ECONOMIC VALUATION OF POTENTIAL LOSSES OF FISH POPULATIONS IN THE SWAN RIVER DRAINAGE

FINAL DRAFT

25 July 1984

Prepared by:

ECO Northwest

For:

Montana Department of Fish, Wildlife, and Parks

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of those who have contributed to this report, both through research and critique of previous drafts. Pat Graham at The Montana Department of Fish, Wildlife, and Parks organized this research effort. Our analysis would not have been possible without his staff's careful administration of the year-long survey to gather the data required. We especially thank Steve Leathe, fish biologist at Kalispell, who coordinated all creel surveys in the Swan River drainage and at other sites as well.

TABLE OF CONTENTS

****PAGE NUMBERS MUST BE REVISED WHEN FINAL REPORT IS FINISHED*******

SUMMARY

I. INTRODUCTION

A. The Federal Energy Regulatory Commission has received several applications for the construction of small-scale hydroelectric plants on tributaries of the Swan River. The value of these plants depends on the extent to which the benefits they generate (primarily electric power) exceed their costs (primarily construction and environmental damage). Among the likely environmental costs is a reduction of populations of fish and the accompanying reduction of the quality of sport-fishing. The primary purpose of this report is to estimate the value of recreational fishing in the Swan River drainage relative to other sites in Montana, and the costs to society of a reduction in fish populations and fishing quality in the drainage.

B. We examined eight economic techniques that potentially could estimate the value of recreational fishing (see Appendix A). From those we selected the three most likely to answer our questions about the value of fish loss. The contingent-valuation approach estimates value from the responses of fishermen to a direct question about a hypothetical (contingent) situation: How much would you pay so that fishing quality would not decrease by 25%? The simple travel-cost approach uses information about how far fishermen will travel to fish at a specific site to estimate the total value they place on that site. The hedonic travel-cost approach conbines data on travel cost with detailed information about the characteristics of different fishing sites (e.g., average size of catch, scenery) to estimate the value of each characteristic, including the size of the fish population.

II. RESULTS

A. CONTINGENT-VALUATION APPROACH

1. The economic survey asked three contingent-value questions at eleven different fishing sites, including Swan River, Swan Lake, and their tributaries. Half of the respondents, chosen at random, were asked about their willingness to pay (WTP): How much money would you be willing to donate each year to prevent a permanent decrease in fish population in the XYZ River drainage by 25%? The other half were asked about their willingness to sell (WTS): How much would you have to be compensated per year if there were a permanent decrease in fish population in the XYZ River drainage of 25%? All respondents, as a check on their answers to either WTP or WTS, were asked about willingness to drive (WTD): Given the 25% reduction in fish population, how many more one-way miles would you drive to get to a site whose quality is as good as that in the XYZ drainage before the reduction? We assume that the responses to the WTP, WTS, and WTD questions measure the value to fishermen of the 25% loss in fish populations.

2. The average (mean) value of fishing as determined by WTP responses (we abbreviate that phrase as 'mean WTP') for all sites was $35 per year with a standard error of 34.8; mean WTS was $386 per year, with a standard error of 441; mean WTD was 106 miles, with a standard error of 41.9. Neither the WTP nor WTS responses for the whole sample were significantly different from zero.

3. When examined site-by-site, mean values for WTP responses were significant in eight of the eleven sights, and varied from $11 to $36 per year. Mean WTS was significant at four of eleven sites, and varied from $25 to $1,172 per year. Mean WTD was significant at all sites, and varied from 46 to 178 miles per trip. If statistically insignificant results are included, the Swan River had the highest mean WTP, $76 per year. Kootenai River had the highest mean WTS, $1,172 per year.

4. By any of several tests, the responses to WTP, WTS, and WTD seem inconsistent.

a. Many sites with significant mean values for WTP did not have significant mean values for WTS, and vice versa.

b. The relative rankings of sites based on WTP and WTS differed markedly (but rankings based on WTS and WTD were very similar).

c. Mean WTS is over six times mean WTP for nine of the sites.

d. Large mean values determined by WTP responases were not matched by large mean values determined by WTD responses; i.e., sites high on one measure were not high on the other.

5. To evaluate the power of the contingent-valuation approach, we performed a number of hypothesis tests about the relative value of the sites. We tested whether sites were statistically different when compared on WTP, WTS, or WTD measures (given the mean values, standard errors, and number of responses). The WTP and WTS variables performed poorly, WTD slightly better. Nor were they able to distinguish sites that appeared to be superior based on other criteria (e.g., Bighorn and Swan Rivers) from other sites. All statistical tests suggest that the contingent-valuation questions in this study, as indicators of the value of fish populations to fishermen, had little ability to distinguish between high-quality and average fishing sites. We also found no significant relationship between social and demographic variables that should affect demand (like income and age), and WTP or WTS (which should be measures of demand).

6. A major problem with WTP and WTS responses is that they are highly skewed. A few repondents gave very large values,

which had the dual effect of biasing the results upward and reducing our confidence that the results constitute reliable representations of the true value the society of fishermen ascribes to fishing at these sites. For example, the median response to WTP questions at different sites ranged from $3 to $25, whereas the mean ranged from $11 to $76; for WTS the median ranged from $0 to $25 (8 of the 11 sites had a median of 0), whereas the mean ranged from $15 to $1,172.

*****PAT AND STEVE: SECTIONS B AND C WILL BE EXPANDED WHEN WE SEND THE FINAL COPY*******

B. SIMPLE TRAVEL-COST APPROACH

C. HEDONIC TRAVEL-COST APPROACH

The hedonic travel cost indicated that the most important characteristic of fishing sites is the fish species. Fishermen were willing to pay $10 and $80 more per trip to fish for trout and bulltrout, respectively. The fish population and individual fish size were also important with an average value per trip of $.32 per catch, per day, and $1.20 per inch of length respectively. Other variables such as lakes, rivers, and scenery were insignificant. The quality rather than the quantity of fishing available in Montana is responsible for the value fishermen place on Montana rivers and lakes.

I. INTRODUCTION

A. BACKGROUND

The shock of rising energy costs in the early 1970's led to increased interest in the feasibility of small hydroelectric generating facilities. By 1983 the Federal Energy Regulatory Commission had received 22 applications for micro-hydroelectric permits on tributaries of the Swan River, at or above Swan Lake. The Swan River drainage currently provides habitat for trout, salmon, and whitefish, and some of the best sport fishing in Montana. The Montana Department of Fish, Wildlife, and Parks (MDFWP) and the U.S. Fish and Wildlife Service rate the Swan River as a Class 2 fishery resource (high priority) and most of its tributaries as Class 3 (substantial fishery resource value). Micro-hydroelectric development has the potential of reducing that habitat and causing the accompanying partial loss of fish populations and sportfishing opportunities. At the most general level, the purpose of this study is to provide information that will help managers evaluate the unavoidable tradeoffs between hydroelectric power and fish.

To determine the value to society of the potential hydroelectric projects, we must know not only the benefits society receives from more or cheaper electricty, but also what society gives up when such projects are built and operated. Damage to the natural environment is an inevitable concommitant of such projects, and is a cost society must consider. (The recently released plan of the Northwest Power Planning Council reinforces this point.) Among the environmental costs are the losses of fish population. To evaluate these losses, we need to answer two distinct questions. The biological question is: By how much will these projects reduce fish populations? Given an answer to this question, an economic question follows: What is the cost to society of these expected reductions? The purpose of this study is to provide the information and analysis necessary to answer the economic question; other researchers will work independently on the biological question.

To begin to estimate the value of potential fish losses we reviewed eight techniques that economists have used to estimate the value of outdoor recreation (see Appendix A of this report). From those techniques we selected the three we determined most likely to answer our questions about the value of a loss of fish. In additon to the brief descriptions of the techniques that follow, we describe them in more detail in Sections II and III, and in Appendix A.

All three techniques attempt to measure the value of the total fish loss by looking at the values to individuals of the fish lost. The total value to society of the fish loss is the sum of what all individuals are willing to pay to prevent the loss. In this study we limit our analysis to the tastes and behavior of the individuals we sampled. Neither our budget nor our work program envisioned our estimating the total number of individual trips made from all residential origins to the eleven Montana fishing sites we examined. Our emphasis is on the relative value of these fishing sites; i.e., do people, on the average, value the fishing more at Swan River than at Kootenai River? We also estimate the prices fishermen will pay for the various aspects of the fishing experience (e.g., type, size, and number of fish caught). Our results, if combined with detailed information on site visitation, comprise the key economic data necessary for estimating the total value of fish lost at a particular site.

The **contingent valuation** approach relies on responses of fishermen in the Swan River drainage to questions such as, "How much would you pay so that fish populations would not decrease by 25%?" While one might initially expect a summation of responses to this direct question to be exactly the estimate we seek, the theoretical literature of economics and many professional studies suggest a large divergence between how people say they will respond (to a hypothetical situation) and how they actually respond (to a real situation). Economists typically favor observing actual behavior when trying to infer values.

In our analysis we use two techniques that are based on the actual behavior of fishermen who choose among a variety of potential fishing sites, some near and some far. The **simple travel-cost** method provides an estimate of the total value of a recreational fishing site by observing how far people will travel to fish in the Swan River drainage. Estimates derived using this method reflect the cumulative value of all aspects of fishing at a particular site--the fishing itself, the scenery, and so on--and, hence, provide an upper bound on the value of the partial fish loss to fishermen, a subset of the value to all members of society (though one could argue that the value to fishermen captures almost the entire value to society).

The simple travel-cost method constructs a demand curve for trips to the site by observing the number of trips per year fishermen will make from different distances. The demand curve is a graphic or mathematical representation of the relationship between the value a fisherman places on additional fishing trips to a site and the total number of trips he has already purchased. Theoretical and empirical work suggests that the value of each new unit of a good (in this case, fishing trips) declines as more of the good is purchased. The travel cost for each fisherman becomes the price of each additional (marginal) trip. In our analysis we construct demand curves for eleven different fishing sites. The value of each site is the sum of the difference between value (the demand curve) and cost (travel cost, estimated as a function of distance traveled). Economists call this difference "consumer surplus," i.e., the difference between how consumers value a resource and what they have to pay to use it. In this case, consumer surplus reflects how valuable a fishing site is and how much should be spent to preserve it.

The simple travel-cost technique estimates the value of the total site. It estimates the value of the whole bundle of site characteristics (such as scarcity, and type and size of fish). Thus, in some sense, it is inappropriate to use this approach to value a single characteristic (in this study, fish population). We suspect, however, that the primary difference in the way fishermen value the sites in our sample results from the type, size, and quantity of the fish in each water body. In other words, qualitative differences among sites likely result from differences in fish population. Sites with "better" fish populations, other things equal, should be more highly valued. Our analysis across eleven sites permits a test of this hypothesis as an additional check on the travel-cost and contingent-valuation techniques.

The third technique, also based on observable behavior, is the **hedonic travel-cost** method, a more sophisticated version of the simple travel-cost method. The technique allows us to estimate the value of a partial loss of fish (rather than the value of the total site) by estimating the unique contribution of each key characteristic (such as average number or size of fish caught, and scenic quality) to the total value of different fishing sites. By looking separately at the value of different characteristics of a site, one can focus on how a partial fish loss, alone, will affect the site's recreational value. In the first stage of the approach, one estimates the marginal price of each characteristic by observing the extra distance people travel to reach better sites. In the second stage, one estimates the demand for each characteristic. The price of the characteristic reveals how much an average consumer values small changes in the amount of the characteristic available. The consumer surplus, the area under the demand curve, reflects the value of larger (non-marginal) changes in the amount of the characteristic available.

Our definitions of value, price, and cost are consistent for all three techniques. In theory, our interest is in the value of the population of fish. We assume that the value of fish derives exclusively from their value to sport fishermen. (They may be additionally valuable for researchers, environmentalists, or for their role in the ecosystem. To the extent these other users value the lost fish, we underestimate the total value of fish.) We cannot observe value directly, but we can make estimates of the price people will pay for quality fishing, either by asking them directly (as in contingent-valuation techniques) or by observing the cost they incur to fish (as in the travel-cost techniques, where the cost shows how much people actually pay to gain access to sites with more or better fish).

B. ORGANIZATION OF THE REPORT

Our report contains three major sections. Section II describes in more detail the three analytical techniques we used, the data they require, the survey we designed to gather those data, and how we conducted the survey. Section III contains the results of our three analyses: contingent valuation, simple travel cost, and hedonic travel cost. It also contains our conclusions about the value of the Swan River drainage as a site for recreational sport fishing and about the usefulness of the analytical techniques we employed. The Appendices contain the technical information supporting Sections II-IV.

II. METHODOLOGY

A. ANALYSIS

1. Contingent Valuation

We designed the contingent-valuation questionnaire in consultation with staff from MDFWP. We asked fishermen either how much they would be willing to pay to prevent a 25% loss of fish in the Swan River drainage, or, how much they would have to be paid (also called "willingness to sell") to compensate them for a 25% loss of fish.

A recurring problem for researchers using the contingent-valuation method is the persistent difference between responses to willingness-to-pay and willingness-to-sell questions. Although economic theory predicts that willingness-to-sell responses will be larger because of the added income from "owning" the resource, economists expect the difference in response to be small. The added wealth a recreational fisherman gets from having the right to fish on a single river or lake rather than having to pay for access is not likely to be large. Further, the additional income is rarely observed to increase substantially how much people value recreational sites. The difference between willingness-to-pay and willingness-to-sell of a factor of eight or more throughout the literature on contingent valuation is consequently an anomaly. Willingness-to-pay or willingness-to-sell responses, or both, must be biased. To learn more about these potential biases we asked both types of questions.

As a further test of whether the willingness-to-pay question implicitly contained a bias, we posed a third contingent-payment question. Instead of paying in forgone income, we asked fishermen how many extra miles they would drive to obtain a level of fishing quality equal to that in Swan River. Our intent was to get a less-hypothetical response from the user. Presumably, the user could more accurately state where else he would travel than he could the amount of a hypothetical payment into a vaguely defined fund. The drawback of the question, however, is that one must convert miles into dollars. To facilitate this conversion, we have asked questions about people's wage rates, which helped us estimate the value people place on travel time. In our final analysis, we used compensation rates typically paid by business and government for work-related mileage, and argued that such rates actually include some small compensation for travel time (we explain this in more detail in Section III-C).

We designed our contingent-valuation questions to avoid other types of bias. To avoid biasing responses by persistent prodding or by suggesting a minimum initial bid, we made these questions open-ended. We described fish loss in terms of a permanent population decline of 25% because fishermen are accustomed to adjusting to natural fluctuations of fish populations in different years. The fishermen's responses to these short-term losses would clearly be different from their reactions to longer-term declines. Brief tests of this hypothesis using a preliminary test of the questionnnaire tended to support this assumption.

2. Simple Travel Cost

The travel cost from residence to a recreation site is part of the cost of using the amenities the site offers. In fact, travel cost is part of the cost of all of our daily purchases. But because the distance and, therefore, the travel cost, is typically small (especially compared to the price of goods purchased) we tend to ignore travel cost when thinking about the price of traditional goods. For outdoor recreation sites, though, the purchase price is usually zero or very small, whereas the distance traveled can be quite large. For outdoor recreation, the travel cost can be the bulk of the price of a site.

The travel-cost technique derives from basic microeconomic theory. In a given season, people will continue to travel to a site until the recreational value of one more trip is equal to the price paid or cost of the trip. Thus, the value to a user of the <u>last</u> trip (the "marginal" trip) he makes to a site is equal to the price he pays for it, which is equal to the cost of traveling to that site. But previous trips the "inframarginal" trips are generally worth more than the marginal trip. For almost all consumption goods, people value each additional unit of the good less than the previous unit. Thus, a fisherman's first trip to a fishing hole is worth more to him than his second, third, and subsequent trips.

The critical issue in determining the value of a site is estimating how much more than the marginal trip the inframarginal trips are worth. The net value of a site is the difference between the benefits it provides and what users pay to get those benefits. What they pay is travel cost, which we assume does not vary with the number of trips made (i.e., the costs of marginal and inframarginal trips are equal). For every inframarginal trip, users get benefits beyond the value of travel costs. The sum of these extra benefits to all users is the net value of a site.

The travel-cost method developed by Hotelling (1949) and Clawson (1959) infers the value of inframarginal trips by observing the number of trips made to a site by people who live different distances from the site. Because they live different distances, they face different prices (travel costs) for use of the site. If we assume the people are otherwise alike, then the different numbers of trips people take result entirely from the different prices (distances) they face. We can infer the value of the inframarginal trips for a person close to the site by looking at the value persons far from the site place upon their own marginal trips. For example, if people 100 miles away go to a site only once, the first trip (at, for example, $.20 per mile) is worth the round-trip cost, or $40 (2 x 100 x .20). If people 90 miles away go to the site only twice, the second trip is worth $36. If people take three trips when they are 80 miles away, the third trip is worth $32. The value of inframarginal trips can be measured by looking at the cost of the last trip taken by users who take fewer trips.

The net value of a given site to a user is the amount above the travel cost that she 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 $40, but they would save $40 of expenses. The net loss to these people is zero. If one takes the same site away from the people who live 80 miles away, they would lose three trips. The first trip they would value at $40, the second at $36, and the third at $32. They would, however, save the travel expenses of three trips, at $32 each. The net loss would be $12 (($40+$36+$32)-(3 X $32)). Twelve dollars is what the users 80 miles away should be willing to pay for the all-or-nothing privilege of having the site exist. This net value is the <u>consumer surplus</u> of trips to the site--it is the sum of the values of the inframarginal trips made by an individual, and the appropriate measure of the individual's value of a site.

We used the travel-cost technique to construct demand curves for eleven different fishing sites and compare them to determine their relative values. For each trip origin (zipcodes, at a known distance from the site) we constructed average measures of socioeconomic characteristics (to control for their effects on the number of trips to the site). Then, with each origin zipcode as a single observation we regressed a measure of the number of visits to the site on distance and other socioeconomic variables. The relationship between distance (price) and visitation rate (quantity) describes a demand curve for trips. The demand curve for trips can be used to estimate how each individual would value a site given its distance. The distance determines the travel cost, or price, of a visit. The value is the area under the demand curve: how much people would be willing to pay for a site. The net value is the consumer surplus, the area under the demand curve and above the price.

Sites may be of greater value simply because they are more <u>accessible</u> by more people: even a site with only average fishing can be very valuable if it gets heavy use because of its proximity to an urban area. Our focus, however, is how the <u>quality</u> of the site may affect the value of a site. We therefore control for accessibility by assuming the distance to all sites to be the same. The difference in consumer surpluses across sites consequently will reflect only differences in the quality of each site. In many of our analyses, we find the slopes of the demand curves for different sites to be the same. That finding simplifies our analysis: it means that the consumer's surplus, which is our measure of value, must be directly proportional to the visitation rate for any given price. At a given price per trip, the site with the greatest visitation rate has the highest quality. The results of this type of analysis allow us to rank the different sites qualitatively.

3. Hedonic Travel Cost

The hedonic travel-cost method is designed to measure the value of site characteristics, not the total value of an individual site. To get the data this technique requires we asked each fisherman we interviewed to rate the site characteristics of three places he had fished the previous year. Economic theory and common sense predict that fishermen will travel greater distances to get to sites of higher quality (i.e., sites with higher ratings for site characteristics). By traveling the extra distance, they demonstrate that they value the extra quality at least as much as the additional cost. Given the existing set of sites available to a user, the marginal value of a characteristic is the extra travel cost he must pay to reach a site with slightly more of that characteristic. We computed the travel cost from each fisherman's residential location to sites of varying quality, using his estimate of distance and our estimate of cost per mile.

For each residential origin (zipcode) we examine up to three of the favorite sites visited in the previous year by each fisherman we interviewed from that origin. (In our survey, we asked each fisherman for information about the three sites he visited most frequently during the previous year.) We assumed each site derives its value from the bundle of characteristics (e.g., fish size, scenery, type of fish) it offers. The cost of purchasing the bundle is the cost of gaining access to the site, which is the travel cost of a visit. To estimate what fraction of this cost should be attributed to each characteristic, we regressed the price of the total bundle (the travel cost) on the characteristics:

$$(1) \quad \text{Value}_i = \text{Travel Cost}_i = P_{1,i}Q_1 + P_{2,i}Q_2 + \ldots + P_{n,i}Qv$$

where n is the number of characteristics, Q^k is the quantity of characteristic k, and $P^{i,k}$ is the value of a unit of Q^k from origin i. Note that the prices are different for different origins. The three key characteristics we used to measure the quality of each fishing site were average number of fish caught per day (by species), average size of fish caught (by species), and a subjective rating of the relative scenic quality (below average, average, above average). We then regressed travel cost on the bundle of characteristics each user purchases $(Q^1,Q^2,\ldots,Q^n)$ to estimate marginal prices $(P^1,P^2,\ldots,P^n)$ people from that residential area will pay for each characteristic. The estimation from equation (1) produces a set of prices for characteristics. Those prices represent what fishermen are willing to pay (measured in increased travel cost) for more of each characteristic.

With the hedonic travel-cost technique, one infers values for various site characteristics by observing the choices fishermen make about which sites to visit from the range of sites available. If all sites were alike, the rational fisherman would just visit the closest site. Fishermen venture to more distant sites because those sites have better quality. The extra distance each fisherman will drive to get more of a characteristic reflects the value of that characteristic to him. For example, if a fisherman will drive ten extra miles to go from a five-fish-per-day site to a six-fish-per-day site, which is otherwise similar, the value of a fish per day is the round-trip travel cost of ten miles.

For a single small hydroelectric project, the results of this first stage of the analysis are probably sufficient to measure the value to various users of a partial reduction of the fish population. But for large changes in fish population, such as might occur if several small hydroelectric projects were developed, prices will change: the prices estimated in equation (1) will no longer be good estimates.

Because demand curves are downward sloping, what people will pay for a unit of fish population will depend on the overall level of fish population. Specifically, as the fish population across many streams falls, the value of a unit of fish population will rise. To cope with such changes, we must estimate a demand curve for each of the three site characteristics so we can see what happens to price as the quantity of fish changes. Thus, in this second stage, we tried to estimate how the marginal willingness-to-pay for a characteristic, P, changes with the level of the characteristic, Q, controling for all other Q's and demographic variables. The coefficient estimated for the variable Q^1 in the equation below is the appropriate measure of this change in willingness-to-pay. For the estimated demand curve, we can calculate what people are willing to pay for non-marginal changes in the amount of characteristics. In this stage, we analyzed the users from all the residential areas. We estimated the demand curve for each characteristic by regressing the price of a given characteristic (P^i) upon the level of the characteristic users are observed to purchase and demographic variables (W) such as age, sex, or income:

$$(2)\ P^i = a^o + a^1Q + a^2Q^2 + \ldots + a^nQ^n + f(w)$$

where a^i is a coefficient telling us how P^i will change as Q^i changes. Note that the coefficients a^o through a^n are the same for all origins. The P^i used in equation (2) are the estimated prices from equation (1). The demographic variables control for some of the differences in tastes we might expect from people of different incomes, age, or other socioeconomic characteristics. The use of these control variables allows us to isolate the effect of a change in the quantity of a characteristic on its price. Equation (2) describes the demand curve for each characteristic. The area under the demand curve between the current level of fish population at Swan Lake and the likely new level (for example, after a new hydroelectric project) is an estimate of the value of the fish loss (see Figure 4 in Appendix A).

B. SURVEY

1. Design

In May, 1983, ECO reviewed the survey used by MDFWP for its creel survey, and designed a series of economic questions that could be appended to the creel survey. We suggested some changes in the form used for the creel survey, and in the location of the economic questions within that form. The questions we asked relate directly to the data we need to use the three analytical techniques described above. In general, the questions covered residential location, distance traveled to the site, fishing experience, income, the average catch, size, target species at each site, a subjective measure of scenery, and contingent-valuation questions. For contingent-valuation questions, half of the fishermen were asked about willingness-to-pay, the other half about willingness-to-sell; all were asked about WTD. Appendix B contains the actual questions.

We made a preliminary test of the questionnaire in May 1984. ECO staff instructed and observed the interviewers; we found no major changes necessary. During the first two months of interviews staff at ECO and MDFWP clarified any remaining ambiguities or inconsistencies that occasionally surfaced. In general, we have no reason to expect that the questions or their presentation introduced a systematic bias into the responses we received.

2. Administration

The staff from MDFWP conducted the surveys for economic information in conjunction with their creel surveys. On Swan Lake, the census clerk worked from a boat (until the lake froze), estimating the number of boats twice a day, and interviewing as many parties as possible. On Swan River and tributaries, the census clerk interviewed fishermen on the banks, with an estimate of the number of parties fishing made once a day by airplane. The census clerks obtained some information from check stations set up on the Swan Highway and at the town of Swan Lake were unsuccessful. During the summer season each clerk worked eight 10-hour days in a 14-day period: five days during the week and three days on weekends.

The census clerks originally tried to have all members of a party read and complete the economic section of the survey. This method led to collaboration, as members of the party would compare and modify answers. We quickly rejected this method in favor of asking the questions to only the one member of the party who was its leader or was otherwise willing to answer the questions.

Staff at MDFWP transferred all survey information from the survey forms to coding sheets for data processing. Rob Mendelsohn (ECO) supervised keypunching and proofreading of the data. To be able to run the travel-cost model we had to control for the population and the characteristics of the average fisherman from each zipcode. To do this we needed information from the 1980 U.S. Census arranged by zipcode. After we entered all the survey data we generated a list of zipcodes and then purchased from National Planning Data Corporation demographic data (including their proprietary estimates of 1983 population and income) by zipcode. We appended demographic data for the appropriate zipcodes to each record (i.e., to each interview).

To expedite the production of a final report, we began our analysis of the data in March, 1984, before all interviews were completed. (We had all the data for the 1983 season, which ended in November.) As a result, we did not include in our regressions approximately 33 interviews that occurred in January and February during the ice-fishing season on Swan Lake, nor did we include approximately 20 interviews that staff at MDFWP expected to occur between March and May, 1984. Thus, our analysis applies only to the main fishing season, May to November.

Both ECO and MDFWP have a computer tape of the complete economic data for all sites.

III. RESULTS

A. INTRODUCTION

We used three techniques to analyze the economic data: contingent valuation, simple travel cost, and hedonic travel cost. We describe our results for each technique in the three sections that follow. We compare the results of the three techniques in Section IV, Conclusions.

For clarity and brevity, we present in this report only those data germane to our final analysis. For example, though we asked questions about trip purpose and the renting of nearby summer residences, we found these variables insignificant, adding no explanatory power to our regressions. Hence, we do not report on them. Similarly, we do not present detailed descriptive statistics on all economic variables, since those descriptions have no bearing on our analysis. MDWFP has the computer tape with all data and can easily produce frequency distributions and crosstabulations by site if a need arises for such statistics.

Nevertheless, a brief overview of the magnitude of the key variables provides a useful introduction to our more detailed analysis. Although there are 942 observations in the entire survey, depending on the analysis, some observations were eliminated because of missing data. Table III-1 shows the number of observations for each of the eleven sites we evaluated. The average catch for the sample was 5.2 fish per day, and the average size of catch was 16 inches. ****Following sentence to be revised with information supplied by Steve Leathe***** Almost two-thirds of the fishermen fish primarily for trout; only two percent fish primarily for bulltrout. The average age of fishermen in the sample was 44 years; they had been fishing an average 30 years prior to the survey year. Average family income for the sample is $34,000; the mean wage was $16 per hour.

B. CONTINGENT VALUATION

As part of the valuation of the Swan drainage and other Montana rivers, we asked three questions requiring contingent valuations. We asked half of the sample, randomly selected, a question about willingness-to-pay (WTP); the other half about willingness-to-sell (WTS) (how much they would have to pay). We asked everyone a question about his willingness-to-drive (WTD) additional miles (see Appendix B). All of the questions focus on the value of a 25% decrease in the fish population at the site. Altogether, the staff at MDFWP sampled eleven fishing sites.

Note that these three contingent variables (WTP, WTS, WTD) are alternative ways of estimating the same thing: the value of a 25% loss of fish population. Ideally, one wants all three measures to be statistically significant and equal (which would indicate consistency). If we can show statistical signifance of a given measure (like WTP) across the eleven sites for which we have data, we have confidence that the measure is internally consistent: responses are not random or wildly divergent. If all three measures were also approximately the same for all eleven sites, we have confidence that the three measures are externally consistent: they are measuring the same thing and giving consistent evidence about the value of the three variables. If we find both statistical significance and consistency, then we feel confident that our measures are good approximations of the "true" value of the fish loss. As we expected, however, we did not get such neat results: some measures were insignificant at many sites, and the estimated values diverged markedly. These facts make it difficult to say what the true value is. To interpret the contingent-value results, we believe one needs other, independent measurements. One such measurement would be expert opinion: for example, which of the contingent-value variables yields site rankings that approximate those of staff at MDFWP? (An obvious problem with this approach is its circularity: the economic questions are supposed to give MDFWP an independent ranking of sites). Another measurement method is revealed preference: what ranking and value of sites is implied by fishermen's behavior? The travel-cost approach (both simple and hedonic) supplies this type of measurement. We use our results from our travel-cost analysis to check and refine our analysis of contingent valuation.

Considering all sites together, the average (mean) value of the fish loss as estimated by WTP was $35 per year. (For the rest of this report we will abbreviate the phrase "mean value of the fish loss as estimated by" as "mean", for example, mean WTS.) In other words, for all fishermen surveyed at all eleven sites, the average amount any single fisherman would pay per year to prevent a 25% loss of fish population at that site is $35. If $35 is the true value for a specific site, and could estimate the total number of fishermen using that site during a year, then one could estimate the total annual value to fishermen of the fish loss by simple multiplication ($35 x # of fishermen/year). The mean willingness-to-sell (WTS) was $386 per year. The mean WTD (additional one-way miles users were willing to drive) to get to a site with the original quality of the interview site (i.e., with the same quality the interview site had before the hypothetical 25% decrease in fish population) was 106 miles. The WTD question differs from the other contingent-valuation questions in two important ways: first, people pay for a site implicitly in miles of driving, not directly in dollars; second, the question focuses on cost or payment per trip rather than annual expenses. To convert miles-per-trip to dollars-per-year, we multiplied average one-way miles by 2 (round-trip), then by an approximate cost per mile ($.25),[1] and then by range of the average number of trips per year (5-20). Using these

---

[1]Twenty cents per mile approximates the compensation often paid employees for driving. Although recreation-related driving may be valued more or less than this figure, it is currently our best estimate of per-mile costs.

calculations, WTD ranges between 265 and 1060 dollars per year, close to the WTS figures. If statistically valid, WTS and WTD could be used in the same way as WTP to estimate the annual value of fish lost at a given site.

Unfortunately, most of our statistical tests call into question the valitity of these average figures. Although the mean response across the entire sample is large, so is the variance. The standard deviations and standard error[2] for the WTP response are 746 and 34.8, respectively, for the WTS response 9,458 and 441, and for the WTD 1,271 and 41.9. Neither the WTP responses nor the WTS responses for the whole sample were significantly different from zero. The standard deviations and standard errors are large because of the extraordinary skewness of the responses. Although most responses to all questions were similar, the top 5% were much, much higher. These extreme values had two effects. First, they substantially raised the means of the estimated values of a 25% loss in fish population. Second, they increased the variances of the estimates to such an extent that they reduce the statistical confidence we can have in any conclusions drawn from the data.

Some of the variation in the aggregate data, however, could be desirable, reflecting true differences in the quality of the eleven different sites being evaluated. Table III-1 shows the results for individual sites. Eight of the eleven sites have mean WTP responses that are significantly different from zero. The WTS answers were less consistent. The values of four sites were significantly different from zero despite the fact that the mean responses were, on average, eleven times the size of the WTP answers. Moreover, two of the four sites where the WTS answers were significant were among the three sites where the WTP responses were insignificant, evidence of inconsistency between the WTP and WTS responses. The relative rankings of the eleven sites based on WTP and WTS gives further evidence of inconsistency: site rankings differ markedly depending on which of the two variables we use for ranking.

In contrast to the WTP and WTS responses, WTD responses are significant at all eleven sites. WTD performed much more consistently than the other questions. The ranking of sites based on WTD is slightly different from WTS, although they both agree on the top four sites: Flathead Lake, Kootenai River, Bighorn River, and Swan River. In contrast, the WTP rankings are quite different from WTD.

---

[2]Standard error, the standard deviation of a sampling distribution of means, is used to test whether a given sample mean is significantly different from some other value (in this case, 0). Standard error equals the standard deviation divided by the square root of the sample size.

TABLE III-1

MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]

	Willingness-to-Pay ($/Year)		Willingness-to-Sell ($/Year)		Willingness-to-Drive (Miles/Trip)	
Swan Lake	29*	(80)	241	(82)	89*	(173)
Swan River	76	(111)	580*	(72)	127*	(192)
Swan Tributaries	13	(12)	79*	(19)	53*	(33)
Bighorn River	36*	(50)	624	(51)	137*	(101)
Kootenai River	23*	(33)	1172*	(34)	154*	(67)
Lake Koocanusa	14*	(43)	196	(42)	92*	(85)
Flathead River	23*	(35)	15	(35)	85*	(70)
Flathead Lake	13*	(25)	917	(27)	178*	(52)
Hungry Horse	14	(20)	81	(20)	46*	(40)
Ashley Lake	11*	(24)	70	(22)	48*	(46)
Thompson River	11*	(43)	25*	(40)	89*	(83)
All Sites	34.5	(476)	386	(444)	106.3*	(942)

[a]Asterisks denote responses significantly different from zero (.05 significance level). Numbers in parenthesis equal number of valid observations.

Our data reflect a problem that occurs in most contingent-valuation studies: a consistent difference between WTP and WTS responses. If responses to these questions reflected true tastes, for most natural resources the WTP and WTS responses should be close to each other; the only difference between the responses should occur because in the WTS case the respondent would have slightly more income available. In fact, WTS responses exceed WTP responses by a factor of 7 to 10 in most studies which have asked both questions.[3] In this study, for every site except the Flathead River and the Thompson River, the WTS response is over six times the size of the WTP response. In the extreme case of Flathead Lake, WTS is 70 times WTP. On average, WTS is eleven times WTP.

We offer a new insight into this differential. Although the mean difference in responses is quite large between WTS and WTP, the difference is generally not statistically significant. As can be seen in Table III-2, only the Swan River and the Kootenai River have significantly different answers to the WTS and WTP questions. Although the mean WTS response is higher than the mean WTP response, people do not consistently give higher WTS than WTP answers (as Table III-6 shows, the <u>median</u> value for WTS is zero for eight of the eleven sites, which indicates that the mean WTS response is higher because it is more skewed than the WTP distribution).

To evaluate the power of the contingent-valuation approach, we perform tests on a number of hypotheses about the relative value of the sites. In Table III-3, we compare all prices of sites using each contingent-valuation measure of value. The null hypothesis is that the estimated value of declines in fish populations is the same for each pair of sites. Of the 55 possible pairs, the WTD question rejected the hypothesis of similarity 14 times (at a 5% significance level), but the WTS and WTP responses rejected the similarity of sites only 4 times each. But site comparisons using an analysis-of-variance test of whether all the sites were alike could not be rejected by the WTP or WTS responses (Table III-4). In other words, based on the contingent-valuation questions only, we have to conclude that in most cases fishermen assign equal values to potential changes in fish populations at the eleven different fishing sites. Only the WTD results could reject the hypothesis that the sites were all alike at a 5% significance level.

We also tested whether specific sites were the same as all the others. In particular, the objective characteristics of the Bighorn River suggest it is superior to the other sites in the sample. Similarly, the characteristics of the Swan River suggest that it is above average. The results of similar overall site comparisons using contingent valuation are shown in

---

[3]See Schulze et. al. [1981] for a good review of recent contingent-valuation studies.

TABLE III-2

COMPARISON OF MEAN VALUES OF WILLINGNESS-TO-PAY
AND WILLINGNESS-TO-SELL

	Sample Size	WTS/WTP	t-statistic[a] H_o:WTP=WTS
Swan Lake	162	8.3	1.45
Swan River	183	7.6	2.61
Swan Tributaries	31	6.1	1.39
Bighorn River	101	17.3	1.86
Kootenai River	67	50.9	2.22
Lake Koocanusa	85	14.0	1.41
Flathead River	70	0.7	.72
Flathead Lake	52	70.5	1.52
Hungry Horse	40	5.8	.90
Ashley Lake	46	6.4	1.26
Thompson River	83	2.3	1.50
	920		

[a]Hypothesis of similarity is rejected at the 5% significance level if t > 1.96.

TABLE III-3

TWO-WAY COMPARISONS OF SITES USING MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]
NULL HYPOTHESIS: COLUMN SITE = ROW SITE[a]

	Swan Lake	Swan River	Swan Tribu	Big-horn	Koo-tenai River	Lake Koo-canusa	Flat-head River	Flat-head Lake	Hungry Horse	Ashley Lake	Thomp-son River
						WILLINGNESS-TO-PAY					
Swan Lake	X		.50		.33	.89	.32	.68		.78	1.02
Swan River	.90	X	.49	.64	.68	.92	.69	.68	.50	.70	.93
Swan Trib.			X							.30	.25
Bighorn River	.31		1.06	X	.96	1.89	.93	1.44	1.03	1.62	2.09
Kootenai River			1.23		X	1.84		1.61	1.10	2.35	2.51
Lake Koocanusa			.18			X		.14		.73	.72
Flathead River			1.04		.04	1.62	X	1.37	.93	1.88	2.15
Flathead Lake			.06					X		.50	.45
Hungry Horse	.63		.13			.04		.12	X	.55	.49
Ashley Lake										X	
Thompson River										.06	X
						WILLINGNESS-TO-SELL					
Swan Lake	X					.20	.43		.46	.58	.97
Swan River	1.21	X	.52			1.20	1.55		.97	1.15	1.66
Swan Trib.			X			.56	1.90		.03	.13	1.72
Bighorn River	1.13	.11	1.01	X		1.14	1.45		.91	1.08	1.55
Kootenai River	2.20	1.22	1.51	.89	X	1.99	2.06	.26	1.36	1.61	2.22
Lake Koocanusa						X	1.19		.50	.63	1.16
Flathead River							X				
Flathead Lake	1.34	.52	1.21	.37		1.42	1.69	X	1.08	1.29	1.82
Hungry Horse							1.28		X	.13	1.17
Ashley Lake							1.24			X	1.09
Thompson River							.69				X
						WILLINGNESS-TO-DRIVE					
Swan Lake	X		1.12				.16		1.45	1.54	.00
Swan River	1.57	X	1.63			1.22	1.26		1.90	2.07	1.13
Swan Trib.			X						.61	.45	.78
Bighorn River	2.11	.34	2.64	X		2.04	1.97		3.07	3.33	1.50
Kootenai River	1.67	.63	1.39	.38	X	.36	1.30		1.59	1.74	1.20
Lake Koocanusa	.14		1.90			X	.33		2.45	2.57	.10
Flathead River			1.17				X		1.56	1.63	
Flathead Lake	2.38	1.13	2.08	.97	.32	2.18	2.00	X	2.35	2.58	1.70
Hungry Horse									X		
Ashley Lake									.20	X	
Thompson River							.11		1.07	1.07	X

[a] Value reported is the t statistic. Value greater than 2.0 implies the row site is significantly more valuable than the column site at the .05 level. Each pair of sites intersects in two different cells; one has a number, the other is blank. Table arranged so that all numbers reported show the significance of the greater mean value at the row site compared to the lesser mean value at the column site.

TABLE III-4

OVERALL SITE COMPARISONS USING MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES

Hypothesis	Willingness-to-Pay	Willingness-to-Sell	Willingness-to-Drive
Bighorn River = All Other[a]	.03	.54	.74
Swan River = All Others[a]	1.23	.58	.52
Swan and Bighorn Rivers = All Others[a]	1.04	.68	.70
All Rivers Alike[b]	.54	1.68	2.15

[a]Figures reported are t-statistics. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

[b]Figure reported is an F-statistic. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

Table III-4. None of the contingent-valuation approaches was able to differentiate significantly between the Bighorn, the Swan, and all the other sites in the sample. All these statistical tests suggest that for WTP and WTS the contingent-valuation approach has very little ability to discern between a high-quality fishing site and an average one.

To clarify the relationship between WTP and WTS, we regressed WTP and WTS on willingness-to-drive (WTD) for the entire sample. If people tell the truth about WTP and WTS, one would expect a consistent correlation between answers to WTD, and WTP and WTS. The regression estimates how much money a mile of driving is worth. On average, users were willing to pay 15 cents per year for each additional one-way mile they were willing to drive per trip. In contrast, they were willing to sell each additional mile for $8.12. The WTP coefficient was insignificantly different from zero, suggesting the responses to WTP and WTD questions were generally inconsistent with each other. That is, a large estimate of WTP was not necessarily accompanied by a large estimate of WTD. In contrast, the WTS coefficient had a t-statistic of 6.06, suggesting that WTS and WTD responses at least were consistent with each other. The belief, often found in the professional literature, that WTP is superior to WTS is not supported by these results.

The contingent-valuation responses measure each consumer's valuation of a major loss of fish population. This response should be closely linked with an individual's valuation of a site, which in turn is linked to his trip-demand function. Consequently, we expect that demographic or social variables that explain shifts in trip-demand functions would also be able to explain some of the variation in contingent-valuation responses across individuals. For example, men are more likely to fish than women, and families with young children might fish more frequently than families with older children. To test these hypotheses, we regressed contingent-valuation responses on the following origin-wide variables that frequently affect trip-demand functions: the percent of young people, income, median age, percent male, and relative income. (These are the variables that proved significant in the simple travel-cost regressions we ran. See Table III-7.)

Table III-5 shows the results of this multiple regression. Only relative income is significant in the willingness-to-pay equation and only the percent of males is significant in the willingness-to-sell equation. Both the percent of young people and the percent male were significantly different from zero in the willingness-to-drive equation. Thus, in the traditional WTP and WTS equations, demand-shift variables have little consistent effect on the contingent-valuation responses. Including all the explanatory variables in Table III-5 only explains from two to five percent of the variation in responses to the contingent valuation questions (i.e., the value for R^2 is less than .05). Of course, some of the remaining variation may reflect true variation in unmeasured tastes across the population. The poor

TABLE III-5

MULTIPLE REGRESSION OF CONTINGENT VALUATION RESPONSES UPON DEMAND-SHIFT VARIABLES[a]

	Willingness-to-Pay ($/Year)	Willingness-to-Sell ($/Year)	Willingness-to-Drive (Miles/Trip)
% Young	-.05 (1.38)	-.03 (.42)	.08 (2.25)
Income	.00 (.84)	-.00 (1.30)	-.00 (.54)
Median Age	-.03 (.59)	-.07 (1.09)	.01 (.33)
% Male	.00 (.08)	.20 (3.32)	.14 (2.16)
Relative Income	.12 (2.24)	.09 (1.45)	.02 (.30)
Constant	3.26 (.88)	14.98 (2.29)	-6.50 (1.78)
R^2	.026	.050	.020
Number of Observations	342	280	665

[a]Figures reported are t-statistics. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

TABLE III-6

MEDIAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]

	Willingness-to-Pay ($/Year)	Willingness-to-Sell ($/Year)	Willingness-to-Drive Miles/Trip)
Swan Lake	10	0	30
Swan River	5	10	50
Swan Tributaries	3	0	40
Bighorn River	25*	25	100*
Kootenai River	20*	25	40
Lake Koocanusa	10	0	65
Flathead River	10	0	40
Flathead Lake	5	0	85
Hungry Horse	5	0	50
Ashley Lake	10	0	30
Thompson River	5	0	25

[a]The standard deviation for the median is measured as the average difference between the first and third quartiles of the distribution. Both the median and its significance are consequently unaffected by responses on the tails of the distribution. Asterisks denote responses significantly different from zero (.05 significance level).

TABLE III-7

SIMPLE TRAVEL-COST REGRESSIONS, BY SITE[a]

Site	Constant	Distance (Miles)	Income ($/Year)	% Young (>14 yrs)	Median Age (Years)	% Male	Relative Income[b]
Swan Lake	-28 (4.15)	-.48 (5.35)	-2.23 (3.79)	4.14 (3.41)	5.88 (4.26)	18.66 (3.80)	-.56 (2.42)
Swan River	36 (1.06)	-.48 (3.35)	-2.01 (3.06)	1.17 (1.98)	3.20 (1.87)	6.84 (1.14)	-.50 (1.97)
Swan Tributaries	-83 (.94)	.01 (.02)	-3.17 (.64)	-.24 (.02)	8.95 (.63)	35.2 (1.48)	.46 (.34)
Bighorn River	-83 (6.74)	-.39 (1.97)	-.89 (1.05)	6.28 (3.64)	8.58 (3.88)	26.1 (4.61)	.57 (1.56)
Kootenai River	-63 (2.10)	-.11 (.57)	-2.93 (2.45)	2.79 (1.75)	6.25 (2.00)	30.38 (2.23)	.59 (1.06)
Lake Koocanusa	-24 (2.74)	-.26 (4.88)	-1.95 (2.20)	4.98 (2.51)	5.25 (2.01)	17.23 (2.21)	-.08 (.23)
Flathead River	34 (.44)	-.60 (3.38)	-1.22 (.89)	2.03 (.78)	4.29 (1.19)	4.28 (.23)	.29 (.73)
Flathead Lake	-126 (2.42)	-.33 (2.44)	-.07 (.04)	9.11 (1.66)	16.75 (3.21)	25.49 (1.47)	.41 (.88)
Hungry Horse	53 (.14)	-.69 (1.88)	4.47 (1.25)	1.19 (.62)	1.15 (.20)	-11.96 (.57)	.45 (.59)
Ashley Lake	-28 (.86)	-.18 (.85)	1.75 (.54)	-2.49 (.33)	4.26 (.36)	15.5 (.96)	-1.13 (1.55)
Thompson River	-12 (2.45)	-.64 (3.36)	-.63 (.68)	.19 (.14)	2.21 (1.03)	17.36 (2.32)	.44 (1.17)
All Sites	-13 (5.06)	-.54 (8.98)	-2.01 (5.00)	2.34 (4.88)	4.65 (4.61)	17.36 (5.14)	-.08 (.54)

[a]The dependent variable is the log of visitation rates. The functional form for this regression is log-linear. The t-statistics are in parentheses.

[b]Relative income is the average sample family income divided by the zipcode family income.

quality of these results, however, also raise the possibility that there is great noise in there responses.

Examining the distribution of responses to the contingent-valuation questions more carefully, we find that the data are highly skewed, with many high-value responses. This problem plagues many contingent-valuation studies. The presence of the responses with very high values explains the large variances observed in the answers. The very high-value responses also have a disproportionate impact on the mean response in the sample. The median response to WTP questions ranges from $3 to $25, whereas the mean response ranges from $11 to $76. The median response to WTS questions ranges from $0 to $25, whereas the mean response range from $15 to $1172.

WTS and WTP mean responses are different primarily because of the responses of the top 10% of respondents. The WTS mean response is higher than the WTP mean because of the answers given by only a few respondents. Evaluated at the median (see Table III-6), the answers given by most of the sample to WTP and WTS are quite close: the much higher responses of the tail of the respondents (the upper 10%) to the WTS question causes the mean value of WTS to exceed the mean for WTP. Though the median values for WTP and WTS are close, the fact that nine of the eleven sites had a median WTS of 0 is disturbing. In other words, at over 80% of the sites, at least half of those interviewed said that they would require no compensation for a 25% loss in fish population, a result at odds with responses to the WTP and WTD results.

We can only guess at the reasons for this result. Perhaps respondents did not understand the question. Perhaps they did not feel they had any right to compensation for loss of a resource they did not feel they owned. Perhaps the response really does indicate a true value. Whatever the explanation, these results reinforce our general finding that the contingent-valuation approach is plagued by severe inconsistencies. The extreme responses by the top 5% of the sample have important policy implications. Their inclusion raises the mean but sharply lowers the consistency of the sample responses. To correct for this problem, if the top 5% of respondents are ignored, or if the mean is replaced by the median, the resulting environmental values are much lower than those generally reported in the literature on contingent-valuation.

C. Simple Travel Cost

To estimate the demand for trips to a site, we must first compute the visitation rates. For our initial estimate of visitation rates we divided the number of observed trips from a zipcode by the population of that zipcode. This measure is biased, however, because some sites were sampled all year long (Swan drainage) while others were sampled for just a few days or weeks. To adjust for these different sampling rates, we use independent estimates of the total annual number of visitors to each site collected in a separate mail survey by the State of Montana. We then adjusted the relative visitation rates in our sample to be consistent with the relative annual visitation to the sites.

We then regressed visitation rates on the price of a visit and other variables that the literature suggest could cause a demand curve to shift up or down (we call these demand-shift variables). For the price of a visit, we use the one-way distance from the origin to the destination. Multiplying this figure by the appropriate cost per mile gives travel cost. However, because the cost per mile is somewhat controversial, we make this multiplication after the regression is completed so that an interested reader could easily recalculate the resulting valuations with whatever cost per mile desired.

For demand-shift variables, we include household income, percent-of-residents-under-14, median age, and percent-male-living-in-each-zipcode. These variables are frequently used in economic literature to explain variations in taste across households for recreation and other goods. We also included relative income: the income of users sampled divided by the average income for the entire zipcode. The relative income measure captures whether users are among the poorer or wealthier members of their zipcodes. We found other variables insignificant--variables such as percent-over-65, the change of household income between 1970 and 1983, the number of persons per household, whether fishing was the sole purpose of the trip, and whether fishermen had a summer residence in the Swan drainage.

We tested three functional forms: linear, semi-log, and log-linear. Through formal goodness-of-fit tests, we determined that the log-linear model performed best. To estimate the log-linear model, we took the logs of all the independent and dependent variables. The regression model is just a linear combination of these logged values. This function form implies that a percentage change in any independent variable leads to a constant relative percentage change in the dependent variable. For example, if the coefficient on distance (price) is -.5, a 10% increase in distance leads to a 5% decrease in visits. This particular percentage-change relationship is called the price elasticity and reflects the responsiveness of quality demanded to changes in price. The price elasticity is the coefficient of the price variable in log-linear regressions. The more inelastic are prices for trips to a site, other things equal, the greater the consumer surplus or value of the site.

The results of the travel-cost model for each site are shown in Table III-7. Ten of the eleven distance coefficients had the correct sign and half were significantly different from zero. Twenty of the 55 demand-shift variable coefficients were also significantly different from zero. These results suggest a well-behaved demand function for visitation rates with consistent and relevant demand-shift effects. Interestingly enough, in 9 of the

11 sites the income elasticity is negative. That suggests that lower-income people are more likely to go fishing in Montana, holding everything else consistent. Also, the greater the percent young in a zipcode, the more likely fishing will occur. The percent young could well be a proxy for the presence of families in this sample. The higher the median age, and the more males, the more likely people are to fish.

To determine whether the travel-cost method could differentiate across sites, we tested several hypotheses. The first hypothesis is that all the sites are alike. We ran a simple travel-cost model across the entire sample to test whether the coefficients across all sites are alike. Table III-7 shows the results. We rejected this hypothesis using a Chou test with an F statistic of 29.05. When all sites are treated alike, the additional distance and income tend to reduce visitation rates, whereas more children, higher median age, and more males all increase visitation rates across zipcodes.

In our second series of tests, we examined whether the demand for trips to all sites were alike except for the intercept of the demand curve. We expect more valuable sites to have higher demand curves, less valuable sites lower demand curves. We assumed that the slopes of the curves and the effects of demand-shift variable would be alike for both high- and low-value sites. We ran the travel-cost regression across all observations adding a dummy variable for all but one site. The dummy variable takes the value of "1" if the observation is from that site and "0" otherwise. The coefficient on the dummy variable reflects whether the demand for that site is higher (positive) or lower (negative) than the demand for the omitted site holding all other factors constant. Presumably, sites with better fishing opportunities would have relatively higher demand curves for visits.

Table III-8 shows the results of these analyses. In the first regression, a dummy variable was included for all sites except the Kootenai River. (The selection of the Kootenai is arbitary. The point in this analysis is to rank ten of our sites relative to the eleventh.) The coefficient on each of these dummy variables reflects the number of visits a person would make to that site compared to the Kootenai, assuming all sites are equidistant. Three of the sites have significantly higher demand curves than the Kootenai: Bighorn River, Flathead River, and Flathead Lake. Four of the sites have significantly lower demand curves than the Kootenai: Swan Tributaries, Swan Lake, Swan River, and the Thompson River. The remaining sites would be visited about as often as the Kootenai. These results suggest that the eleven sites can be broken down roughly into three categories of quality: high, medium, and low.

The second regression in Table III-8 takes advantage of this grouping by leaving out all the medium-quality sites. The dummy variable coefficients consequently reflect how an individual site compares to the group of medium sites. Flathead Lake is the most highly valued site, with the Bighorn River a very close second.

TABLE III-8

SIMPLE TRAVEL-COST REGRESSIONS, MULTIPLE SITES[a]

Regression Number:	1	2	3
Constant	-27.2 (8.49)	26.3 (8.42)	24.0 (7.88)
Distance	-.35 (7.61)	-.35 (7.57)	-.29 (3.82)
Income	-1.81 (6.26)	-1.87 (6.55)	-1.95 (6.45)
Children	2.21 (6.42)	2.23 (6.57)	2.23 (6.22)
Median Age	4.39 (6.10)	4.39 (6.18)	4.53 (6.09)
% Male	20.6 (8.64)	20.6 (8.63)	20.0 (7.96)
Relative Income	-.04 (.39)	-.06 (.52)	-.07 (.58)
SHIFT DUMMIES			
Bighorn River	1.31 (4.27)	1.08 (4.46)	3.37 (3.21)
Flathead River	.82 (2.30)	.59 (1.95)	1.51 (2.66)
Flathead Lake	1.45 (4.06)	1.22 (4.10)	1.81 (2.04)
Swan River	-1.34 (4.84)	-1.56 (7.56)	-.63 (.81)
Swan Lake	-1.85 (6.67)	-2.10 (10.38)	-.81 (1.10)
Swan Tributaries	-3.22 (7.66)	-3.46 (9.26)	-3.87 (3.16)
Thompson River	-.97 (3.24)	-1.21 (5.22)	-- --

TABLE III-8 continued

Hungry Horse	.53 (1.26)	-- --	-- --
Lake Koocanusa	.41 (1.34)	-- --	-- --
Ashley Lake	-.02 (.06)	-- --	-- --
SLOPE DUMMIES			
Bighorn River	-- --	-- --	-.36 (1.88)
Flathead River	-- --	-- --	-.18 (1.04)
Flathead Lake	-- --	-- --	.06 (.44)
Swan River	--	--	-.17 (1.27)
Swan Lake	-- --	-- --	.11 (.78)
Swan Tributaries	-- --	-- --	.16 (.45)
R^2	.74	.73	.72
Sum of Squared Residuals	425	429	456

---

[a]The dependent variable is the log of visitation rates. The functional form is log-linear and the t-statistics are in parentheses. These regressions were performed across eleven sites.

The Flathead River is a more distant third. On the other side of the ledger, the Swan River is ninth of the eleven sites. Swan Lake is tenth, and the Swan Tributaries are a distant last.

The final regression in Table III-8 explores the possibility that the slopes as well as the intercepts of the visit demand functions might vary across sites. A dummy variable for the price slope (distance times the 1,0 dummy variable for the site) of each site is included in the regression. The slope of the demand curve is important because the value of the site is equal to the area under the demand curve. If a demand-for-visits curve is very flat, it implies that people have close substitutes for trips to that site: if the site visit gets even a little more expensive, people would stop going to the site altogether. Such a site, therefore, has little net value. In contrast, if the slope of a site visit demand function was very steep, it implies users feel the site is unique: although with greater expense they do reduce visits, it is difficult for them to find close substitutes so they reduce visits very slowly. In other words, they are willing to pay a great deal for access to the site, especially as the total number of trips is reduced. Sites with relatively steeper slopes, all other things equal, are consequently more valuable.

The third regression in Table III-8 implies that the slope coefficients are in fact similar across sites. None of the dummy variables for slope coefficients are significantly different from zero. That is, the data are unable to find a difference in the slopes across sites. We assume that the slopes of the demand functions are the same for all sites.

We also tested whether the coefficients for the demand-shift variables were significantly different across sites. We examined the null hypothesis that the second regression in Table III-8, which captures just the intercept effects, was different from the 11 individual regressions in Table III-7, which capture all differences across sites. We could not reject the null hypothesis, which suggests that the demand-shift effects were indeed similar across sites. The second regression in Table III-8 is our best model for these data; it explains all significant variations across sites with the fewest coefficients.

In a final set of tests, we perform a series of pairwise comparisons among sites similar to those we performed for contingent-valuation-responses in Table III-3. We analyzed every combination of sites, assigning a dummy variable to one site of the pair, to test which had a higher demand curve for visits. If the dummy for site A were positive when compared with site B, then site A would be a better quality site than B. If the dummy were also significant, then the difference in quality is also significant. Table III-9 shows the t-statistics of the dummy variable. A t-statistic greater than 2.0 implies a significant difference. Of the 55 comparisons, 40 were significant. Compared to the results of the contingent valuation, the travel cost method was able to make sharper distinctions about the quality of

TABLE III-9

TWO-WAY COMPARISONS OF SITES USING TRAVEL-COST METHOD
NULL HYPOTHESIS: COLUMN SITE = ROW SITE[a]

	Swan Lake	Swan River	Swan Tribu	Big-horn	Koo-tenai River	Lake Koo-canusa	Flat-head River	Flat-head Lake	Hungry Horse	Ashley Lake	Thomp-son River
Swan Lake			4.59								
Swan River	2.24		4.64								
Swan Trib.											
Bighorn River	14.352	9.034	11.18		2.91	3.39	0.30		0.99	3.29	7.51
Kootenai River	6.72	3.91	6.74								2.72
Lake Koocanusa	9.06	5.86	9.32		0.71					0.71	5.48
Flathead River	8.38	5.01	10.09		2.64	1.72			0.98	2.07	6.15
Flathead Lake	9.26	6.02	7.71	0.36	2.94	3.21	0.63		0.94	3.45	5.47
Hungry Horse	5.36	3.26	7.15		1.46	0.03				0.41	3.64
Ashley Lake	4.91	3.02	6.07		0.008						2.77
Thompson River	3.45	1.01	6.30								

[a]A row site is superior to a column site if there is a number in the row associated with that column. The figure shown is the T-statistic.

sites. The same waterbodies identified as high quality in Table III-8 are found valuable in Table III-9: Flathead Lake, Bighorn River, and Flathead River. Similarly, the lowest quality sites, the Swan drainage and the Thompson River are given low ratings by both methods of comparisons using travel cost. The pairwise comparisons confirm the results found in the overall site analysis.

D. Hedonic Travel Cost

Although the simple travel-cost technique was able to differentiate high-quality from average sites, it could not estimate the value of individual characteristics of sites. At its best, the simple travel-cost technique can estimate total value of a recreation site in all uses; it cannot estimate, for example, the separate value of fishing or beautiful scenery. The hedonic travel-cost method, however, values the individual characteristics of sites.

Estimating the value of these characteristics involves two sets of calculations. In the first stage, we estimate the value by regressing, for each origin, travel cost on the characteristics of the sites visited. The coefficients of the independent variables (the site characteristics) tell us how much the dependent variable (travel cost) changes when the characteristics change. In other words, the coefficients may be interpreted as the values, or prices, of the characteristics.

For each respondent, we use data he provided about the three fishing sites he said he most frequently visited during the previous year. We perform this regression independently for each origin, that is, we estimate the average value of a unit of each characteristic at each origin. The characteristics we looked at (our independent variables) were catch rate (number of fish caught per day), average size of catch (in inches), scenery, percent trout-as-primary-species, percent bull-trout-primary-species, river, man-made lake, and managed-as-a-trout-water-body. We use a linear functional form in these price regressions, implying a constant marginal price for each characteristic. For example, residents from Missoula are willing to travel, on average, an extra 5.6 miles for an extra inch in the size of fish they catch. The linear functional form suggests that an extra inch costs Missoula residents 5.6 miles, whether they want 10 inch or 16 inch fish.

The second stage of the technique involves estimating the demand function for the characteristic, which shows what users are willing to pay for each level of the characteristic. We regress the marginal price of each characteristic (the price coefficient from the first-stage regression) on the levels of characteristics and a set of demand-shift variables.

In the first stage, we regress travel cost on the observable characteristics of sites: catch per day, size of fish, trout or not, bulltrout or not, management designation, and scenery. To determine which of these variables contribute to site quality, we must have many trips from a single origin. But when data are collected by site instead of by origin, it is difficult to get adequate samples from specific origins. By combining zipcode areas around certain cities, we were able to identify thirteen origins with sufficient data to perform price regressions. Table III-10 shows the thirteen cities. All of the out-of-state price regressions were insignificantly different from zero. The poor performance of these more-distant users can probably be explained by their small numbers (from a specific origin), the fact that they are more likely to be on a multiple-purpose trip, and our relatively poorer measurements of their next best alternative sites.

After omitting sites, we have only 504 observations in the sample for the hedonic travel-cost analysis. When all the variables are included in the regression, the management designation--whether the river body is a river, lake, or manmade lake or trout managed--and scenery were insignificant. That is not to say that users do not care whether the sites are in the scenic Rocky Mountains or not. Rather, the results suggest that users do not care about the observable variation in scenery among sites in Western Montana. Similarly, fishermen do not care whether they fish on natural or manmade lakes or rivers as long as the fishing is equally good. It is the fishing which matters, not the water body.

A similar inference can be made about management designations. The fact that rivers may be designated for trout does not matter to the fisherman. What matters is the quality of the fishing. Consequently, the benefits of the management programs can be measured precisely by their impact on the actual fishing.

Because of their lack of significance, we dropped management designations and scenery from the regressions. Table III-10 shows the remaining hedonic price regressions for each of the thirteen origins. Note that although each characteristic is significant in several regressions, many variables have negative coefficients. In each of there origins, the negative coefficients suggest people travel further to avoid these characteristics. Although it is possible each of these characteristics might be deemed undesirable, the negative coefficients probably either reflect measurement problems (noise), omitted variables (bias), or the small sample.

We combined the 504 observations from the thirteen origins to calculate the demand for each characteristic. Table III-11 shows the results, many of which are promising. The own-price coefficient (that is, the effect of changes in the price of a characteristic on that characteristic) for all four attributes is negative as expected. For example, the amount a fisherman will pay to catch a fish one inch longer declines by 50% for each inch

TABLE III-10

HEDONIC PRICE REGRESSIONS[a]

Zip Code Origin	Constant	Catch (fish per day)	Size (inches)	Trout (dummy)	Bulltrout (dummy	R^2
Billings	203.0*	-.58	1.14	-126.0*	1967*	.23
Great Falls	-70.8	14.8*	1.6	72.4*	838*	.54
Conrad, Shelby	206.0*	-15.0*	-6.5	72.4*	1391*	.92
Haure	38.0	-36.0	6.4	141.0	2818*	.41
Helena	-62.0*	5.0*	-.29	93.0*	1464*	.80
Butte	-192.0	-.8	4.3	191.0	4098*	.42
Missoula	-18.0	.38	5.6*	16.5	7.5	.12
Charles	-123.0*	10.0*	6.1*	52.0*	-211	.46
Kalispell	-48.0*	.04	4.7*	52.0*	-386*	.21
Big Forke	-112.0*	3.6*	5.9*	56.8*	-230*	.27
Columbia Falls	6.0	1.1	1.2	20.8	-268*	.18
Whitefish	0.2	4.1	0.1	68.0*	-342	.13
Libby	130.0*	-2.0	-2.7	57.0*	634	.25

[a]Linear regressions with one way distance in miles as a dependent variable. Coefficients shown are the additional miles traveled to get another unit of a characteristic. Asterisks denote responses significantly different from zero (.05 significance level).

TABLE III-11

DEMAND FOR FISHING SITE CHARACTERISTICS[a]

Dependent Variable	Constant	Catch (per day)	Size (inches)	Trout (dummy)	Bulltrout (dummy)	R^2
Price of Catch	.86	-.007	.08*	-1.72*	-.25	.03
Price of Size	4.72*	.04*	-.05*	1.42*	3.01*	.06
Price of Trout	62.1*	1.56*	-1.2*	-42.7*	24.2	.09
Price of Bulltrout	-391*	-15.7*	12.2	746*	-564	.11

[a]Linear regression with coefficients shown and significance from zero at .05 level of significance marked by an asterisk. All prices are measured in miles per unit.

of fish already caught. The demand function for these attributes slopes downward. The own-price coefficient is significantly different from zero for both the size of fish and whether trout is the target species. There are also significant interactions among the characteristics. Fishermen targeting trout are willing to pay less for both the number and size of catch. The bigger the size of catch, the more fishermen will pay for more frequent catch. Finally, if trout are the target species, fishermen are willing to pay more for bull trout.

On the other hand, Table III-11 is not an unmitigated success. The equations were unable to explain much of the observed variation in hedonic prices. This may reflect measurement problems with the prices themselves, omitted characteristics of sites, or the absence of important variables which explain people's preferences for site qualities.

Catch rates, size, and targeting bull trout are all characteristics with elastic demand functions near the mean of the sample. That is, what fishermen are willing to pay for a little more of each of these characteristics does not change very much with the level of characteristics purchased. The price of these charactertistics can be used as a reasonable approximation of the average value of the characteristic across a broad range of values.

Targeting trout appears to have a unitary price elasticity. That is, for each 10% increase in trout fishing there is a 10% decline in the marginal willingness-to-pay. Suppose at the mean of the sample, fishermen are willing to pay $10 per trip to target trout. A 25% decline in the frequency of trout fishing would, therefore, increase the value of targeting trout by $2.50 per trip to $12.50.

IV. CONCLUSION

In this study, we used three different methodologies to analyze the value of fish in Montana. We had two goals. First, we want to evaluate the methods to determine which are most useful. Second, we hoped to provide useable estimates of the value of fish lost from hydroelectric development in the Swan drainage.

First, let us discuss the results of the methodological comparison. We used both the travel-cost and contingent-valuation questions to rank the sites (Table IV-1). The rankings are clearly not uniform across the techniques. The only water body consistently classified across all four methodologies is the Swan Tributaries, which as expected clearly is of relatively lower quality than the other sites we samples.

Rankings based on willingness-to-pay are the most different from all the others. None of the water bodies identified by the travel-cost method as higher quality is ranked as higher quality by the WTP responses. The Swan River, ranked by travel-cost as lower quality, is ranked first by the WTP response. The WTP response also differs from the WTS and WTD rankings. For example, both the Kootenai River and Flathead Lake are ranked in the top group by WTD and WTS. The WTP ranking puts them in the middle and bottom, respectivaly.

The WTS and WTD responses are somewhat closer to each other. For example, both the Kootenai River and Flathead Lake are ranked higher quality by both methods. However, WTD also recognizes the Bighorn River and Swan River as top sites, whereas WTS ranks them as medium. In comparison with travel cost, both WTS and WTD recognized the value of Flathead Lake but only WTD ranked the Bighorn as highly as travel cost.

Given the focus of this study on Swan River and Swan Lake, note that all the contingent-valuation measures ranked both of these water bodies more highly than the travel-cost method did. It is indeed possible that contingent-valuation surveys, which focus on one site at a time, over-value that site relative to alternative sites. That is, once a policy question arises such as whether to dam a particular river, contingent-valuation surveys focused on that river may overestimate its value. To avoid this bias using contingent valuation, it may be necessary to value the sites in a system prior to the time a policy issue attracts public attention to a specific site.

In addition to just ranking the sites, we also compared the internal consistency or hypothesis-testing ability of each approach in Table IV-2. Obviously, one would like a technique that is not only unbiased but also accurate. In this respect, we found the responses to each approach varied a great deal. Whereas all the approaches value fish highly, the contingent-valuation estimates tend to have wide variances. This problem is especially evident with the willingness-to-pay and the

TABLE VI-1

RELATIVE RANKINGS OF SITES

	CONTINGENT VALUATION			REVEALED PREFERENCE:
	WTP	**WTS**	**WTD**	**Travel Cost**
Higher Quality	Swan River	Kootenai Flathead Lake	Flathead Lake Kootenai Bighorn Swan River	Flathead Lake Bighorn Flathead River
Medium Quality	Bighorn Swan Lake Kootenai Flathead River	Bighorn Swan River Swan Lake Koocanusa	Koocanusa Swan Lake Thompson Flathead River	Hungry Horse Koocanusa Kootenai Ashley
Lower Quality	Koocanusa Hungry Horse Flathead Lake Swan Trib. Ashley Thompson	Hungry Horse Swan Trib. Ashley Thompson Flathead River	Swan Trib. Ashley Hungry Horse	Thompson Swan River Swan Lake Swan Trib.

TABLE IV-2

STATISTICAL POWER OF APPROACHES[a]

Null Hypothesis	--Contingent Valuation-- WTP	WTS	WTD	Revealed Preference: Travel Cost
Value of sites are zero	8	4	11	10
Pairwise sites are alike	4	3	14	40
Sites equal to the average	0	0	3	7

[a]The figures represent the number of sites where the responses could reject the null hypothesis with a 5% significance level. The higher the numbers, the better able the technique to draw distinctions amongst sites.

willingness-to-sell approaches. Despite an average valuation for all sites of $386 per year for a 25% fish loss, only four of the eleven responses to WTS were statistically different from zero. When comparing sites one with each other, only three pairs were significantly different according to WTS despite the research plan to provide a wide distribution of quality sites. The WTP pairwise comparisons were only slightly better with four distinct pairs. In contrast, willingness-to-drive responses could identify 14 distinct pairs and travel cost identified 40 distinct pairwise comparisons. Further, the WTP and WTS approaches were unable to distinguish any site from the group average. The WTD responses were slightly more powerful, picking out three sites as below average. In contrast, travel cost identified seven sites as being different from the average. The contingent-valuation methods suffered from a high degree of noise or random responses, especially the willingness-to-pay and willingness-to-sell approaches.

The contingent-valuation method suggests that fishermen care about reduction of fish at all the sites they visit. The contingent-valuation method, however, could not distinguish between the species of fish, the number of fish, or the size of fish. That is, despite the fact that these variables vary over all eleven sites, the contingent-valuation method valued a 25% loss of the existing fish population at each site equally. In contrast, the hedonic travel cost method suggests that fishermen care a great deal about species especially trout and bulltrout, and to a lesser extent about size and catch per day. Thus, the loss of 25% of a fish population in general is not worth a great deal to fishermen. However, the loss of an opportunity to fish for trout or bulltrout is worth a great deal. The policy implications of the results of the contingent-valuation and hedonic travel-cost methods are consequently quite different.

Because we asked all individuals two contingent-valuation questions, we can make a final check for consistency by comparing individual responses to both questions. In the half of the sample asked willingness-to-sell questions, we found that people who value fishing highly with WTS all value fishing highly with WTD. The two approaches are consistent across individuals. In contrast, we found that people who value fishing highly when asked willingness-to-pay questions did not necessarily value that same fishing highly with the willingness-to-drive question. The individual's valuation of the same river seemed to change depending upon whether one asked WTP or WTD. People are clearly not interpreting these questions as purely valuation issues or the responses would have been closely correlated. Exactly how people are truly interpreting and responding to these questions is difficult to know, which makes it difficult to correct for these hidden influences. Identifying and mitigating these invisible but disconcerting influences is the challenge facing practitioners of the contingent-valuation method.

In addition to comparing the methodologies, the study was also intended to arrive at concrete estimates of the value of fish loss in the Swan drainage. The travel-cost method provides an upper limit to the value of this loss because it measures the total value of the sites. At worst, the loss of some fish would be equivalent to the loss of the site altogether. More likely, the loss of some fish will only decrease the value of the site, not make it worthless.

We calculate the net value of Swan River, Swan Lake, and the Swan Tributaries using the simple travel-cost regressions in Table III-8. First, we evaluate these regressions using the mean value for all the demand shift variables. This simplifies the equations to:

Swan Lake	ln (visit) = 8.3 - .35 ln (distance)
Swan River	ln (visit) = 8.8 - .35 ln (distance)
Swan Tributaries	ln (visit) = 6.8 - .35 ln (distance)

where ln is the commong log. Although this functional form fits the data best in the region of the observations, the form implies behavior outside the region of the data which is unlikely. The form suggests that people would visit each of these water bodies often even if they lived thousands of miles away. Our data on visits do not show this result, suggesting such an inference is incorrect. We consequently put the functions into a linear form to yield more accurate estimates of behavior at greater distances. Figure III-1 shows the difference between the log and linear form, and how we converted from log to linear.

INSERT FIGURE III-1

The approximate linear equations are:

Swan Lake	visits = 1086 - 2.6 distance
Swan River	visits = 1226 - 2.6 distance
Swan Tributaries	visits = 449 - 2.6 distance

To convert distance in one-way miles to travel cost, we use $.25 as an estimate of total cost per mile. This total cost includes part of out-of-pocket costs, fixed transportation costs (insurance, license, etc.), and travel time. All out-of-pocket costs should probably be included. Fixed costs, however, are more controversial. Whereas the State of Montana may pay $.23 per mile to include all of fixed costs, it is not clear that recreationists actually value miles at such a high rate.

Similarly, although people could value their time at their marginal wage rate, they tend to behave as though their time is worth only a fraction of wages. Commuters tend to value their time at 1/3 of their wage. Recreationists, who probably travel on more beautifal roads, may put a net value on their time even lower than the commuters. The reader who finds $.25 per mile too low can adjust the travel cost estimates in the text in proportion to his or her estimate of travel cost per mile. For example, if travel cost per mile is really $.50 not $.25, then the estimates of site value would double.

Multiplying distance by $.25 per mile by 2 (round trip distance) and dividing into the distance coefficient yields the following demand functions:

Swan Lake	visits = 1086 - 5.3 P
Swan River	visits = 1226 - 5.3 P
Swan Tributaries	visits = 449 - 5.3 P

where P is price measured in dollars. Now assuming the average user travels 50 miles to use each of these sites, the area under the demand curve but above $25 per trip is:

Swan Lake
$$\int_{25}^{20} (1086 - 5.3\,P)\,dP = \$\ 90{,}000$$

Swan River
$$\int_{25}^{23} (1226 - 5.3\,P)\,dP = \$113{,}817$$

Swan Tributaries
$$\int_{25}^{85} (449 - 5.3\,P)\,dP = \$114{,}468$$

Note that the integral is defined from a price of $25 up to the price where visits fall to zero. Assuming we have correctly estimated the number of fishermen at each water body, the figures in Table IV-3 represent the maximum annual aggregate value fishermen place on each of the respective water bodies.

Let us compare this estimate with the results of the contingent-valuation survey. Assuming each fisherman spends about 23 hours of fishing per year at each site, the total value of the reduction is simply the number of fishermen who visit the site times the mean value. The number of fishermen at Swan Lake, Swan River, and the Swan Tributaries each year are estimated to be about 286, 334, and 64, respectively. Multiplying the number of fishermen by the average value of a 25% decrease in fish

TABLE IV-3

AGGREGATE VALUATION OF A DAM FISH LOSS BY METHOD[a]
DOLLARS/YEAR

	Contingent Valuation			Revealed Preference	
	WTP	**WTS**	**WTD**	**Travel Cost**	**Hedonic Travel Cost**
Swan Lake	8,300	69,000	12,800	90,000	13,000
Swan River	25,400	194,000	21,000	113,800	
Swan Trib.	800	5,000	1,600	11,500	

[a]All of these estimates are contingent on the uncertain total visits and total number of fishermen at each site per year. See the text for a discussion of the statistical reliability of each estimate.

population gives the aggregate values listed in table IV-3. Willingness-to-drive one-way miles is converted to dollars using the same assumptions as with travel cost. We have the choice of either doubling the number of one-way miles to convert to round-trip miles, or doubling the travel-cost per one-way mile. We do the latter, using a travel-cost of $.50 per one-way mile (instead of $.25 per round-trip mile).

Finally, using hedonic travel cost, we assume that for all individuals using the Swan drainage, the fish population loss will eliminate the bulltrout fishing and cut the trout targeted fishing in half. Again, converting one way miles to travel-cost by a constant $.50, we find the average price of targeting bulltrout is about $450 and the average price of targeting trout is $30. Assuming that of the 684 parties estimated to visit the Swan drainage to fish each year 2% fished for bulltrout and two-thirds targeted trout, about 14 parties targeted bulltrout and 458 parties targeted trout. Multiplying these number of people by the percentage reduction in opportunity (100% for bulltrout, 50% for trout) by the value they place on the opportunity, yields $6870 for trout and $6300 for bulltrout. The total loss in the entire drainage is about $13,000 per year. Most of this loss is probably felt in the Swan River where the trout and bulltrout fishing is the strongest.

Comparing the results in Table IV-3, the travel-cost estimates appear high as expected because they value the whole site, not just the 25% loss of fish. Given that the travel cost estimate is probably an upper bound, the willingness-to-sell figures appear to be too high. Despite their lack of correlation on an individual level, the willingness-to-pay and willingness-to-drive estimates are similar. In contrast, the hedonic travel cost figures suggest a much lower value for the lost fish than the contingent valuation estimates. Given the other evidence in the sample that the contingent-valuation numbers for the Swan drainage seemed high compared to substitute sites, it appears likely that contingent-valuation overestimated the value of the fish loss.

Because the survey approach was not designed to estimate the aggregate number of fishermen who visit the site or the aggregate number of visits, the results in Table IV-3 very likely need adjusting. For example if twice as many users came to the Swan drainage each year, then the annual estimates would all have to be doubled. Also, if users come to the Swan drainage more or less than three times a year on an average, the revealed preference relative to the contingent-valuation figures would have to be adjusted. The more mean visits per year, the larger are the dollar estimates of fish loss value based on travel cost (based on visits) to the contingent valuation (based on users).

Our research contains two important policy results. First, simple contingent-valuation questions provide unreliable measures of the value of recreation sites. Secondly, simple travel-cost and hedonic travel cost methods yield consistent and significant measures of the value of recreation sites. For these revealed preference techniques to be more useful for policy purposes, however, additional research is needed. To better understand the tradeoffs users make in choosing sites, more sites need to be surveyed. The additional sites and additional observations permit a deeper understanding of the natural characteristics users value and also a better understanding of the impact of fishing regulations. For example, with more sites and more observations, it will be possible to collect more accurate estimates of fish populations in streams. This, in turn, would lead to more accurate estimates of the values fishermen place on both the number and size of each fish species. Additional sites would also make it possible to evaluate fishing regulations such as minimum size, catch limits, or restricted gear. Careful selection of sites could also be used to evaluate public launch sites, fish stocking, and other public expenditure programs.

In summary, the success of this and other similar studies suggest that game managers now have available sophisticated evaluation tools in the simple and hedonic travel cost methods. A large scale regional survey using these methods could prove an invaluable asset for state and federal fish and wildlife management programs.