Economic Valuation of the Chinook Salmon Sport Fishery of the Gulkana River, Alaska, under Current and Alternate Management Plans

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ABSTRACT. *This paper extends the standard travel cost method (TCM) to develop estimates of the economic value of recreational chinook salmon fishing on the Gulkana River, Alaska, under existing and hypothetical fishery management conditions. Respondents were asked to state how the number of trips that they took to the study area would change if alternative fishery management practices were imposed. Three hypothetical management conditions were considered: a doubled 1992 sport fish harvest, a doubled daily bag limit, and a season bag limit of five. Each of the hypothetical fishery management conditions provides increased economic returns to anglers.* (JEL Q21)

I. INTRODUCTION

The first commercial fishery on the Copper River system in Alaska was established in 1889. By the 1920s, commercial fishing had become the dominant use. Eighty to ninety percent of the chinook (*Oncorhynchus tshawytscha*) and sockeye (*O. nerka*) salmon harvested from the Copper River system in recent years have been taken in the commercial fishery. The balance of the catch is divided among three user groups: subsistence, personal use, and sport. The sport fishery primarily targets chinook salmon.[1] The chinook salmon range from 20 to 60 pounds and are prized for their vigorous fighting abilities. The Alaska Department of Fish and Game (ADF&G) estimates that 98 percent of the Copper River Basin chinook sport fish harvest occurred on the Gulkana and Klutina Rivers, and that 93 percent of the effort occurs on the Gulkana River alone (Whitmore and Vincent-Lang 1991).

This paper examines three issues relating to the Gulkana River chinook salmon sport fishery. First, we use a travel cost model to develop a benchmark measure of the economic benefits generated by the chinook salmon sport fishery on the Gulkana River under current management policies. Next, we estimate the change in benefits to the sport fishery that would have resulted from an increase in chinook abundance. Not only does the abundance of chinook salmon vary naturally, but the number of chinook available to the sport fishery could also be increased (reduced) by reducing (increasing) commercial catches. Finally, we estimate the change in benefits to the sport fishery from changes in sport fishing regulations, holding chinook abundance constant. Anglers are currently restricted to one fish per day and one in possession with no season limit. We examined two alternative bag limit regulations. The first alternative would hold anglers to a five-fish season bag limit, but would not impose daily bag limits.[2] The second alternative would liberalize the daily bag limit to two chinook per day and two in possession but would not impose a season bag limit.

Fisheries managers are interested in stock abundance, catches, and angler days (effort), because these are the variables that they traditionally measure. Resource economists have traditionally focused on measures of consumer's surplus. The traditional travel cost method has been useful for measuring

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[1] Slightly larger numbers of sockeye salmon are taken in the sport fishery, but are generally of secondary importance to the anglers.

[2] The State has adopted a 1994 season bag limit of five chinook salmon, twenty inches or more in length for the combined upper Copper River and upper Susitna River basins. A separate five-chinook bag limit is in place for the lower Susitna River and its tributaries. One-fish-per-day and one-in-possession requirements remain in effect in both drainages.

consumer's surplus (although, see Randall 1994), but only for historical data. To derive information about hypothetical changes, economists have usually used the contingent valuation method (see Cummings, Brookshire, and Schulze 1986 or Mitchell and Carson 1989). The contingent valuation method (CVM) produces a (Hicksian) measure of consumer's surplus. While this provides managers with a measure of the economic consequences of a change in management regimes, it does not provide estimates of expected fishing effort.[3]

To develop estimates of effort and consumer's surplus in a framework suitable for historical as well as contingent data, we asked respondents how many trips they would have made under three hypothetical management conditions. We call this method the hypothetical travel cost method (HTCM). In contrast to CVM, our methodology asks users the quantity of trips they would have made to the site rather than how much they are willing to pay to make a trip to the site. Both the CVM and the HTCM measure consumer's surplus under actual and hypothetical situations. However, the HTCM should be less prone to strategic manipulation, less taxing on respondents, and more familiar to fisheries managers. When used with historical data, the TCM and the HTCM are identical. However, the HTCM is also capable of providing estimates of the consequences of hypothetical policy changes.

II. EXPERIMENTAL DESIGN

A. The Travel Cost Method

The TCM uses observed expenditures and behavior to develop an indirect measure of the value of nonmarket goods. The number of visits to a fishing site serves as a proxy for the quantity variable, while the sum of travel and opportunity costs serves as a proxy for the price variable. A demand function is estimated from these proxies for the price and quantity variables. Much of the literature of the modern TCM considers how to address problems that have arisen from the empirical implementation of the methodology. The problems associated with TCM-based estimates arise from difficulties associated with the specification and measurement of quantity, price, and substitute site variables.

Many studies (e.g., McConnell 1975; Morey 1981; Smith, Desvousges, and McGivney 1983; Forster 1989) suggest that the quantity of visits should be trips of equal time lengths at a recreational site. Morey (1981) included only persons taking single day trips in his study of demand for skiing in Colorado. Brown and Mendelsohn (1984) developed three TCM models using separate demand schedules for one-day trips, two- to three-day trips, and trips greater than four days in length. The length of trips is inversely proportional to travel distance. People who travel a short distance tend to take many short trips while people who travel a long distance take fewer, but longer trips.

The price measure in TCM suffers from three principal ambiguities: what costs should be included; what is the opportunity cost of time; and, how to apportion costs for multipurpose trips. Clawson (1959) included only out-of-pocket expenses. Brown and Nawas (1973), Cesario (1976), Cesario and Knetsch (1976), McConnell and Strand (1981), and Donnelly et al. (1985) report that the number of recreational trips taken depends not only on actual cash costs, but also the opportunity cost of scarce time. Unfortunately, there is little agreement about the most appropriate valuation of the opportunity cost of time (see Shaw 1992). Furthermore, there is no clear direction on how to account for the purchase price of durable recreational equipment. Nevertheless, Bishop and Heberlein (1979) and Bishop et al. (1988) found that both TCM and CVM produced reasonable estimates for outdoor recreational activities when compared to a simulated market.

The prices included in a TCM demand equation for a recreational site depend upon what alternative activities would be consid-

[3] Effort is generally defined as a function of price in a CVM study.

ered as close substitutes or complements. The marginal utility for one commodity generally depends upon the quantities of all other commodities consumed. Theoretically, a price change for any commodity could affect the price of any other commodity. Many empirical studies suggest that substitute prices should be included in TCM outdoor recreational demand functions. (See, for example, Burt and Brewer 1971; Gum and Martin 1975; Cicchetti, Fisher, and Smith 1976; Morey 1981; Caulkins, Bishop, and Bouwes 1985; Rosenthal 1987; Kling 1989; Wilman and Pauls 1987; and Wilman and Perras 1989.)

The sport fishing demand for chinook can be represented with a general travel cost model:

$$v_{ij} = f(p_{ij}, y_i, d_i, q_i, s_{ij}) \quad [1]$$

where v_{ij} is the number of visits to a recreational site j by individual i, p_{ij} is the implicit price or travel cost to the site by individual i, y_i is individual i's income, d_i is a vector of demographic characteristics of an individual, q_i is a vector of the quality characteristics specific to the site,[4] and s_{ij} the price faced by individual i for visits to substitute sites j. This equation can be treated as a Marshallian demand in the implicit travel cost prices.

B. The Contingent Valuation Method

While the travel cost method asks people to report their actual behavior, the contingent valuation method asks people to report the value they obtain from the behavior. Methodologically, the CVM can be much more difficult to implement than the TCM. The CVM method involves the construction of a contingent market to elicit how much the respondent is willing to pay (or accept) to have access to the resource. The CVM uses surveys or personal interviews to derive willingness-to-pay or willingness-to-accept measures for particular sites. Respondents are asked to use the information provided in the questionnaire to predict what they would be willing to pay if a change occurred in the quality of the resource (Mitchell and Carson 1989). For example, an angler could be asked how much they would be willing to pay if the payment would be used to stock a particular lake to control for other influences. Thus CVM studies have been prone to problems with outliers, protest responses, strategic manipulation for open-ended elicitation methods, and to problems of anchoring and starting point biases for payment card elicitation methods (Mitchell and Carson 1989).

More complicated experimental designs such as the dichotomous choice elicitation method avoid some of these problems, but have their own unique problems. For example, given the take-it-or-leave-it nature of dichotomous choice questions, one only learns whether the respondent was willing to pay (or accept) the amount asked. Therefore, large numbers of respondents must be queried for each bid price to obtain an estimate of the binomial probability of a "yes" to the question: "Are you willing to pay $X to have access to the resource?" Furthermore, obtaining reliable estimates of the median (or any other measure of central tendency) requires considerable knowledge about the distribution prior to sampling (e.g., Cooper 1993). Consequently, CVM often requires time consuming and costly pretests. Moreover, although the dichotomous choice method appears to be superior to other methods in terms of the psychological challenge presented to respondents, it still requires subjects to respond to questions on issues that they may not have fully considered (Harris et al. 1989). In addition, the CVM estimates of willingness to pay have been found to be sensitive to the embedding effects and to descriptions of substitutes. For example Kahneman and Knetsch (1992), Loomis et al. (1993), and Hoehn and Loomis (1993) suggest the willingness-to-pay estimates depend upon whether the good is

[4] In the traditional travel cost model, the quality variables may be included only if there are several sites to be considered or if visits to the sites are measured at different times, with the quality conditions changing over time.

defined to be embedded in a larger bundle of goods.

C. The Hypothetical Travel Cost Method

One advantage of CVM over TCM is that it allows the net benefits of policies to be estimated without actually being implemented. Managers often require information on how individuals will value a recreational site with different levels of quality at the site. Also, managers are interested in the changes in value that may occur under various management options that have never been implemented. The traditional TCM does not adequately address either of these considerations. However, this advantage comes at the cost of protest and strategic responses, and anchoring and starting point biases.

The methodology we propose is a blend of the TCM and CVM methods. We use the number of trips taken and the travel costs incurred to estimate the demand for recreation opportunities under current circumstances. We then construct hypothetical management scenarios and ask the respondent how many trips they would have made under those circumstances. We call this method the hypothetical travel cost method (HTCM). The markets we construct are considerably simpler than those used in CVM studies. In contrast to traditional CVM models, price and payment vehicle are not explicitly stated. However, the contingency questions follow questions about actual trips taken to the site and to substitute sites, actual expenditures per trip, and hypothetical questions about what the respondent would have done if they had not taken the trip in question. Therefore, respondents are reminded of their decisions under actual conditions prior to answering questions about hypothetical behavior. Respondents are also likely to treat the chinook salmon fishing trip as an ordinary commodity since their participation involves direct expenditures and they typically have a history of using the resource (Vatn and Bromley 1994). Since price does not change with the circumstances, we believe that the travel cost is an unbiased measure of cost for these hypothetical questions.

Since management conditions can be controlled by resource managers, qualitative differences and the effects of possible management policies are tested using three policy-oriented HTCM questions. Four observations were obtained from each respondent. They are the actual number of trips that they made to the Gulkana River and the number of trips that they would have made under three hypothetical management conditions. The four observations on the ith respondent are:

v_i^1 = actual visits to the Gulkana River in 1992;

v_i^2 = hypothetical visits to the Gulkana River contingent on the harvest of increasing from 2,000 to 4,000 chinook per year;

v_i^3 = hypothetical visits to the Gulkana River contingent on the bag limit increasing to two-per-day and two-in-possession, while holding the total harvest of chinook at 2,000 per year;

v_i^4 = hypothetical visits to the Gulkana River contingent on a total season bag limit of five chinook salmon, while holding the total harvest of chinook salmon at 2,000 per year.

The hypothetical visitation rate equations quantify changes in consumer surplus that occur from changes in visitations as a consequence of possible management conditions. The number of visits per angler to the Gulkana River will increase or decrease depending on whether they expect the hypothetical management proposal will have a beneficial or detrimental effect on the value they obtain from chinook salmon fishing.

The HTCM framework broadens the TCM model to include possible management policies that have yet to be implemented. For fish and game managers, this type of analysis offers distinct advantages over the traditional TCM model. Specifically, managers will have a tool for forecasting how different tested management proposals will affect the consumer surplus values of recreational participants before actual proposals have been put in place. Only a few studies (Ribaudo and Epp 1984; Forster 1989; and Cameron 1992) consider the incorporation of the CVM within the TCM framework. However, none of these studies used a methodology similar to that developed here. Cameron (1992) measured the demand at two different prices, the travel cost estimate of price and the contingent valuation price. Her model forces respondents to directly reveal how much they are willing to pay for access to the resource, does not allow for quality changes, and it can only be estimated for cases where substitutes do not readily exist. These drawbacks are avoided by the HTCM.

III. ECONOMETRIC RESULTS

A. Sampling Methodology

The sample was drawn from names and addresses obtained from the 1991 and 1992 annual Sport Fish Surveys conducted by the Alaska Department of Fish and Game (Mills 1991, 1992). This sample was the subset of respondents to ADF&G's random sample of licensed sport fishermen indicating that they had fished in the Copper River basin during either 1991 or 1992.[5] A survey entitled "1992 Chinook Salmon Sport Fishing Survey" was mailed out to 644 Alaskan residents on April 30, 1993. The survey consisted of 16 pages divided into seven sections. A second survey mailing occurred on June 18, 1993, to all individuals who had not responded to the first mailing. As of September 1, 1993, a total of 369 (57 percent) of the surveys had been returned. Of these, 343 (93 percent of returns) were from people who fished the Gulkana River.[6] The statistical results presented in this paper are based on these 343 surveys.

B. Econometric Design

The traditional TCM specifies the number of visits as an exponential function of travel costs and other explanatory variables. (See, for example, Smith 1975; Vaughan and Russell 1982; Strong 1983; Donnelly et al. 1985; McConnell 1985; McCollum 1986; Bishop et al. 1988; and Adamowicz, Fletcher, and Graham-Tomasi 1989.) The coefficients of exponential models can be estimated with ordinary least squares by regressing the natural logarithm of visits on the travel cost and other explanatory variables. The estimated model of the demand for chinook salmon sport fishing is represented by the semi-log equations:

$$\ln(v_i^j) = \sum_{j=1}^{4} a_j D_i^j + \sum_{k=1}^{3} \beta_k TC_{ki} + \sum_{l=1}^{m} \gamma_i Other_{li}. \qquad [2]$$

The dependent variable, $\ln(v_i^j)$, is the natural logarithm of trips (actual or hypothetical) to the Gulkana River by person i under management condition j, where $j = 1$ for actual trips, $j = 2$ for a hypothetical doubled harvest, $j = 3$ for a hypothetical doubled daily bag and possession, and $j = 4$ for a hypothetical season bag limit. The dummy variables D_i^j are demand shifters which control for the three hypothetical cases ($D_i^l = 1$ for all i). The costs for person i to travel to site k are TC_{ki}, where $k = 1$ is the travel cost to the Gulkana River, while $k = 2$, and $k = 3$, are the travel costs to chinook fishing areas on the Susitna River and Kenai Peninsula, respectively. Other variables specified in the model include annual income, education level, a binary variable for nonresponses on the income question, a binary variable to test for differences in response to first and second survey mailings, and other qualitative variables representing complementary non-fishing activities

[5] This means that there are two layers of nonresponses biases built into the estimates. Given that nonrespondents are generally less avid than respondents (Thompson 1991), the estimates are probably biased upwards.

[6] Some people fished both the Klutina and the Gulkana Rivers. The sample size for the Klutina was 73 (19 percent of returns), thus about 12 percent indicated fishing on both rivers. Estimation results for the Klutina River, which are not reported, are similar to those for the Gulkana River. These results are available from the authors.

TABLE 1
VARIABLES USED IN THE REGRESSIONS

Variable	Description	Mean	Std Dev	Min	Max
CONSTANT	= 1	1.00	0.00	1	1
DOUBLE HARVEST	= 1 if double harvest rate	0.22	0.41	0	1
DOUBLE BAG LIMIT	= 1 if double bag limit	0.26	0.43	0	1
SEASON LIMIT FIVE FISH	= 1 if season bag limit is 5	0.26	0.44	0	1
TC GULKANA	Travel cost to Gulkana	417.49	239.62	0	1,572.5
TC KENAI	Travel cost to Kenai	547.14	245.93	0	1,668.3
*MAILING*1	= 1 if first mailing	0.74	0.44	0	1
INCOME	= summer wages per week	47.43	29.47	0	125
INCOME NR	= 1 if no income reported	0.09	0.28	0	1
EDUCATION	= years of formal education	14.64	3.38	0	18
RAFT	= 1 if also used a raft	0.26	0.44	0	1
CAMP	= 1 if also camped	0.56	0.50	0	1
VIEW	= 1 if also viewed wildlife	0.58	0.49	0	1
PHOTO	= 1 if also photographed	0.04	0.20	0	1
DIPNET	= 1 if also dipnetted	0.03	0.13	0	1
SOCKEYE	= 1 if fished for sockeye	0.10	0.30	0	1
GRAYLING	= 1 if fished for grayling	0.11	0.31	0	1
NSTRIP	= number of non-chinook salmon trips to the Gulkana	0.58	1.81	0	20
MOTOR	= 1 if dislikes motor boats	0.028	0.166	0	1

(boating, rafting, canoeing, photography, wildlife viewing, and dip netting); complementary fishing activities (fishing trips for sockeye, grayling, and Dolly Varden); and opinions about management issues (limit guides, limit motorized boats, and increase access or services). Table 1 lists and defines these variables.

The HTCM questions represent the shift in the demand for chinook salmon sport fishing based on the different possible management options. Under a doubling of the harvest of chinook salmon, the intercept shifts up from α_1, to $\alpha_1 + \alpha_2$. Under a doubling of the daily bag limit the intercept is $\alpha_1 + \alpha_3$, and with a season bag limit of five, the intercept is $\alpha_1 + \alpha_4$. The change is net benefit can be estimated by calculating the consumer surplus under each shift in the demand for chinook salmon sport fish trips. The statistical significance of the change in consumers surplus can be examined with a *t*-test on the difference between the actual and hypothetical intercepts.

C. Variable Construction

The dependent variables used in equation [2] are derived from responses to survey questions on the number of trips actually made and the number of trips that would have been made under three hypothetical management options. The explanatory variables are also based on data received in the survey. The construction of the travel cost or price variable used in the Gulkana River visitation rate equations follow standard methods (Cesario 1976; Cesario and Knetsch 1976; McConnell and Strand 1981; Smith, Desvousges, and McGivney 1983; and McCollum 1986). The travel cost equation is composed of two costs—direct costs and the opportunity cost of time. Direct costs consist of expenditures on market goods incurred to travel to a site. The opportunity cost of time is an estimate of the cost of an individual's time while they are traveling to a fishing site. The following equation was used to develop the travel cost variable required for equation [2],

$$TC_{ki} = \frac{(Distance_k)(Cost\ per\ mile)}{(Group\ Size_i)} + (\%Wage)\left(\frac{Income_i}{2000}\right)(Time_k) \quad [3]$$

where $Distance_k$ is the round-trip distance from the respondent's home to fishing area k, *Cost per mile* is the variable cost per mile traveled, $Group\ Size_i$ is the number of people per vehicle on a trip to the Gulkana River, *%Wage* is the percentage of the wage rate applied to the value of recreation time, $Income_i$ is the respondent's annual income, and $Time_k$ is the round-trip travel time to fishing area k calculated from distance of the respondent's hometown to fishing site k at a speed of sixty miles per hour.

We constructed six different estimates of TC_{ki} for each observation. Two methods were used for estimating $Distance_k$ and *Cost per mile*. The first method used the average distance between a participant's town and fishing area k as reported in the *Milepost*[7] and the average *Cost per mile* reported in a 1992 American Automobile Association (AAA) pamphlet. The second method used values reported by the survey respondents. People are often unaware of the actual costs of a trip, so their behavior is determined by their perception of costs. Moreover, Donnelly et al. (1985) suggest that the perceived costs of a trip may be more appropriate measures since these costs reflect the individual's true willingness to pay. In each case, the opportunity cost of time was evaluated at 100, 60, 30, and 0 percent of the hourly wage rate (*%Wage*), following McCollum (1986) and Bishop et al. (1988).

The Copper and Susitna River basins and the Kenai Peninsula are the major road-accessible salmon fishing areas in Alaska. Fishing trips to the Susitna River and Kenai Peninsula are the principal substitutes for fishing trips to the Gulkana River.[8] Therefore, travel cost estimates to these substitute sites are included in the demand equation for Gulkana River chinook salmon fishing trips. The substitute price variables TC_{ki} k = Kenai, Susitna) are calculated using equation [3]. The variable $Group\ Size_i$ is unobserved for possible trips to the Kenai and Susitna Rivers. The observation of this variable for Gulkana River fishing trips is assumed to be the same for substitute chinook salmon trips to the Kenai or Susitna. The substitute price variables also incorporate the various wage rate estimates.

D. Gulkana River Results

Gulkana River anglers returned 343 surveys with 1,373 actual and hypothetical observations of the dependent variable. The OLS model uses only non-zero observations of the dependent variable (393 actual and hypothetical observations indicated zero trips), reducing our sample size to 979. These results are presented in Table 2. Respondents who had visited the Gulkana River in 1992 were asked to report a larger set of explanatory variables than those respondents who had not fished the Gulkana River in 1992. If a respondent had not visited the Gulkana River in 1992, they reported only whether they would visit the site under the hypothetical scenarios and demographic data. Data regarding trip expenditures and characteristics were not reported since the respondent had made no actual trips. We estimated the model for Gulkana River trips using the zero observations in a Tobit model using only the demographic variables. These results are presented in Table 3.

For model specification, we used one set of travel cost variables (AAA, 100% wage rate), to arrive at a restricted model. This model is estimated using the same set of explanatory variables across all the travel cost variable sets to allow comparisons between models. Model specification on the Gulkana River OLS equations required several steps. We began by estimating a single equation that included dummy variables to

[7] *Milepost* (Robinson 1992) is an annually updated tourist book that provides detailed highway mileage between all towns and cities in Alaska as well as between sites of interest.

[8] Fifty percent of Alaska's population lives in the Anchorage area. Twenty percent live in the Fairbanks area. These population centers are nearly equidistant from the Gulkana River. Although the Susitna Basin and the Kenai Peninsula are nearly equidistant from Anchorage, they are only about half the distance of the Gulkana River. Fishing areas on the Susitna, Gulkana, and Klutina Rivers are nearly equidistant from Fairbanks, while the Kenai River is roughly twice as far. The three fishing areas differ in angler-success, suitability for boating, and congestion. Although there are some differences in salmon run-timing, the overlap is considerable, therefore, anglers must choose between sites.

TABLE 2
OLS ESTIMATES OF THE HTCM FOR THE GULKANA RIVER

Travel Costs[a]	AAA[b]	Reported[c]	AAA	Reported	AAA	Reported	AAA	Reported
	0% wage rate		30% wage rate		60% wage rate		100% wage rate	
Variable	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*
CONSTANT	0.7091	0.75301	0.75151	0.64419	0.70262	0.63756	0.64670	0.62153
	**(5.996)	**(5.606)	**(5.992)	**(4.927)	**(5.653)	**(4.933)	**(5.221)	**(4.837)
DOUBLE HARVEST	0.33745	0.30959	0.33937	0.32290	0.33460	0.32300	0.32842	0.31999
	**(5.638)	**(4.948)	**(5.761)	**(5.245)	**(5.685)	**(5.295)	**(5.565)	**(5.271)
DOUBLE BAG LIMIT	0.30227	0.27085	0.30145	0.28251	0.29515	0.28113	0.28816	0.27759
	**(5.070)	**(4.349)	**(5.138)	**(4.610)	**(5.036)	**(4.630)	**(4.904)	**(4.593)
SEASON LIM FIVE FISH	0.21651	0.18294	0.21667	0.19217	0.21025	0.19183	0.20287	0.18917
	**(3.602)	**(2.916)	**(3.663)	**(3.112)	**(3.559)	**(3.135)	**(3.425)	**(3.106)
TC GULKANA	−0.00727	−0.000418	−0.00478	−0.00329	−0.00387	−0.00278	−0.00297	−0.00206
	**(9.410)	(0.552)	**(11.38)	**(6.136)	**(11.20)	**(7.084)	**(10.31)	**(6.885)
TC KENAI	0.00338	−0.00068	0.00143	0.00042	0.00118	0.00278	−0.00100	0.00017
	**(6.512)	*(1.974)	**(6.215)	(1.954)	**(5.128)	(1.313)	**(4.277)	(0.823)
INCOME	0.00269	0.00063	0.00574	0.00445	0.00808	0.00711	0.00936	0.00863
	**(3.115)	(0.722)	**(5.811)	**(4.012)	**(7.121)	**(5.593)	**(7.462)	**(6.330)
INCOMENR	0.5476	0.26693	0.46047	0.42691	0.57009	0.54814	0.63225	0.61809
	**(3.914)	**(2.832)	**(5.003)	**(4.359)	**(5.975)	**(5.410)	**(6.403)	**(5.973)
EDUCATION	−0.02419	−0.02755	−0.02094	−0.02276	−0.019234	−0.02112	−0.01795	−0.01998
	**(3.450)	**(3.765)	**(3.032)	**(2.805)	**(2.786)	**(2.947)	**(2.589)	**(2.797)
*MAILING*1	0.12447	0.10310	0.11494	0.11060	0.11198	0.11127	0.10695	0.10867
	**(2.606)	*(2.063)	*(2.443)	*(2.247)	*(2.382)	*(2.283)	*(2.269)	*(2.241)
RAFT	−0.16528	−0.11407	−0.15904	−0.11650	−0.15068	−0.12071	−0.13572	−0.11983
	**(3.189)	*(2.114)	**(3.107)	*(2.135)	**(2.957)	*(2.291)	**(2.669)	*(2.290)
PHOTO	0.40857	0.42578	0.41002	0.47090	0.42867	0.47846	0.44306	0.48044
	**(3.823)	**(3.806)	**(3.898)	**(4.278)	**(4.078)	**(4.384)	**(4.200)	**(4.422)
VIEW	0.1993	0.19055	0.10068	0.13762	0.10573	0.13207	0.11610	0.13541
	**(2.681)	*(2.433)	*(2.279)	**(2.971)	*(2.401)	**(2.891)	**(2.637)	**(2.991)
NSTRIP	0.65860	0.07068	0.06586	0.07323	0.06797	0.07398	0.06983	0.07440
	**(4.637)	**(4.764)	**(4.711)	**(5.016)	**(4.866)	**(5.110)	**(4.984)	**(5.161)
SOCKEYE	0.18155	0.19055	0.20110	0.17932	0.20011	0.18201	0.19826	0.18483
	*(2.418)	*(2.433)	**(2.726)	*(2.326)	**(2.714)	*(2.381)	**(2.680)	*(2.429)
GRAYLING	−0.11450	−0.13455	−0.12807	−0.14536	−0.13865	−0.15592	−0.14477	−0.16028
	(1.468)	(1.651)	(1.666)	(1.808)	(1.803)	(1.955)	(1.876)	*(2.019)
MOTOR	0.77262	0.85881	0.62069	0.76885	0.59080	0.70788	0.58448	0.67625
	**(6.064)	**(6.468)	**(4.888)	**(5.832)	**(4.634)	**(5.380)	**(4.559)	**(5.145)
R^2	0.2542	0.1858	0.2768	0.2103	0.2774	0.2237	0.2728	0.2305
N	979	979	979	979	979	979	979	979
$F(17, 979)$	**18.86	**12.42	**22.01	**15.04	**21.68	**15.96	**21.25	**16.90

Note: Numbers in parentheses are the absolute value of the *t*-statistics.
*Significant at 95 percent, ** significant at 99 percent, two-tailed test.
[a] Dependent variable: natural logarithm of the number of trips to the Gulkana River.
[b] Estimates of distance and travel costs developed from the 1992 *Milepost* (Robinson 1992) and 1992 AAA driving costs.
[c] Estimates with distance and travel costs reported by individuals in the 1992 *King Salmon Fishing Survey*.

allow for changes in the slope and the intercept of the demand equation to test for differences between the actual and hypothetical situations. Qualitative taste and preference variables were included in the model to explain additional variance. These variables represent individual preferences for outdoor recreation in the Gulkana River geographical region. We used an F-test to determine whether we could eliminate sets of variables which were insignificant in the general equation and to test whether the taste and preference effects could be restricted to being the same across equations.

TABLE 3
OLS ESTIMATES COMPARED TO TOBIT ESTIMATES OF THE GULKANA RIVER HTCM

Travel Costs[a, b]	OLS[c]	TOBIT[d]	OLS	TOBIT	OLS	TOBIT	OLS	TOBIT
	0% wage rate		30% wage rate		60% wage rate		100% wage rate	
Variable	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*
CONSTANT	0.69910	1.0248	0.68724	1.0309	0.66585	0.99952	0.63666	0.95257
	**(9.915)	**(9.713)	**(10.02)	**(9.806)	**(9.786)	**(9.592)	**(9.397)	**(9.228)
DOUBLE	0.31643	0.46385	0.32206	0.48312	0.31638	0.47493	0.30821	0.46114
HARVEST	**(4.960)	**(4.949)	**(5.168)	**(5.154)	**(5.084)	**(5.072)	**(4.941)	**(4.930)
DOUBLE	0.27932	0.40945	0.28253	0.42383	0.27499	0.41280	0.26557	0.39735
BAG LIMIT	**(4.397)	**(4.393)	**(4.556)	**(4.550)	**(4.441)	**(4.437)	**(4.279)	**(4.276)
SEASON LIMIT	0.18928	0.27746	0.19411	0.29119	0.18662	0.28014	0.17689	0.26467
FIVE FISH	**(2.955)	**(2.961)	**(3.104)	**(3.109)	**(2.989)	**(2.995)	**(2.827)	**(2.833)
TC GULKANA	−0.00807	−0.01183	−0.00540	−0.00809	−0.00442	−0.00663	−0.00345	−0.00517
	**(10.06)	**(9.845)	**(12.88)	**(12.41)	**(12.64)	**(12.20)	**(11.66)	**(11.32)
TC KENAI	0.00382	0.00560	0.00178	0.00266	0.00149	0.00224	−0.00013	0.00019
	**(6.940)	**(6.883)	**(7.424)	**(7.351)	**(6.260)	**(6.223)	**(5.284)	**(5.268)
INCOME	0.00164	0.00240	0.00496	0.00744	0.00758	0.01138	0.00916	0.01371
	(1.840)	**(4.846)	**(5.071)	**(5.059)	**(6.802)	**(6.750)	**(7.429)	**(7.356)
INCOMENR	0.43703	0.64065	0.53172	0.79764	0.64773	0.97232	0.71910	1.0759
	**(4.855)	**(4.846)	**(5.881)	**(5.854)	**(6.945)	**(6.888)	**(7.467)	**(7.392)
σ	—	1.4659	—	1.5001	—	1.5011	—	1.4962
	—	**(44.249)	—	**(44.249)	—	**(44.249)	—	**(44.249)
R^2	0.1409		0.1796		0.1807		0.1753	
$\chi^2(9)$		**1,761.81		**1,766.91		**1,766.66		**1,788.77
N	979	1,372	979	1,372	979	1,372	979	1,372
F(8, 979)	**19.76		**26.65		**26.77		**25.75	

Note: Numbers in parentheses are the absolute value of the *t*-statistics.
*Significant at 95 percent, ** significant at 99 percent, two-tailed test.
[a]Dependent variable: natural logarithm of the number of trips to the Gulkana River.
[b]Estimates of distance and travel costs developed from the 1992 *Milepost* (Robinson 1992) and 1992 AAA driving costs.
[c]OLS regressions for comparison with TOBIT regressions.
[d]TOBIT regressions using demographic explanatory variables.

These restrictions were accepted.[9] We next tested the model with coefficients on the travel cost variables restricted to being the same across equations (i.e., that the slopes were identical). The null hypothesis that they were identical could not be rejected at the 95 percent confidence level ($F_{3,951}$ = 0.168). The final model restricted the constants that represent differences between the intercepts of the actual and the three hypothetical Gulkana fishing trips. This model was rejected at a 95 percent confidence level ($F_{3,951}$ = 12.82). Thus the model specification process for Gulkana River sample demonstrates that there is a statistically significant difference between the number of fishing trips actually taken and the number of trips that would have been taken under each of the hypothetical management conditions. Furthermore, the slope of the actual and hypothetical demand curves do not differ significantly.

The Gulkana River visitation equation results are reported in Table 2. Using the criterion of McCollum (1986), the equation with the best fit based on the highest R^2 and the lowest sum of squared errors, is represented by the 60% wage rate and the AAA travel cost variable (Table 2). A comparison of the reported travel cost models showed that the models with the higher R^2 and higher *t*-statistic on income may be related. However, for the reported travel

[9] These tests are available from the authors.

cost variable, the equation with the best fit is represented by 100% of the wage rate, and the income variable shows the highest significance when compared to the other reported travel cost variable models (60%, 30%, and 0%). The weakest models occur using 0% wage rate travel cost variables.

The intercept is positive and significantly different from zero across all six equations. The coefficients on the hypothetical policy dummy variables, indicating the shift in the intercept, are also positive and statistically significant for each policy scenario. This signifies that respondents indicated that their demand for chinook fishing on the Gulkana River would be significantly increased under each of the hypothetical policies.

The coefficient on the own travel cost variables are negative across all six equations. The t-statistics on the AAA travel cost equations are higher than the reported travel cost equation. The explanation for this difference probably lies in the less accurate distance, time, and cost estimates provided by survey respondents.

Since chinook salmon fishing trips to the Susitna and Kenai Rivers were assumed to be substitutes, the sign of the substitute travel cost variables would be expected to be positive. In all but one travel cost model (AAA, 100% wage rate), the t-statistic on the *TC Susitna* variable was insignificant. After we omitted the *TC Susitna* variable, *TC Kenai* variables became positive and statistically significant for the AAA TC models; however, for the reported TC models the t-statistic was not significant (*TC Kenai* at 100% wage rate, t-statistic 0.82, at 60% wage rate, 1.32, and at 30% wage rate, 1.95). One possible explanation for the apparent lack of substitution between Susitna and Gulkana chinook salmon fishing trips is that the road accessible portions of the Susitna River and its tributaries are restricted to four three-day openings in June, while the Gulkana River is open from early June through mid-July.

Because about 9 percent of the respondents did not report income, a dummy variable *INCOME NR* was created for these people. Both the income and the income dummy variables are positive and significant across the six equations. Income for the reported travel cost equations is the midpoint of a range of incomes reported on the survey. For AAA equations, income is the mean income of the geographical region of angler residence. To measure vaidity bias (Thompson 1991), a dummy variable for respondents to the first mailing (*MAILING*1) was included. The model results also indicate that respondents to the first mailing were significantly different than respondents of the second mailing for the AAA models for the 30% and 60% wage models of the three regressions, but that it had a p-value between 0.05 and 0.1 in each of the other regressions. The significance of this variable showed that the most interested anglers responded earliest in our survey. Though we have no observations on nonrespondents, the significance of the *MAILING*1 variable suggests that our sample consists of more avid anglers than the population. Therefore, our estimates are probably biased upwards.

Education, interestingly, was significant and negative in each of the regressions. People who used rafts on their fishing trip (26 percent) took fewer trips. People who also photographed or viewed wildlife, and those who fished for sockeye salmon on other trips took significantly more trips than those who fished solely for chinook salmon. Respondents who reported that they disliked motorboats on the Gulkana River also took significantly more trips than their counterparts in the population.

Table 3 presents Tobit estimates using the 1,372 observations including the zero-trip observations. In all cases, the models in Table 3 are estimated using AAA estimates of travel cost. The zero-trip dependent variables are taken to be the natural log of 0.0001 since the log of zero is not defined. This is clearly ad hoc, but it gives an idea of whether or not the zero observations affect the results. The variable σ is the estimated standard deviation of the error distribution. The model does not change in terms of significance and sign of the variables at all with the inclusion of the zero-visit observations and the Tobit estimation. However, the coefficients in the Tobit model are al-

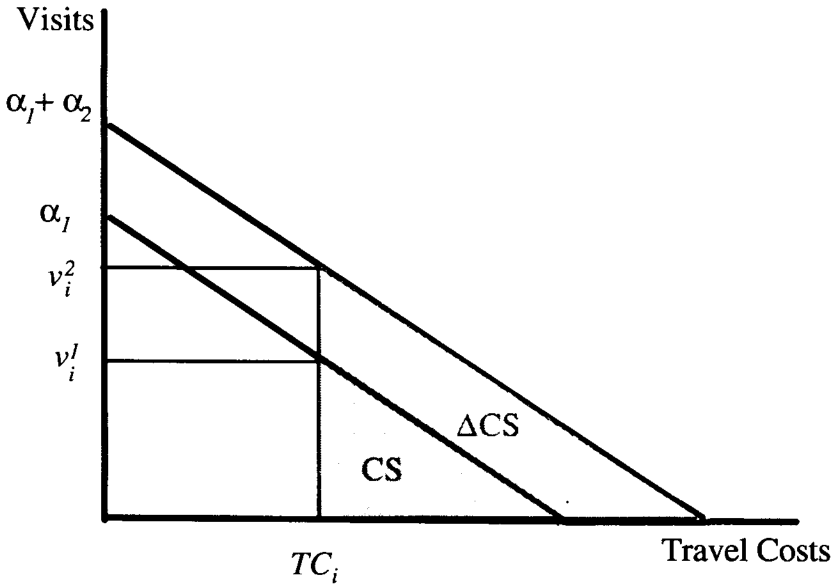

FIGURE 1
CHANGE IN CONSUMER'S SURPLUS FOR HYPOTHETICAL TRIPS

ways larger in absolute value than in the OLS model.

E. Consumer Surplus Estimates

Consumer surplus represents the benefit that individuals derive from an activity in excess of their participation costs. The goal of the travel cost method is to develop consumer surplus or benefit estimates for nonmarket activities. The consumer surplus for chinook fishing on the Gulkana River is the area below the travel cost visitation curve and above the travel cost incurred by each individual. This relationship is shown in Figure 1 assuming all other demand shift variables have a minimal effect on shifting the demand curve. The consumer surplus is

$$CS_i = \int_{TC_{1i}}^{\alpha} \exp\left(\sum_{j=1}^{4} a_j D_i^j + \sum_{k=1}^{3} \beta_k TC_{ki} + \sum_{l=1}^{m} \gamma_l Other_{li} \right) dTC_1 \quad [4]$$

where TC_{1i}, is the ith observation travel cost to the Gulkana River. Equation [4] provides an estimate of total individual consumer surplus.

The mean number of trips and the mean number of days for each policy scenario is presented in Table 4. The interesting thing to note from Table 4 is that even though the number of trips increases for each of the hypothetical scenarios, the *length* of trip declined relative to the status quo. Indeed, the total number of days respondents indicated they would spend on the Gulkana River declined for each of the hypothetical management scenarios relative to the status quo.

Table 5 presents estimates of the consumer surplus using equation [4]. The median estimate of consumer surplus is higher for the Reported travel cost models than for the AAA travel cost models for every management scenario and for every wage rate percentage. For the Reported travel cost models, the management policy "double harvest rate" produces the largest consumer surplus for every wage rate percentage.

TABLE 4
MEAN NUMBER OF TRIPS AND DAYS/TRIP SPENT AT THE GULKANA RIVER

Management Option	Number of Trips	Days per Trip	Total Days
Actual Trips (status quo)	2.67	5.5	14.68
Hypothetical Trips (double harvest)	3.29	3.7	12.17
Hypothetical Trips (double daily bag limit)	3.19	3.9	12.41
Hypothetical Trips (season bag limit of five fish)	2.79	3.5	9.77

However, for the AAA travel cost models, the largest consumer surplus occurs with the "double harvest rate" policy for the 30% and 60% wage rate models and with the "season bag limit of five" for the 0% and 100% wage rate models. In all cases except the AAA 100% model, the status quo model produces the lowest consumer's surplus.

An alternate measure of consumer surplus is consumer surplus *per day* (see Morey 1994). Estimates for Gulkana River chinook salmon fishing trips consumer surplus per day are contained in Table 6. These estimates are calculated from the empirical distribution of the consumer's surplus estimates for each individual using equation [4]. The per day consumer surplus estimates were created by dividing the results of equation [4] by the mean number of trips and then by the mean number of days under each policy scenario. The estimates of the mean consumer's surplus per day range from \$16.99 to \$60.80 for actual trips (depending upon the wage rate used). Doubling the 1992 harvest results in mean consumer's surplus from \$23.07 to \$81.94 per day. Doubling the daily bag limit results in consumer's surplus from \$21.89 to \$77.74 per day. Implementing a season bag limit of five chinook results in consumer's surplus of \$27.07 to \$96.17 per day. In each of these cases, the most conservative estimates were provided by the AAA travel cost equation using 30% of the wage. (This equation also provided the highest R^2 statistics.) The means are also higher than the medians in every case, indicating that the distribution has a "fat" tail on the right-hand side. However, the median estimates (and the 25 percent and 75 percent quartiles) show the same pattern in measures of consumer's surplus per day. In every case, the estimates suggest that the hypothetical policy scenarios provide greater net benefits to Gulkana River chinook anglers. The hypothetical trips for a season bag limit of five generated the greatest net benefit while net benefits for trips based on doubled harvests, doubled daily bag limits, and actual trips followed in decreasing order. Note that the per day consumer surplus estimates and the season consumer surplus estimates do not produce identical orderings. This suggests that Morey's (1994) concerns regarding con-

TABLE 5
MEDIAN OLS CONSUMER'S SURPLUS ESTIMATES (SEASON) COMPARISONS

Percent Wage Rate	Actual Trips (Status Quo)	Double Harvest Rate	Double Bag Limit	Season Bag Limit of Five Fish
		AAA Estimated Travel Cost		
100	523.93	540.35	522.71	642.28
60	397.24	550.45	532.51	397.64
30	328.24	338.57	327.50	328.47
0	222.99	230.01	267.81	277.08
		Reported Travel Cost		
100	791.84	872.95	844.50	827.71
60	587.05	640.87	620.00	609.75
30	494.28	544.24	526.56	518.79
0	397.24	453.94	439.19	433.30

TABLE 6
CONSUMER'S SURPLUS ESTIMATES (PER DAY) FOR CHINOOK SALMON FISHING ON THE GULKANA RIVER

	Percent Wage Rate	AAA Travel Costs Mean	AAA Median 25%	AAA Median 50%	AAA Median 75%	Reported Travel Costs Mean	Reported Median 25%	Reported Median 50%	Reported Median 75%
Actual Trips (Status Quo)	100	$42.28	$30.58	$35.69	$46.26	$60.80	$45.59	$53.94	$64.84
	60	$32.35	$23.56	$27.06	$35.77	$44.74	$33.93	$39.99	$47.85
	30	$26.05	$19.19	$22.36	$28.56	$28.91	$37.64	$33.67	$39.58
	0	$16.99	$12.78	$15.19	$18.28	$32.35	$23.56	$27.06	$35.77
Double Harvest Rate	100	$57.17	$38.04	$44.40	$57.56	$81.94	$58.42	$71.73	$90.46
	60	$43.84	$39.38	$45.23	$59.78	$60.36	$44.07	$52.66	$65.77
	30	$35.36	$23.87	$27.82	$35.53	$37.86	$50.80	$44.72	$54.58
	0	$23.07	$15.90	$18.90	$22.74	$43.84	$30.39	$37.30	$48.48
Double Bag Limit	100	$54.24	$36.09	$42.12	$54.60	$77.74	$55.42	$68.05	$85.82
	60	$41.59	$37.36	$42.91	$56.71	$57.26	$41.81	$49.96	$62.40
	30	$33.55	$22.65	$26.39	$33.71	$35.91	$48.20	$42.43	$51.78
	0	$21.89	$15.09	$17.93	$21.58	$41.59	$28.83	$35.39	$45.99
Season Bag Limit of Five Fish	100	$67.11	$56.32	$65.74	$69.57	$96.17	$70.25	$84.72	$104.19
	60	$51.46	$35.43	$40.70	$53.79	$70.82	$52.45	$62.41	$76.04
	30	$41.50	$28.86	$33.62	$42.95	$45.15	$59.59	$53.10	$62.93
	0	$27.07	$19.22	$28.36	$27.49	$51.46	$36.53	$44.35	$55.99

sumer surplus per day are empirically validated by this study.

Table 7 contains estimates of mean consumer surplus using the OLS and Tobit models of Table 3. These results are produced as per day estimates using the AAA travel cost estimates. The main conclusion from Table 7 is that there does not appear to have been a bias resulting from omission of the zero-trip respondents. That is, the estimated per day consumer surplus value of a day of fishing on the Gulkana River does

TABLE 7
TOBIT/OLS CONSUMER'S SURPLUS ESTIMATES (PER DAY) COMPARISONS

	AAA Travel Cost % Wage	TOBIT Mean	OLS Mean
Actual Trips (Status Quo)	100	$36.71	$35.67
	60	$28.31	$27.73
	30	$22.99	$22.54
	0	$15.14	$14.93
Double Harvest Rate	100	$49.15	$47.93
	60	$38.01	$37.36
	30	$30.94	$30.44
	0	$20.35	$20.14
Double Bag Limit	100	$46.62	$45.47
	60	$36.06	$35.44
	30	$29.35	$28.88
	0	$19.31	$19.11
Season Bag Limit of Five Fish	100	$57.87	$56.25
	60	$44.75	$43.85
	30	$36.43	$35.72
	0	$23.95	$23.63

not change when the zero-trip responses are included and the truncation taken into account.

While it is not clear how respondents understood the hypothetical questions, familiarity with other ADF&G management practices might have helped. For example, a season bag limit could be enforced by having anglers record their catches on the back of their sportfishing license as is currently required for chinook catches on the Kenai Peninsula and in the Susitna drainage. In retrospect, it is apparent that some of the respondents were concerned that increased sport fishing catches would have adverse effects on future salmon stocks. The survey failed to assure respondents that the catch increases could be accommodated either through restrictions on commercial fishing effort or through intensified hatchery activities. The commercial fishery on the Copper River Flats (Gulf of Alaska) accounts for an average of over 80 percent of total (sport, subsistence, and commercial) catches of Gulkana River chinook salmon.

However, our approach allows respondents to predict their own response to alternative policies. For example, fishermen may not expect to double their own daily catches under a doubled daily bag limit. Nevertheless, respondents are better able to predict how the policy change will affect the net benefits that they will obtain from the fishery than are the analysts.

IV. DISCUSSION AND CONCLUSIONS

The first objective of this paper was to develop an estimate of the monetary value of chinook salmon sport fishing for the Gulkana River. While the consumer surplus or economic value estimates may not conform to one precise number due to limitations in the travel cost methodology, they do provide a range of estimates that may be useful for resource management, allocation, and policy decisions.

The second objective was to develop a methodology for addressing hypothetical policies within a TCM framework. Our purpose here was to discover possible changes in recreational fishing demand based on proposed policy initiatives. Table 4 presents the consumer surplus estimates of three hypothetical policy options in comparison to consumer surplus estimates for actual Gulkana River sport fishing trips. In every case the hypothetical management conditions provided higher economic values.

Overall, blending hypothetical questions with the travel cost methodology was successful. However, hypothetical travel-cost questions need to provide an easily understood description of the policy options that are of interest. This, of course, is no different from what is required to implement the contingent valuation method. Furthermore, we believe that the problems that have lead the CVM research away from using simple open-ended surveys does not seem to be as troublesome with the HTCM. In addition, this research has shown that the hypothetical travel-cost method is consistent with the TCM in that the travel cost variable and tastes and preferences variables affect actual trips and hypothetical trips in the same manner (e.g., Kealy, Montgomery, and Dovidio 1990). Future research would need to test whether the predictions are reliable in a test-retest framework and whether they are valid in a test-retest framework where the hypothetical situation is realized.

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