constraint, and where trips are a nonnegative integer. They show that the conventional formula to find consumer surplus for a semilog model also holds for the case of the integer constrained quantity demanded variable. The Poisson regression, with a linear relation on the explanatory own monetary price variable is equivalent to a semilog functional form. Adamowicz et al. (1989), show that the annual consumers surplus estimate for demand with continuous variables is $E(Q_s)/(-ß)$, where ß is the estimated slope on price and $E(Q_s)$ is average annual visits. Consumers surplus per trip from home to site is $1/(-ß)$.

Application of Poisson regression incorporating the endogenous stratification adjustment results in an estimated coefficient of -0.0284 on out-of-pocket travel cost. Consumers surplus per angler per trip is the reciprocal or about $35. Average angler trips per year to fishing sites in the Snake River basin in the full sample was 6.72. Total surplus per angler per year is average annual trips times surplus per trip or $236 per year. Without the endogenous stratification adjustment the consumers surplus estimate would have been $42 per angler per trip based on the estimated cost coefficient of -0.0239. Thus, consumer surplus estimates would have been almost 19 percent higher without the adjustment for endogenous stratification. This is contrary to the normal expectation that the consumer surplus estimate would be higher after adjustment for endogenous stratification. A larger portion of responses from local anglers were incomplete and thus removed from the sample.

## Summary Remarks

A mail survey was conducted on anglers in the Snake River Basin in Central Idaho for the purposes of measuring willingness-to-pay for fishing trips. The survey was conducted by a single mailing using a list of names and addresses collected from anglers on site in the Snake River Basin and surveys distributed by fishing guides. The collection of names and addresses on site was hindered by a lack of central sites where anglers could be contacted by university students to obtain the names and addresses of those willing to participate in the survey. One result was that a share of the returned surveys were incomplete. About 30 percent of the 366 returned sportfishing demand surveys were missing critical information and could not be used for the demand analysis although they were useful to estimate averages.

The sportfishing demand analysis used a model that assumed anglers did not (or could not) give up earnings in exchange for more free time for sportfishing (Shaw and Feather 1999, Bockstael et al. 1987, McConnell 1999). This model requires extensive data on angler time and money constraints, time and money spent traveling to the river fishing sites, and time and money spent during the sportfishing trip for a variety of possible activities. The travel cost demand model related annual sportfishing trips by groups of anglers to the dollar costs of the trip, to the physical time costs of the trip, to the monetary and time costs for substitute or complementary trip activities, and other socioeconomic variables. The dollar cost of the trip was based on reported travel distances from home to site times a cost per person of 7.6 cents per mile.

Consumer surplus was estimated at $42 per person per trip before adjustment for endogenous stratification and $35 after adjustment. The average number of sportfishing trips per year was 6.72 (for any river in Central Idaho and based on the full sample) resulting in an average annual willingness-to-pay of $236 per year per angler.

## References

Adamowicz, W.L., J.J. Fletcher, and T. Graham-Tomasi. 1989. "Functional Form and the Statistical Properties of Welfare Measures." American Journal of Agricultural Economics 71:414-420.

Bockstael, N.E., and K.E. McConnell. 1981. "Theory and Estimation of the Household Production Function for Wildlife Recreation." Journal of Environmental Economics and Management 8:199-214.

Bockstael, N.E., I.E. Strand, and W.M. Hanemann. 1987. "Time and the Recreational Demand Model." American Journal of Agricultural Economics 69:293-302.

Brown, W.G., and F. Nawas. 1973. "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions." American Journal of Agricultural Economics 55:246-49.

Englin, J., and J.S. Shonkwiler. 1995. "Estimating Social Welfare Using Count Data Models: An Application to Long-Run Recreation Demand Under Conditions of Endogenous Stratification and Truncation." The Review of Economics and Statistics 77(1):104-112.

Greene, W.H. 1992. LIMDEP, Version 6. Econometric Software, Inc. Bellport, New York.

Gum, R., and W.E. Martin. 1975. "Problems and Solutions in Estimating the Demand for the Value of Rural Outdoor Recreation." American Journal of Agricultural Economics 57:558-66.

Hellerstein, D.M., and R. Mendelsohn. 1993. "A Theoretical Foundation for Count Data Models." American Journal of Agricultural Economics 75:604-611.

Larson, D.M. 1993. "Joint Recreation Choices and Implied Values of Time." Land Economics 69(3):270-86.

Larson, D.M. 1993. "Separability and the Shadow Value of Leisure Time. American Journal of Agricultural Economics 75(3):572-77.

Maler, K.G. 1974. "Environmental Economics: A Theoretical Inquiry." Johns Hopkins University. Baltimore.

McConnell, K.E., and I.E. Strand. 1981. "Measuring the Cost of Time in Recreational Demand

Analysis: An Application to Outdoor Recreation." American Journal of Agricultural Economics 63:153-56.

McConnell, K.E., and I.E. Strand. 1983. "Measuring the Cost of Time in Recreation Demand Analysis: Reply." American Journal of Agricultural Economics 65:172-74.

McConnell, K.E. 1999. "Household Labor Market Choices and the Demand for Recreation." Land Economics 75(3):466-77.

McKean, J.R., D.M. Johnson, and R.G. Walsh. 1995. "Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation." Land Economics 71:96-105.

McKean, J.R., R.G. Walsh, and D.M. Johnson. 1996. "Closely Related Goods Prices in the Travel Cost Model." American Journal of Agricultural Economics 78:640-646.

Normandeau Associates, University of Idaho, and Agricultural Enterprises, Inc. 1998. Sport Fishery Use and Value on Lower Snake River Reservoirs. Phase I Report. US Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

Randall, A. 1994. "A Difficulty With the Travel Cost Method." Land Economics 70(1):88-96.

Shaw, D. 1988. "On-Site Samples' Regression Problems of Non-Negative Integers,Truncation and Endogenous Stratification." Journal of Econometrics 37:211-223.

Shaw, W. D., and P. Feather. 1999. "Possibilities for Including the Opportunity cost of Time in Recreation Demand Systems." Land Economics 75(4):592-602.

Smith, V.K., W.H. Desvouges and M.P. McGivney. 1983. "The Opportunity Cost of Travel Time in Recreation Demand Models." Land Economics 59(3):259-78.

Walsh, R.G., J.R. McKean, and D.M. Johnson. 1990. "Nonmarket Values from Two Decades of Research on Recreation Demand." In Advances in Applied Microeconomics Vol. V. V.K. Smith and A.N. Link, Eds. JAI Press, Inc.Greenwich, Connecticut. pp. 167-194.

Walsh, R.G., L.D. Sanders, and J.R. McKean. 1990. "The Consumptive Value of Travel Time on Recreation Trips." Journal of Travel Research 29:17-24.

Ward, F.A. 1983. "Measuring the Cost of Time in Recreation Demand Analysis: Comment." American Journal of Agricultural Economics 65:167-68.

Ward, F.A. 1984. "Specification Considerations for the Price Variable in Travel Cost Demand

Models." Land Economics 60:301-5.

Ward, F.A. 1989. "Efficiently Managing Spatially Competing Water Uses: New Evidence from a Regional Recreation Demand Model." Journal of Regional Science 29(2):229-246.

Ward, F.A. and D. Beal. 2000. Valuing Nature With Travel Cost Models: A Manual. New Horizons in Environmental Economics. Edward Elgar Publishing, Inc. Northampton, MA. 255pp.

Table 1. Definition of Variables[4]

| variable | units | mean | definition |
|---|---|---|---|
| $Q_s$ | trips | 6.72 | annual trips (full sample) to Snake River Basin fishing site (dependent variable) |
| $P_s$ | $ | 28.1 | angler's out-of-pocket round trip travel cost to the Snake River fishing site. |
| $L(t_s)$ | hours | 15.01 | round trip travel time to the fishing site. |
| $t_{or}$ | hours | 5.75 | time spent on other recreation while at the fishing site |
| $L(P_{as})$ | $ | 26.22 | angler's purchases at an alternate fishing site in the Snake River Basin. |
| E* | $ | 71993 | annual family earned and unearned income. |
| L(T*) | days | 91.38 | angler's discretionary time available per year. |
| L(TASTE) | days | 6.67 | angler's hours fished per year. |
| L(EXP) | years | 9.82 | angler's total sportfishing experience in the Snake River Basin. |

Table 2. Snake River Basin sportfishing demand estimated with truncated Poisson regression, before adjustment for endogenous stratification.[5]

| variable | Coefficient | t-Ratio | elasticity |
|---|---|---|---|
| Constant | 0.8583 | 4.28 | na |
| $P_s$ | -0.023852 | -7.71 | -0.67 |
| $L(t_s)$ | -0.2958 | -6.97 | -0.296 |
| $t_{or}$ | -0.0211 | -3.89 | -0.121 |
| $L(P_{as})$ | 0.0621 | 3.45 | 0.062 |
| E* | -2.8E-06 | -2.92 | -0.201 |
| L(T*) | 0.0932 | 2.97 | 0.093 |
| L(TASTE) | 0.5476 | 6.78 | 0.548 |
| L(EXP) | 0.1506 | 4.99 | 0.151 |

Table 3. Snake River Basin sportfishing demand estimated with Poisson regression (not truncated), after adjustment for endogenous stratification.[6]

| variable | coefficient | t-ratio | elasticity |
|---|---|---|---|
| Constant | 0.4951 | 2.26 | na |
| $P_s$ | -0.028415 | -8.46 | -0.798 |
| $L(t_s)$ | -0.3439 | -7.56 | -0.344 |
| $t_{or}$ | -0.0254 | -4.3 | -0.146 |
| $L(P_{as})$ | 0.0724 | 3.72 | 0.072 |
| E* | -3.3E-06 | -3.2 | -0.238 |
| L(T*) | 0.1092 | 3.22 | 0.109 |
| L(TASTE) | 0.6472 | 7.37 | 0.647 |
| L(EXP) | 0.1793 | 5.45 | 0.179 |

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[4] L is the log transformation.

[5] The dependent variable ($Q_s$) is trips per year to the river, with mean of 4.24 for the sample 270 not the full sample of 366. Estimated $R^2$ equals 0.29 (estimated by a regression of the predicted values of trips from the truncated Poisson model on the actual values).

[6] The dependent variable modified for endogenous stratification ($Q_s$*) is trips per year minus one, with mean of 3.24 for the sample 270 not the full sample of 366. Estimated $R^2$ equals 0.29 (estimated by a regression of the predicted values of trips from the Poisson model on the actual values).