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The Economic Value of the Henry's Fork Fishery

Abstract

We used a simple travel-cost model of recreational demand to estimate recreational benefits of angling on the Henry's Fork of the Snake River in the Island Park area of eastern Idaho. Using a sample of 356 anglers contacted in 1996, we determined angler expenditures and socioeconomic and site-quality characteristics and estimated the recreational value of the Henry's Fork fishery. Most respondents were male (81%), Idaho residents (69%) and wealthy. The average respondent traveled 720 miles one-way from his or her residence to get to Island Park at a cost of $766.45, spent $60.88 on-site daily, and planned to spend about 15 days fishing in Island Park during the summer. Trip and mean daily consumer-surplus estimates were $2,426.25 and $159.31, respectively. The total annual value of the recreational fishery between Island Park Dam and Hatchery Ford was $5,012,509. This amount represents benefits that anglers receive above and beyond all costs associated with their trips to the region.

Key words: Henry's Fork, angling, economics, consumer surplus, recreation.

Introduction

The Henry's Fork of the Snake River offers one of the finest angling opportunities in the world. In a recent survey conducted by Trout Unlimited, the Henry's Fork was voted the best trout stream in the United States (Ross 1998). The Henry's Fork is a river replete with large, wild fish and scenic environs, and it provides recreational anglers with one of the greatest fishing paradises on earth (Brooks 1984, Staples 1991). Although numerous people have described the endless beauty of the region, and certainly everyone who has visited it recognizes the Henry's Fork as a valuable resource, quantifying the value of the region and fishery is a difficult task. There is a paucity of objective information on ecosystem values within the greater Yellowstone region, considering the importance of public and private decisions on the resource. We present an estimate of the value of the "blue-ribbon" trout fishery on the Henry's Fork in the Island Park area. We hope that policy makers will use the information to help with management decisions regarding the fishery.

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A Model of Recreational Behavior

Harold Hotelling (1949), in a letter to the director of the National Park Service, first suggested the simple travel-cost model of valuing non-market resources. Hotelling thought that public benefits resulting from national parks could be measured by the total cost individuals were willing to pay to travel to the parks. Clawson and Knetch (1966) later developed the formal method of travel-cost valuation and popularized its application. Put simply, the travel-cost method posits that the recreationist will continue to make trips to a recreation site until the marginal or incremental benefit of the last trip equals the marginal cost of getting to the site. Over the past 30 years, the travel-cost methodology often has been used to model recreation demand (Mendelsohn and Markstrom 1988) and to estimate the value of environmental resources.

Economists measure the value of a resource in terms of what an individual is willing to pay rather than what they actually do pay. Figure 1 demonstrates how benefits are measured for fishing on the Henry's Fork. On the vertical axis is dollars. On the horizontal axis is the number of days spent on the Henry's Fork. The additional benefit of spending another day of fishing on the Henry's Fork is assumed to eventually decline as more days are spent fishing. Although this relationship is shown as linear in Figure 1, this may or may not be the case. The relationship between benefits and days fishing is depicted by the marginal benefit (MB) curve. The cost of spending an additional fishing day is the marginal cost (MC). As long as the marginal benefit of spending an additional day on the Henry's Fork exceeds the marginal cost of spending the additional day, the recreationist will

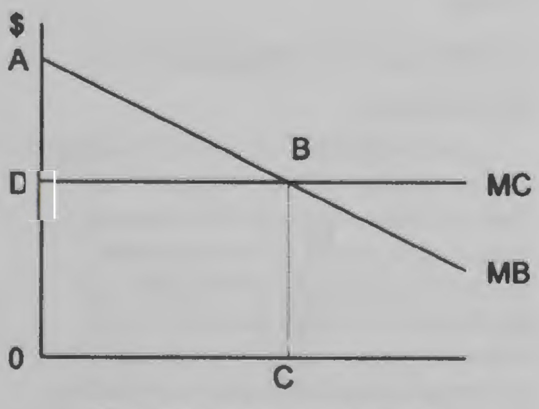

Figure 1. *Hypothetical marginal cost (MC) and marginal benefit (MB) functions for the Island Park fishery. Consumer surplus is the area of triangle ABD.*

elect to spend the day fishing. At the point where MB=MC, the individual will make no additional trips to the Island Park, Idaho, area and spend no additional days fishing the Henry's Fork. The total benefit the individual receives from fishing on the Henry's Fork is given by the area ABC0. This area is the sum of the marginal benefits of each day's fishing. The cost of fishing each day is MC, so the total cost of fishing is area DBC0. The difference between what the angler actually pays and what he or she would be willing to pay is area ABD. This area is defined as consumer surplus, the net benefits consumers receive from using the resource. It is this value we estimate in this paper.

The travel-cost method relies on several important assumptions that make its application to destination resorts, such as Island Park, difficult. The most critical of these assumptions are: 1) for each trip to the site, the sole purpose of the recreationist is to visit the site; 2) there is no utility or disutility in traveling to the site; 3) the opportunity cost of the trip is the wage rate of the visitor; 4) all visits are of the same duration; and 5) the visitor reacts to a change in travel costs in the same way he or she reacts to a change in the price of admission to the area.

We used a modification of the travel-cost model called the on-site travel-cost model. This modification, first proposed by Bell and Leeworthy (1990), uses total time on site as the dependent variable in the estimated demand equation. It assumes the recreationist maximizes his or her budget-constrained utility obtained from total fishing time spent on the site. Unlike the standard travel-cost model, the on-site model allows the recreationist to increase or decrease total recreation time either by spending more or less time on-site during a given trip or taking more or fewer trips to the site. These two choices imply that expenditures on long-distance travel need to be separated from other expenditures made at the recreation site and that the budget constraint contains separate prices for time spent on-site and long-distance travel.

The on-site cost model is better suited than the standard travel-cost model to recreation decisions involving trips of varying duration on-site as well as heterogeneous travel modes and distances traveled. Allowing recreationists to respond differently to the two prices (on-site and long-distance travel) is consistent with much empirical evidence (McConnell 1992).

Hof and King (1992) offered theoretical support for the on-site cost model of recreational demand. Given the condition of weak complementarity, which also is required in the traditional travel-cost models, they showed that the value of the resource can be estimated by changing on-site costs only. An important advantage of this model is that many of the assumptions of the traditional travel-cost model become less burdensome. When on-site costs become the primary focus of the model, and visitors are allowed to react differently to on-site costs and long-distance travel costs, assumption (5) of the traditional travel-cost models is relaxed. In addition, the difficulty of assuming that each trip has a single unique purpose is less important because welfare effects are calculated from changes in on-site costs, which are independent of the number of stops along the way.

METHODS

To apply the on-site travel-cost model, we formulated the demand equation for the Henry's Fork trout fishery as:

DAYSFISH = f(PFISH,PLD,SEV,SQV)

where DAYSFISH was the number of recreation days spent fishing the Henry's Fork during the season, PFISH was on-site cost, PLD was long-distance travel cost, SEV represented a group of socioeconomic variables (age, number of children, residency, gender, income, and annual recreation expenditures), and SQV was a group of site quality variables (catch rate, mean size of fish caught, maximum size of fish caught, and number of other anglers observed while fishing). Definitions of the variables are given in Table 1.

The explanatory variable PFISH was on-site costs per day, or the daily cost of fishing. It included the cost of the prior night's lodging, all direct fishing expenditures, and the cost of traveling to the day's fishing location from the prior night's lodging location.

The variable PLD was the total long-distance travel cost incurred by the recreationist to get to the Henry's Fork from the respondent's home. For those traveling by vehicle, a cost per mile was assigned incorporating the type of vehicle used (private car, rental car, motor home, or car with trailer; U.S. Federal Highway Administration 1984) and inflated to 1996 dollars. The cost per mile was multiplied by the number of miles traveled. The opportunity cost of time was also included in PLD. This was assumed to be the recreationist's wage rate, calculated by dividing annual income by 1920, the average number of hours worked per year. The time spent in long-distance travel was obtained by dividing the total distance traveled by 50 miles per hour. To address the issue of paid vacations and fixed income, the product of wage rate and travel time was multiplied by a factor of one-third (Shaw 1992). For simplicity, we assumed no utility or disutility was gained from the long-distance travel itself.

Socioeconomic variables (SEV) used to help explain demand included the respondent's age (AGE) and number of children (KIDS). We included a binary variable (LOCAL) to control for differences between resident and nonresident anglers (Duffield *et al.* 1992). LOCAL was assigned a value of one if the angler had a resident fishing license and a value of zero for nonresidents. A binary variable for gender (GENDER; 0 if male and 1 if female) was also included. Respondents were asked to check which of eight income categories matched their family income (INCOME). We used the mean level of income from each category in our analysis; this simplification had no meaningful effect on our results. The variable OREXP represented the total amount of money the respondent spent on outdoor recreation that summer.

We included four variables to control for the angler's perception of the quality of the fishery. CATCHRATE was the number of fish caught during the last day divided by the number of hours spent fishing. CROWD gauged perceived congestion along the river and was equal to the number of anglers encountered by the respondent during their last day of fishing. AVSIZE was the average length of fish caught, and BIGSZ was the length of the longest fish caught.

During the summer of 1996, a student employed by the Henry's Fork Foundation conducted 356 interviews with visitors in the Island Park, Idaho, area to gather the information described above. Interviews were conducted along the Henry's Fork, in local campgrounds and motels, and at other recreational sites in the area. Surveying was conducted from Memorial Day to Labor Day. Because the fishing season in Island Park extends from the Saturday before Memorial Day to 30 November, we under-sampled anglers who fish primarily in the autumn. People who came to Island Park primarily to fish, as well as to take advantage of other recreational activities the area has to offer, were surveyed. Few people were not willing to complete the survey, but individuals who appeared to be busy were not asked to complete the survey. To better meet the assumptions of the travel-cost model, the sample was limited to individuals who drove to Island Park, stayed in the area for at least one night, and visited no other locations on their trip. Therefore, we under-sampled single-day visitors. The sample is best described as a convenience sample. Sampling in such a manner is likely to result in a length-biased sample (Nowell *et al.* 1988), wherein those spending more time in the area have a greater likelihood of being sampled than individuals who spend less time in the area. The magnitude of this problem is greater as the correlation between the variable of interest (in this case, consumer surplus) and length of stay increases. In our application, the simple correlation between an individual's length of stay and an individual's consumer surplus was positive but small and not statistically significant. Because of this low level of correlation, no correction for length-biased sampling was undertaken.

We estimated the expected number of days spent fishing on the Henry's Fork using the data described above. Because the dependent variable is the result of a repeated discrete choice, the dependent variable will follow a Poisson distribution. Using the Poisson distribution, the probability that the *i*th individual spends n_i days fishing on the Henry's Fork is given by

$$P(n_i = 0,1,2,3,\ldots) = \frac{e^{-\lambda_i}\lambda_i^{n_i}}{n_i!},$$

where $\ln \lambda_i = \sum \beta Z_i$, β represents the estimated parameters, and Z_i represents the explanatory variables discussed above. The estimated mean value of λ_i is interpreted as the mean of the dependent variable DAYSFISH conditional upon Z_i. The use of truncated count data models is common in recreation demand analysis (Parsons and Wilson 1997, Hellerstein 1999).

Consumer surplus was calculated to estimate the economic value of the Henry's Fork fishery. Consumer surplus is defined as the difference between what an angler is willing to pay to fish, and what he or she actually does pay. Consumer surplus estimated the recreation value of the resource only for fishing and excluded hikers, horseback riders, floaters, hunters, bird watchers, and all others who care about the region. In the Poisson model, the expected value of consumer surplus is given by

$$e^{-\sum \beta z_i} / \beta_{\mathrm{PFISH}},$$

where β_{PFISH} is the estimated coefficient associated with the on-site cost variable, PFISH (Hellerstein 1999). We calculated consumer surplus at the mean for all explanatory variables. The total annual recreation value of the Henry's Fork fishery was estimated by multiplying annual angler effort (in hours) by consumer surplus per hour.

Results and Discussion

Of those interviewed, 241 (68%) had been fishing on the Henry's Fork during their current visit to Island Park. Our analysis was based on this sample of 241 respondents. Respondents were overwhelmingly male (81%), Idaho residents (69%), and predominately wealthy (Table 1); the modal response for income level was "$75,000 - $100,000." The average respondent had fished the Henry's Fork for 18.8 hours this trip and had caught 0.67 fish per hour, slightly less than the catch rates reported in nearby Yellowstone National Park (Franke 1997). On average, they spent $60.88 to fish for the day. The average respondent planned to spend about 15 days fishing in Island Park during the summer season and had spent $766.45 to travel 720 miles one-way from his or her residence to get to Island Park (Table 1).

The magnitudes of the estimated coefficients of the explanatory variables (Table 2) do not offer straight-forward interpretation, but the signs of the coefficients indicate whether the

Table 1. *Definitions, means, and standard deviations of variables used in the demand equation for the Henry's Fork fishery.*

Variable	Definition	Mean	Standard Deviation
DAYSFISH	Number of days spent fishing on the Henry's Fork during the summer	15.23	15.92
PFISH	On-site daily expenditures on fishing (travel, lodging, equipment, guides, etc.)	$60.88	91.15
PLD	Price of long-distance travel (residence to Island Park)	$766.45	1402.19
AGE	Age of respondent (years)	42.12	13.43
LOCAL	0 = nonresident fishing license; 1 = resident fishing license	0.69	0.46
CATCHRATE	Number of fish caught per hour today	0.67	0.45
CROWD	Number of other anglers observed while fishing today	7.13	5.75
AVSIZE	Average size fish caught today (inches)	8.91	6.64
BIGSZ	Biggest fish caught today (inches)	11.31	8.25
GENDER	0 = male; 1 = female	0.19	0.39
KIDS	Number of children	1.89	1.88
INCOME	Family income	$69,351	37,243
OREXP	Total recreation expenditures during the current year	$2496	2575

Table 2. *Estimated coefficients and significance of the explanatory variables related to days spent fishing on the Henry's Fork.*

Variable	Estimated Coefficient	*t*-ratio	*P*-value
CONSTANT	2.19	28.20	0.000
PFISH	-0.0012	-9.47	0.000
PLD	0.00009	-4.76	0.0001
AGE	0.008	5.48	0.0001
LOCAL	-0.10	-2.44	0.015
CATCHRATE	-0.04	-2.01	0.044
CROWD	-0.0004	-0.14	0.88
AVSIZE	-0.003	-0.46	0.64
BIGSZ	0.04	6.00	0.0001
GENDER	-0.002	-0.02	0.97
KIDS	0.006	0.58	0.56
INCOME	-0.000003	-5.45	0.0001
OREXP	0.00007	10.99	0.000
Restricted Log-Likelihood	-1742		
Log – Likelihood	-1465		

variables were directly (positive estimated coefficients) or negatively (negative estimated coefficients) related to days spent fishing on the Henry's Fork. Overall the model appeared to fit the data well. Using a likelihood ratio test, the null hypothesis that all estimated coefficients were equal to zero was rejected at $\alpha = 0.001$. The pseudo-R^2 was 0.16.

The estimated coefficient on PFISH was negative and significant (Table 2; $\alpha = 0.01$) inferring that, as expected, days spent on site and the price of spending a day on site were negatively related. The coefficient on PLD also was negative and significant, suggesting that, as long-distance travel costs increased, recreationists responded by spending less time on site.

The estimated coefficient on INCOME was negative and significant, whereas the estimated coefficient on OREXP was positive and significant (Table 2). All else equal, individuals with higher incomes spent fewer days on-site, and individuals with large outdoor recreation expenditures spent more time on-site. Neither GENDER nor KIDS appeared to be related to the number of days an individual spent fishing. AGE was positively related to days spent on-site. The coefficient associated with the binary variable LOCAL was negative and significant, indicating that Idaho residents spent less time on the Henry's Fork than did non-residents.

The estimated coefficients on the site-quality variables CATCHRATE and AVSIZE were not significant, but the coefficient on BIGSZ was positive and significant (Table 2). The estimated coefficient associated with CROWD was not significant. These results indicate that people did not spend more days on-site as they caught greater numbers of fish, and that at 1996 levels of crowding, additional anglers did not negatively affect the amount of time an individual spent fishing the Henry's Fork. Anglers who caught a large fish spent more time fishing in contrast to those who caught more fish or larger fish on average.

We calculated a mean consumer surplus per trip of $2,426.25. This equates with a mean daily consumer surplus (for 15.23 days) of $159.31. Mean consumer surplus estimates for anglers on Montana's Big Hole River have been estimated to be between $680 and $164 for non-resident anglers and from $225 to $55 for resident anglers

(Duffield *et al.*). Anglers on Montana's Rock Creek valued angling at between $259 and $353 (1993 dollars) per day (Graham 1989). Daily consumer surplus estimates for anglers on the Madison River, Yellowstone River, Slough Creek, and the Gallatin River ranged from $330 to $859 (Kerkvliet and Nowell in press).

The total annual recreation value of the Henry's Fork fishery was estimated by multiplying annual angler effort (in hours) by consumer surplus per hour. Angler effort on the Henry's Fork has been estimated by the Idaho Department of Fish and Game and a variety of other researchers (Table 3). Although these estimates come from different years, total angler effort between Island Park Dam and Hatchery Ford is likely about 117,060 hours per year. Given that the average angler in our survey spent 3.72 hours fishing per day, the hourly consumer surplus estimate based on mean consumer surplus was $42.82. The total annual value of the fishery between Island Park Dam and Hatchery Ford for recreational angling was therefore $5,012,509. This amount represents the benefits anglers receive above and beyond all costs associated with their trips to Island Park.

We made many assumptions in determining the value of the Henry's Fork fishery. These included variable selection, sampling procedures, functional form, values for time and travel, and preferences for visits versus visit length. All of these assumptions influenced the estimated demand equations and the resulting welfare estimates. Regardless, our work suggests that the recreational benefits from angling on the Henry's Fork are substantial. The agencies that regulate angling and other activities in the Island Park area should consider the effects of their decisions on these values.

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Table 3. *Angler effort estimates for reaches of the Henry's Fork used to calculate total annual recreational value of the fishery.*

River reach	Effort (angler hours)	Time period (year)	Reference
Henry's Lake Outlet	9,756	Opening Day to Labor Day (1999)	Van Kirk 1999
Henry's Lake Outlet to Mack's Inn	9,264	Opening Day to 30 September (1999)	IDFG Unpublished
Mack's Inn to Coffee Pot	8,311	Opening Day to 30 September (1999)	IDFG Unpublished
Island Park Dam to Last Chance	26,967	Opening Day to 30 November (1996)	Van Kirk *et al.* 1999
Last Chance	15,767	Opening Day to 31 August (1982)	Rohrer 1984
Last Chance to Pinehaven	35,283	Opening Day to 31 August (1982)	Rohrer 1984
Pinehaven to Hatchery Ford	11,712	Opening Day to Labor Day (1987)	Angradi and Contor 1989
Total	117,060		

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