A Discrete Choice Contingent Valuation Estimate of the Value of Kenai King Salmon

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ABSTRACT: A new method for estimating the demand curve for publicly supplied goods when quantities are restricted to a few discrete levels is introduced. The method involves fitting a conditional logit model to choices from a set of survey options in which price and quantity are both varied and consumer *attitudes* are explicitly controlled. The estimated parameters of the valuation function serve to trace the marginal value of the good at each level of hypothetical consumption in survey data. We apply the method to the valuation of salmon on Alaska's Kenai River. We find that there is a distinct kink in the marginal valuation function and that sport fishermen may place a negative marginal value on fish permits exceeding their desired catch levels.

1. INTRODUCTION

In this study we develop a method for measuring the demand curve for a publicly supplied good when that good is provided in only a few discrete

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quantities, and consumer attitudes are a major factor in determining willingness to pay. We began our research as an investigation into the economic effects of altering the King salmon catch limits for sport fishermen on the Kenai River. The Kenai River is the world's premier salmon fishery with Kings of over 60 pounds not uncommon. At the time of the study a sport fisherman could catch and keep at most two Kings, and the Alaska Department of Fish and Game (ADF&G) was considering reducing this limit to one King or increasing it to three, or possibly five or more Kings. As an increase in the number of King salmon allocated to sport fishing is achieved by reducing the allocation to commercial fishing, the optimal policy depends on the marginal value of salmon in sport fishing at each catch limit. If the value of a salmon in sport fishing at the current catch limit exceeds its value in the commercial fishery an increase in the catch limit is potentially beneficial from society's view point. We therefore sought a measure of the consumer valuation of different catch limits on the Kenai River which incorporates the diversity of tastes in the population.

Two features of this problem serve to differentiate it from previous work in the valuation of publicly supplied goods. First, the good is inherently discrete; the catch limit under study is confined to one, two, three, four, or five King salmon. Although this range could conceivably be extended on the basis of analysis, the ultimate number of outcomes is likely to be small. To adequately reflect the lumpy nature of the good, a discrete choice analytic framework is called for. Second, the quantities for which valuations are required are mostly outside the range of previous experience on the Kenai River. Given the low catch limit historically in effect, extrapolating a demand curve based on a travel cost methodology might yield unreliable results and be quite sensitive to model assumptions. We therefore work within the contingent valuation (CV) framework. A third difference is manifested in how we analyze the CV data, as we incorporate consumer attitudes into the core of the model.

In the simplest sense, contingent valuation is a survey approach in which respondents are asked what they would be willing to pay for one or more levels of a good. The respondent's willingness to pay is said to be "contingent" on the conditions of the hypothetical scenario(s) posed. The contingent valuation framework is extremely flexible and its acceptance in both applied and theoretical work has increased rapidly.[1] In cases where the quantities of the public good of interest have not been experienced, CV may be the only available method of measuring economic value.

Our methodology consists of the application of the CV model to a multinominal discrete choice problem to trace out a complete demand curve. It can be seen as a direct descendant of estimation methods developed within a CV framework for binary choices.[2,4][2] Bishop and Heberlein for example looked at the issue of how to value a goose permit, which allowed a hunter to take one goose in the Horicon preserve in Wisconsin. It can also be seen as the discrete analogue of estimating willingness to pay as a continuous function of the level of the public good.[3] It differs from hedonic CV approaches that include quality or quantity as a continuous right-hand side variable[(3)] or which measure the value of a continuous characteristic variable such as average fish size or average catch rate.[(12)] By design, these latter studies look at either a small portion of the willingness to pay (WTP) schedule of measure average WTP. By contrast, we measure willingness to pay for each quantity of interest to yield a complete demand curve.

It is instructive to note the relationship of our paper to contingent ranking.[(1,10)] In a contingent ranking exercise, respondents are given several different packages, each of which consists of a bundle of goods or the same good with different characteristics, and are asked to rank order the packages in terms of their preferences.[4] Our method is simpler since it requires respondents to pick only their most preferred package; it does not ask them to rank order the remaining alternatives. This is less demanding for the respondent in the field, and is consistent with behavioral models that do not assume complete rankings of alternatives. Also within our choice sets, the respondent always has one option that involves a zero monetary expenditure. This avoids a potential anomaly of contingent ranking exercises, in which the top ranked choice is not actually purchased and the preference rankings reveal nothing about willingness to pay.

The remainder of this paper is organized as follows: in Section 2 we provide background to the study and describe the target population, the survey instrument, and summary statistics of the main variables. In Section 3 we develop the theoretical model that guides our econometric specification and interpretation of our results. Section 4 contains estimates of the model parameters and the results of our CV methodology. Finally, the conclusion suggests directions for further work.

2. STUDY BACKGROUND

In 1985 the Alaska Department of Fish and Game funded a major study to measure the economic value of the sport fisheries in Southcentral Alaska. This study included estimation of aggregate expenditures of sport anglers by water body and species, the regional economic impact of angler spending, consumer's surplus measures of sport fishing by water body and species, and a variety of other studies made possible by the survey design.[5] The population of interest for this paper was the set of Southcentral Alaskan households with one or more members who fished in 1986. Those households were identified via a 7500 household post card survey of a random sample of Southcentral Alaskan households. Fishing households identified were asked to fill out a series of diary questionnaires on their fishing trips. The experimental CV questions on which this paper is based were appended to the end of the last diary questionnaire.

From the final data set, a subset was selected for the analysis of the contingent valuation questions. This subset included individuals who had responded to all of the diary questionnaires, and who provided consistent data on the number of King salmon they expected to catch, the number of days they expected to spend King salmon fishing in the coming season, and who filled out the contingent valuation questions. This subset consists of 669 households.[6] The CV questions, which constitute the basis of our data, are reproduced in Table 1. The survey module begins by asking how many days

Table 1: Valuation Questions

Some people in the last survey suggested that one way to improve conditions on the Kenai River would be to start charging a fee for catching and keeping Kenai King salmon (using the money collected to improve the King salmon fishery). Please tell us what you would do in the following three situations.[1]

Situation 1

Suppose that when you purchased your fishing license at the beginning of the season you had to get a Kenai King salmon stamp that allowed you to catch and keep a specified maximum number of Kenai Kings. If the fees for the stamps, which allow different numbers of Kings to be kept cost the following amount (in addition to the standard Alaskan resident fishing license fee), which **one** would you buy?

Choose one option

- ☐ No Extra Fee/Maximum 1 Kenai King allowed to be kept
- ☐ $10/Maximum 2 Kenai Kings allowed to be kept
- ☐ $25/Maximum 3 Kenai Kings allowed to be kept
- ☐ $50/Maximum 5 Kenai Kings allowed to be kept
- ☐ $250/Maximum 10 Kenai Kings allowed to be kept
- ☐ Would not fish for Kenai Kings therefore no stamp needed

Situation 2

Here is a different situation. Now assume that special Kenai King salmon stamps cost the amounts listed below. Given the alternatives, which one would you buy?

Types of King Salmon Stamps (choose one)

- ☐ $10/Maximum 1 Kenai Kings allowed to be kept
- ☐ $50/Maximum 2 Kenai Kings allowed to be kept
- ☐ $100/Maximum 3 Kenai Kings allowed to be kept
- ☐ $300/Maximum 5 Kenai Kings allowed to be kept
- ☐ $5000/Maximum 10 Kenai Kings allowed
- ☐ Would not fish for Kenai Kings therefore no stamp needed

[1]The third situation dealt with the respondent's perception of an ideal regulation scheme and is not considered in this paper.

Table 2: Stamp Prices, Average, and Marginal Salmon Prices

Number Kings	Situation 1 Stamp Price	Situation 1 Average Price	Situation 1 Marginal Price/King	Situation 2 Stamp Price	Situation 2 Average Price	Situation 2 Marginal Price/King
1	$0.00	$0.00	$0.00	$10.00	$10.00	$10.00
2	$10.00	$5.00	$10.00	$50.00	$25.00	$40.00
3	$25.00	$8.33	$15.00	$100.00	$33.33	$50.00
5	$50.00	$10.00	$12.50	$500.00	$100.00	$200.00
10	$250.00	$25.00	$40.00	$5000.00	$500.00	$900.00

the angler expects to spend fishing for Kenai Kings in the next year, and how many Kings he expects to catch and keep. The two CV questions hypothesize that the number of Kings one could catch and keep would be determined by a stamp purchased with one's fishing license. Stamps permitting between one and ten Kings are offered according to a price schedule, and the respondent is asked to state which he would purchase, if any, in each hypothetical price-quantity scenario. A listing of the full price schedules appears in Table 2, and the response counts appear in Table 3.

In Situation 1, looking only at those who would fish (PCT—P column), about 57 percent of the sample will stop at one fish. This implies that they value a second fish at less than $10 since the price of going from one fish to two fish is $10. About 28 percent value the second fish at more than $10, 9 percent are willing to pay at least $15 for a third fish, about 4 percent will pay $12.50 per fish for a fourth and fifth King, and one person would pay $40 per fish to go from 5 to 10 Kings. The zero stamp row of Situation 1 corresponds to the case in which the respondent would not fish for Kenai Kings even if the stamp were free, and accounts for about one third of the sample.[7] The second situation allows us to refine what we know about

Table 3: Responses to the Contingent Valuation Questions

Choice Stamp	Situation 1 (N = 669) Count	Situation 1 Pct	Situation 1 Pct_P[1]	Situation 2[2] (N = 449) Count	Situation 2 Pct	Situation 2 Pct_P[1]
0	220	32.9		378	56.5	35.0
1	259	38.7	57.0	255	38.1	56.0
2	130	19.4	28.0	29	4.3	6.4
3	41	6.1	9.1	7	1.0	1.6
5	18	2.7	4.0	—	—	—
10	1	.1	0.2	—	—	—

[1]PCT_P = percent of those who would actually fish for Kenai Kings.
[2]Situation 2 reports responses for the 449 respondents who would fish in Situation 1, if there were no charge.

persons who value the first King at some positive price. In this higher priced scenario where the first fish costs $10 and the second costs an additional $40, fully 35 percent of the sample would not fish for Kenai Kings. Fifty six percent would pay $10 for the first fish, but only 6.4 percent would go to the extra $40 for the second fish.

This brief perusal of the data indicates that about a third of the anglers would not pay $10 for their first fish, two thirds would pay more than $10, over 6 percent would pay $40 for a second King and about 10 percent would pay more than $15 for a third King. The question that remains is how to translate these casual observations into systematic estimates that can be used to guide policy. This is the subject of the next section.

3. THEORETICAL VALUATION MODEL FOR THE CONTINGENT VALUATION SURVEY

To analyze the responses to the contingent valuation questions, we develop a model of respondent behavior consistent with potential survey responses. The model is used to structure both the formulation of the statistical specification and the interpretation of the results.

The questionnaire asks individuals to evaluate scenarios in which they can catch and keep different numbers of Kenai King salmon by paying fees for special fishing licenses. The hypothetical choice is intended to reveal respondents' preferences for Kenai King salmon and their willingness to pay for greater access to the sport fishery.

The possible responses to the questionnaire can be classified into two groups. The first group comprises individuals who have no interest in catching and keeping Kenai Kings even in the present system in which there is no charge. These people may prefer catch and release salmon fishing, or they may prefer catch and keep fishing at some other location, or they may not engage in King salmon fishing at all. The second group is comprised of individuals who want to catch and keep King salmon on the Kenai River but who might forego or reduce this activity if the required license was sufficiently expensive.

Respondents are placed in the first group if they indicated that they do not expect to catch any Kenai River Kings next year and if they checked the alternative "Would not fish for Kenai Kings so no stamps needed" in choice Situation 1. All other respondents are presumed to belong to the second group.[8]

Our primary analysis is on the responses of the 449 persons who would fish at a zero stamp price, as these individuals provide us with willingness to pay information.[9]

We assume that individuals choose their most preferred option when selecting among alternative fishing licenses, and that their preferences vary with both systematic (measurable) factors and random (nonmeasurable) differences in tastes. The systematic factors include the license price and the number of fish permitted by the license, i.e., the price and quantity combination offered. We also believe that a key factor influencing an individual's choice is likely to be the number of Kenai King salmon he *expects* to catch and keep. How highly a license is valued by an angler should depend on whether the number of fish he or she would like to keep is more or less than the number permitted by the license.

To formalize this we introduce some notation. For convenience, we employ the vocabulary of utility maximization to develop the model, but the rationality assumptions of this choice model are fairly weak. Let U_i $(i = 0, 1, 2, 3, 5, 10)$ denote the utility of fishing for Kenai Kings and being allowed to keep the fish, I denote the individual's household income, and P_i denote the cost of buying the i^{th} type of license. Let X^* denote the number of Kings that individual i expects to keep in the absence of any license restrictions and let X_i $(= 1, 2, 3, 5, 10)$ denote the number permitted by the i^{th} type of license. We then write the utility of obtaining a fishing license for X_i $(= 0, 1, 2, 3, 5, 10)$ Kenai Kings as

$$U_i = V(X_i, X^*, I, P_i) + \omega_i \tag{1}$$

where ω_1, ω_2, ω_3, are error terms. If these are independent extreme value random variables with a mean of zero, the probability that an individual selects the i^{th} type of license is

$$\Pi_i = \text{Prob } (i_{th} \text{ license chosen}) \tag{2}$$

$$= \text{Prob } [V(X_i, X^*, I, P_i) + \omega_i \geqslant V(X_j, X^*, I, P_j) + \omega_j, \text{ all } _j]$$

Under these assumptions this is a multinomial conditional logit model,

$$\Pi_i = [1 + \sum_{j \neq i} \exp(V_j - V_i) \tag{3}$$

To estimate the model, we need to specify the structure of the deterministic component in (1), $V(\bullet)$. For simplicity, we assume that it is linear in $(I - P_i)$ which implies that license selection probabilities are indepenent of an individual's income. In a neoclassical utility model, it also implies that willingness to pay coincides with willingness to accept. The crucial issue is how $V(\bullet)$ depends on X_i, the number of fish permitted by the license and

X^*, the number of fish that the individual expects to catch and keep in the absence of a special license requirement. It is a fairly weak assumption to specify that the individual's utility increases linearly with X_i until $X_i = X^*$. When $X_i < X^*$, the license actively constrains the individual by preventing him from catching and keeping as many fish as he wishes, therefore, any increase in X_i makes the individual better off.

When $X_i > X^*$, i.e., when the license permits a larger number of fish than the respondent expects to keep, there are three possibilities. First, the individual's total satisfaction might remain unchanged for any $X_i > X^*$. For example, if he only expects to catch and keep three King salmon, a license permitting four or five salmon makes him no better off than a license permitting three fish. That is, the marginal value of any fish above X^* might be zero. On the other hand, an angler may feel better off with a license permitting four rather than three Kings even if he does not expect to keep the fourth fish; the larger limit might function as "insurance" against a change in desires or plans during the season. The marginal value of any "insurance" fish, while possibly positive, would surely be less than the marginal value of a fish expected to be kept. Thus the second possibility is that when $X_i > X^*$, satisfaction increases with X_i, but not as *steeply* as when $X_i < X^*$. The third possibility—which we actually observe in our data—is that, disregarding license costs, anglers actually like a license for $X_i > X^*$ fish *less* than a license for X^*; when $X_i > X^*$ the satisfaction of a license for X_i fish is lower than that of a license for X^* fish.

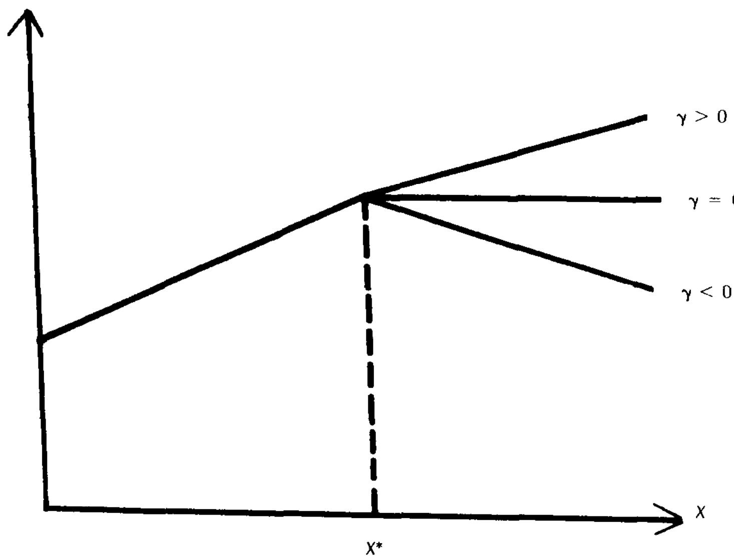
A special feature of this behavioral model is that it is anchored around and has a "kink" at X^*. To the extent that people differ in their fishing expectations (i.e., different values of X^*), they will also differ in their preferences for licenses. Algebraically, the formula for the utility function is

$$V(X_i, X, I, P) = \alpha + \beta(I - P_i) + \begin{cases} (\gamma + \delta)(X_i - X^*) & \text{if } X_i \leq X^* \\ \gamma (X_i - X^*) & \text{if } X_i > X^* \end{cases} \quad (4)$$

where $\beta > 0$ is the marginal value of money, and γ and $(\gamma + \delta)$ are the marginal value of any extra Kenai King, with $(\gamma + \delta) > 0$ and $\delta > 0$. The graph of utility as a function of the number of fish permitted by the license, X_i, is shown in figure 1.

The scenarios described above correspond respectively to $\gamma = 0$; $\gamma > 0$; and $\gamma < 0, \delta > -\gamma$. The intercept in (4), α, determines the level of utility when $X_i = X^*$. It cannot be estimated, however, because the choice probabilities depend on utility differences and the term α drops out of

Figure 1: Utility



all such differences. Thus, the estimable parameters are β, γ, and δ. In the following estimated model, we allow these parameters to vary as functions of X^* by estimating separate choice models for each group of respondents with a different value of X^*.

A possible refinement of the model is to allow the intercept α to vary across alternative fishing licenses. In the present context, it would be desirable to have a separate intercept for the special case where $X_i = 0$ (i.e., one *cannot* catch and keep any Kenai Kings). In such a model, the intercept in (4) would be replaced by the following:

$$\alpha = \begin{matrix} \alpha' & \text{if } X_i > 0 \\ \alpha' - \theta & \text{if } X_i = 0 \end{matrix} \qquad (5)$$

where $\theta > 0$ captures the extra disutility of not being able to keep any Kenai Kings at all. To estimate this model, we need a choice situation in which not being able to fish is a real option. Such is *not* the case with the first set of choices in our contingent valuation survey. Because one Kenai King is offered without a fee, there is no reason for any individual to prefer no license if he or she is interested in fishing for Kenai Kings. Therefore, that option was excluded from our analysis of the first set of choices. In the second set of choices the "zero option" is a real possibility since even an avid King angler might prefer not to fish when the fees are sufficiently high. Consequently, the option of not fishing *was* included in our analysis of the second set of choices.

Before discussing the coefficient estimates, it will be useful to show how they can be used to place an economic value on sport fishing for Kenai Kings. It follows from the economic model consisting of (1) and (4) that the willingness to pay for an extra fish up to and including X^* is

$$\text{marginal willingness to pay (\$/fish)} = \frac{(\gamma + \delta)}{\beta} \quad (6)$$

Given the individual's expected catch of Kenai Kings, X^*, we propose to measure his or her willingness to pay for this fishery by

$$\text{Value (WTP) of fishery} = \frac{(\gamma + \delta)}{\beta} X^* \quad (7)$$

This formula can be derived formally from the above structure of the choice model; it applies to the basic model (4). For the modified version, incorporating the refinement in (5), the corresponding formula is

$$\text{Value (WTP) of} = \theta + \frac{(\gamma + \delta)}{\beta} X^* \quad (8)$$

We were unable to obtain a significant estimate of θ from our data.[10] Thus, the focus will be on the model in (4) without the refinement implied by (5). Therefore, we employ the formula (7), recognizing that it will be an underestimate of the formula in (8). We now turn to the results of our econometric modeling.

4. EMPIRICAL FINDINGS

We begin our analysis with a simple discrete choice model to explain whether a respondent expected to fish for Kenai Kings. The model is formulated as a binary logit and the predictors include a short list of price, income, taste, and quality indicators obtained from other parts of the survey instrument. The estimated logit equation is displayed in Table 4.

These results indicate that individuals who live far enough from the Kenai Peninsula to require an overnight stay are less likely to fish for Kenai Kings. If an individual has a cabin on the Peninsula, or likes fishing for salmon, or

Table 4: Logit Model of Expected Kenai King Participation

Variable	*Coefficient(β)*
Intercept	−.296 (3.055)
Has cabin on the Kenai Peninsula	1.637 (5.106)
Would have to stay overnight if visiting Kenai	−0.550 (4.649)
Participates in salmon fishing	(0.348) (4.423)
Crowding tolerance index	(0.093) (2.643)
Household income	1.790 (1.571)
Travel cost per trip to Kenai River	−0.723 (0.898)

Absolute value of *t*-statistics in parenthesis.
Cabin, overnight, and salmon participation are dummy variables coded Yes = 1, No = 0.
Crowding tolerance index is from a factor analysis of attitudes toward crowding. Index is positive if the respondent does not mind crowding and negative if the respondent dislikes crowding.
Household income and trip costs are in thousands of dollars.

is relatively tolerant of crowding, the probability of fishing for Kenai Kings naturally increases. Price, as measured by travel cost per trip to the Kenai River, reduces the probability of fishing, and finally, household income raises the probability of participating in the fishery. None of these results is surprising; we present them simply for completeness.

Turning to the 449 persons who would fish for Kenai Kings, we examine their responses to the CV questions of Table I. These respondents were stratified into four groups corresponding to $X^* = 1$, $X^* = 2$, $X^* = 3$, and $X^* = 4$ or 5. The sizes of each group are at the top of each column in Table 5. For each individual there were two observations representing the choices in each license set. The two observations were pooled within each group, and the logit model derived from (4) was estimated by group. For the fourth group ($X^* = 4$ or 5), the coefficient estimates were imprecisely estimated and are not reported. The estimates for the other three groups are presented in Table 6.

The results consist of three estimated parameters: the negative of the marginal utility of money or the disutility of price, the marginal value of a fish permitted when one has fewer permitted than one would like (X^*), and the marginal utility of a fish permitted when one already has a permit for at

Table 5: Estimated Logit Model for Choice Among Alternative Licenses

	$X^* = 1$ *Subsample*	$X^* = 2$ *Subsample*	$X^* = 3$ *Subsample*
Coefficient	(N = 118)	(N = 109)	(N = 40)
Stamp cost (– β)	0.0569	–0.0679	–0.0639
	(3.29)	(5.82)	(2.81)
(γ + δ)	1.599	1.1904	0.6023
	(6.65)	(5.04)	(1.64)
δ	2.2930	1.4728	0.9885
	(8.51)	(5.88)	(1.72)
γ	–0.6940	–0.2824	–0.3862
s.e. (γ)	0.294	0.246	0.388
$\frac{(\gamma + \delta)}{\beta}$	28.10	17.53	9.43
s.e. $\frac{(\gamma + \delta)}{\beta}$	5.80	1.81	3.08

Absolute Value of *t*-statistics in parentheses
γ is not estimated directly, instead, it is derived from the estimates of (γ + δ) and δ

least X^*.[11] Estimates of $(\gamma + \delta)/\beta$ and standard errors are presented in the last two rows of Table 5.[12] We first note that the price coefficient is virtually identical across the three groups, and this is confirmed by a likelihood ratio test on the restricted model with a common price coefficient. The core results appear in Table 6, where the marginal willingness to pay is shown. The point estimates are $27.40 per fish for the $X^* = 1$ group, $17.53 per fish for the $X^* = 2$ group, and $9.43 per fish for the $X^* = 3$ group. Interpreting these dollar values as the willingness to pay for that fish which brings the total to X^*, they trace out the demand curve for one, two, and three fish.

When the permit is larger than X^* we have allowed the marginal utility to change, and it does so substanitally for each level of X^*. For each subgroup, the preferences implied by the point estimates correspond to the scenario where $\gamma < 0$. This means that the value of each fish permitted above X^*

Table 6: Estimates of Marginal and Total Net Willingness to Pay for King Salmon Catch Limits on the Kenai River

	Marginal WTP(γ < 0)	*Marginal WTP(γ < 0)*	*Total WTP(γ < 0)*	*Total WTP(γ ≠ 0)*
$X^* = 1$	$28.10	$28.10	$28.10	$28.10
$X^* = 2$	$17.53	$21.69	$35.06	$43.38
$X^* = 3$	$9.43	$15.47	$28.29	$46.41

detracts from satisfaction. One possible explanation for this negative value of the excess license was suggested by the focus groups conducted in the initial design phases of the surveys. Sport fishermen tend to regard their own X^e as a reasonable limit on catch and feel that any license allowing more than X^e fish will encourage over-harvesting of the fishery. It suggests that fishermen are considering issues of fairness and the possible deleterious externalities of over-harvesting in their valuations.[13]

For the groups $X^e = 2$ and $X^e = 3$, the estimate of γ is not statistically significant (the t-statistics are -1.15 and -0.995, respectively) suggesting that an additional fish above X^e adds nothing to utility. This is still consistent with the notion that fairness issues play a part in the license valuation. We can also conclude, though, that sport fishermen put little or no value on an "insurance" that they might ultimately want to catch and keep more fish than they originally planned for.[14]

To derive an overall estimate of the value of the Kenai River King salmon fishery to residents of Southcentral Alaska, it is necessary to apply these values to the subset of the population which is interested in fishing for Kenai Kings.[15] Among the sample of survey respondents, about 50 percent were interested in fishing for Kenai Kings; this is slightly higher than the fraction of housholds who actually fished for Kenai Kings in 1986. Given this population, the distribution of X^e is needed to apply the WTP amounts in Table 6. In our sample X^e seems to vary completely at random. We were not able to predict its value on the basis of any information available in the data set. Assuming that X^e is also distributed randomly in the population, we recommend using a value of about $40 per interested fisherman for raising individual limits to their desired catch.[16]

5. CONCLUSION

We have extended the set of techniques for the valuation of certain public goods by merging the contingent valuation and multinomial logit methodologies. The result is a method for tracing out the complete demand curve for a discretely supplied good. Further, by explicitly taking consumer tastes into account, we have obtained marginal valuations that differed depending on the quantity of the good expected to be consumed. Other measures for capturing consumer attitudes could easily be incorporated into this framework.[(4)]

Our specific results on the demand schedule for Kenai King salmon limits appear to be quite plausible. While direct comparison with travel cost estimates are inappropriate (e.g., Jones and Stokes[(7)] also value site availability, or Sorg et al.[(12)] Cameron and James[(3)], Thompson and Huppert[(13)] have valued increases in average catch) these other studies suggest an average salmon value in the range of $20 to $50. This is quite consistent with our findings.

Beyond determing a dollar value for Kenai King salmon, we have also discovered two striking results concerning sport fishermen's behavior. First, it appears that these individuals place no value on an insurance component in the license to fish. They desire a permit that increases in total value for catch limits up to their preferred catch, but which does not increase in value for levels beyond this personal limit. Second, there is some evidence that sport fishermen have a sense of fair or appropriate harvesting levels tied to a notion of preserving the fishery, and that they disapprove of permits beyond these levels, even for themselves.

Conceptually, there is more work to be done in four areas. First, we need to find a better way to model demand for the transition between zero and one King salmon. This range of the demand curve seems to be fundamentally different than that say, between two and three King salmon. Many other public goods which come in discrete quantities are likely to have similarly featured demand curves. Second, it is worth investigating the restrictions we might place on the demand curve to improve efficiency in estimation. The most obvious restriction, monotonicity, which holds for a private good, does not necessarily have to hold for a public good. Third it is worth investigating how to make the demand curve more flexible while still leaving the model relatively easy to estimate. There are a number of flexible functional forms that could be tested to achieve this objective. Implementing such techniques would require a data set that is richer in terms of the variation in the assignment of the price-quantity options. Finally, more work on capturing notions of fairness in the model needs to be done, particularly for congested public goods.

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NOTES

1. The first contingent valuation study was Davis.[5] The study of the value of air visibility improvements by Randall, Ives, and Eastman[11] is largely responsible for the current interest in contingent valuation. A comprehensive look at the theory and application of contingent valuation is found in Mitchell and Carson.[9]
2. The work on discrete choice contingent valuation methods is to some degree motivated by the perception that it is easier for a respondent to give a yes or no answer to a fixed quantity-price choice than to give his actual maximum willingness to pay for a specified quantity level and that discrete responses are somewhat less vulnerable to potential strategic behavior. The trade-off, of course, is that the discrete indicator contains much less information than the continuous willingness to pay amount.

3. These valuation functions are estimated from respondents' reports on what they would be willing to pay for a few levels of a continuous public good. See Mitchell and Carson[9] for a discussion of the issues (and review of attempts) in estimating valuation functions from contingent valuation data.
4. Closest in spirit to our method is a recent paper by Train, McFadden, and Goett[14] in which respondents chose between two competing rate structures for electric utility services. Both methods make explicit use of consumer attitudes in fitting the models.
5. See Jones and Stokes Associates[7] for further details of the study objectives, survey instruments, and preliminary findings.
6. In interpreting our results one cautionary note should be made. While this sample appears to be close to a random sample of Alaskan fishing households, it was designed primarily for the purpose of travel cost estimation for which a random sample, while desirable, is not strictly necessary. Contingent valuation, on the other hand requires a random sample of the population of interest for making concrete policy estimates. There are some minor sample stratifications, which we have ignored in the analysis to be presented and, more importantly, the population of fishing households is not well enough defined from other high-quality external sources to allow us to weight our resulting sample to look like the population of interest.
7. This should not be surprising as stamp fees may be quite small relative to other costs, such as travel and lodging. Further, special fishing tackle is required for large salmon and there are many respondents adverse to the big crowds common when the King salmon are running.
8. Of course, respondents who checked the alternative "Would not fish for Kenai Kings so no stamp needed" in choice Situation 2, but *not* in choice Situation 1, *would* prefer to fish for Kenai Kings if there were no charge.
9. We also report the results of the binary fish/nofish decision as well. Although technically the fish/nofish choice and the license choice could be placed in a single tree diagram, it is not possible to treat them as part of a nested logit model. This is discussed further.
10. The estimate of θ had the wrong sign but was small with a large standard error. We would need more data and more variation in the cost for one Kenai King to be able to estimate θ precisely. The value of θ was ultimately not of interest to the Alaskan Department of Fish and Game because the State would not consider denying an Alaskan resident the right to catch and keep one Kenai King.
11. The model as estimated was parametrized so that the last parameter measured the *change* in the slope of the marginal utility curve as the point X^*. The results are reported after transforming the original parameters and recalculating the standard errors.
12. Standard errors for linear functions of the parameters are computed from the covariance matrix of the model parameters; standard errors for nonlinear functions are approximated using the *delta* method.
13. A recent discussion of the role of such considerations in economic behavior appears in Etzioni.[6]
14. If there is a risk that ought to be insured, this behavior might parallel the failure to insure against disasters. See, for example, Kunreuther, et al.[8]
15. This assumes that the population of Kenai Kings is not threatened and that sport

fishermen would continue to have at least some access (i.e., a minimum limit of 1 Kenai King).

16. The precision of the estimates is somewhat less than might be desired for policy purposes. The most obvious remedy in a subsequent study would be to increase the sample size. We could also obtain more variation in the price-quantity combinations by randomly assigning prices (subject to an ordering constraint).

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