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On the Marginal Value of a Fish: Some Evidence from a Steelhead Fishery

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Abstract *Policymakers and other interested parties frequently request information on the recreational value of a fish. Although fishing valuation studies date back at least 25 years, most studies focus on the* average *value of a fish. If the purpose of such estimates is to measure the value of incremental changes in fish numbers, then use of average estimates may lead to an incorrect policy decisions. The objective of this analysis is to estimate the* marginal *value of a steelhead trout in a recreational fishery on the John Day River of Oregon. The study uses contingent valuation procedures to elicit willingness to pay estimates for improvements in fish numbers and success rates. For the anglers in this survey, the value of an additional steelhead is $6.65 under current catch conditions. This value is much lower than values currently used in public debates in the Pacific Northwest, but similar to some marginal values reported in the recent literature. Implications of these values relative to average values are discussed.*

Introduction

> Here is no sentiment, no contest, no grandeur, no economics. From the sanctity of this occupation, a man may emerge refreshed and in control of his own soul. He is not idle. He is fishing, alone with himself in dignity and peace. It seems a very precious thing to me.
>
> John Steinbeck (1954)

Few would question Steinbeck's belief that recreational fishing is an enriching experience. Indeed, fishing is one of the fastest-growing recreational activities in the United States. As the demand for recreational fishing increases, policymakers and other interested parties frequently request information on the value of the fishing experience, and even values for each fish caught. The latter type of information is needed in addressing issues of habitat investments, water allocations, and other factors that influence fish populations. In the Pacific Northwest, values per fish often enter into deliberations concerning the benefits and costs of meeting judicially and legislatively mandated increases in anadromous fish populations to mitigate for hydroelectric projects.

Interest in estimating the value of recreational fishing dates back at least 25 years (Brown et al., 1964). Although most studies, particularly those based on travel cost procedures, provide estimates of *average* values for fishing experiences, there is limited research on the value of incremental changes in fish numbers or fish catch (recent exceptions include Brown and Mendelsohn (1984), Samples and Bishop (1985), Cameron and James (1987), and Loomis (1988). Not surprisingly then, policymakers and others have attempted (incorrectly) to derive marginal values by dividing consumer surplus estimates for the total recreation experience by numbers of fish caught (see, e.g., Scott et al. 1987). The resultant estimates, often "transferred" by policy analysts from the specific sites at which they were estimated to other settings, potentially overstate the marginal as well as the average value of a fish. The net effect of using these "average" values for marginal values in policy decisions is readily apparent—a likely misallocation of resources when dealing with alternative habitat enhancement projects.

The overall objective of this analysis is to estimate the marginal value of a steelhead trout (*Salmo gairdneri*) in an important recreational fishery in the Columbia River Basin of Oregon and Washington. Specifically, the study focuses on the recreational value of incremental changes in steelhead catch rates on the John Day River of northcentral Oregon, a fishery characterized by an entirely self-sustaining stock of steelhead trout. The river basin is experiencing habitat investments designed to mitigate for habitat losses in the Columbia River. Previous decisions to invest in specific habitat or other enhancement programs have been based on values per fish derived from extant studies. The results of this analysis are intended to provide a more accurate measure of the marginal value of a sport caught steelhead in this setting.

Background

Over the last three decades, several methodologies have arisen to circumvent the lack of market data for public goods by either indirectly imputing a price to the good in question or by directly querying consumers as to their willingness to pay (WTP) for stated provisions of the good in question. The former approach is exemplified by the travel cost method (TCM), whereas the latter approach is the contingent valuation method (CVM).

Since the TCM utilizes actual market behavior (i.e., observed visitation rates and expenditures), it is often preferred over CVM techniques structured around hypothetical markets. Samples and Bishop (1985) successfully use the multiple-site travel cost method in estimating the value of variations in anglers' success rates for salmon and trout sportfishing on Lake Michigan. Strong data requirements, however, may preclude a similar use of the TCM to estimate marginal values on other recreational fisheries. Specifically, the TCM requires that recreationists know the fishing quality prior to visiting a site and that this knowledge translates into changes in observable behavior. Unfortunately, in many settings these requirements may not be met. A second drawback hinges on the TCM's treatment of fishing quality as an exogenously produced attribute of the fishing trip.[1] In reality, fishing quality is rarely entirely endogenous or exogenous, but is instead a combination. This is evidenced by observed variations in success rates across individuals at the same site. Individuals may alter their success rates by purchasing variable and fixed inputs such as equipment, bait, guides, or by renting a boat. Benefits arise when public policies or actions increase stock levels and lower the marginal cost of catching a fish.

When a particular resource setting is not amenable to the TCM, the CVM may be an appropriate methodology for deriving marginal value estimates. An important aspect of CVM is the user-defined contingency market, that is, a hypothetical market partially defined by the respondents' own experience and skill levels. Such a market allows the incorporation of both exogenous and endogenous components of fishing quality.

Whereas the hypothetical nature of CVM markets expands the range of environmental goods and services that can be valued, it also has the potential for introducing numerous biases. Consequently, the CVM has generated much debate, as evidenced by the large volume of literature pertaining to its potential weaknesses. Cummings et al. (1986), in an extensive review of the CVM, are generally positive with regards to the use of the CVM as a valuation procedure. More detailed discussions of this technique are found in Cummings et al. (1986) and Mitchell and Carson (1989).

Theoretical Basis

To convey the theoretical basis underlying the contingent valuation method, we begin by noting that an angler's success rate, S, is determined by both exogenous and endogenous factors:

$$S = S(F,\mathbf{W},\mathbf{Q}) \tag{1}$$

where F is the (exogenously given) fishery stock level, **W** is a vector of other exogenous factors influencing the success rate (such as stream conditions, fishing regulations, and weather), and **Q** is a vector of goods and services purchased by the individual that are used as inputs in producing a fishing trip (such as fishing equipment and guide services).

The angler's optimization problem is to

$$\text{Max } U\,[S(F,\mathbf{W},\mathbf{Q}),\mathbf{Z},\mathbf{X}] \tag{2a}$$

subject to

$$(\mathbf{P}_Q * \mathbf{Q}) + (\mathbf{P}_X * \mathbf{X}) \leq Y \tag{2b}$$

where $U(\cdot)$ is the angler's utility function, **Z** is the vector of factors that influence the quality of the angling experience (e.g., scenery and congestion), **X** is a vector of other goods, $\mathbf{P}_Q$ and $\mathbf{P}_X$ are the price vectors associated with **Q** and **X**, respectively, and Y is angler income.

The indirect utility function associated with (2) is specified as

$$V^\circ = V(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F^\circ, \mathbf{W}^\circ, \mathbf{Z}^\circ, Y^\circ). \tag{3}$$

$V(\cdot)$ gives the maximum utility attainable given the current level of prices, exogenous inputs, and angler income. The success rate does not directly enter into (3). Instead, it is determined by the other parameters. If success rates were exogenously determined, F° and $\mathbf{W}^\circ$ would be replaced by S°, yielding essentially the same specification as employed by Samples and Bishop (1985). Inverting $V(\cdot)$ with respect to Y yields an expenditure function E, where $E^\circ = E(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F^\circ, \mathbf{W}^\circ, \mathbf{Z}^\circ, V^\circ)$. This gives the minimum expenditure necessary to achieve utility level V°.

Public agencies can increase angler benefits by investing in stock enhancement projects, or by altering elements of **W** and **Z** under their control. For example, fishing regulations may be relaxed to allow larger daily limits or access to an especially scenic section of a river may be improved. This latter improvement may yield benefits both by increasing the aesthetic value of a fishing trip and by lowering transportation costs. The research described here is limited to the benefits arising from a change in success rates. Since the marginal value of a steelhead is required when evaluating the benefits arising from habitat improvement projects, we assume that these success improvements arise via an increase in stock levels.

Hicks (1943) defines four measures of welfare changes: compensating variation, equivalent variation, compensating surplus, and equivalent surplus. The compensating measures are defined as the amount of compensation, paid or received, that will maintain the individual at his initial utility level, Vo, given that the individual is allowed to adjust his consumption bundle after the change. The equivalent measures are similarly defined using the postchange utility level as the frame of reference. In the context of the CVM, these values are expressed as either the respondents' willingness-to-pay (WTP) or willingness-to-accept (WTA) to face or forego stated hypothetical changes. Without exploring the arguments as to which measure is theoretically correct, WTP values have been shown to give more consistent estimates and are thus preferred for most CVM applications (Mitchell and Carson 1988).

For valuing increments in quality, WTP corresponds to the Hicksian compensating variation, CV. Letting F' denote the new stock level, the following relation holds:

$$V(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F^\circ, \mathbf{W}^\circ, \mathbf{Z}^\circ, Y^\circ) = V(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F', \mathbf{W}^\circ, \mathbf{Z}^\circ, Y^\circ - CV) = V^\circ \quad (4)$$

or in terms of the expenditure function,

$$CV = E(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F^\circ, \mathbf{W}^\circ, \mathbf{Z}^\circ, V^\circ) = E(\mathbf{P}^\circ_Q, \mathbf{P}^\circ_X, F', \mathbf{W}^\circ, \mathbf{Z}^\circ, V^\circ) \quad (5)$$

Expression (5) is graphically presented as a bid curve in Fig. 1. F° represents stock levels under current conditions. The vertical axis measures the compensation necessary to maintain the angler at this initial utility level given changes in the stock level. For example, WTPc(+) represents the angler's willingness to pay (Hicksian compensating variation) to enjoy an increment in the stock level from F° to F^+. Similarly, WTAc(−) represents the compensation the angler would demand to voluntarily face a lower stock level, F^-. Aggregate benefits can be derived by vertically summing individual bid curves (Bradford 1970).

The thrust of the contingent valuation method is to construct a market in which the above individual can "buy" an increment or "sell" a decrement of the good. Bidding games, open-ended questions, and closed-ended dichotomous choice questions are the standard formats for these markets. In an attempt to more accurately simulate real markets, the closed-ended dichotomous choice approach offers a "take it or leave it" price for the good. These yes/no answers can then be analyzed in a discrete choice model such as the logit. Recent developments by Cameron and James (1987) expand the usefulness of these "closed-ended" answers and allow estimation of the marginal value of various attributes (i.e., elements of **W** and **Z**) of a recreational experience.

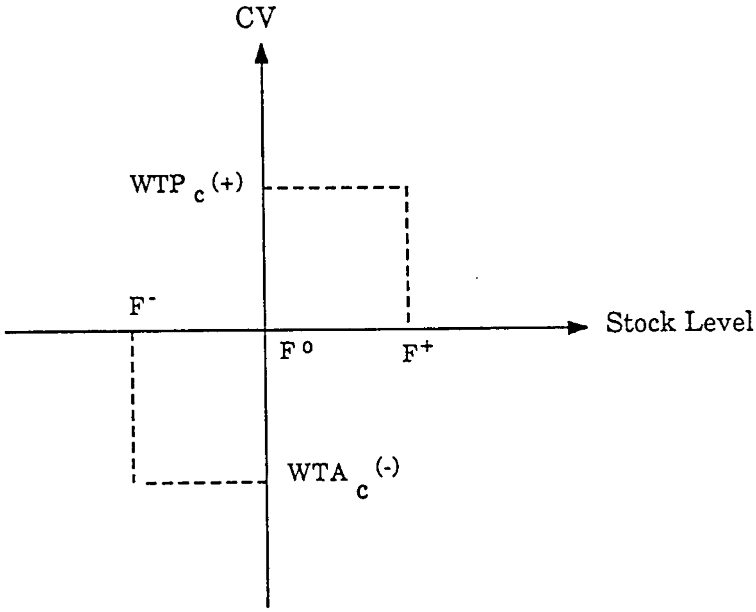

Figure 1 An individual angler's bid curve for change in stock levels.

An Empirical Application

Study Area

The empirical setting for this study is the John Day River of northcentral Oregon. A major tributary of the Columbia River, the John Day River basin encompasses 8,010 square miles in the northcentral part of the state, ranging in elevation from 150 feet above sea level at the mouth of the John Day River to 9,038 feet on Strawberry Mountain. The basin supports the largest runs of wild spring chinook salmon (*Oncorhynchus tshawytcha*) and summer steelhead in eastern Oregon (ODFW 1985). Decrease in summer flows due to riparian damage, coupled with the basin's semiarid climate, have exacerbated potential conflicts between instream and out-of-stream water users during the critical summer flow period. The basin's economy, largely centered around agriculture and livestock production, heightens the need for reliable data on the value of instream water, of which the production of salmon and steelhead are one component. This topic is explored in more detail in Johnson and Adams (1988).

Questionnaire Design

The CV questionnaire was designed and pretested on the Alsea River salmon fishery in August and September 1986. The main body of the questionnaire was devoted to collecting the angler's willingness-to-pay (WTP) and willingness-to-accept (WTA) values for stated increments or decrements in fishing quality. The procedure used to elicit WTP values for improvements in the fishing quality was as follows. First, given information on the average success rate on the John Day River in each of the preceding five years, the angler was asked to state his expected catch rate on the John Day in an average year. This gave a base level of fishing quality on which to construct the contingent market.

The respondent was then told that there were three postulated increases in the number of steelhead in the river: 33%, 67%, and 100% above the average level. The focus on benefits for improvements above the current angler success level is motivated by the Northwest Power Planning Council's stated objective of doubling Columbia River fish runs and the Oregon Department of Fish and Wildlife's goal of increasing average John Day steelhead production from the current escapement level of 15,000 adults to 23,000 (ODFW 1985). Under each of these improvement levels, the respondent was asked to state his new expected catch rate. This format allowed the angler to define the contingent market such that it reflected his own skill and experience level.

Once the contingent market was defined the respondent was asked the following questions:

> 21A. If improvement A takes place would you be willing to pay $ ______ for a John Day Steelhead Stamp? YES NO
> 21B: What would be the maximum fee you would be willing to pay? $ ______

Question 21A was stated in a dichotomous choice fashion for two reasons. First, it more accurately reflects the real marketplace for fish and wildlife stamps, a market with which anglers are already familiar. Second, it facilitates fitting a dichotomous choice model to the data, allowing estimation of expected WTPc for improvement A (see Cameron and James 1987). The proposed stamp fee levels, ranging from $2 to $24, were systematically assigned prior to each week's surveying. A questionnaire was then randomly selected prior to each interview.

Several possible sources of bias need to be noted at this point. First, following the closed-ended question with an open-ended form introduces the possibility of respondents "anchoring" on the proposed fee level. This "anchoring bias" is conceptually analogous to starting point bias in iterative bidding formats. In addition, two open-ended questions eliciting WTPe and WTAc for decrements in fishing quality had already been posed, introducing an additional source of anchoring. Another bias may be attached to the use of a "John Day Steelhead Stamp" as the payment vehicle. These biases are further discussed later.

Question 21B and all subsequent WTPc questions were stated in an open-ended fashion:

> 22A: Now suppose that, instead of improvement A taking place, improvement B occurs. What would be the maximum ADDITIONAL amount you would be willing to pay for the stamp for this additional improvement from A to B? $ ________

Under each improvement level the respondent was also asked to reveal his expected change in hours spent fishing and in the number of fishing trips taken to the John Day annually. If there was an increase (decrease) in either of these, the respondent was asked from what activity he would take this time (or what he would do with this extra time). The intent of these questions was to collect information on substitute activities and to examine the possibility of increased fishing pressure and congestion, which might negatively impact the fishery and hence lower individual benefits.

The survey was administered to 67 John Day River steelhead anglers during the

1986–1987 fishing season. Five other anglers declined to be interviewed, resulting in an acceptance rate of 93 percent. Administering the survey took 15–30 minutes each. Five surveys were deemed unusable due to key questions that remained unanswered. The question eliciting the respondent's expected catch rate under each improvement level posed the most difficulty. Failure to answer this question resulted in an undefined contingent market.

Analysis of Data

Prior to estimating willingness-to-pay values for the postulated improvement levels, the data were examined for evidence of anchoring and payment vehicle biases.

Anchoring bias. The usual test for anchoring, or starting point, bias is to regress the final bid values against the originally offered price (or compensation, in WTA questions) (Boyle et al. 1985). Utilizing this test the following relationship was obtained:

$$\text{WTPc(A)} = \underset{(4.09)}{9.58} - \underset{(-0.35)}{0.10}\ \text{FEE} \qquad (6)$$

where WTPc(A) is the open-ended bid response for improvement A (question # 21B) and FEE is the proposed stamp fee in the preceding dichotomous choice question (# 21A). Standard errors are presented in parentheses. Using this procedure, we fail to reject the null hypothesis of no anchoring bias. As noted earlier, however, a prior question had elicited the respondent's willingness-to-pay, WTPe(−), to avoid a decline in the success rate. Including this bid as an explanatory variable and retesting for anchoring bias produces the following:

$$\text{WTPc(A)} = \underset{(-0.24)}{-\,0.37} + \underset{(0.124)}{0.21}\ \text{FEE} + \underset{(0.046)}{0.97}\ \text{WTPe}(-) \qquad (7)$$

Given the t-statistic of 1.69 on FEE in this case, the null hypothesis can be rejected at the .10 significance level.[2] According to Freeman (in Cummings et al. 1986), anchoring on offered prices may not "bias" results as long as the mean of the offered bids is close to the true mean WTP. The mean of FEE is $10.32, whereas the mean WTPc(A) bid is $8.58. Thus if anchoring bias exists, its effect will be in a slight upward bias of WTPc(A) in this case. From the coefficient on WTPe(−), it is evident that respondents based their WTPc(A) bid on their prior bid. This is not unexpected; given an angler (or consumer) with certain tastes and preferences, it is likely that he would place similar value on marginal increments or decrements in quality (or quantity).

Payment vehicle bias. Prior CVM studies of recreation benefits, such as Daubert and Young (1981), have adopted the practice of throwing out "protest" bids. These are either zero WTP or large WTA bids that were felt to be protests against either the payment vehicle or the contingent market in general. This was not done in this study even though 9 of the 62 usable questionnaires had zero WTPc bids for improvement A. There are several reasons for not excluding these zero bids. First, recall that respondents were allowed to define the contingent market to reflect their own skill and experience level. Three of the zero bids can be explained by noting that these anglers did not expect a 33% increase in the stock level to change their success rate. Two other respondents expressing zero bids expected to catch at least 10 steelhead in an average year given current condition. Since anglers face a 10-steelhead per year and 2-steelhead per day catch limit in northeastern Oregon, these anglers may merely be expressing the effect of this catch limit constraint. This also raises the possibility that significant benefits may arise by relaxing current catch limits. Finally, it is interesting to note that four of the nine respondents giving zero bids for improvement A later gave nonzero bids for improvement levels B or C. Zero or low bids may partially reflect the uncertainty respondents attach to small expected improvements.

Whereas the above explanations can rationalize eight of the nine "protest" bids, it is likely that these bids, as well as other low bids, partially reflect the respondents' feelings towards a "John Day Steelhead Stamp." This type of reaction has been termed "payment vehicle bias" in the CVM literature. The broad use of this terminology is rather unfortunate. As noted by both Arrow and Kahneman (in Cummings et al. 1986), preferences are sensitive to the social arrangement within which payments are to take place. Thus it is rational for different payment vehicles to yield different WTP values. True payment vehicle bias exists only insofar as the "wrong" payment vehicle is selected for a particular study, and this misspecification leads to different WTP responses compared to the "true" payment vehicle.

In response to the above observations, Cummings et al. (1986) suggest considering ". . . what payment vehicle would most likely be employed, in fact, if the commodity were to be provided?" (Cummings et al. 1986, p. 210). Many investments in fishery enhancement in the Pacific Northwest are judicially or legislatively mandated to compensate for damages caused by Columbia River hydroelectric projects. Consumers will ultimately pay for these improvements via higher utility bills. Consequently, a utility bill payment vehicle may have been more appropriate. It should be noted, however, that the Oregon Department of Fish and Wildlife (ODFW) takes an active role in implementing habitat improvements. In postinterview discussions with several respondents, it was learned that many local anglers did not hold high opinions of ODFW. Much of this sentiment arose out of an incident in September 1982. While poisoning sections of the John Day River to eliminate trash fish, ODFW accidentally killed many early returning steelhead. Use of a steelhead stamp as the payment vehicle appears to have captured respondents' feelings toward ODFW with respect to this, and other, incidents. In retrospect, a more realistic approach would have been to use a utility bill payment vehicle combined with a clear statement of which state and federal agencies would be responsible for implementing the proposed habitat improvement projects. The effect of this survey instrument misspecification is purely conjectural but is felt to have resulted in a downward bias in WTPc values, given how habitat improvements are currently implemented and funded.

Computation of Willingness-to-Pay

Aggregate bid method. The derivation of estimates for expected willingness-to-pay for improvements in fishing quality follows the procedures of Brookshire et al. (1980). A total bid curve is obtained by aggregating individual bid curves. Since the entire population of (potential) John Day steelhead anglers was not sampled, we instead use the mean bid and quality levels to arrive at a mean individual bid curve. An important issue arises in aggregating individual values to arrive at a mean bid. An angler who fishes more often is more likely to be included in the survey. This angler may also place a higher value on an increase in quality due to the quality/quantity interaction. At the same time, he may be nearer his seasonal limit (10 steelhead in northeastern Oregon) and consequently not value an increase in seasonal catch as highly as someone who catches only one or two steelhead per year. In attempts to test for this, no significant difference could be found between bids from frequent and infrequent John Day anglers. Hence, no adjustment was made in calculating the mean bids.

The mean bid curve is graphically presented in Figure 2, where quality is represented as hours per steelhead. This curve can be represented by a quadratic functional form:

$$\underset{}{WTPc = \underset{(1.22)}{0.27} + \underset{(0.91)}{4.12}\,\Delta\,\text{HRSFISH} - \underset{(0.14)}{0.32}\,(\Delta\,\text{HRSFISH})^2 \quad N = 4} \tag{8}$$

where Δ HRSFISH is the improvement in the success rate (hours per steelhead). The values in parentheses are standard errors; the adjusted R^2 is approximately 0.95. A constant term was included since the current success level was included as an observation (i.e., WTPc = 0, Δ HRS = 0).

The Marginal Value of a Steelhead

As alluded to by Steinbeck, there is more to fishing than catching fish. This point was illustrated by two of the questions posed during the survey. When asked at what catch rate anglers would stop fishing on the John Day River, 45% reported that they would continue to fish even if they never caught a fish; 12% reported that they did not expect to catch any steelhead in an average year. Still, most anglers would agree that catching an

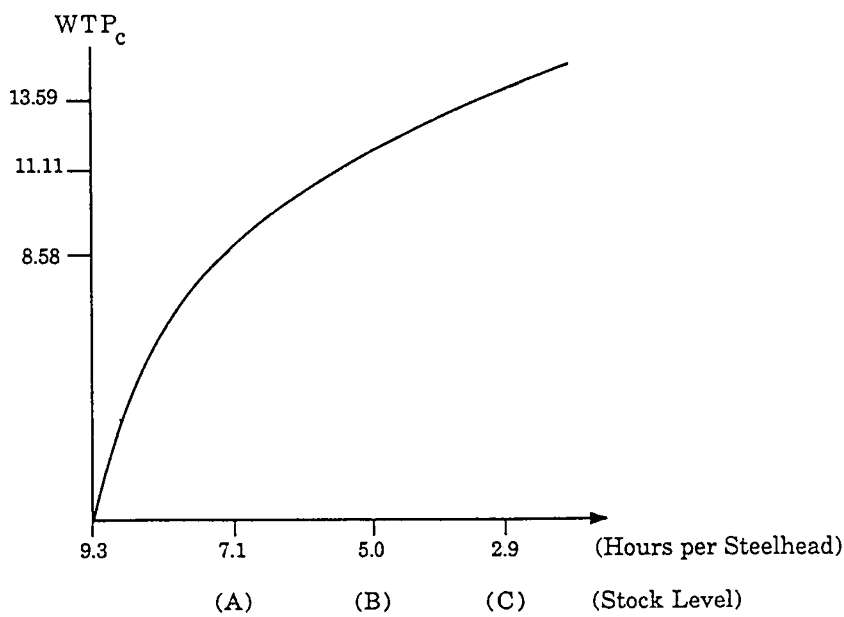

Figure 2 Mean individual bid curve for improvements in stock levels and success rates.

additional steelhead will increase the value of a fishing experience. Our concern is with what this additional fish is worth. This will depend on both the catch rate at which it is measured and whose marginal value is measured. For policy purposes, the *average* marginal value of a steelhead is appropriate. This can be calculated from Eq. (8) in combination with an estimate of average annual angler effort. From survey responses, the average John Day steelhead angler spends approximately 39 hours per year fishing and catches approximately 4.2 steelhead in a season. To catch an additional steelhead requires an improvement-in-success rate to 7.5 hours per steelhead (from the base level 9.3 hours per steelhead). Eq. (8) gives the average willingness-to-pay for such an increase in success rate as $6.65. Hence, one may infer that the average value of an additional steelhead during the fishing season is $6.65 under current average catch conditions. These values reflect only net benefits accruing to users of the resource. Estimation of nonuse benefits, such as increased existence or bequest values, was not attempted in the present study.

Currently, policy analysts in the Northwest tend to use a much higher value for salmon and steelhead than those reported here. Scott et al. (1987), for example, use $166.22 as the average economic value of a sport caught steelhead. This value was derived by dividing consumer surplus per fishing day (from Brown et al. 1980 as modified by Meyer Resources 1982) by catch per day of fishing effort. As acknowledged by Scott et al., ". . . the average consumer surplus per fish obtained in this manner is greater than the marginal increase in consumer surplus that would be obtained from an increase in catch." No mention is made of how much higher these values are.

It should be noted that there is no one correct value that can be used as "the" marginal value of fish. Values will vary by species, location, fishery quality, and angling method employed. Still, several recent studies lend credibility to the notion that values currently used for policy analysis regarding salmon and steelhead may be upper bounds. For example, Samples and Bishop (1985), utilizing a multiple-site travel cost model, estimated the average value of an additional sport-caught salmon or trout in the Lake Michigan sportfishery (mainly troll fishing) as approximately $10.25 (expressed in 1987 dollars). The base level of success was 0.47 fish per trip.

A second study, conducted by Loomis (1988), also employed a regional multiple-site travel cost demand model to estimate marginal values for salmon and steelhead caught in coastal freshwater and ocean fisheries of Oregon and Washington. An improvement in Loomis' methodology over that employed by Samples and Bishop is that it allows estimation of site-specific fish values. Estimated steelhead values, for example, ranged from $23 (1984 $s) for the Alsea River to $103 for the Nestucca River. Salmon values varied from $7.48 for the Alsea River to $64.61 for ocean fishing originating from the Port of Tillamook. Unfortunately, no reference success rates were reported for these values.

A subtle difference in how Loomis defines his marginal values compared to the definition used in this study is worth pointing out. In calculating the marginal value per fish, Loomis divides the incremental increase in consumer surplus by the change in fish catch, where fish catch is defined as fish caught and kept. The approach used in this study is similar but does not distinguish between fish caught and kept vs. those caught and released. This leads to a divergence in what is actually being measured, with Loomis' definition yielding higher values except in special cases where anglers are constrained to keep all fish caught. With data on catch-and-release percentages, it would be possible to more accurately compare estimates obtained from the two definitions.

A third supporting study was based on a survey conducted in 1984 by Cameron and James (1987). Utilizing maximum likelihood estimation techniques, Cameron and James fitted a qualitative choice model to responses from a "closed-ended" contingent valuation survey. The marginal value of a chinook salmon (caught and kept) was estimated as $14.47 (1984 Canadian $'s), whereas negative values were obtained for coho salmon. The coho values would appear to be incorrect unless one remembers that, in the fishery studied, anglers face a per-day catch limit and chinook are, in general, the more preferred fish of the two species. If an angler perceives that keeping a coho (perhaps early in the fishing trip) later lowers the number of chinook that can potentially be kept, their utility may be lowered. This again illustrates that the nature of catch limits and other restrictions may affect benefit estimates.

This study confirms other recent analyses that the marginal value of salmon and steelhead to recreational anglers may be lower than values currently used in policy decisions.[3] This implies that fisheries managers and policymakers may be overvaluing some benefits arising from anadromous fish enhancement projects, with a resultant inefficient allocation of public funds. This conclusion, however, must be tempered by the realization that many enhancement projects arise from legally mandated mitigation for fishery losses suffered due to hydroelectric project or for restoration of native American fishery rights. Also, nonuse values may be of interest. Still, an attempt should be made to clearly define and substantiate benefit estimates employed in specific project analyses.

Concluding Comments

Numerous assessments of the value of recreational fishing, based largely on the travel cost method, have been used to infer a value per fish by dividing total consumer surplus for a fishery by the number of fish caught. For theoretical and empirical reasons, use of these values as measures of marginal value is inappropriate. Nonetheless, such values have been widely used in "benefits transfer" exercises and in policy debates. The present study estimated the value of incremental improvements in a steelhead fishery and from that, the value of an additional sport caught steelhead. This value is substantially below values currently used in policy decisions but is similar to some recent estimates for anadromous fish in other areas. If policy decisions are to be based on marginal values, analysts need to understand the differences between the *average* values in the literature and marginal values. Failure to distinguish portends misallocation of scarce wildlife habitat resources.

The contingent valuation methodology is the most appropriate technique for the steelhead fishery being valued here. Whereas CVM suffers from numerous drawbacks, none proved to be severely limiting. The main "bias" observed was related to the use of a "John Day Steelhead Stamp" as a payment vehicle. However, the purpose of this study was not to establish what anglers would pay to bring about an improvement. Rather, it was to estimate how much better off anglers would be *if* an improvement did occur. The negative response observed in some bids due to this payment method may have contributed to a downward bias of this estimate.

Further research into the use of user-defined CVM markets may prove successful in decreasing hypothetical bias. Allowing respondents to define key components of the market appears especially fruitful where actual or perceived quality varies across individuals. Given the problems associated with payment vehicle "bias," a user-defined payment vehicle may also be worthwhile. This would be relevant for studies whose purpose is not to set optimal or revenue-maximizing fee levels but to obtain a general measure of consumer surplus generated by an increase in recreation quality.

Further research could also be expended on identifying the components of an angling experience. Anglers rarely base the total value of their angling experience on the number of fish caught, i.e., other aspects of the trip also have value. Focusing exclusively on the catch rate component when considering a policy designed to increase the value of a fishery ignores other attributes that contribute to net benefits. Generalizing such benefit assessments to the full set of experiences requires more data than is typically collected in such analyses. The closed-ended valuation techniques of Cameron and James (1987) may prove useful in this endeavor.

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Notes

1. This is in contrast to a third valuation procedure's (the household production function approach) treatment of fishing quality as an endogenously produced attribute.
2. Boyle et al. (1985) also found evidence of starting point bias in three CVM studies. The effect of the biases found appears small. The severity of this bias will vary case by case and is heavily dependent on the design of the survey instrument, as well as respondents' familiarity with the good or amenity being values. See Cummings et al. (1986) or Mitchell and Carson (1989) for further discussion.
3. An analysis of elk hunting in Arizona (Cory and Martin, 1985) also revealed values for an additional elk to be well below those frequently used in habitat or management decisions.

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