LITERATURE REVIEW OF METHODOLOGIES TO EVALUATE RECREATION ASSOCIATED WITH FISH IN THE SWAN RIVER DRAINAGE

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By

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I. Introduction

The State of Montana is currently considering a set of hydro projects on tributaries of the Swan River. To understand the environmental repurcussions of these hydro projects, the state has engaged in two research efforts: (1) to measure the physical changes resulting from the projects and (2) to evaluate the net losses to society these changes entail. The major expected physical change is a reduced population of certain species of fish. The purpose of this literature review is to present an overview of the various techniques currently available to measure the value of this loss of fish.

The following literature review will assess eight possible methodologies which have been used in the literature: travel cost, own price-quality travel cost, demand-system travel cost, hedonic travel cost, gross expenditure, household production function, contingent valuation, and gravity models. A brief description of each method is offered as well as critique of each method's strengths and weaknesses. The applicability of the methodology to perform the desired task -- evaluating the partial loss of a fish population -- is discussed for each approach.

II. Gross Expenditure

The gross-expenditure method infers the value of the site from the total of all expenses related to trips to the site. These expenditures would include meals, lodging, equipment, clothing, ammunition, bait, guide services, rentals, and transportation costs. With this method, the value of a day spent by a user at a site is the total of all the expenditures made over the day. Thus, the annual value of a site would be the sum of all the expenditures for all the trips users made to the site.

The technique is labelled gross rather than net expenditures because it includes purchases of goods in addition to the site. The user not only purchases access to some site A but he also buys a steak dinner and sleeps in a hotel with a pool. All the costs of these other goods, the dinner and lodging, are mistakenly lumped together with the site. In fact, it is entirely plausible that a user might like site A 20 dollars more than site B but nonetheless spend 30 dollars more on site B trips than site A trips because of a great restaurant near site B. It would be sad if managers of site A then altered their site to look like site B because of the gross expenditures. In this example, it is the restaurant not the quality of site B which drives the gross expenditures.

The gross-expenditures method consequently is a poor tool for managing outdoor recreation sites. Too much of the variation in gross expenditures is related to the purchase of other goods not directly related to the site. There is no reason to believe that sites which are the destination of more expensive trips are necessarily more valuable.

III. Travel Cost

One component of gross expenditures, the travel cost to a site, can help evaluate an outdoor recreation site. The travel cost from residence to outdoor site is part of the cost of consuming the site. In fact, the travel cost is also part of the cost of purchasing vegetables, clothes, and movies. In the case of these latter goods, however, the distance travelled tends to be small especially relative to the purchase price for the good once at the store. Thus, we have come to ignore travel cost when thinking about the price of traditional goods even though it is nonzero. For outdoor recreation sites, though, the purchase price is often trivial whereas the distance travelled can be quite large. Thus, for outdoor recreation, one can often ignore purchase price and instead focus upon travel cost as the price of a site.

In a given season, people will continue to travel to a site until the value of one more trip is no longer greater than the price. The same principle applies to all other goods purchased in the market: people continue to buy more apples until the value of the last (marginal) apple is equal to its price. Stated another way, people spread their dollars (budget) across goods to make themselves as happy as possible. The extra relative happiness they receive from the last unit of all the goods they purchase is reflected in the relative prices of the goods. Thus, the last trip to a site is equal to the price or travel cost associated with the site.

The inframarginal trips, however, are generally worth more than the marginal trip. The last gallon of water someone purchases might be worth only 2 cents, the price of the water. However, the person might have purchased 1000 gallons. If one restricted the consumer to 500 gallons, it is unlikely the 500th gallon was only worth 2 cents. If one restricts the person to 10 gallons, the person is likely to be willing to spend a great deal more than 2 cents per gallon to be allowed 11 gallons. For almost all consumption goods, people value an extra unit of the good less and less the more of the good the person has. Thus, the sixteenth trip to the fishing hole is not worth as much as if the person were allowed to go only once.

The critical issue in determining the value of a site is estimating how much the inframarginal trips are worth over the marginal trip. The net value of a site is the amount in excess of travel costs a person is willing to pay to have access to the site. The marginal trip is equal in value to the travel cost to the site. Assuming the travel cost to a site is the same regardless of the number of times one goes to a site, the net value of a site is equal to the difference between the inframarginal and marginal trips to the site.

How does one measure the value of inframarginal trips? Looking at the behavior of a single individual facing a single price for trips, it is impossible to measure the value of inframarginal trips. All one knows is that the inframarginal trips were worth taking (that they were at least as valuable as the travel cost to the site). The travel cost method first developed by Hotelling (1949) and Clawson (1959) infers the value of inframarginal trips by looking across people who face different prices. People face different prices for trips to a specific site if they live different distances from the site. Assuming the people are otherwise alike, the different number of trips people take are due entirely to the different prices (distances) the people face. The value of the inframarginal trips for a person close to the site can be inferred from the value persons far from the site place upon their own marginal trips. For example, if people from 100 miles away go to a site once, the first trip (at $.25 mile) is worth $50 (200 x .25). If people 90 miles away go to the site twice, the second trip is worth $45. If people take a third trip when they are only 80 miles away (see Figure 1), the third trip is worth $40. The inframarginal value of trips can be measured by looking at the marginal value (which is observable) of users who took fewer trips.

The value of a given site is the amount over and above the travel cost that each user will pay for each trip. The net value of the marginal trip is zero. For example, if one took the above site away from the people who lived 100 miles away, they would lose a trip which they value at $50. On the other hand, they would save $50 of expenses. The net loss to these people is zero. If one takes the same site away from the people who live

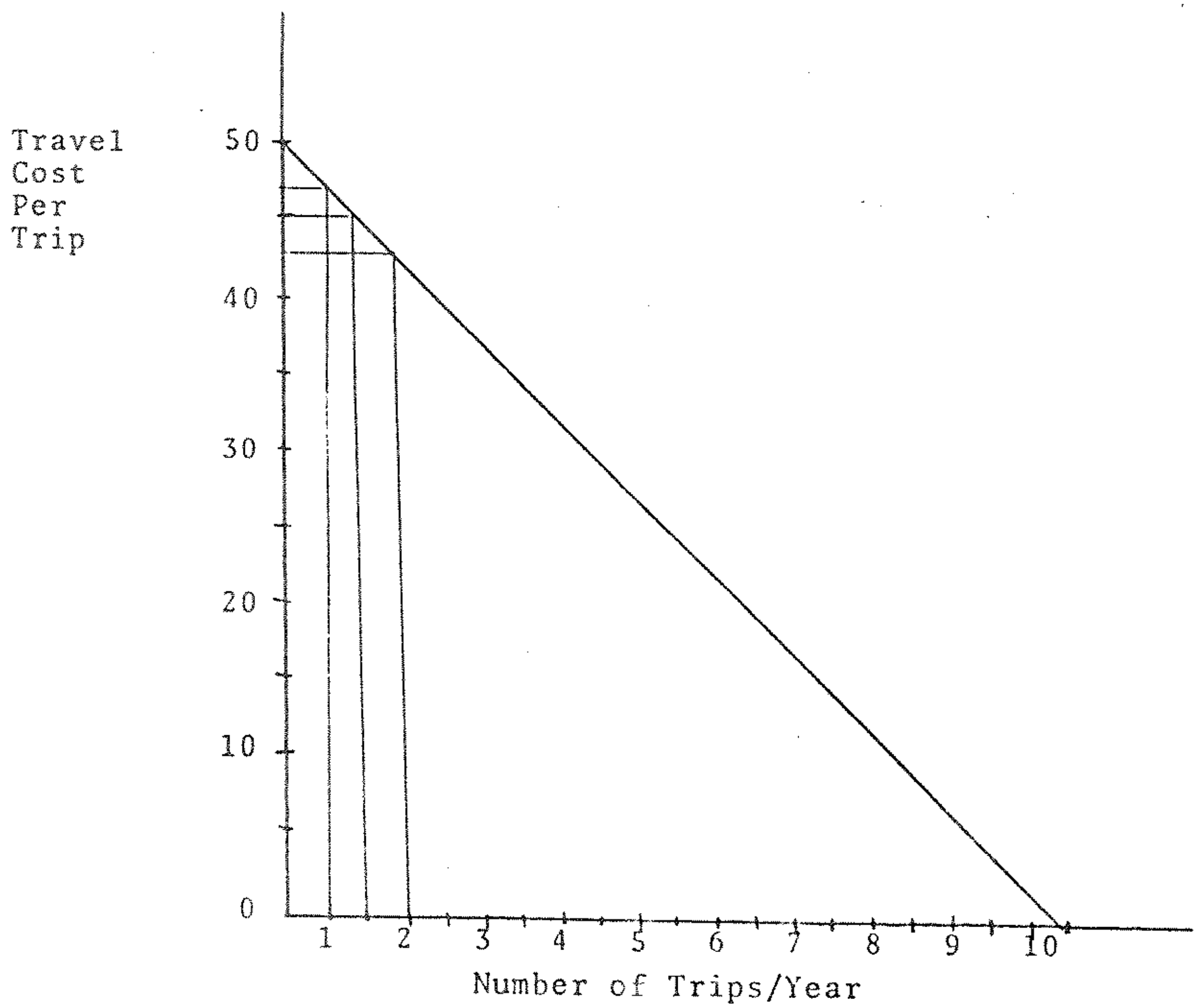

Figure 1. Annual Demand for Trips

80 miles away, they would lose three trips. The first trip they would value at $50, the second at $45, and the third at $40. On the other hand, they would save the travel expenses of three trips. The net loss would be $15. Fifteen dollars is what the 80 miles away users would pay for the all or nothing privilege of having the site exist. This net value is the consumer surplus of trips to the site and it is an appropriate measure of the value of a site.

Note that the underlying assumption permitting this evaluation of inframarginal trips is that people at different distances from the site are similar. If this assumption is violated, then it is no longer possible to assume that everyone values the first trip the same. The price of the marginal trip for the people who take only one trip would no longer be an appropriate measure of the value of the first trip of people who take more trips.

A second assumption of the technique is that the travel cost be incurred solely to arrive at the site. If, for example, people visited multiple sites, then part of the reason for making the travel expenditure is to enjoy the other sites. Attributing the entire travel cost to the target site would overstate what the person is willing to spend for the marginal trip to it. If people from further away are more likely to engage in multiple-purpose trips, it is possible to overvalue the first few trips users make and thus overestimate the consumer surplus of trips -- the value of the site. Ideally, the analysis should be limited to single-purpose trips.

A third problem of the travel-cost approach is that it is difficult to know the appropriate travel cost per mile. Some users may look at their travel choices solely in terms of the out-of-pocket costs of the trip -- the extra gasoline. Others may roll in maintenance and upkeep costs. Still others could value a mile driven at the same costs of renting a car. Finally, consumers may also value the time spent travelling. Thus, the possible range of values for a mile driven could range from a few cents a mile to a dollar or two depending upon the appropriate definition of travel cost. This range of values of dollars per mile, in turn, is reflected in a range of possible values for the site.

All three of the above difficulties are also problematic to different degrees with the alternative revealed-preference techniques. The own-price-quality, demand-system, and hedonic travel cost models all are built on the travel-cost model. The household production function and gravity models also depend upon these same travel-expenditure assumptions to infer values.

A fourth problem with the simple travel-cost model is that it measures the all-or-nothing value of a single site. Thus, for example, using travel cost one could determine the recreational value of the Swan River drainage. This would certainly serve as an upper bound of the value of a loss in fish population in the valley. However, the Swan River Valley, even with the reduced fish population, would nonetheless continue to provide recreational services. The total value of all recreation services in the drainage may grossly overestimate the partial loss of service due to the reduced fish. The simple travel cost is designed to value sites, not changes in the sites. As such, it is inappropriate, as a measure of the value of fish, except as a biased upper bound.

IV. Demand System Travel Cost Model

The demand-system travel-cost model pioneered by Burt and Brewer (1981) and also applied by Cichetti, Fisher, and Smith (1972), looks at systems of sites instead of individual sites. Types of sites are ranked according to objective characteristics such as size, manmade, elevation, etc. The number of trips the consumer makes to each type of site is then compared not only to the cost of that site but also to the cost of alternative sites. For example, representing the travel cost to a type of site i as p_i, the number of trips (q_i) a consumer makes to site i depends upon the price of that site p_i as well as the price of substitute sites p_k:

$$q_i = f_i(p_i, p_k, w)$$

$$q_k = f_k(p_i, p_k, w),$$

where w represents demographic differences across people that might influence their desire to visit the site (such as their age, sex, or income).

The demand-system approach offers two improvements over the simple travel-cost which are relevant to the issue at hand. First, the demand system, by taking account of substitutes explicitly, does a better job of measuring the value of any single site. Clearly, the demand for a nice, medium-sized lake will be different if the lake is located in Minnesota or Arizona (where there may be thousands or only a handful of substitutes).

Second, the demand system offers a chance to value changes in the nature of the site. As long as one is considering changing an existing site, say i, to physically resemble another existing site, say k, the value of the change can be measured by the demand system. The value is equivalent to the change in consumer surplus associated with making site type k closer to some individuals than it was before, minus the cost of making site type i further away.

The demand-system travel-cost method consequently could be used to value change in fish population if it is possible to identify types of existing sites which resemble the transformed site. Another requirement of the demand-system approach, of course, is that it requires data about use across a wide variety of sites.

V. Own-Price-Quality Travel-Cost Model

The own-price-quality travel-cost model was first developed by Vaughn and Russell (1983). The model is on the one hand an extension of the simple travel-cost model to include quality and on the other hand a compression of the demand-system model's examination of substitutes.

With the own-price-quality model, the number of trips to a specific site is assumed to depend only on the price of getting to that site and its quality (Z_i):

$$Q_i = f_i(p_i, Z_i)$$

$$Q_j = f_j(p_j, Z_j).$$

If, in fact, people had only one site to choose from in their region but sites varied across regions, the model would be appropriate. However, in a world with substitutes, it is not at all obvious why the prices and qualities of alternative sites would not affect the number of trips a person would make to a specific type of site. The own-price-quality model assumes these substitute sites have no effect. In other words, each site draws consumers independently of all other sites. Clearly, the model implies people will be very busy in residential areas close to a multitude of possible destinations.

An advantage of the own-price-quality model is that it requires only a minimal amount of data. If the assumption that alternative sites are of little importance is correct, the approach offers an easy methodology to evaluate quality. The quality paramenters simply shifts the demand for trips. The value of the quality improvement is just the added consumer surplus (see the shaded area in Figure 2) above the travel cost summed across all individuals.

VI. Gravity Model

The gravity model, unlike the travel-cost model, was first developed for transportation engineers to predict travel burdens on highway networks rather than evaluate sites. In principle, the two models are identical. The sophisticated gravity model utilizes an individual's demand for trips to predict the number of trips a person would take and where he will go. As with the demand models, there are a variety of gravity models from naive to sophisticated.

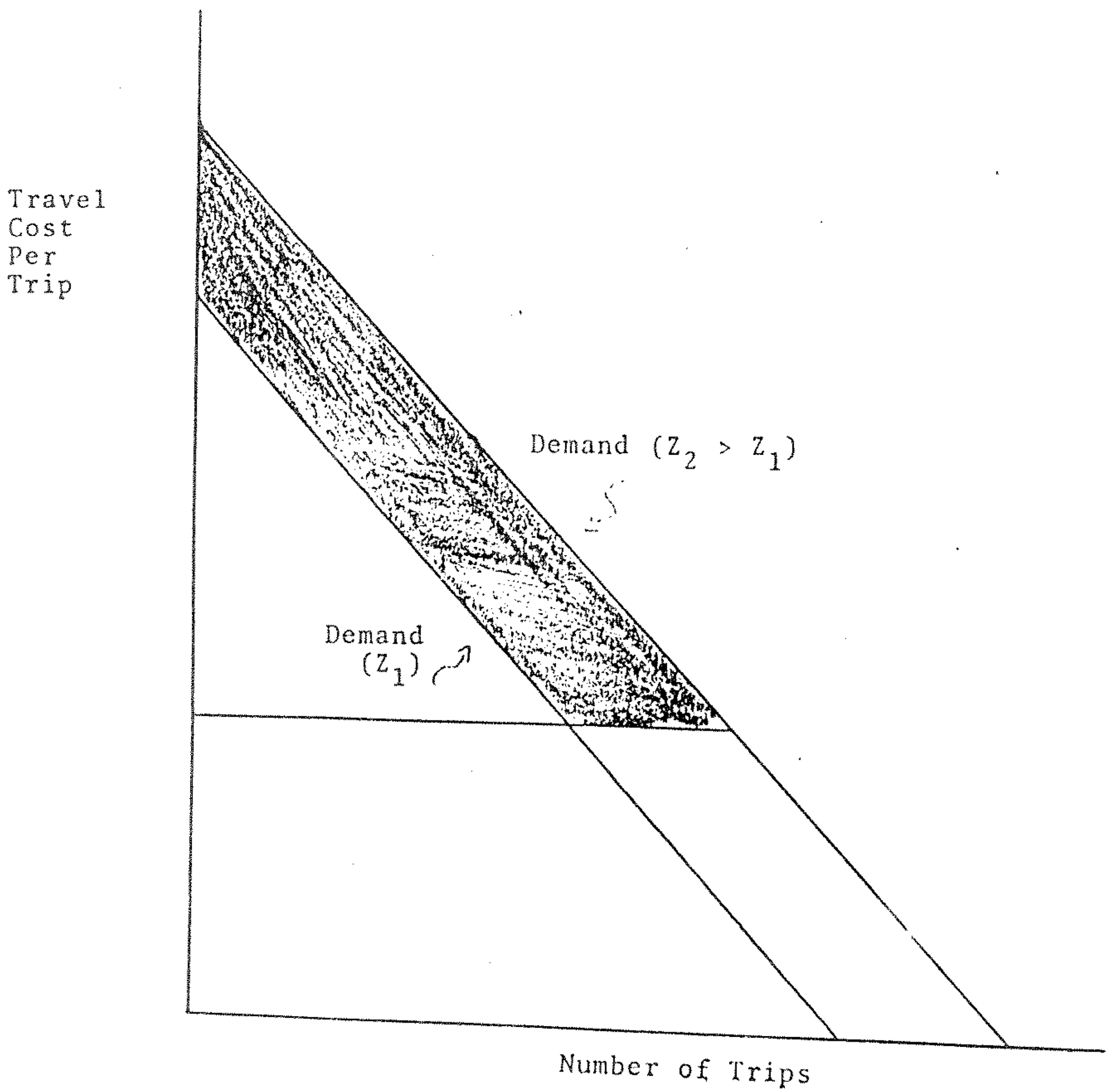

Figure 2. Demand for Quality

The simplest gravity model predicts trips in terms of the quality of the site (Z) and the cost of getting to the site (C_{ij}):

$$t_{ij} = KZf(C_{ij})$$

where t_{ij} is the number of trips per capita. Note the similarity between this model and the own-price-quality model. An implicit assumption of the model is that the number of trips from each residence i to each site j is not affected by any other possible sites.

Another common gravity model predicts trips in terms of the relative quality of each site to all other sites. Total trips are assumed exogenous; the model merely allocates the total across the available sites:

$$t_{ij} = KZ_j f(C_{ij}) / \sum_k Z_k f(C_{ik}).$$

The model is more realistic in its handling of the inter-relationship across sites because it explicitly acknowledges the relevance of substitutes. On the other hand, this formulation takes total trips as exogenous whereas one would expect that total trips would depend on the opportunities facing residents at i.

The most general gravity model resembles the advanced travel-cost models: demand-system and hedonic-travel cost. The trips function has the following form:

$$t_{ij} = kg(\sum Z_k f(C_{ik})) \cdot h(Z_j) f(C_{ij}) / \sum (Z_k) f(C_{ik}).$$

Total trips are determined by g( ), the total opportunities available. The division of trips across sites depends upon both the site's characteristics and the travel cost relative to those of other sites.

The exact functional form assumed for $f(C_{ij})$ and $h(Z)$ determines the shape of the underlying demand curve. Although, in practice, users of the gravity model tend to assume reasonable functional forms, they often restrict themselves to unnecessarily rigid specifications. Also, in practice, the users of the gravity model have failed to construct adequate submodels of the role of site characteristics $h(Z)$. For example, Cesario and Knetsch (1976) use an attractiveness index which is subjectively defined on the popularity of the site. The connection between attractiveness and objective characteristics is observed. Further, there is a possibility that attractiveness may reflect site access, a variable supposedly captured by the travel-cost function $f(C_{ij})$. Finally, most practitioners of the gravity model appear to be unaware that the specification of the gravity model implies a particular underlying demand function. For example, Sutherland (1982), estimates both a demand function and an inconsistent trip generation function in the same analysis. The trip generation function recognizes substitute sites whereas the demand function does not. Further, the estimated shapes of both functions are inconsistent with each other. The true tastes which generated the trip function could not have also produced the estimated demand function.

Because the purpose of the analysis is evaluation of sites or site quality rather than transportation planning, the gravity model is not a particularly useful transformation of the demand system model. All the insights gained from estimating the trip-generation model must be transformed back into a demand-for-trip framework. Consequently, it is generally preferable to estimate the demand-for-trip model directly.

VII. Hedonic Travel Cost

The hedonic travel-cost method, developed by Brown and Mendelsohn (1980), combines the hedonic procedure now familiar in the urban and labor literature with the traditional Hotelling-Clawson travel-cost method. Recreation sites are viewed as bundles of homogeneous characteristics. The price or cost of purchasing a bundle for a trip is the marginal travel cost from an origin to the recreation site. By examining the variety of purchases of a group of people from a single origin, it is possible to estimate the marginal expenditures necessary to purchase additional units of each characteristic. Armed with these "prices" of characteristics, the demand for each recreational attribute can be estimated by comparing origin residence zones which have varying access to sites.

The initial step of the technique is to estimate the price people must pay to obtain more of each characteristic. By regressing travel costs upon the bundle of characteristics people can purchase at each site, it is possible to estimate these marginal prices for each characteristic. Thus, for the set of plausible sites facing each residence area, one performs the following regression:

$$V = F(Z_1, Z_2, \ldots, Z_n)$$

where V is travel costs and Z_i is the level of each characteristic. As discussed in the travel-cost section, the travel cost is the total cost of travelling from the residence to the site. As such, it includes time cost, out of pocket expenses, and wear and tear on the vehicle. The exact dollar value per mile to place on travel cost is somewhat uncertain and thus the final dollar values of site characteristics are uncertain. The probable value in 1982 dollars, however, is about $.25/mile.

Every characteristic of importance should be included in the analysis. Data limitations, however, often force the analyst to choose from a more limited set. In the case of Montana fishing sites, it is probably adequate to choose two variables: scenic quality and fish density. Fish density -- the availability of fish -- can be conveniently measured in average catch per unit effort (e.g., catch per ten days fishing). Because this measure is supposed to reflect the quality of the site and not the skills of the fisherman, catch rates should be averaged across all the sampled fishermen at each site. To value specific types of fish, separate estimates of fish density must be made for each species. Scenic quality is a more difficult parameter to measure objectively. In practice, it might be sufficient to identify whether a site has below-average, average, or above-average scenery.

Having performed this initial step for each residential site in the sample, one can calculate the price each person in the sample faces for each characteristic. This price describes how much a person is willing to pay to improve each characteristic slightly. For small changes in site characteristics, these prices provide a reasonable measure of site changes. For example, if the price of fish density were $2.50 per catch per ten days and mean catch were reduced from 5 to 4.5, the value of the change would be $1.25 per trip. To estimate the total value of the site change, one would simply multiply the $1.25 per trip times the total number of trips to the site.

For large changes in site quality, the price becomes increasingly an inaccurate measure of the change. For improvements (deterioration) the price overestimates (underestimates) aggregate value. Large changes affect the price of the characteristic so that it is no longer desirable to value quantity changes at a single price. For large changes in the site, it is desirable to include the effect of price changes in a measure called consumer surplus. Consumer surplus is just the area under the demand curve (see Figure 3). To measure the consumer surplus of a large site change, for example, from $\hat{Q}$ to $\overline{Q}$, one must first estimate the demand for the relevant characteristic. The value of the change in quality is the consumer surplus (the shaded area) associated with the price change from $\hat{P}$ to $\overline{P}$. In this study, the relevant issue is the demand for and consumer surplus of fish density.

The demand for fish density can be estimated by observing how much fish density is purchased by users who face different prices for fish density. That is, by comparing the behavior of near and far fishermen, one can estimate how fishermen value access to the fishery. Removal or enhancement of a site, after all, only changes how far the fishermen must drive to obtain a site of the desired quality. The demand for the fish density of each species can be obtained by regressing the level actually purchased against the prices of each characteristic:

$$Z = g(P_{z1}, P_{z2}, \ldots, P_{zn}).$$

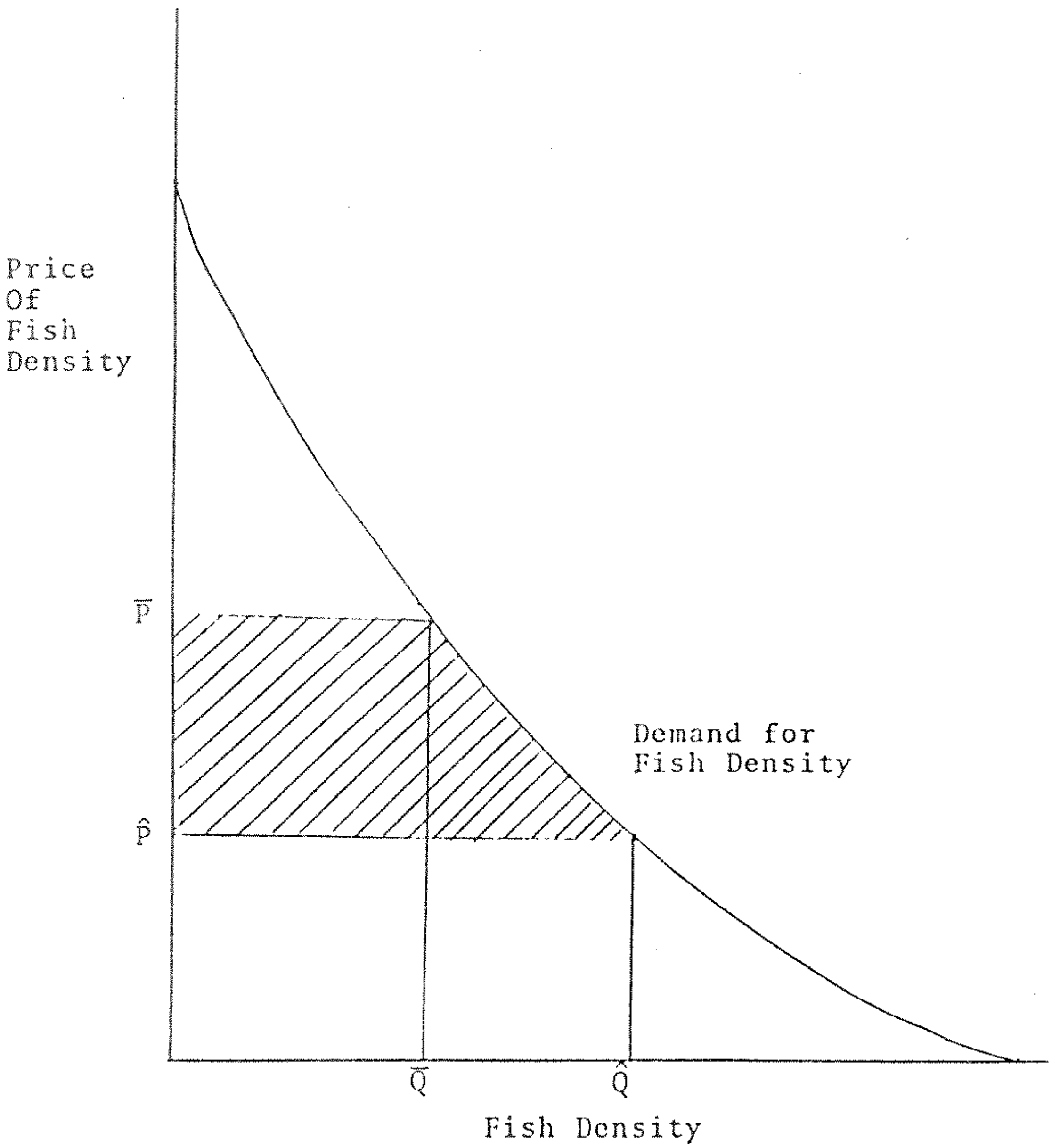

Figure 3. Consumer Surplus of Fish Density

This second regression must be done across the entire sample -- including all the residential zones in the same analysis. The shape of the estimated demand function, in turn, will lead to an estimated consumer surplus for any specified change in characteristics.

The advantage of the hedonic travel-cost method is that it focuses upon valuing site characteristics such as fish density. Consequently, it is designed to value exactly the good in question. The disadvantage of the approach is that it requires substantial data about site characteristics and user behavior. Although such data are feasible to collect, they are generally unavailable and must be explicitly collected for this purpose.

VIII. Contingent Valuation

The contingent-valuation procedure, unlike the seven other methods mentioned here, does not depend on user behavior. The value of desired commodities is revealed, instead, by how a person responds to a battery of hypothetical questions. By constructing the correct set of questions, the researcher tries to get the individual to reveal the true values.

Although the contingent-valuation approach seems the most straightforward of the methods described, it in fact is one of the most difficult of the approaches to apply. There are a number of potential problems that the methodology can encounter. A successful resolution of these problems requires substantial skill. Six biases potentially present in contingent-valuation designs have been identified: hypothetical, strategic, payment-vehicle, starting-point, information and interviewer bias.

The hypothetical bias is really just a random error that results from the person not truly answering as he would behave in a real situation. The problem arises because the person does not fully visualize the hypothectical setting, fails to account for all his feelings when put in such a setting, or does not wish to reveal his true values. The strategic bias suggests the individual intentially mis-states his preferences in order to force others to share his values. For example, someone who likes a certain public good has an incentive to overstate that preference in order to increase the average value of the good. Payment-vehicle bias reflects the fact that how people pay and whether they must pay or be paid, itself, influences their responses. Payment-vehicle bias is often used to explain the large number of protest votes encountered whenever the contingent-valuation method is used. Payment-vehicle bias, by identifying who must pay, also explains the large discrepancy between what people offer to pay versus what they think they should be paid for changes in public goods. Neither answer reflects solely the value of the good; it also reflects a sense of values about how goods should be paid for.

Starting-point bias originates from willingness-to-pay questions which request specific amounts people must pay. By starting at $25 rather than $1 infers that $25 is a low bid. People sometimes respond accordingly, with the average bid rising proportionately with the starting bid.

Information bias originates from the "facts" presented in the hypothetical question. For example, if one begins by saying that air pollution is a known health hazard and ecological disaster, one obtains a different response than if one begins by stating that air pollution is a necessary byproduct of our standard of living and causes little effect. The phrasing of the hypothetical situation consequently can alter the responses.

Interview bias arises from the fact that interviewers are different and can impose their values upon respondents. Untrained interviewers, for example, might rephrase questions to interpret them for the respondents. Depending upon the interpretation of the interviewer, a different set of responses would be forthcoming. At least with adequate training, it appears possible one can overcome interview bias.

To provide representative answers, the questionnaire must be phrased in such a way as to avoid each of these potential pitfalls. Unfortunately, not enough is known about this art to assure the accuracy of any single survey instrument. At least, a variety of questions could be asked. If all the responses are consistent, the survey instrument would be at least robust. Additional comparisons between the survey method and alternative sources of information would also provide useful indicators of the validity of the method.

Although difficult to apply, the contingent-valuation method is clearly relevant to the valuation of fish population changes. By asking the correct battery of questions, it may indeed be possible to determine the value of such changes from the answers users provide.

IX. Household-Production-Function Approach

Whereas traditional demand theory is concerned with the demand for goods observed to be purchased in the market place, the household-production-function approach concerns itself with goods produced at home. Households are perceived as suppliers of commodities which they in turn consume. The commodities are produced by combining purchased goods, household technology, and time. The approach has been used in the recreation context to value the outputs produced by users. For example, a hunter might combine a site, ammunition, rifle, and time to produce a day of hunting and a kill. Note in contrast to the travel-cost methods, the focus of the valuation is not the site but rather what the household produces at the site. The household production functions, to take another example, might value a day of fishing and catch of each species, but it cannot directly value the fish population of each species. The value of catch is a gross measure which includes the cost of catching each fish. The desired social measure is the net value of fish -- how much each user would pay to have the fish population increased (or not decreased). The gross measure is an overestimate of willingness-to-pay since the fisherman would still have his expenditures and time if he did not fish at all. To arrive at a new value, one must subtract the value of time and other expenses from the gross measure of catch value.

The mechanics of the household approach is similar to the hedonic travel-cost method. In the first stage, a cost function is estimated. The total expenditure of the trip (the gross expenditure including total time, not just travel costs) is regressed upon all the outputs produced. For a fishing trip, the obvious outputs are days fishing and catch. However, one must be careful to include other possible objectives such as days of solitude, outdoor experiences, culinary events, or attractive lodging which the fisherman may also be seeking in his trip. This regression allocates the expenditure made over the set of possible outputs. The partial derivative of this estimated cost function reveals the price of each output. Given exogenous demand-shift parameters which reflect only differences in taste, the demand for the output can be estimated in a second-stage regression.

The estimation of the demand for the outputs of the household production function are plagued by econometric difficulties. The absence of measured outputs tends to bias the estimation of the cost function. The presence of nonlinearities and joint production forces marginal prices to vary with the level of outputs purchased. The endogeneity of prices, in turn, leads to identification and selectivity bias problems in the estimation of the structual equations. These problems have yet to be overcome in a recreation-based example of a household production function.

Given the difficulty of estimating the demand for the outputs of user activities and given the policy need to estimate the demand for inputs (sites) not outputs, the household-production-function approach is not applicable. It is not user days which need to be valued but fish populations. Alternative approaches such as the hedonic travel-cost method which directly value imputs, are preferable to utilizing indirect methods that value outputs which then must be converted back to inputs.

X. Summary

To measure the net economic loss associated with the potential loss of fish population in the Swan River Drainage, we propose to adopt three independent methodologies: hedonic travel cost, demand-system travel cost, and contingent evaluation. The first two techniques estimate values based upon the observed opportunities and choices of users. The contigent evaluation method, in contrast, poses a set of hypothetical questions designed to illicit the true values of respondents. By adopting three separate approaches, we hope to increase the probability of making a reliable estimate and also compare the strengths and weaknesses of each methodology.

In the following discussion, we outline each methodology and describe how estimates will be performed.

A. The hedonic travel-cost method was designed to value the characteristics of sites. Given the existing set of sites available to a user, the marginal value of a characteristic is the extra travel costs he must pay to get a site with slightly more of that characteristic. For each user, the travel cost from the user's residential location to sites of varying quality will be computed from maps. Regressing travel cost r(V) upon the bundle of characteristics each user purchases (Z_1, Z_2...), one can estimate prices:

$$1) \quad V = f(Z_1, Z_2...).$$

Discussion with Montana Fish and Wildlife staff suggest that precise measures of characteristics may be difficult to obtain. We consequently may be limited to high-, medium-, and low-quality fish density, river vs lake, and scenic vs not scenic as the available characteristics. To facilitate making these objective evaluations, we ask fishermen to assess the qualities of the Montana sites they visit most frequently. The estimation from equation 1) will produce a set of prices for characteristics - the marginal cost of traveling to sites with more of each characteristic.

The second stage of the hedonic travel-cost method is an estimation of the demand for characteristics. This second stage reveals what people are willing to pay for non-marginal changes in the amount of characteristics. In this stage, one analyzes the users from all the residential areas. The demand curve for each characteristic derives from regressing the level of characteristics (Z) users are observed to purchase upon the prices (P) they face and demographic variables (W) such as age, sex, or income:

$$2) \quad Z_i = q(P,W).$$

The area under the demand curve between the current level of fish at Swan Lake and the proposed new level is an estimate of the value of fish de-population. (See Figure 4.)

B) The demand-system travel-cost method identifies types of sites based on their objective characteristics. Critical to this assessment is finding sites equivalent to the current Swan River drainage (including the drainage itself) and sites similar to what Swan River may become after the fish loss. Utilizing the travel cost to a site (V_i) as the price of the site K_i, one can

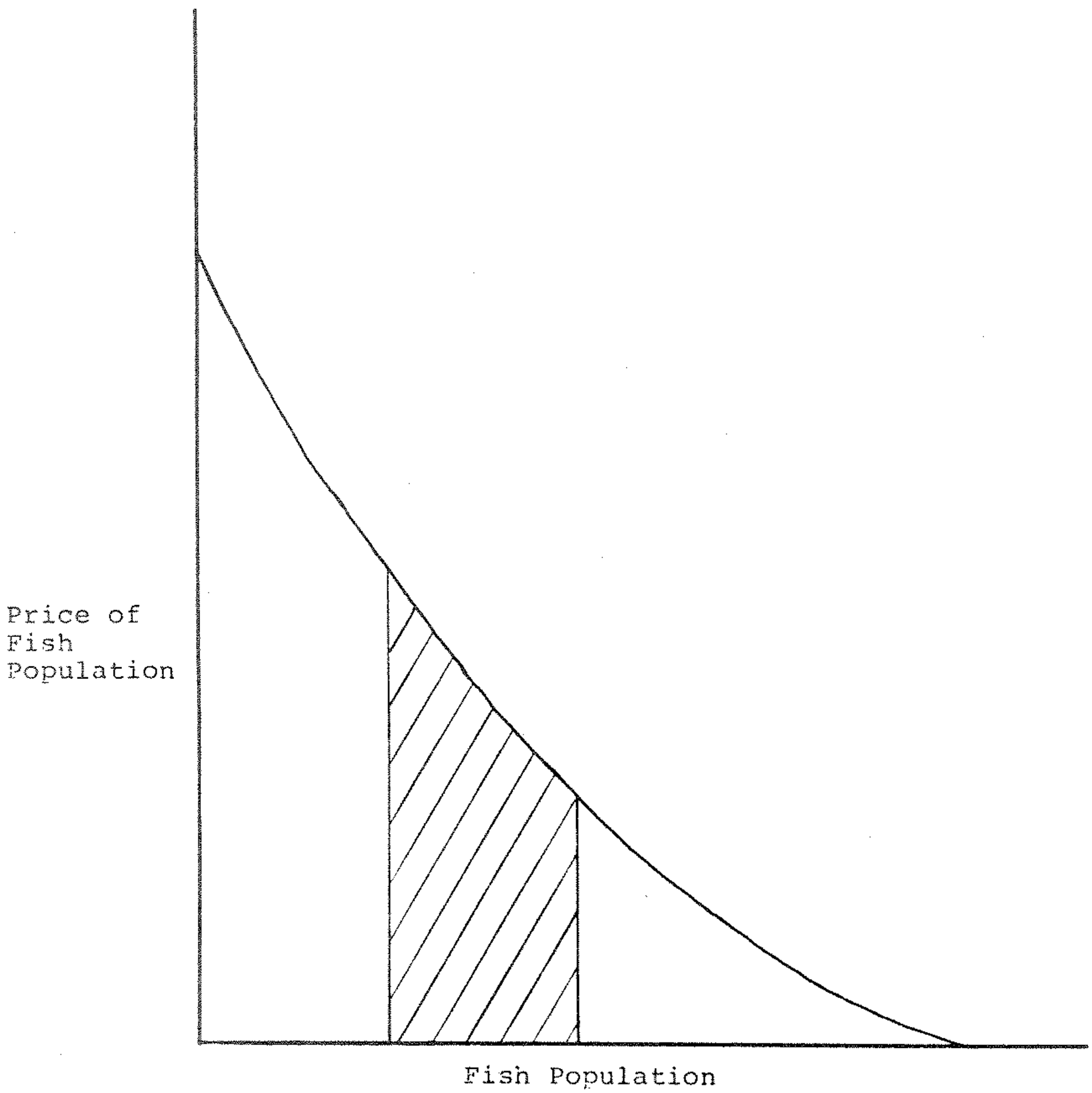

Figure 4. The Value of Fish Depopulation

estimate the prices each user must face to buy each type of site. The demand for each site is then estimated by regressing the probability of travelling to the site upon the price (travel cost) of the site, the prices of all other sites (K,) and demographic demand shift variables (W):

$$3)\quad \begin{aligned} TT_i &= f(K_i, K_j, W) \\ TT_j &= f(K_i, K_j, W) \\ TT_k &= f(K_i, K_j, W). \end{aligned}$$

The value of changing a site from type K to type J is the consumer surplus associated with making the type J site closer minus the consumer surplus associated with making the type K site further away. Thus, if the change is a loss in fish population, there is the loss of the originally good site but the gain of a new poor site. The net loss is the sum of these two effects. (See Figure 5.)

To get more information about the alternative sites Montana fishermen use, we supplement the Creel Survey with questions about where users have fished. This information should permit us to estimate the value of sites similar to the Swan Lake drainage after the decline in fish density.

C) The contingent-valuation questionnaire was designed in consultation with the Montana Fish and Wildlife staff. In an attempt to avoid biasing responses by persistent prodding or initials bids, the willingness-to-pay questions were open-ended. Because we felt that responses would be sensitive to the payment vehicle, the willingness to pay question was phrased in terms of a fund which would be used to prevent a permanent decrease in fish polulation. We felt that leaving the curve of the fish decline unspecified would not bias or distort responses. Brief

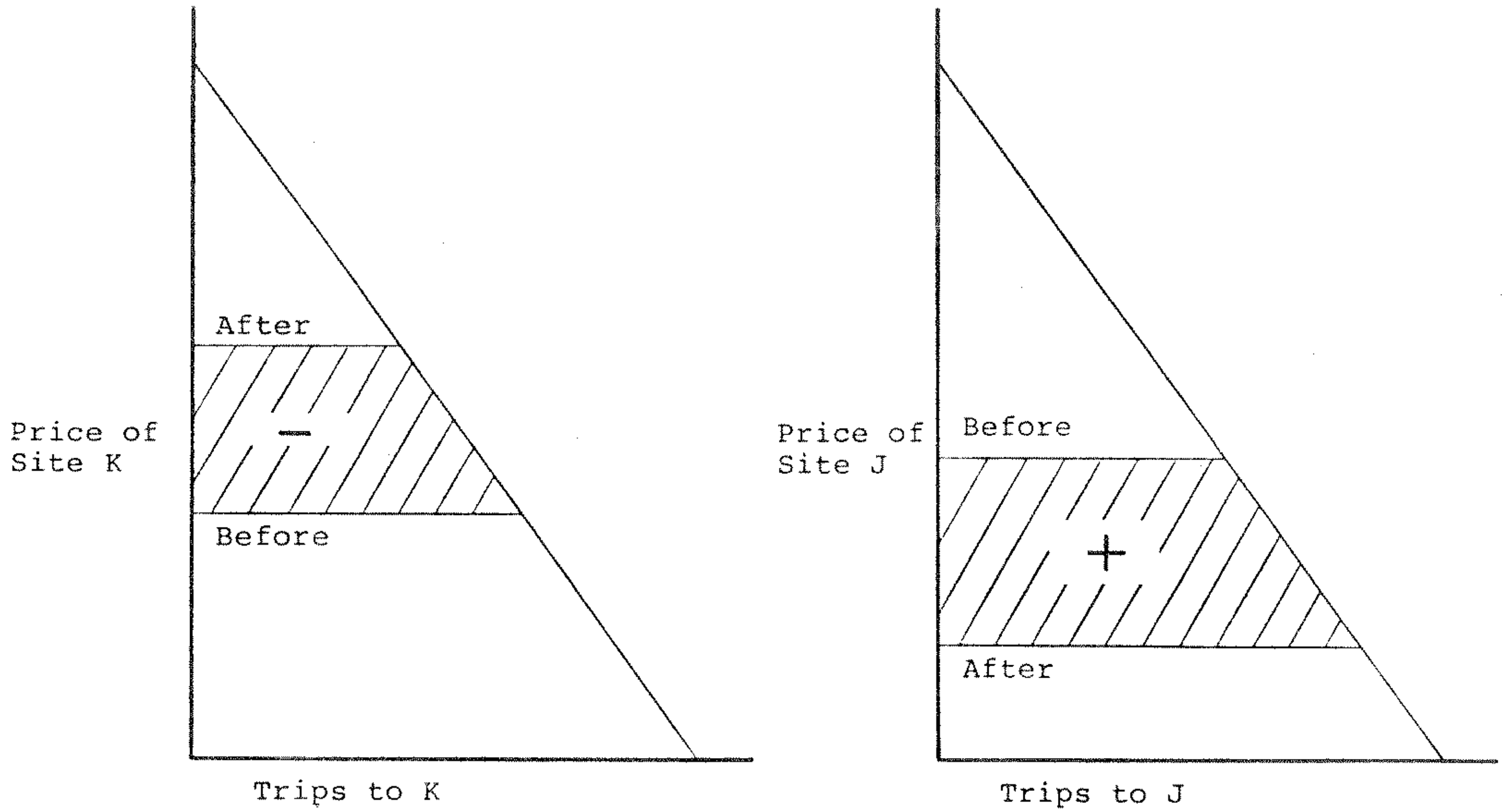

Figure 5. The Value of Changing a Site From Type K to Type J

tests of this hypothesis using a pre-test tended to support this assumption. The description of a permanent population decline was felt important because fishermen are accustomed to adjusting to natural fluctuations of fish populations across seasons. The fishermen's responses to these short-term losses would clearly be different from their reactions to longer-term declines.

One of the recurring embarrassments to users of the contingent-valuation method is the persistent differences between responses to willingness-to-pay and willingness-to-sell. Although small differences in the true value of these responses are expected, observed differences of a factor of eight throughout the literature suggests responses are biased. It is widely believed that willingness-to-sell is biased upwards. Again the pre-test confirmed this concern, and so willingness-to-sell questions were dropped from the survey.

To verify whether the willingness-to-pay question implicitly contained a vehicle bias as well, we posed a second contingent-payment question. Instead of paying in forgone income, however, the user was asked to drive extra miles to obtain an equivalent level of quality as in Swan River. The intent of this latter question is to require a less hypothetical response from the user. Presumably, the user could more accurately reflect where else he would travel in contrast to a hypothetical payment into a vaguely defined fund. The drawback of the question, however, is that one must re-value a mile driven in dollar terms. To facilitate this re-valuation, we have also asked questions about people's wage rates which, presumably, can help us estimate the value people place on travel time.

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