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The Value of a Trout Stream Fishery

Archie Allen Dyer

Utah State University

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Archie Allen Dyer
THE VALUE OF A TROUT STREAM FISHERY

by

Archie Allen Dyer

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Forest Science

Approved:

Major Professor

Head of Department

Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

1968
TABLE OF CONTENTS

INTRODUCTION .................................................. 1
Recreation Valuation ........................................... 1
The Central Utah Project ....................................... 2
The Stream Fishery of the Uinta Basin ....................... 2
The Objectives .................................................. 5

THE STUDY AREA ................................................ 7

THE MODELS ..................................................... 8
Recreation Valuation .......................................... 8
Consumer's Surplus ............................................. 8
Recreation Use-Prediction ..................................... 11

METHODS AND PROCEDURES .................................... 14
Data Collection ................................................ 14
Use Levels ..................................................... 14
Length-of-Stay Bias ........................................... 15
Use-Prediction ................................................ 17
Fishery Valuation ............................................. 18
Demand ........................................................ 18
Consumer's Surplus Valuation ................................ 19

RESULTS ......................................................... 21
Total Use and Use By Fisherman Origin ..................... 21
Use-Prediction ................................................ 21
Fishery Valuation ............................................. 28
Demand ........................................................ 28
Consumer's Surplus ............................................ 34

CONCLUSIONS .................................................. 38
Recreation Valuation ......................................... 38
Use-Prediction ................................................ 41

LITERATURE CITED ............................................. 43

APPENDIX ....................................................... 45
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Summary of Uinta Basin average fisherman-days before and after completion of the Bonneville Unit of the Central Utah Project</td>
<td>6</td>
</tr>
<tr>
<td>2. Illustration of correction-for-length-of-stay bias</td>
<td>16</td>
</tr>
<tr>
<td>3. 1966 season use estimate for Currant Creek</td>
<td>22</td>
</tr>
<tr>
<td>4. 1966 season use estimate for the West Fork of the Duchesne River</td>
<td>23</td>
</tr>
<tr>
<td>5. Stream use by county of fisherman origin for the West Fork of the Duchesne River</td>
<td>24</td>
</tr>
<tr>
<td>6. Stream use by county of fisherman origin for Currant Creek</td>
<td>25</td>
</tr>
<tr>
<td>7. Origin use-determinants for Currant Creek</td>
<td>26</td>
</tr>
<tr>
<td>8. Origin use-determinants for the West Fork of the Duchesne River</td>
<td>27</td>
</tr>
<tr>
<td>9. Predicted use of and travel and equipment costs by origin associated with a fisherman day on Currant Creek</td>
<td>29</td>
</tr>
<tr>
<td>10. Predicted use of and travel and equipment costs by origin associated with a fisherman day at the West Fork of the Duchesne River</td>
<td>30</td>
</tr>
<tr>
<td>11. Estimate of annual consumer's surplus for Currant Creek</td>
<td>35</td>
</tr>
<tr>
<td>12. Estimate of annual consumer's surplus for the West Fork of the Duchesne River</td>
<td>36</td>
</tr>
</tbody>
</table>
##LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The location of the Central Utah Project in Utah</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>The Bonneville Unit of the Central Utah Project</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Illustration of consumer's surplus</td>
<td>10</td>
</tr>
<tr>
<td>4.</td>
<td>Statistical estimate of the demand schedule for the trout fishery of Currant Creek</td>
<td>32</td>
</tr>
<tr>
<td>5.</td>
<td>Statistical estimate of the demand schedule for the West Fork of the Duchesne River</td>
<td>33</td>
</tr>
</tbody>
</table>
ABSTRACT

The Value of a Trout Stream Fishery

by

Archie Allen Dyer, Master of Science

Utah State University, 1968

Major Professor: R. S. Whaley
Department: Forest Science

The data analysis indicated that travel distance, user age, and user income level are important determinants of use of trout streams. These variables were incorporated into regression analysis to develop a use-prediction model.

This use-prediction model was used to determine predicted use levels of sample streams. The predicted use levels combined with travel costs and expenditures on new fishing equipment were used to derive a statistical estimate of the demand schedules for the sample streams.

These statistical demand curves were subjected to consumer surplus procedures to determine the values of the sample streams.

(page 55)
INTRODUCTION

Recreation Valuation

The significance of recreation as an integral part of water storage project planning is generally accepted. This general acceptance is emphasized in Senate Document No. 97 which is a statement of the federal government's water storage project policy. Supplement No. 1 to Senate Document No. 97 says:

The interdepartmental statement of Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources (Senate Document No. 97-87th Congress, 2nd Session) approved by the President on May 15, 1962, provides for full consideration of recreation as a purpose in project formulation and evaluation.

This document makes outdoor recreation a full partner in the planning of water storage projects. It defines recreation as a joint product rather than a by-product of water storage projects (Brewer, 1962). However, a problem arises when attempts are made to incorporate recreation into water storage project decisions.

The decision making process has been cast in economic logic which has taken the form of Benefit-Cost Analysis. Benefit-Cost Analysis in its simplest form involves the comparison of the benefits resulting from a project with the costs of the project. These costs and benefits must be expressed in monetary terms (Castle, et al, 1963).

Since recreation is, for all practical purposes, administered outside the market system, there is no ready made dollar value assignable to it. The question arises, how can recreation be put into its
appropriate place in water storage project analysis in view of the lack of a market determined value?

The Central Utah Project

A specific valuation problem with a peculiar twist is illustrated by the Bonneville Unit of the Central Utah Project located in the Bonneville and Uinta Basins of Northern Utah (Fig. 1). In this case, high-quality fishing, which is usually complimentary to the main purpose of water storage facilities, may be competing with other uses if not to the point of mutual exclusiveness to the point of significantly limiting them. By means of a complex system of reservoirs, diversion dams, tunnels, aqueducts, canals, pumping plants, power plants, dikes, and drains, the Bonneville Unit of the Central Utah Project (Fig. 2) will divert a portion of the water resource of the Uinta Basin for irrigation, municipal and industrial water, and power production (Bureau of Reclamation, USDI, 1964). This will be to the detriment of the stream trout fishery of the Uinta Basin.

The Stream Trout Fishery of the Uinta Basin

Some of Utah's most valuable trout streams will be changed by the diversion of their flows. These include Rock Creek, the West Fork of the Duchesne River, Currant Creek, and the Strawberry River. Other Uinta Basin trout streams which will be diverted are Water Hollow Creek, Layout Creek, Wolf Creek, Twin Creek, Hades Creek, and the South Fork of Rock Creek (Fish and Wildlife Service, 1965).

The interception of the flows of these streams will eliminate trout fishing below the points of diversion in all but Rock Creek,
Figure 1. The location of the Central Utah Project in Utah.

See Figure 2 for detail map of shaded area.
Figure 2. The Bonneville Unit of the Central Utah Project.

Scale: 1" = 12 miles
Currant Creek, and the Strawberry River. The trout fishing values of these three streams will also be greatly reduced.

The effect on the potential man-days of fishing gives an indication of the effect the project will have on the trout stream fishery of the Uinta Basin. Without the project, it has been estimated that the affected streams could provide an average of 164,000 man-days of fishing annually, and that with the project, they could be expected to provide an average of 45,000 man-days of fishing annually. Table No. 1 includes estimates of potential annual man-days of fishing before and after construction of the Bonneville Unit for each of the affected streams (Fish and Wildlife Service, 1965).

It follows that benefits accruing to beneficiaries other than trout stream fishermen must be to a considerable degree at the expense of the trout stream fishermen.

The Objectives

This study attempted to deal with the problem of fitting trout stream fishing into its proper place in Benefit-Cost Analysis in view of the absence of a market determined value. Specifically, the objectives of the study were:

1. To develop a mechanism to predict the use of a trout stream fishery,

2. using the use-prediction model, to calculate the use levels of the study streams, and

3. to develop a reasonable estimate of the loss in primary benefits which will result with a reduction in the stream trout fishery potential of the Uinta Basin when the Bonneville Unit of the Central Utah Project is implemented.
Table 1. Summary of Uinta Basin average man-days of fishing before and after completion of the Bonneville Unit of the Central Utah Project

<table>
<thead>
<tr>
<th>Stream</th>
<th>Without the Project</th>
<th>With the Project</th>
<th>Gain or Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Creek</td>
<td>96,500</td>
<td>24,700</td>
<td>-71,800</td>
</tr>
<tr>
<td>South Fork of Rock Creek</td>
<td>600</td>
<td>0</td>
<td>-600</td>
</tr>
<tr>
<td>Hades Creek</td>
<td>200</td>
<td>0</td>
<td>-200</td>
</tr>
<tr>
<td>Twin Creek</td>
<td>100</td>
<td>0</td>
<td>-100</td>
</tr>
<tr>
<td>Wolf Creek</td>
<td>800</td>
<td>0</td>
<td>-800</td>
</tr>
<tr>
<td>West Fork of the Duchesne River</td>
<td>5,600</td>
<td>0</td>
<td>-5,600</td>
</tr>
<tr>
<td>Currant Creek</td>
<td>10,500</td>
<td>3,400</td>
<td>-7,100</td>
</tr>
<tr>
<td>Layout Creek</td>
<td>200</td>
<td>0</td>
<td>-200</td>
</tr>
<tr>
<td>Water Hollow Creek</td>
<td>300</td>
<td>0</td>
<td>-300</td>
</tr>
<tr>
<td>Strawberry River</td>
<td>21,800</td>
<td>3,000</td>
<td>-18,800</td>
</tr>
<tr>
<td>Duchesne River</td>
<td>27,500</td>
<td>14,700</td>
<td>-12,800</td>
</tr>
<tr>
<td>Total</td>
<td>164,100</td>
<td>45,800</td>
<td>-118,300</td>
</tr>
</tbody>
</table>

1/ Fish and Wildlife Service. 1965. Fish and Wildlife Resources in Relation to the Bonneville Unit, Central Utah Project, Initial Phase.
THE STUDY AREA

The need to test and quantify the models required collection of sample data. The West Fork of the Duchesne River and Currant Creek above U.S. Highway 40 were selected for data collection. Currant Creek is located approximately ninety miles east of Salt Lake City on the south slope of the Uinta Mountains (Fig. 2). Access to the stream is by pave surface roads for the lower reaches and by dirt surface roads for the upper reaches of the stream. The stream is twenty-four miles long, and runs from an elevation of about 9,000 feet to about 6,000 feet. There is a fair to poor dirt surface road running parallel to the stream for its entire length above Highway 40. The section of Currant Creek below Highway 40 was not sampled. Estimated use levels do not reflect use of this one and one-half mile length of the stream.

The West Fork of the Duchesne River is located approximately seventy miles east of Salt Lake City on the south of the Uinta Mountains (Fig. 2). Access is by dirt surface roads for all reaches of the stream. The stream is ten miles long, and runs from an elevation of about 9,000 feet to about 6,000 feet. There is a good to poor dirt surface road running parallel to the stream for its entire length.

Both streams are planted with catchable trout regularly throughout the fishing season. Both streams are used for a variety of outdoor recreation activities including camping, hunting, and hiking.
THE MODELS

Recreation Valuation

The valuation problem must be considered in light of some valid and accepted definition of value. It is commonly agreed that major decisions of investment and allocation of resources to recreational use lie under public aegis (Brewer, 1962). Investment and allocation decisions by government should follow welfare economics criteria. That is, an attempt should be made to maximize the well-being of society as defined by society's preferences. The recreational resource valuation procedure should give a measure of value appropriate to welfare criteria. It is suggested that the relevant concept of value for this study is one which equates value to a measure of the utility a person or society derives from the utilization of a thing. Assuming that this is the correct concept of value, how can it be estimated?

Consumer's Surplus

The consumer's surplus procedure proposed by Hotelling was selected as the appropriate valuation model (Hotelling, 1949). The logic behind the selection of this model stems directly from the definition of value accepted above. The following is offered as an explanation of this logic.

Consumer's surplus analysis follows from an observation by Alfred Marshall in Principles of Economics (Marshall, 1925). Given the demand curve assumption of diminishing marginal utility for a commodity and constant marginal utility of money, Marshall says:
We have already seen that the price which a person pays for a thing can never exceed, and seldom comes up to that which he would be willing to pay rather than go without it: so that the satisfaction which he gets from its purchase generally exceeds that which he gives up in paying away its price; and he thus derives from the purchase a surplus of satisfaction. The excess of the price which he would be willing to pay rather than go without the thing, over that which he actually does pay, is the economic measure of this surplus satisfaction. It may be called consumer's surplus.

Use of consumer's surplus as a basis for resource valuation results in derivation of a value which is net of purchase costs. Wennergren says, "It is a value measure of the net utility derived from the use of a commodity and provides a reasonable corollary to the use of other net values such as profits as the basis for land or other income property valuation." (Wennergren, 1965). This seems to be an appropriate measure of recreation resource value considering the background of government administration and welfare economics.

Consumer's surplus valuation of a commodity is accomplished by analysis of the demand curve for the commodity. If a consumer acts rationally, he will allocate his resources devoted to the purchase of a commodity so that the net utilities associated with the marginal purchase will be zero; or for the marginal unit purchased, the marginal costs of the purchase will be just equal to the value of the utility of the marginal unit purchased. This implies that the expenditure on the marginal unit is a measure of the value of the utility of the marginal unit.

A simple example will serve to clarify the consumer's surplus model. Given a consumer's demand curve, $D_oD_x$, for a commodity 'A' (Fig. 3) where "P" is the market price, "Q_0" the quantity taken at the market price, and "Q_x" and arbitrary unit of "A", the consumer's surplus is equal to the area $PP'D_o$. 
The conclusion that the consumer's surplus is equal to the area PP'D₀ can be explained as follows. First, assume that the area under the demand curve D₀D₁ has been subdivided into small trapezoids each representing one unit of commodity "A". Consider one such trapezoid QₓS. The consumer's expenditure for the Qₓ unit is equal to the market price "P" (QₓR). He would have been willing to pay "P₀" (the value of the utility of the Qₓ unit). Therefore, as a result of the purchase of the Qₓth unit, our consumer acquired a surplus of value equal to:

\[ QₓS - RQₓ = RS \]

By similar reasoning, it follows that the surplus for the Q₀ unit (the marginal unit at the market price "P") will be zero, and that the total surplus value (consumer's surplus) accruing to our consumer is equal to the area bounded by the demand curve D₀D₁ and the market price line PP' or the area PP'D₀ (Marshall, 1947).

Figure 3. Illustration of consumer's surplus.
These conclusions hinge on five critical assumptions (Wennergren, 1964).

1. The consumer attempts to maximize satisfaction from his available income and other resources.
2. The consumer has perfect knowledge or at least acts on his expectations as though he had such knowledge regarding the various costs of purchase and accompanying utility.
3. The commodity generates a total utility function which at some point encounters diminishing marginal utilities.
4. The units of utility and cost are equivalent such that a statement of net utility can be derived.
5. The utility generated by utilization of the commodity is the causal agent in the consumer's decision to undertake the purchase.

Recreation Use-Prediction

Economic demand theory serves as the framework of the use-prediction model. The rationale for this is the hypothesis that use of a non-market commodity such as recreation is defined by a set of constraints similar to those that define use of a market commodity. Demand theory postulates that consumption of a commodity is a function of:

1. Market Price,
2. Consumer Tastes and Preferences,
3. The number of consumers under consideration,
4. Consumer's Incomes,
5. The Price of Related Goods, and
Accepting use and demand as equivalent concepts, it follows that the use-prediction model could take the form of a multiple regression equation with Use being the dependent variable and the demand determinants being the independent variables.

Relating the suggested use-prediction model to demand theory, the following relationships are postulated:

1. Travel distance is a proxy for market price. This results from the hypothesis that travel costs to and from the site constitute the major part of the relevant expenditures (Clawson, 1959).

2. Consumer tastes and preferences are correlated with consumer socio-economic characteristics (ORRRC, 1962). This suggests that it is possible to use socio-economic characteristics as indicators of tastes and preferences. This hypothesis was used in selecting percent of population 65 years old and older as one of the independent variables of the model.

3. Percent of families with annual incomes in the $4,000 to $6,999 range was selected as a proxy for the income demand determinant in the model.

4. Population was not included as an independent variable. Rather, use per thousand population was defined as the dependent variable. This allowed concentration on the other use-determinant variables. Ferber in defining urban trade areas states that use of a population variable tends to conceal the presence of significant variables (Ferber, 1958).

5. The price of related goods and the range of goods available were not included because of measurement problems and the lack of means to quantify them.
The use-prediction model then became:

$$U_{ij} = f(D_{ij}, A_i, Y_i)$$

where "i" is the origin of the user,

"j" is the stream fishery under consideration,

"U_{ij}" is the number of angler days per season at stream "j" per thousand population from origin "i",

"D_{ij}" is the round trip distance in miles from origin "i" to stream "j",

"A_i" is percent of population 65 years old and older at origin "i", and

"Y_i" is the percent of families with annual incomes in the $4,000 to $6,999 range at origin "i".
METHODS AND PROCEDURES

Data Collection

Data were collected by on-site personal interview throughout the fishing season which ran from July 4, 1966, to November 30, 1966. The data collected included the permanent residence of the fisherman, the primary purpose of the trip, the number of fishermen in the party, and expenditure data (Appendix No. 1, Interview Schedule).

The streams were sampled on alternate days in most instances. On the day a particular stream was to be sampled, the length of the stream was examined for fishermen once during the morning and once during the early evening. No observed fishermen declined the interview.

All sampling was done with replacement. Sampling with replacement involves putting sampled units back into the population after they are tabulated. Thus, each fisherman was interviewed during each sample period he was encountered, even if he had been interviewed in one or more prior sampling periods. The sampling with replacement procedure was followed in order that certain data analysis procedures (Correction for Length-of-Stay Bias) could be completed.

Fishermen, for the purpose of sampling, were defined as persons who indicated that the primary purpose of their trip was to fish the sample stream. Subjects who participated in other outdoor recreation activities were included in the sample if they indicated that the primary purpose of their trip was to fish the sample stream.

Use Levels

The sample data were stratified by month of sample and by weekend-holiday or weekday within each month, and expanded to a
estimate of total stream use. The Fourth-of-July was handled separately from the rest of the weekend-holiday data. The difference between the Fourth-of-July use level and the other weekend-holiday use levels of July clearly indicated that the Fourth-of-July fishermen were from another use population. This could probably be attributed to angler interest in the streams created by their late opening season. The sample streams were unique in that the fishing season began on July 4 compared to June 4 for most Utah trout streams.

**Length-of-Stay Bias**

Estimates of total use and use from various origins were corrected for length-of-stay bias. Estimates of total fisherman days will be biased upward unless this adjustment is made. This results from the fact that the probability of a fisherman falling into the sample is a function of his length of stay.

The procedure for correcting for length-of-stay bias requires multiplying the total days stayed by sample parties with a stay of X days by 1/X and totaling the products. The product of 1/X times the total days stayed will hereafter be referred to as the weighted use, and the sum of these products will be referred to as the sum of weighted use. The sum of weighted use is multiplied by the inverse of the sampling rate, 1/(percent sample), and an estimate of total fisherman days is obtained (Lucus, 1963). A simple example will illustrate the procedure.

Assume a campground with two camp units in it and a use season of 10 days. Further, assume that one of the camp units is used by different parties on each of the 10 days during the season, while the second camp unit is used by the same party for the entire 10-day season. For clarity, a party size of one will be assumed.
Given the assumptions above, it is obvious that the total use of the campground complex is 20 man-days. What will be the estimated use level if a 20 percent sample is made?

A 20 percent sample of the assumed use season would be two days. If the campground was sampled on two days, the data in table 2 would result.

Table 2. Illustration of correction for length-of-stay bias

<table>
<thead>
<tr>
<th>Sample Data</th>
<th>Uncorrected Use</th>
<th>Corrected Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/</td>
<td>2/</td>
</tr>
<tr>
<td>Unit</td>
<td>Sample Day</td>
<td>Party Size</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

Total sampled man-Days 22 4

1/ Man-Days is equal to party size times length of stay.
2/ 1/X is equal to the inverse of the length of stay.
3/ Corrected man-days is equal to man-days times 1/X.

These data can be expanded to total use estimates by multiplying the total sampled man-days times the sampling rate inverse (1/.20 = 5).

When the data which were uncorrected for length-of-stay bias are used, an incorrect result is obtained (5 x 22 = 110). The correct
result is obtained \((5 \times 4 = 20)\) when the data which were corrected for length-of-stay bias are expanded.

**Use-Prediction**

Data analysis for the use-prediction model derives from the definition of Use and Demand as parallel concepts and Hotelling's comments on empirical demand curves for national parks. Hotelling said:

Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of the zones is approximately constant. The persons entering the park in a year, or a suitably chosen sample of them, are to be listed according to the zone from which they come. The fact that they come means that the service of the park is at least worth the cost, and this cost can probably be estimated with fair accuracy... The comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone enables us to plot one point for each zone on a demand curve for the service of the park. By a judicious process of fitting it should be possible to get a good enough approximation to the demand curve..." (Hotelling, 1949).

The use determinants age and income were added to this basic framework to complete the use-prediction model.

The sample data were stratified and analyzed by county of fisherman origin as opposed to the concentric ring approach suggested by Hotelling. This permitted use of the United States Bureau of the Census *Census of the Population Report* to estimate population, the population age variable, and the population income variable for each origin.
Fishery Valuation

The first step in determining consumer's surplus values for the sample streams was to estimate demand schedules for each of them. The demand estimation procedure followed the Hotelling procedure referred to above. Again, counties were defined as origins instead of the concentric rings proposed by Hotelling. The result of this procedure was an equation for each stream of the form

$$P = f(X)$$

where "P" is market price and "X" is the quantity demanded.

Demand

The absence of a market price for trout fishing was noted above. Since, by definition, any empirical estimate of a demand schedule must be based on a price-quantity relationship, a proxy for market price was used. It is postulated that travel costs to and from the trout stream plus new expenditures on fishing equipment (i.e. hooks, bait, line, etc., purchased so that the interview trip could be made) constitute the relevant expenditures (price). The rationale for this postulate is the definition of these expenditures as the marginal or variable cost trout fishing.

Once the fisherman has purchased a fishing license and his basic fishing equipment (i.e. rod and reel), he will normally join the fisherman population for the coming season.

This does not mean that he must fish. It does mean that he must incur these costs regardless of the amount of fishing he does. The fisherman's short run decision is not controlled by total fixed costs, or average fixed costs which will decline as use increases.
The number of trips taken will be controlled by the variable costs that must be incurred in direct relation to the number of fishing trips taken. A fisherman using a given stream will make trips to that stream until the added utility or satisfaction received equals his related marginal costs. The marginal cost is a function of the variable costs of fishing and is not influenced by the fisherman's fixed investment in fishing licenses and fishing equipment (Wennergren, 1965). Therefore, the marginal costs are defined as the round trip travel costs plus expenditures on new fishing equipment such as bait, fish hooks, and fishing line.

Travel costs were computed by applying the American Association of State Highway Official's estimate of the cost of a mile of travel at 40 miles per hour ($0.0516). (American Association of Highway Officials, 1960).

To arrive at the travel cost associated with a fisherman day from origin "i", it was necessary to divide the total cost associated with one automobile by two. This was a result of an average party size of two fishermen as reflected by sample data.

The dependent variable demand or use associated with each origin cost (price) level was determined by applying the use-prediction model to the various origins (counties).

Consumer's Surplus Valuation

Given the demand functions, the computation of the consumer's surplus for continuous demand functions such as the ones derived is a straightforward integration process (Yamane, 1962). The consumer's surplus, given the market price, can be shown to be equal to,

\[ \int_0^{x_1} [f(X) - P_iX] \]
where \(f(X)\) is the demand function,

"i" is the origin under consideration,

\(P_i\) is the cost (price) for origin "i", and

\(X_i\) is the quantity taken by origin "i" at price \(P_i\).

In applying this procedure, it is necessary to consider each county (origin) as a separate market situation since each county is associated with a different market price (cost). The consumer's surplus value of a stream fishery is then,

\[
\sum_{i=1}^{n} \int f(X) - P_i X_i
\]
RESULTS

Total Use and Use by Fisherman Origin

Tables 3, 4, 5, and 6 list total use for Currant Creek; total use for the West Fork of the Duchesne River; and stream use by fisherman origin for Currant Creek and the West Fork of the Duchesne River respectively. Correction for length-of-stay bias procedures were followed in completing the four tables.

Use-Prediction

Tables 7 and 8 list the use determinant variables and use levels for each origin for Currant Creek and the West Fork of the Duchesne River. These data were incorporated into a computer step-wise-deletion multiple regression program to quantify the parameters of the use-prediction model. The analysis was done with the origin observations for the two sample streams pooled. The resulting equation was:

\[ U_{ij} = -32.716 - 0.054 D_{ij} + 1.633 A_i + 0.903 Y_i \]

where "U_{ij}" is the use per thousand population from county (origin) "i" to stream "j",

"D_{ij}" is the round trip distance in miles between county "i" and stream "j",

"A_i" is the percent of the population of county "i" which is 65 years old or older, and

"Y_i" is the percent of families in county "i" with annual incomes in the $4,000 to $6,999 range.
Table 3. 1966 season total use estimate for Currant Creek in man-days 1/

<table>
<thead>
<tr>
<th>Month</th>
<th>Weekday</th>
<th>Sum 2/</th>
<th>Sample 3/</th>
<th>Sample Rt. Inverse</th>
<th>Total Annual 4/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wt. Use</td>
<td>Rate</td>
<td></td>
<td>Man-Days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>Weekday</td>
<td>26</td>
<td>23.81</td>
<td>4.20</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Weekend</td>
<td>62</td>
<td>33.33</td>
<td>3.00</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td>4th July</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>314</td>
</tr>
<tr>
<td>August</td>
<td>Weekday</td>
<td>25</td>
<td>17.40</td>
<td>5.75</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Weekend</td>
<td>40</td>
<td>25.00</td>
<td>4.00</td>
<td>160</td>
</tr>
<tr>
<td>September</td>
<td>Weekday</td>
<td>19</td>
<td>9.52</td>
<td>10.50</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Weekend</td>
<td>89</td>
<td>33.33</td>
<td>3.00</td>
<td>267</td>
</tr>
<tr>
<td>Oct.-Nov.</td>
<td>5/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1380</td>
</tr>
</tbody>
</table>

1/ A man-day was recorded if a fisherman fished during the day without regard to the number of hours fished.
2/ The sum of weighted use is equal to (1/length of stay) (total days stayed) for the samples falling into a stratum.
3/ The sample rate is equal to the number of sampled days in a stratum divided by the total number of days in that stratum.
4/ Total angler days is equal to (sample rate inverse) (sum of weighted use).
5/ Spot checks were made in October and November; no fishermen were observed.
Table 4. 1966 season total use estimate for West Fork of the Duchesne River in man-days 1/

<table>
<thead>
<tr>
<th>Month</th>
<th>Weekday Sum Wt. Use</th>
<th>Weekend Sum Wt. Use</th>
<th>Sample Rate</th>
<th>Sample Rt. Inverse</th>
<th>Total Annual Man-Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td>Weekday</td>
<td>Weekend</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>30</td>
<td>38</td>
<td>23.81</td>
<td>4.20</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th July</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>92</td>
</tr>
<tr>
<td>August</td>
<td>15</td>
<td>21</td>
<td>17.40</td>
<td>5.75</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>15</td>
<td>47</td>
<td>9.52</td>
<td>10.50</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct.-Nov.</td>
<td>5/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>842</td>
</tr>
</tbody>
</table>

1/ A man-day was recorded if a fisherman fished during the day without regard to the number of hours fished.
2/ The sum of weighted use is equal to (1/length of stay) (total days stayed) for the samples falling into a stratum.
3/ The sample rate is equal to the number of sampled days in a stratum divided by the total number of days in that stratum.
4/ Total angler days is equal to (sample rate inverse) (sum of weighted use).
5/ Spot checks were made in October and November; no fishermen were observed.
Table 5. Stream use by county of fisherman origin for the West Fork of the Duchesne River

<table>
<thead>
<tr>
<th>County</th>
<th>1/ Number</th>
<th>2/ Wt. Use</th>
<th>3/ Percent of Sample Use</th>
<th>4/ Total Annual Fisherman Days</th>
<th>5/ Annual Fisherman Days per M-Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>47,600</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Duchesne</td>
<td>7,170</td>
<td>7</td>
<td>3.80</td>
<td>32</td>
<td>4.46</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>319,276</td>
<td>109</td>
<td>59.25</td>
<td>499</td>
<td>1.56</td>
</tr>
<tr>
<td>Summit</td>
<td>5,673</td>
<td>4</td>
<td>2.17</td>
<td>18</td>
<td>3.18</td>
</tr>
<tr>
<td>Tooele</td>
<td>17,868</td>
<td>9</td>
<td>4.89</td>
<td>41</td>
<td>2.30</td>
</tr>
<tr>
<td>Uintah</td>
<td>11,585</td>
<td>3</td>
<td>1.63</td>
<td>14</td>
<td>1.21</td>
</tr>
<tr>
<td>Utah</td>
<td>107,089</td>
<td>9</td>
<td>4.89</td>
<td>41</td>
<td>0.38</td>
</tr>
<tr>
<td>Wasatch</td>
<td>5,308</td>
<td>17</td>
<td>9.24</td>
<td>78</td>
<td>14.69</td>
</tr>
<tr>
<td>Weber</td>
<td>110,744</td>
<td>26</td>
<td>14.13</td>
<td>119</td>
<td>1.07</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>842</strong></td>
<td></td>
</tr>
</tbody>
</table>

2/ Sum of the weighted use is equal to the sum of (1/length of stay) (total days stayed) for the sample originating from the respective origins.
3/ Percent of sample use was calculated by dividing the sum of weighted use as defined above by the total stream sum of weighted use.
4/ Total county fisherman-days is equal to the percent of the sample use times the total stream use.
5/ Total fisherman-days divided by county populations in thousands.
Table 6. Stream use by county of fisherman origin for Currant Creek

<table>
<thead>
<tr>
<th>County</th>
<th>Sum of Wt. Use</th>
<th>Percent of Sample Use</th>
<th>Total Annual Fisherman Days</th>
<th>Annual Fisherman Days per M-Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td>47,600</td>
<td>2</td>
<td>0.58</td>
<td>8</td>
</tr>
<tr>
<td>Duchesne</td>
<td>7,179</td>
<td>6</td>
<td>1.73</td>
<td>24</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>319,276</td>
<td>223</td>
<td>64.45</td>
<td>889</td>
</tr>
<tr>
<td>Summit</td>
<td>5,673</td>
<td>13</td>
<td>3.76</td>
<td>52</td>
</tr>
<tr>
<td>Tooele</td>
<td>17,868</td>
<td>5</td>
<td>1.44</td>
<td>20</td>
</tr>
<tr>
<td>Uintah</td>
<td>11,585</td>
<td>2</td>
<td>0.58</td>
<td>8</td>
</tr>
<tr>
<td>Utah</td>
<td>107,089</td>
<td>61</td>
<td>17.63</td>
<td>243</td>
</tr>
<tr>
<td>Wasatch</td>
<td>5,308</td>
<td>32</td>
<td>9.25</td>
<td>128</td>
</tr>
<tr>
<td>Weber</td>
<td>110,744</td>
<td>2</td>
<td>0.58</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>1,380</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


2/ Sum of the weighted use is equal to the sum of (1/length of stay) (total days stayed) for the sample originating from the respective origin.

3/ Percent of sample use was calculated by dividing the sum of weighted use as defined above by the total stream sum of weighted use.

4/ Total county fisherman-days is equal to the percent of the sample use times the total stream use.

5/ Use per 1000-Pop. is equal to total fisherman-days divided by county population in thousands.
Table 7. Origin use determinants for Currant Creek

<table>
<thead>
<tr>
<th>County</th>
<th>Round Trip Distance</th>
<th>Percent Population 65 Years</th>
<th>Percent Income 4000-6999</th>
<th>Annual Use per 1000-Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>196</td>
<td>2</td>
<td>42</td>
<td>0.16</td>
</tr>
<tr>
<td>Duchesne</td>
<td>98</td>
<td>6</td>
<td>38</td>
<td>4.46</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>210</td>
<td>8</td>
<td>40</td>
<td>2.76</td>
</tr>
<tr>
<td>Summit</td>
<td>110</td>
<td>1</td>
<td>50</td>
<td>9.17</td>
</tr>
<tr>
<td>Tooele</td>
<td>296</td>
<td>5</td>
<td>45</td>
<td>1.06</td>
</tr>
<tr>
<td>Uintah</td>
<td>230</td>
<td>5</td>
<td>41</td>
<td>0.69</td>
</tr>
<tr>
<td>Wasatch</td>
<td>66</td>
<td>8</td>
<td>43</td>
<td>24.11</td>
</tr>
<tr>
<td>Weber</td>
<td>238</td>
<td>7</td>
<td>42</td>
<td>0.72</td>
</tr>
</tbody>
</table>

3/ Use per 1000-population is taken from Table No. 4.
Table 8. Origin use-determinants for the West Fork of the Duchesne River

<table>
<thead>
<tr>
<th>County</th>
<th>Round Trip Distance</th>
<th>1/ Miles</th>
<th>2/ Percent Population 65 Years</th>
<th>2/ Percent Income 4000-6999</th>
<th>3/ Annual Use per 1000-Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>184</td>
<td>2</td>
<td>42</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Duchesne</td>
<td>120</td>
<td>6</td>
<td>38</td>
<td></td>
<td>4.46</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>200</td>
<td>8</td>
<td>40</td>
<td></td>
<td>1.56</td>
</tr>
<tr>
<td>Summit</td>
<td>100</td>
<td>1</td>
<td>50</td>
<td></td>
<td>3.18</td>
</tr>
<tr>
<td>Tooele</td>
<td>310</td>
<td>5</td>
<td>45</td>
<td></td>
<td>2.30</td>
</tr>
<tr>
<td>Uintah</td>
<td>266</td>
<td>5</td>
<td>41</td>
<td></td>
<td>1.21</td>
</tr>
<tr>
<td>Utah</td>
<td>216</td>
<td>3</td>
<td>44</td>
<td></td>
<td>0.38</td>
</tr>
<tr>
<td>Wasatch</td>
<td>62</td>
<td>8</td>
<td>43</td>
<td></td>
<td>15.08</td>
</tr>
<tr>
<td>Weber</td>
<td>262</td>
<td>7</td>
<td>42</td>
<td></td>
<td>1.07</td>
</tr>
</tbody>
</table>

3/ Use per 1000-population is taken from Table No. 4.
R² for the relationship was 0.74, and the coefficients and model were significant at the 10 percent level.

In addition to the variables incorporated into the final model, the following socio-economic characteristics of the user populations were tested as independent use-prediction variables.

1. the percent of origin population between 20 and 64 years of age,
2. the percent of origin population between 20 and 45 years of age,
3. the percent of origin families with annual incomes over $10,000,
4. the percent of origin families with annual incomes in the $7,000 to $9,999 range, and
5. the percent of the origin population which is urban. None of these variables added to the model sufficiently to warrant its inclusion.

Fishery Valuation

Demand

Tables 9 and 10 list the use and cost data associated with each origin for Currant Creek and the West Fork of the Duchesne River respectively. These data were incorporated into regression analysis to arrive at statistical estimates of the demand schedules for the two streams. The log linear function describing this relationship for Currant Creek is,

\[ \ln Y = 4.22527 - 2.20355 \ln X \]

The relationship for the West Fork of the Duchesne River is,

\[ \ln Y = 3.96188 - 1.95644 \ln X \]
Table 9. Predicted use of and travel and equipment costs per fisherman-day associated with fishing use of Currant Creek

<table>
<thead>
<tr>
<th>County</th>
<th>Distance</th>
<th>Total Travel Costs</th>
<th>Fisherman Travel Costs</th>
<th>Equip. Costs</th>
<th>Total Costs</th>
<th>Predicted Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miles</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Numbers</td>
</tr>
<tr>
<td>Davis</td>
<td>196</td>
<td>10.11</td>
<td>5.05</td>
<td>0.25</td>
<td>5.30</td>
<td>0.00</td>
</tr>
<tr>
<td>Duchesne</td>
<td>98</td>
<td>5.06</td>
<td>2.28</td>
<td>0.00</td>
<td>2.28</td>
<td>6.10</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>210</td>
<td>10.84</td>
<td>5.42</td>
<td>0.11</td>
<td>5.53</td>
<td>5.13</td>
</tr>
<tr>
<td>Summit</td>
<td>110</td>
<td>5.68</td>
<td>2.84</td>
<td>0.07</td>
<td>2.91</td>
<td>8.13</td>
</tr>
<tr>
<td>Tooele</td>
<td>296</td>
<td>15.27</td>
<td>7.64</td>
<td>0.17</td>
<td>7.81</td>
<td>0.10</td>
</tr>
<tr>
<td>Uintah</td>
<td>230</td>
<td>11.87</td>
<td>5.94</td>
<td>0.15</td>
<td>6.09</td>
<td>0.00</td>
</tr>
<tr>
<td>Utah</td>
<td>170</td>
<td>8.77</td>
<td>4.39</td>
<td>0.21</td>
<td>4.60</td>
<td>2.73</td>
</tr>
<tr>
<td>Wasatch</td>
<td>66</td>
<td>3.41</td>
<td>1.70</td>
<td>0.10</td>
<td>1.80</td>
<td>15.61</td>
</tr>
<tr>
<td>Weber</td>
<td>238</td>
<td>12.28</td>
<td>6.14</td>
<td>0.25</td>
<td>6.39</td>
<td>3.79</td>
</tr>
</tbody>
</table>

1/ Distance is equal to round trip travel distance.
2/ Total travel cost is equal to $0.0516 times round trip travel distance in miles.
3/ Fishermen travel costs are equal to total travel costs divided by two (adjustment for party size).
4/ Equipment cost is equal to average expenditure on new fishing equipment (from sample data).
5/ Total cost is equal to fisherman travel cost plus equipment cost.
6/ Predicted use is equal to use per thousand population (from the use-prediction equation).
### Table 10. Predicted use and travel and equipment costs per fisherman-day associated with fishing use of the West Fork of the Duchesne River

<table>
<thead>
<tr>
<th>County</th>
<th>Distance</th>
<th>1/ Total Travel Costs</th>
<th>2/ Fisherman Travel Costs</th>
<th>3/ Equip. Costs</th>
<th>4/ Total Costs</th>
<th>5/ Predicted Use</th>
<th>6/ Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Dollars</td>
<td>Dollars</td>
<td></td>
<td>Numbers</td>
</tr>
<tr>
<td>Davis</td>
<td>184</td>
<td>9.49</td>
<td>4.74</td>
<td>0.00</td>
<td>4.74</td>
<td>0.00</td>
<td>4.91</td>
</tr>
<tr>
<td>Duchesne</td>
<td>120</td>
<td>6.19</td>
<td>3.10</td>
<td>0.10</td>
<td>3.20</td>
<td>4.91</td>
<td>5.67</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>200</td>
<td>10.32</td>
<td>5.16</td>
<td>0.18</td>
<td>5.34</td>
<td>5.67</td>
<td>8.67</td>
</tr>
<tr>
<td>Summit</td>
<td>100</td>
<td>5.16</td>
<td>2.58</td>
<td>0.29</td>
<td>2.87</td>
<td>8.67</td>
<td>0.00</td>
</tr>
<tr>
<td>Tooele</td>
<td>310</td>
<td>16.00</td>
<td>8.00</td>
<td>0.00</td>
<td>8.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Uintah</td>
<td>266</td>
<td>14.53</td>
<td>7.26</td>
<td>0.08</td>
<td>7.34</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Utah</td>
<td>216</td>
<td>11.15</td>
<td>5.58</td>
<td>0.38</td>
<td>5.96</td>
<td>0.25</td>
<td>15.83</td>
</tr>
<tr>
<td>Wasatch</td>
<td>62</td>
<td>3.20</td>
<td>1.60</td>
<td>0.15</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weber</td>
<td>262</td>
<td>13.52</td>
<td>6.76</td>
<td>0.20</td>
<td>6.96</td>
<td>2.49</td>
<td></td>
</tr>
</tbody>
</table>

1/ Distance is equal to round trip travel distance.
2/ Total travel cost is equal to $0.0516 times round trip travel distance in miles.
3/ Fisherman travel costs are equal to total travel costs divided by two (adjustment for party size).
4/ Equipment cost is equal to average expenditure on new fishing equipment (from sample data).
5/ Total cost is equal to fisherman travel costs plus equipment cost.
6/ Predicted use is equal to use per thousand population (from the use prediction equation).
In both expressions above, \( Y \) is equal to county use per thousand population; and \( X \) is equal to variable cost per fisherman-day (travel costs plus expenditures on new fishing equipment) associated with the respective counties.

\( R^2 \) for the Currant Creek relationship is 0.55 and the average price elasticity - 2.204 is significant at the 5 percent level.

\( R^2 \) for the West Fork of the Duchesne River relationship is 0.51, and the average price elasticity -1.96 is significant at the 5 percent level.

The two equations above express use as a function of price (cost). Standard economic demand curves express price as a function of use. To achieve conformity, both of the demand schedule estimates were rearranged to express price as a function of use. The equation for Currant Creek becomes,

\[
\ln X = 1.917 - 0.454 \ln Y,
\]

and the equation for the West Fork of the Duchesne River becomes,

\[
\ln X = 2.025 - 0.511 \ln Y.
\]

When general reference is made to these equations, \( f(X) \) will be used.

The functions for Currant Creek and the West Fork of the Duchesne River and their associated scatter diagrams are shown in figures 4 and 5 respectively.

These demand schedule estimates were obviously derived by cross-sectional analysis. They are, therefore, subject to the usual assumptions of this type of methodology. That is,

1. Homogeneity of consumers (fishermen) among origins.
2. The constancy of the marginal utility of money (Wennergren, 1965).
Figure 4. Statistical estimate of the demand for the trout fishery of Current Creek.
Figure 5. Statistical estimate of the demand for the trout fishery of the West Fork of the Duchesne River.
The assumptions are believed to be correct enough that the results are a fair approximation of reality.

**Consumer's Surplus**

Tables 11 and 12 contain the consumer's surplus valuations of Currant Creek and the West Fork of the Duchesne River respectively. The consumer's surplus value of the Currant Creek and the West Fork of the Duchesne River trout fisheries for the 1966 season were $4,431.17 and $5,933.79 respectively. The average consumer's surplus value of a fisherman day (1966) was $2.67 for Currant Creek and $7.05 for the West Fork of the Duchesne River.

If these are assumed to be constant annual values, the capitalized values of the streams can be calculated. Assuming a discount rate of 5 percent, the capitalized consumer's surplus value of the stream trout fishery of Currant Creek is equal to

\[
\frac{4,431.17}{.05} = 88,623.40,
\]

and the capitalized consumer's surplus value of the West Fork of the Duchesne River stream trout fishery is equal to

\[
\frac{5,933.79}{.05} = 118,675.80.
\]

If a constant annual consumer's surplus is assumed, it must also be assumed that population levels, cost levels, and levels of the socio-economic use-determinant variables will remain constant.

It should be pointed out that these are conservative value estimates. All of the value estimates are affected by the definition of fishermen used for sampling purposes. Those fishermen who were not included in the sample because the primary purpose of their trip was
Table 11. Estimate of annual surplus for Currant Creek

<table>
<thead>
<tr>
<th>County</th>
<th>Predicted Average Per 1000-Pop. Use</th>
<th>Average Variable Cost</th>
<th>( \int f(X) )</th>
<th>Average Per 1000-Pop. Variable Cost</th>
<th>Average Per 1000-Pop. Consumer's Surplus</th>
<th>Number</th>
<th>Total County Consumer's Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>0.00</td>
<td>5.30</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>47,600</td>
<td>151.07</td>
</tr>
<tr>
<td>Duchesne</td>
<td>10.64</td>
<td>2.28</td>
<td>45.33</td>
<td>24.26</td>
<td>21.07</td>
<td>7,170</td>
<td>151.07</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>1.58</td>
<td>5.53</td>
<td>15.99</td>
<td>8.74</td>
<td>7.25</td>
<td>319,276</td>
<td>2,314.75</td>
</tr>
<tr>
<td>Summit</td>
<td>6.50</td>
<td>2.91</td>
<td>34.62</td>
<td>18.92</td>
<td>15.70</td>
<td>5,673</td>
<td>89.07</td>
</tr>
<tr>
<td>Tooele</td>
<td>0.74</td>
<td>7.81</td>
<td>10.55</td>
<td>5.78</td>
<td>4.77</td>
<td>17,868</td>
<td>85.23</td>
</tr>
<tr>
<td>Uintah</td>
<td>0.00</td>
<td>6.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>11,585</td>
<td>0.00</td>
</tr>
<tr>
<td>Utah</td>
<td>2.37</td>
<td>4.60</td>
<td>19.95</td>
<td>10.90</td>
<td>9.05</td>
<td>107,089</td>
<td>969.16</td>
</tr>
<tr>
<td>Wasatch</td>
<td>18.94</td>
<td>1.80</td>
<td>61.72</td>
<td>33.73</td>
<td>27.99</td>
<td>5,308</td>
<td>148.57</td>
</tr>
<tr>
<td>Weber</td>
<td>1.15</td>
<td>6.39</td>
<td>13.43</td>
<td>7.35</td>
<td>6.08</td>
<td>110,744</td>
<td>673.32</td>
</tr>
</tbody>
</table>

Total Consumer's Surplus: 4,431.17

1/ Average-per-thousand population use is equal to use divided by county population in thousands.
2/ Average variable cost is equal to average variable cost per trip for each county.
3/ The expression \( \int f(X) \) is equal to the integral to the demand function \( X = 6.8038 Y - .45381 \), between zero and \( X_i \) (the quantity taken).
4/ Average-per-thousand-population variable expenditure is equal to per thousand use times average variable cost per trip.
5/ Average-per-thousand-consumer's surplus is equal to \( \int f(X) \) - (average-per-thousand-population-variable expenditure).
7/ Total-county-consumer's surplus is equal to average-per-thousand-population consumer's surplus times county population in thousands.
Table 12. Estimate of annual surplus for the West Fork of the Duchesne River

<table>
<thead>
<tr>
<th>County</th>
<th>Predicted Average Per 1000-Pop. Use</th>
<th>Average Variable Cost</th>
<th>$f(X)$</th>
<th>Average Per 1000-Pop. Variable Cost</th>
<th>Average Per 1000-Pop. Consumer's Surplus</th>
<th>County Population</th>
<th>Total County Consumer's Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis</td>
<td>0.00</td>
<td>4.74</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>47.600</td>
<td>0.00</td>
</tr>
<tr>
<td>Duchesne</td>
<td>5.40</td>
<td>3.20</td>
<td>35.35</td>
<td>17.28</td>
<td>18.07</td>
<td>7.170</td>
<td>129.56</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>1.98</td>
<td>5.34</td>
<td>21.66</td>
<td>10.57</td>
<td>11.09</td>
<td>319.276</td>
<td>3,540.77</td>
</tr>
<tr>
<td>Summit</td>
<td>6.68</td>
<td>2.87</td>
<td>39.22</td>
<td>19.17</td>
<td>20.05</td>
<td>5.673</td>
<td>113.74</td>
</tr>
<tr>
<td>Tooele</td>
<td>0.00</td>
<td>8.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>17.868</td>
<td>0.00</td>
</tr>
<tr>
<td>Uintah</td>
<td>0.00</td>
<td>7.34</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>11.585</td>
<td>0.00</td>
</tr>
<tr>
<td>Utah</td>
<td>1.60</td>
<td>5.96</td>
<td>19.50</td>
<td>9.54</td>
<td>9.96</td>
<td>107.089</td>
<td>1,066.61</td>
</tr>
<tr>
<td>Wasatch</td>
<td>17.60</td>
<td>1.75</td>
<td>62.96</td>
<td>30.80</td>
<td>32.16</td>
<td>5.308</td>
<td>170.71</td>
</tr>
<tr>
<td>Weber</td>
<td>1.18</td>
<td>6.96</td>
<td>16.81</td>
<td>8.21</td>
<td>8.60</td>
<td>110.744</td>
<td>952.40</td>
</tr>
</tbody>
</table>

Total Consumer's Surplus $5,933.79

1/ Average-per-thousand population use is equal to use divided by county population in thousands.
2/ Average variable cost is equal to average variable cost per trip for each county.
3/ The expression $\int f(X)\ dx$ is equal to the integral of the demand function $X = 6.8038 Y - .45381$, between zero and $X_1$ (the quantity taken).
4/ Average-per-thousand-population variable expenditure is equal to per thousand use times average variable cost per trip.
5/ Average-per-thousand-consumer's surplus is equal to $\int f(X)\ dx -$ (average-per-thousand-population-variable expenditure).
7/ Total-county-consumer's surplus is equal to average-per-thousand-population consumer's surplus times county population in thousands.
not to fish did in fact gain some value or utility from the stream fishery. This value is not reflected in the value estimates.

The capitalized consumer's surplus values are probably also understatements. The procedure used ignores population growth, probable changes in the socio-economic use-determinant variables, and probable changes in the cost (price) structures.

Since those projections available suggest that future levels of these variables will lead to higher use levels, understatements of the capitalized consumer's surplus values are probable.

There is also the question of what is the proper social discount rate. The capitalized value is obviously affected by the rate selected. If the proper rate is something less than 5 percent, the values are understated. If the proper rate is something larger than 5 percent, the values are overstated.
CONCLUSION

Recreation Valuation

The results suggest that annual gains resulting from engineered water management must be in excess of $4,431.17 for Currant Creek and $5,933.79 for the West Fork of the Duchesne River, or that the capitalized value of the annual gains resulting from engineered water management must be in excess of $88,623.40 for Currant Creek and $118,675.80 for the West Fork of the Duchesne River. 1/

These conclusions assume two things concerning the consumer's surplus values. The first is that values arrived at by consumer's surplus procedures accurately reflect the values accruing to society. The second is that the consumer's surplus values are directly comparable with the pseudo-market values of irrigation water, power, and industrial water, and domestic water.

That consumer's surplus in an indicator of the value society places on a commodity is generally accepted. The problems arise when attempts are made to compare consumer's surplus values directly with market values. Market values are based on a simple price times quantity relationship. Consumer's surplus, on the other hand, is defined

1/Engineered water management is meant to describe the proposed water management plan for the Bonneville Unit of the Central Utah Project. As mentioned above, this plan would manage for irrigation, municipal and industrial water, and power production without explicit regard for the stream trout fishery of the Uinta Basin.
by a complex analysis of demand schedules. The two values, being
based on entirely different premises, are in no sense directly com-
parable.

What does this imply for application of consumer's surplus
valuations in management decisions? Obviously, it denies that consumer's
surplus valuations can be placed side by side with market valuations
and a decision made. It does not, however, completely negate the use-
fulness of the concept. The procedure gives a value which theoreti-
cally could be consistently obtained with a degree of accuracy. Given
this, relative comparisons of consumer's surplus valuations of recrea-
tion with consumer's surplus valuations of engineered water management
are indeed meaningful.

The argument for demand curve valuation in general and consumer's
surplus valuation specifically of recreation as opposed to alternative
methods such as gross expenditure, net expenditure, and subjective
judgement is that the procedure gives an estimate of consumer's
valuation of recreation complexes. This conclusion has as its basis
the concept of marginal utility which underlies demand theory and the
consumer's surplus model.

Another factor that must be considered is that the alternatives
to consumer's surplus (i.e. gross expenditure) are no more comparable
to market values than is consumer's surplus. As with consumer's sur-
plus, the alternatives are based on a procedure other than a price
times quantity relationship; and simply can not be equated to price-
quantity market values.

These observations would seem to lead to the conclusion that
consumer's surplus may be the best alternative available even in view
of the extremely restrictive assumptions underlying the demand curve and the procedure used to arrive at the consumer's surplus valuation.

Specific consumer's surplus problem areas worthy of comment are (1) the process of arriving at travel costs, and (2) the definition of the relevant users.

The per mile costs used to calculate travel costs vary greatly depending on the source one quotes. The estimates of travel costs per mile range from ones which include only gas and oil expenditures to ones which consider every possible charge including depreciation on the automobile. Since the choice of a cost-per-mile-traveled charge will greatly influence the final consumer's surplus results, the choice should be made with care. This choice must be made in light of the concept of variable or marginal costs underlying demand theory. This being the case, the relevant cost can be defined as those costs recreationists assign to the trip, consciously or subconsciously. These may be only gas and oil expenditures, or they may include every conceivable charge including depreciation.

The assumption that a particular experience, in this case trout fishing, is the factor which motivates a person to take a trip is vital to consumer's surplus analysis. If this assumption is not valid, and some of the travel cost is assignable to some other experience, the final results will be invalid. This problem is particularly bothersome in defining the relevant users and collecting data. Problems are not experienced in the extreme cases of an ardent fisherman or a group which has gathered for a family reunion. It is when fishing and the family reunion are both motivating factors that problems occur.
It could be that many or most users fall into the problem category. If this is the case, the limits of the type of analysis are very narrow.

**Use-Prediction**

The concept of a use-prediction model will mean a great deal to resource managers. With an equation that expresses use of a resource as a function of easily measured variables, resource managers could efficiently estimate future resource use levels based on the projected levels of use-determinant variables or estimate present use levels of resources for which use data are not available.

The model developed in this study was based entirely on travel distance and socio-economic characteristics of the user populations. There are other variables which may be as important or more important than the ones used. The variables which seem to hold the most promise are indexes of resource quality and indexes of intervening opportunities. Both of these possibilities have been used by marketing analysts for some time.

Huff, in developing a use-prediction model for shopping centers, used counter space as an index of shopping center quality (Huff, 1963). This suggests that the size of the complex, i.e. length of stream, could be used as one of the independent variables. This would, however, require sampling a wide range of stream sizes. An obvious measure of trout stream quality is the catch success experienced on the stream. This proved to be of no use in analysis of the study streams. The Utah Department of Fish and Game's trout planting program eliminated variation in catch success. Catch success became an
index of the planting program which apparently was approximately the same for both streams.

Other variables which might be helpful in measuring the quality of a stream trout fishery are indexes of esthetics, climate, water characteristics (i.e. flow and depth), and complimentary facilities (i.e. campgrounds).

Huff also used the concept of intervening opportunities in developing his use-prediction model for shopping centers. Normally, if all alternatives to a source of a good are eliminated, the use of that source will increase; and vice-versa if the number of alternative sources increase the use of the source in question will decrease. The fact that there were alternatives to fishing the sample streams suggests that a measure of intervening opportunities would add to the explanatory power of the model.

Huff approached the problem by considering characteristics of competing shopping centers (i.e. counter space devoted to sale of a particular commodity) and the distances between the competing shopping centers and the shopping center in question. This approach could also be applied to trout fishing. That is, the characteristics of competing trout streams could be examined and combined with a measure of the distance between streams to formulate a measure of intervening opportunities.
LITERATURE CITED


Bureau of Reclamation, Department of the Interior. 1964. Central Utah Project, Initial Phase, Bonneville Unit. Salt Lake City, Utah. 191 p.


INTERVIEW SCHEDULE

Utah State University
Project 706
Stream Fishery Valuation
In The Central Utah Project

STREAM ______________________          DATE ______________________
SPOT ______________________          TIME ______________________
AUTO LICENSE NO. ______________

(1) Where is your permanent place of residence? ______________________

(2) Was fishing the primary purpose of your trip? ______________________

(3) Besides fishing in what other activities did you participate this trip?
   CAMPING ______________        PLEASURE DRIVE ______________
   HIKING ______________        SWIMMING ______________
   SIGHTSEEING ______________   OTHER ______________
   PICNICKING ______________

(4) What is your intended or completed length of stay here?

(5) How many hours have you been fishing this stream today?

(6) Will you fish, or have you already fished other streams today?

(6a) If you have, which ones:

__________________________________________
__________________________________________
(7) How many fish have you caught today? What is their average length?

<table>
<thead>
<tr>
<th>Number</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Rainbow</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td></td>
</tr>
<tr>
<td>Cutthroat</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

(8) Where would you fish if this stream were destroyed or seriously damaged?

[space for handwritten answer]

REFER TO MAP ON LAST PAGE FOR QUESTIONS 9 & 10

(9) Where would you fish if the stream fishery west of and including Rock Creek to Current Creek was destroyed or seriously damaged?

[space for handwritten answer]

(10) How many are in your party?__________

(10a) Did you share the travel costs?

(10b) If the travel costs were shared, how was it done?

Contribution to the driver________________________

Other__________________________________________
Other than travel costs, what other costs were incurred during this trip?

Fishing accessories purchased since your last fishing trip

__________________________________________

Food__________________________________________

Lodging_______________________________________

Other_________________________________________