AN ABSTRACT OF THE THESIS OF

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Title: Distortions to Travel Cost Derived Demand Curves: Water Quality and Durable Goods

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Russell L. Gum

The travel cost method of deriving demand and value of recreation does not include fixed costs of recreational durable goods purchases or allow for supply restrictions on the number of suitable sites available. The omission of these two real-world situations results in derivation of demand curves which are more inelastic than truly exist and, consequently, incorrect estimates of value.

Anglers visit sites based on how far they must travel, the water quality of the site, and the presence of facilities. These site characteristics may not be available in adequate supply to meet demand. If so, a supply restriction will exist such that recreators must travel farther or settle for less quality. Simple regression would fit a downward-sloping function through a scatter plot of both supply and demand which would be steeper than the true demand curve. In addition, regression is limited in its ability to deal with interaction of variables and a categorical data set. The loglinear model for categorical data accounts for variable interactions. Results of the empirical study of Pacific Northwest recreational fishing demand and value show that anglers respond to the supply problem rationally and in accordance with utility theory. The per angler per year value of improving all average water quality sites to good-excellent levels was between \$8.98 and \$34.14, only slightly higher than estimates of other recent studies. Also, installation of facilities and water quality improvement at primitive sites of poor-bad water quality resulted in increased annual benefits of nearly 7000%.

Recreators who purchase durable goods incur fixed as well as variable costs. The investment reduces household income but also lowers per trip expenditures. Recreators face two demand curves, one for owning and one for renting the capital good, where utility maximization determines which curve will be chosen. Fit of a scatter by ordinary least squares would estimate a more inelastic demand curve than either of the demand curve pairs unless ownership is considered. Errors in policy are inescapable unless corrections are made. The more capital-intensive the activity, the greater the distortion should be. An empirical study is suggested to test the hypotheses of the theory presented.

DISTORTIONS TO TRAVEL COST DERIVED DEMAND CURVES: WATER QUALITY AND DURABLE GOODS

by

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CHAPTER I

INTRODUCTION

The economics of recreation has undergone considerabe refinement since its birth in 1949. However, some special topics in the field have not been rigorously analyzed. This research is composed of two parts, both of which consider situations previously unaddressed in recreation economics. One is a loglinear analysis of categorical data on recreators and recreation site characteristics which tests the possibility that interactions between and among variables exist. The existence of interactive effects, if not included in a recreation model, distort resulting demand curves. The other is a theoretical framework of durable goods purchases by recreators. The model shows how ignoring fixed costs of capital goods acquisition yields incorrect recreation values and policy implications.

The Problem

The first topic addressed is that of water quality improvement to water-based recreation in the Pacific Northwest states of Oregon, Idaho, and Washington. A general loglinear model is used as the analytical tool to derive recreation demand curves for three levels of water quality. The general model is composed of two submodels: a probability model that a household will engage in recreation and a model of demand by those who recreate. The loglinear approach is used rather than regression since categorical rather than continuous data were collected by the United States Environmental Protection Agency in the 1980 survey.

Use of the loglinear technique allows kinks to emerge in fitting the best relationship from the data provided. Thus, it is easy to see whether availability of recreation sites is constrained at some point due to the interaction of variables. For example, if there are few developed sites of high water quality within a 10-mile radius of a population center but many more beyond, a scatter plot would show an upward-sloping or vertical demand response to the situation in the supply restricted range and downward-sloping in the unrestricted range given that there is sufficient demand. The standard ordinary least squares (OLS) method does not take into account this possibility and would erroneously fit the best, linear, unbiased estimate of the scatter plot as seen in Figure 1. If OLS were used piecewise to determine whether there were a kink due to supply problems, a series of costly iterations would be required. Loglinear--in one pass--can determine whether there is a statistically significant interaction of facilities and water quality which would elicit the supply-restricted response. Second, the loglinear technique is useful for analysis of categorical data while OLS is more applicable to continuous data. Since only categorical data were provided, the former was deemed appropriate.

There are, or course, limitations to the technique. Among these are the inability of the approach to be used for marginal analysis and the rapid loss of degrees of freedom with the additions of variables and interactive effects. However, compared to the futility of regressing the continuous dependent trips variable against a series of independent dummy variables, these problems are relatively insignificant.

The loglinear model is one way which, in spite of its shortcomings, can be used to test hypotheses, deal with categorical data, identify demand distorting effects, and correct for those distortions. In the context of this research, the model was used to estimate the relative improvement in recreator welfare of increased water quality in the Pacific Northwest Region. It was hypothesized that better water quality was preferred to worse water quality, *ceteris paribus*, that availability of facilities at sites influenced demand regardless of water quality, and that shortage of sites distorted demand curves at low surrogate price levels. All tests were positive, as seen in Chapter III. Objective measures of water quality and site quality are described in Appendix VI.

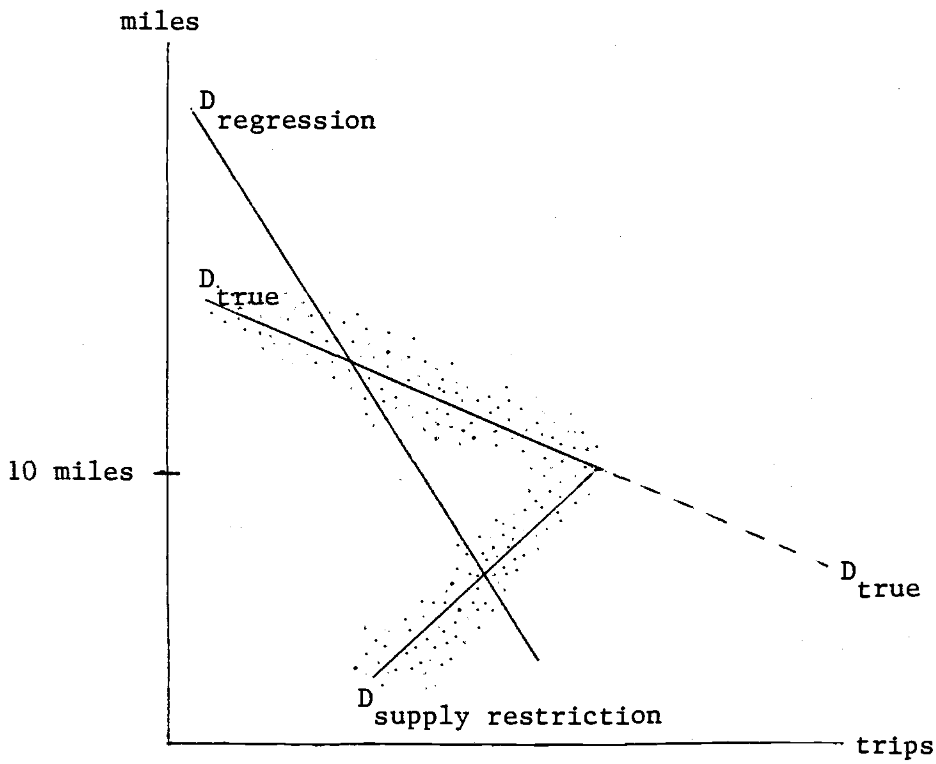

Figure 1

Hypothesized Distortion to Travel Cost
Derived Demand Curve Due to Supply Restriction

The second topic considered was that of the impact on recreation values of recreator acquisition of durable goods. The travel cost method includes variable costs of recreation such as miles traveled, time spent, rented equipment, and entry fees per trip but ignores the fixed costs associated with recreation capital goods: annual license fees for boats, storage of the durable, or down-payments on new purchases which reduce income available to the recreating household. Neglecting these fixed costs for those who incur them leads to incorrectly specified demand curves for recreation and subsequent errors in policy.

There are actually two underlying demand curves for recreation--one based on ownership and one on non-ownership--and the utility-maximizing household elects one or the other. *Ceteris paribus*, the owner faces lower income but lower variable costs of recreating than the non-owner. The pair of curves can then be used to derive a single curve of variable cost to a site which is discontinuous at the point of indifference between owning and not owning the durable good. As seen in Figure 2, regression on a scatter plot of both owners and non-owners yields a demand curve rotated clockwise from the true relationship.

Any policy change to increase variable costs, increased entry fees to sites for example, results in owners close to the point of indifference selling their durables and shifting to non-ownership status. They take fewer trips than the continuous demand curve derived by OLS would predict. If revenues from fees are to be used for some purpose, anticipated revenues would be overestimated since the elasticity of the true curve is greater than that for the incorrectly specified curve.

The problem is easily solved. Restructuring survey instruments to include ownership as a dummy variable or adopting a method which includes durables such as the household production function are only two examples of remedies.

Elimination of distortions to demand are vital if values of recreation site improvements or reasonably correct estimates of future

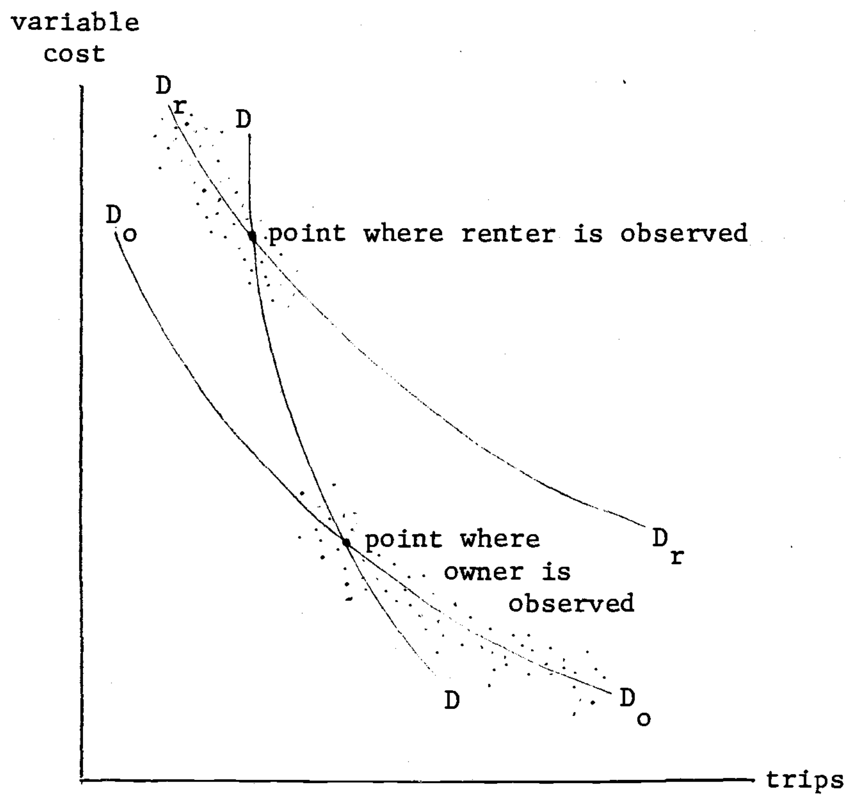

Figure 2

Hypothesized Distortion to Travel Cost
Derived Demand Curve Due to Ignoring
Capital Goods Acquisition by Recreators

participation are desired. Since rectification of the problems of supply shortages and durable goods is fairly simple, it is recommended that future research include the suggested modifications if at all possible.

Objectives

The general purpose of this research is to identify two sources of distortions to travel cost derived demand curves and suggest methods to eliminate or at least reduce biases. Specific objectives are:

1. Develop an empirical model of freshwater recreational fishing demand for the Pacific Northwest Region.
2. Test the hypothesis that a supply restriction exists which distorts the demand structure and identify causes of that restriction.
3. Estimate value of water quality improvement to Pacific Northwest anglers.
4. Derive unbiases demand structures for average sites within the Region and determine relative increases in benefits of site improvements.
5. Develop a theoretical model of recreation demand which includes fixed costs of durable goods purchases as well as variable costs.
6. Determine the distortion to travel cost derived demand of excluding durable goods purchases by recreators.
7. Suggest techniques to correct both types of distortions.
8. Evaluate impacts on welfare estimates of using uncorrected demand curves in policy decisions.

CHAPTER II

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The two basic building blocks of any economic research are established theory and past work in the field. Thus, these two are discussed before proceeding to the main topics of this research.

Theoretical Framework

Demand is a concept derived from consumer utility theory and is a useful starting point for describing the economic analysis of recreation. The demand curve for a specific commodity relates the alternative quantities of the good that would be purchased at various market prices of that good at a particular point in time, all other things being equal. With the exception of the insignificant Giffen's paradox, the demand curve is negatively sloped. That is, as the price of a good falls, the quantity demanded of that good rises. Changes in price result in movement along the demand curve. In Figure 3, when price drops from p^0 to p^1, the quantity demanded increases from q^0 to q^1.

Other determinants of quantity demand--income of the population, consumer tastes and preferences, population size, and prices of substitute and complement goods--influence the actual level of quantity demanded. If, for example, it becomes more fashionable to purchase a particular commodity, the demand curve shifts up and to the right for each price-quantity combination as in Figure 4. At any given price, the corresponding quantity demanded is greater for D'D' with the change in tastes than for the original condition DD.

Consumer's surplus is a measure of additional satisfaction the consumer receives from a commodity above the price he paid for it. The consumer has some idea of what he or she is willing to pay rather than do without; this price must be at least as much as he or she does pay. The value corresponds to the area beneath the demand curve and above the price line as is shown in Figure 5.

The price elasticity of demand is a measure of the relative re-

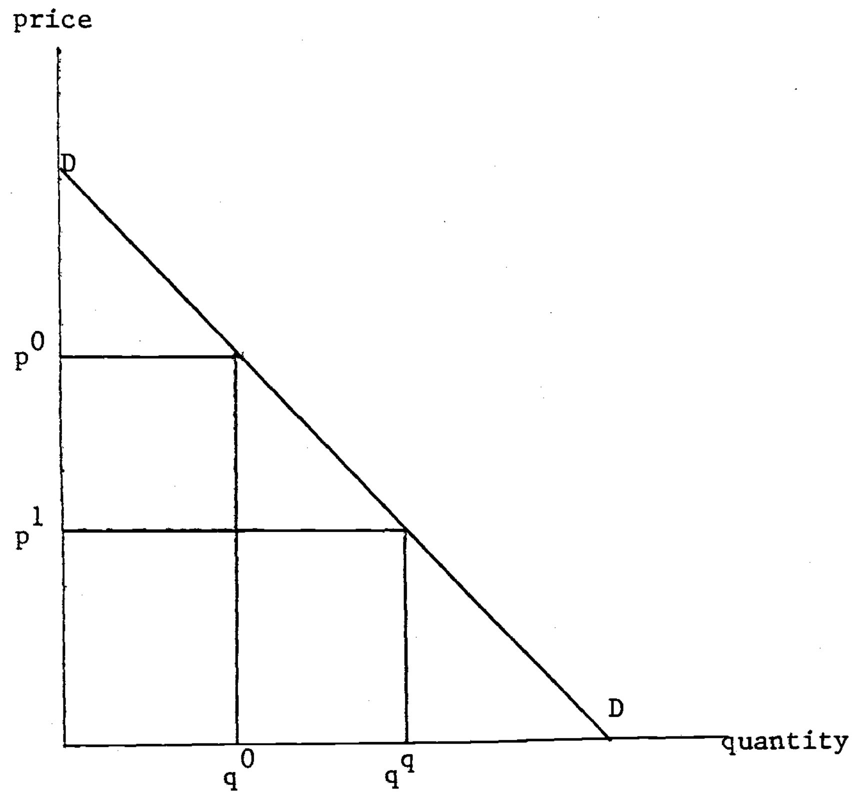

Figure 3

An Example of a Demand Curve

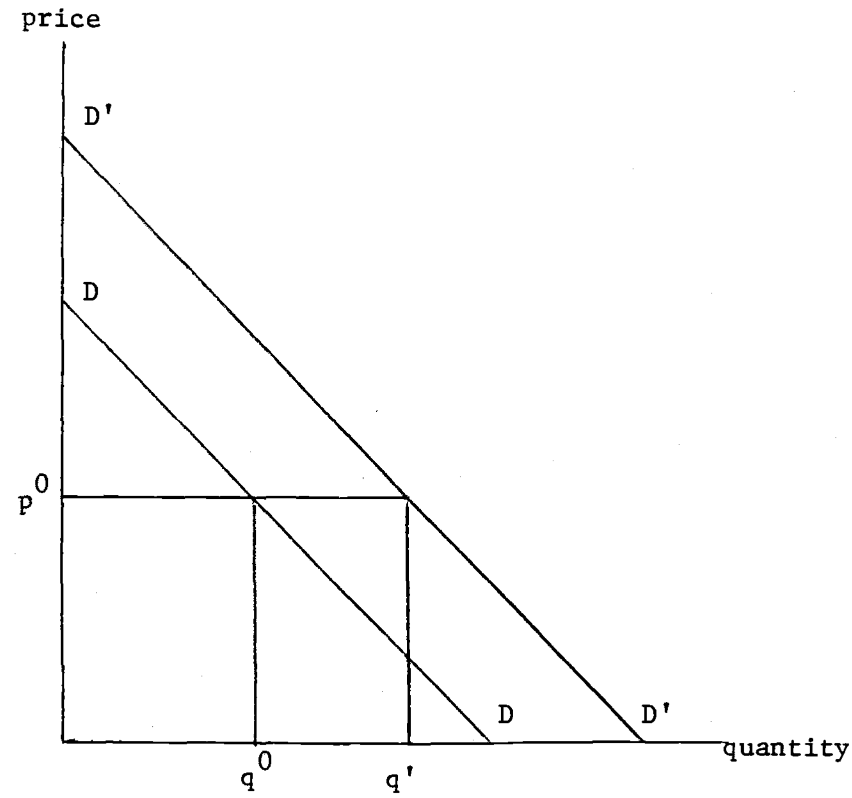

Figure 4

An Example of a Shift in Demand

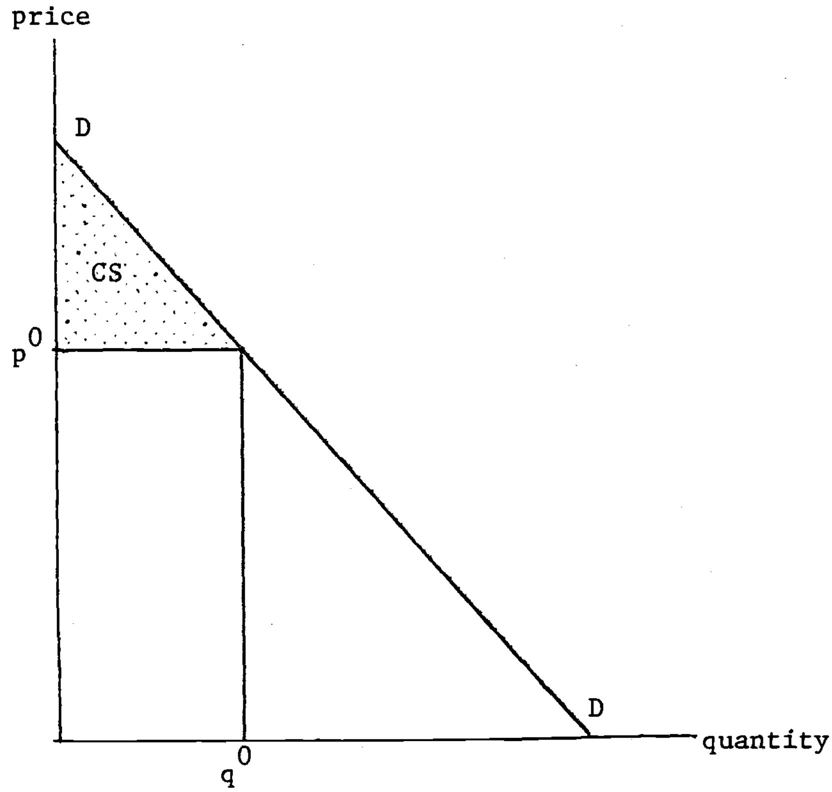

Figure 5

An Example of Consumers' Surplus

sponsiveness of quantity demanded to changes in price. It is calculated by dividing the percentage change in quantity demanded by the corresponding percentage change in price:

$$\frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{p}{q}\frac{\Delta q}{\Delta p} \rightarrow \frac{p}{q}\frac{dq}{dp}$$

If price declines by 1% and the quantity demanded increases by 2%, then the price elasticity of demand is -2. Since elasticities are always less than zero because demand curves are negatively sloped, it is convenient to present them in absolute value. If price elasticity, abbreviated E, is greater than one ($E > 1$), demand is said to be elastic. If $E = 1$, demand is unitary elastic. Finally, if $E < 1$, demand is inelastic. Price elasticity of demand has strong implications for total revenue. In response to a price increase and subsequent quantity decrease, if

a) $E < 1$, total revenue increases,

b) $E = 1$, total revenue remains unchanged, and

c) $E > 1$, total revenue decreases.

An important difference between outdoor recreation and an ordinary market commodity is that recreation normally lacks a formally defined market price. Although some recreation areas have an admission fee, many do not and, in fact, these admission fees are fixed and often low. Since no price-quantity variation is directly observed, statistical estimation of a demand curve from aggregate market data is impossible. However, recreation does have value and a demand curve can be estimated using a surrogate price. This proxy price is discussed later.

Traditional consumer behavior theory is based on utility maximization subject to an income constraint. Utility is represented graphically in an indifference map which depicts the consumer's unique preference structure. Indifference curves are continuous, convex to the origin in the first quadrant of a Cartesian coordinate system, have negative slopes, never intersect, and lie above and to the right of one another such that higher rightward curves imply greater satisfaction than those below and to the left. These properties are consistent with the consumer utility theory assumptions of nonsatiation, transitivity of preferences, and diminishing marginal utility.

Consumers always prefer more to less, but the highest levels of utility are unattainable if income is insufficient to purchase the amounts of goods necessary to reach those utility levels. Thus, the consumer seeks to maximize utility given his or her income. In other words, the consumer solves the optimization problem

$$\max U = U(x, M)$$

$$\text{s.t. } M = \sum_{i=i}^{n} p_i x_i$$

or, indirectly,

$$\max V = V(p, M)$$

$$\text{s.t. } M = \sum_{i=1}^{n} p_i x_i$$

where V(p, M) means utility is an indirect function of income (M) and prevailing prices of commodities (p). The constraint $M = \Sigma p_i x_i$ asserts that all income is spent on a variety of commodities (x) that the consumer may purchase. The solution is a point at which the budget constraint and highest level of utility are tangent.

This can be shown in a simple example of a two-commodity world in Figure 6. The consumer has a fixed income of M^0 and may purchase combinations of goods x_1 and x_2 at prices p_1 and p_2 respectively such that

$$M^0 = p_1 x_1 + p_2 x_2$$

The consumer also has a utility structure given by I_1, I_2 and I_3. Utility is maximized at I_2 at point A corresponding to quantities x_1^0 and x_2^0. Shifting purchases to x_1^1 and x_2^1 at point B is possible

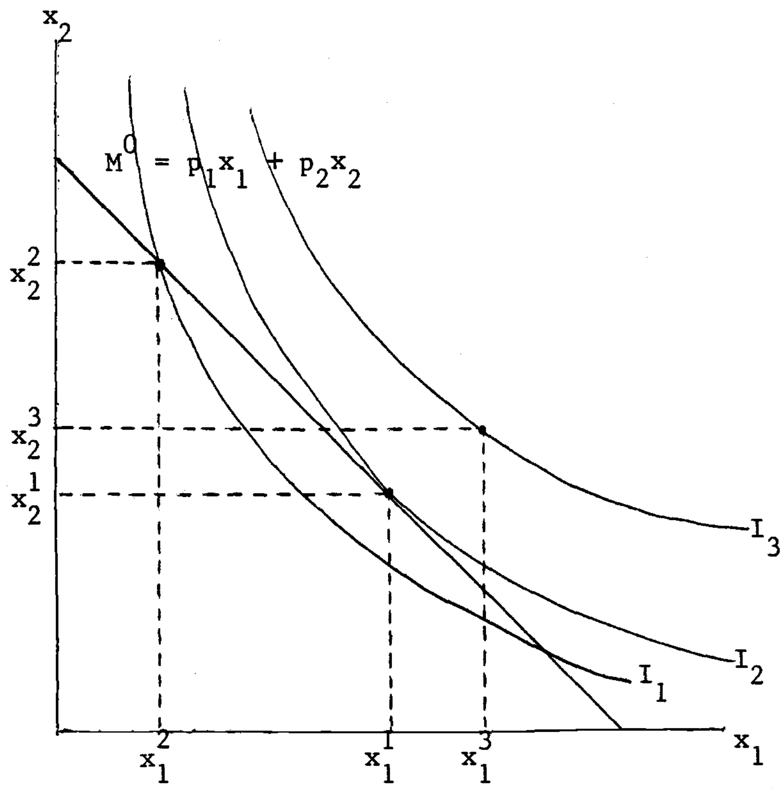

Figure 6

Utility Maximization Subject to a Budget Constraint in a Two Commodity World but results in lowering utility to I_1. A higher level of utility at point C on I_3 is impossible since income is insufficient to purchase x_1^3 and X_2^3.

Now, suppose p_1 falls to p_1' such that more of x_1 may be bought at the same M^0 and p_2. The budget constraint rotates outward as in Figure 7, and the consumer is now able to reach the higher I_3 at point C with purchases x_1^3 and x_2^3.

Referring now to Figure 8a, the price of x_1 decreases with M^0 and p_2 held constant. Utility maximizing tangencies at each p_1 are W, X, Y, and Z. The locus of all tangencies is known as the price-consumption curve which is used to derive the demand curves for x_1 where demand for x_1 represents the quantities of x_1 purchased at varying levels of p_1, all other things held constant. This derivation is seen in Figure 8b. It should be noted that increases in income shift the entire budget constraint outward such that its slope is unchanged and the analysis for redistribution of commodities purchased is the same for a price change. The locus of tangencies, however, is known as an income consumption curve and yields an Engel curve from which income elasticities of demand can be derived.

The exact money measure of the utility change associated with a change in price is of great interest. This is given by the amount of money the consumer would be willing to pay rather than forego the change in price. In other words, compensating variation is the subtraction from consumer income required to return the consumer to his or her original utility level. In equation form (Just, Hueth, and Schmitz, 1982), this is

$$U(p^1, M^1 - CV) = U(p^0, M^0), \text{ and}$$
$$CV = M_1 - M(p^1, U^0)$$
$$= M_1 - M_0 + M(p^0, U^0) - M(p^1, U^0)$$

where M is money income, p is price, U is utility, and CV is compensating variation. Subscripts and superscripts 0 and 1 identify the level of the variable as being before or after the price change respectively. Alternatively, equivalent variation is the addition to consumer income required to restore a consumer's utility level associated with the change in price and can be described mathematically

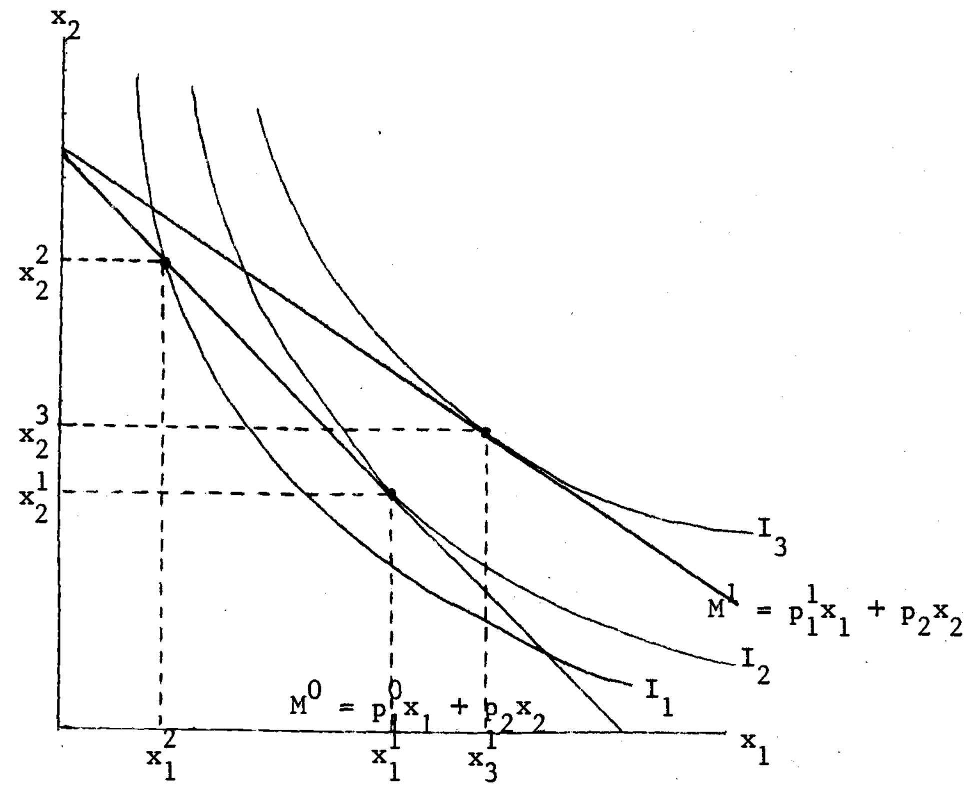

Figure 7

Change in Consumption Due to Change in Price
and Subsequent Utility Maximization Subject
to a Budget Constraint in a Two Commodity World

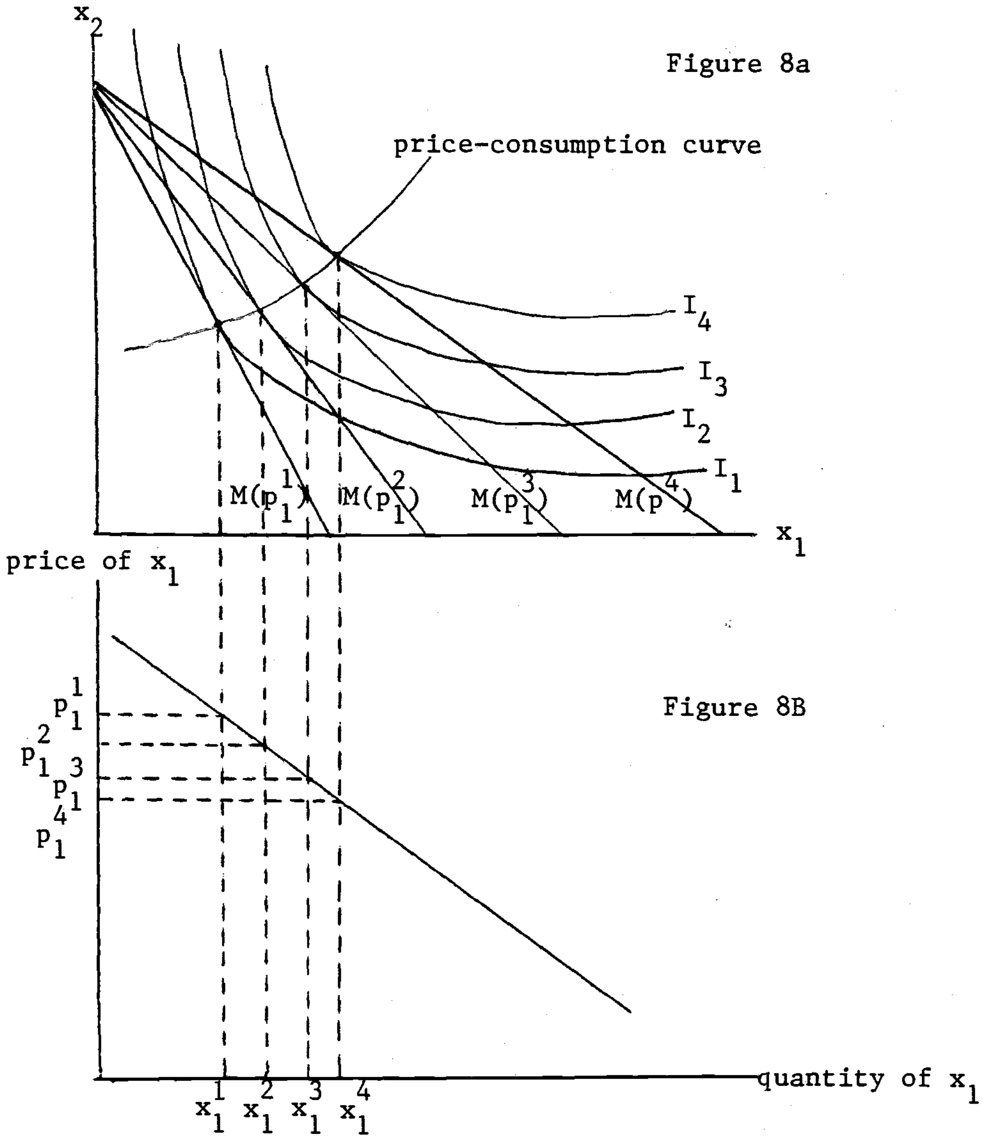

Figure 8

Utility Maximization for Price Decreases in One Good, Price Consumption Curve, and Derived Demand Curve in a Two Commodity World as, where EV is now equivalent variation,

$$U(p^0, M^0 + EV) = U(p^1, M^0), \text{ and}$$

$$EV = M(p^0, U^1) - M_0$$

$$= M(p^0, U^1) - M(p^1, U^1) + M_1 - M_0.$$

It has been shown (Willig, 1976; Cory, et al., 1981) that both compensating and equivalent variation are approximated by the change in consumer's surplus, the area beneath the demand curve and above the price line.

It is assumed that a consumer is a recreator. Recreation, as has been discussed, has no easily observed price. Costs of time and distance traveled are proxies for the cost of recreating. Given a particular origin and destination, this surrogate price does not change if real prices remain stable. However, the quality of the site can be changed through the installation of better facilities and, particularly for water-based activities, water quality can be improved. When extended to include a variable for water quality (b) the model above becomes

$$U(p^1, b^1, M^1 - CV) = U(p^0, b^0, M^0)$$

or, equivalently,

$$U(p^0, b^0, M^0 + EV) = U(p^1, b^1, M^1)$$

where demand shifts with changes in b since water quality is included in the recreator's utility structure. The value to the consumer of an increase in b alone is equal to CV or EV when income and all other prices are held constant; that is, when $M^1 = M^0$ and $p^1 = p^0$. Since consumer's surplus is an approximation of these exact measures of utility change, the change in area of the demand curve corresponds to the value of a water quality change from b^0 to b^1. Surrogate prices are unchanged, so the recreator is getting more recreation for the same distance traveled. There would be, therefore, an outward shift in the demand for recreation at all distances traveled and the value of the water quality change ($b^1 > b^0$) is estimated by the area between demand curves as in Figure 9. A more rigorous treatment of this measurement of water quality change is found in Appendix II.

A theoretical example of water quality improvement is presented in Vaughan and Russell (1982) and seen graphically in Figure 10. Supply curve S_0 represents the number of sites available for water-

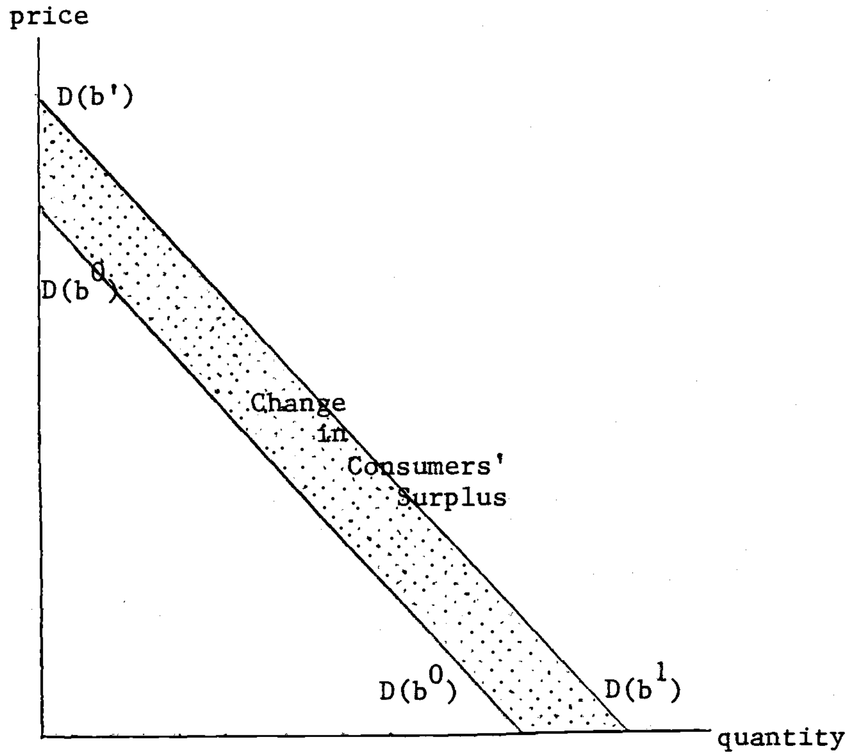

Figure 9

An Example of Change in Consumers' Surplus
Caused by Water Quality Improvement

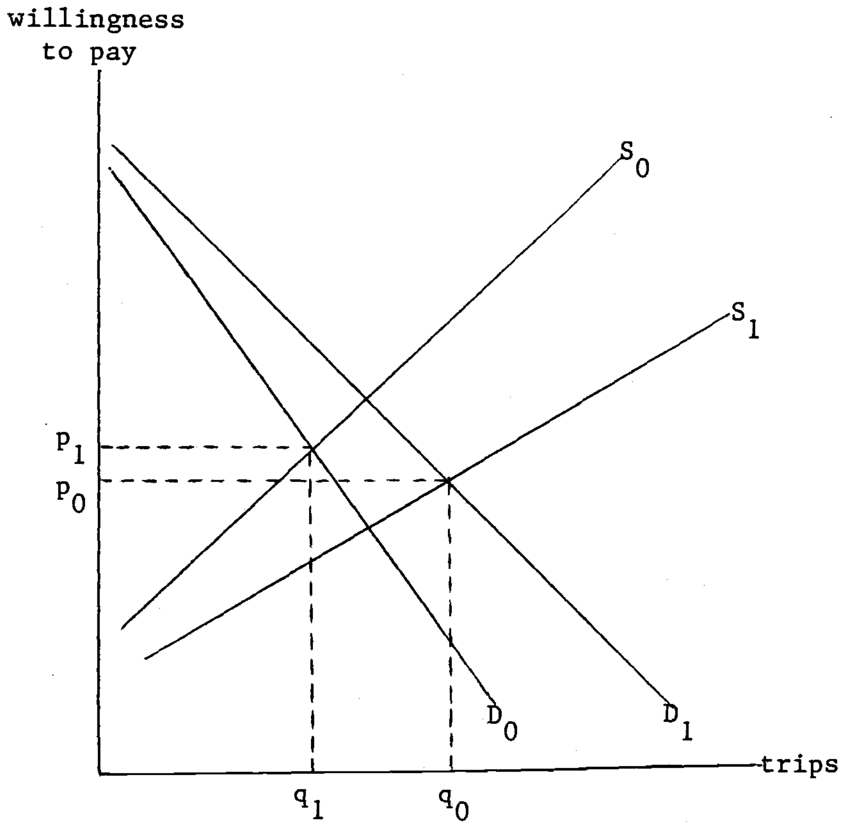

Figure 10

Hypothetical Supply and Demand Curve Shifts
Due to Water Quality Improvements

based recreation before a water quality improvement program goes into effect. The upward slope may be thought of as reflecting the greater number of sites available as a household travels farther or the increased fish management cost required for a given level of water quality to induce greater participation. Demand D_0 is simply decreasing per trip willingness to pay for additional trips at a given level of water quality.

Once a water quality improvement program is implemented, S_0 shifts to S_1 as more fishing areas are opened up due to better water quality or since less fish management is required to provide a specific number of fishing trips. Also, D_0 shifts to D_1 as potential users become users due to the improvement and current users take more trips.

The shift from D_0 to D_1 and S_0 to S_1 will always result in an increase in the number of trips taken, but the change in willingness to pay by recreators may be more, less, or unchanged in the aggregate depending on the relative slopes and degree of shift of the curves. Willingness to pay, p, will be

a) $p_1 > p_0$ if, overall, recreators are willing to pay more

b) $p_1 < p_0$ if, overall, recreators are unwilling to pay more

c) $p_1 = p_0$ if, overall, recreators are willing to pay the same for the improved water quality.

The objective of Chapter III of this research is to derive demand curves for a subset of sites in the Pacific Northwest of various water quality levels and test the hypothesis that recreators always prefer better water quality. Analysis will extend to include the relative improvement in welfare of water quality changes. The condition that comparisons are made *ceteris paribus* is imposed to allow for possible differences in participation due to a desire for variety and a greater dislike of congestion at high quality sites than low water quality at sites of low or no congestion.

Chapter IV addresses the problems of using only variable costs of recreating--note that the above theory considers only costs which are allowed to vary on a per trip basis. The introduction of fixed costs and durable goods purchases affects recreator willingness to pay in that he or she has already made a substantial investment.

Literature Review

Welfare economic theory is primarily concerned with changes in quantities of goods and services purchased at different prices under various market conditions and the social benefits or costs associated with those changes. As outdoor recreation generally has no actual purchase price, it poses a special problem of economic evaluation. Experts agreed that recreation had value but, lacking a logical model consistent with established theory, did not actively pursue the subject until recently. Some economists rationalized their hesitancy in claiming data collection would be too time consuming and expensive to justify, some declared outdoor recreation was simply per capita gross national product multiplied by the number of days in a year, and still others felt outdoor recreation should not be evaluated at all as an economic good (Clawson, 1959). Economic analysis of recreation was a mystery; no one knew how to evaluate a good that had, in most cases, no purchase price but was not free.

In 1949, Harold Hotelling suggested that a proxy for the price of recreation be utilized. He posited that concentric zones around national parks of equal travel cost could be substituted for "prices" of the parks and, consequently, one could derive the value of those parks. He justified his idea by claiming people would not visit a site unless its value to them was at least as great as the cost of traveling to that site. Nine years later, Trice and Wood applied the approach to three areas of the Sierras, but Hines (1958) correctly asserted that the analysis was based on the unrealistic assumption that individual utility functions were identical. Nonetheless, further studies continued to employ the travel-cost approach.

Marion Clawson (1959) used the technique to derive the demand for a recreation experience. In a demand framework, he plotted recreation visits on the quantity-axis and cost per visit on the price-axis. The demand curve allowed him to estimate the value of outdoor recreation by calculating the consumers' surplus, the area below the entire demand curve, since price was assumed negligible, and he was also able to determine how the number of visits could change with changes in the surrogate price through elasticities of demand.

Knetch (1963) enhanced the basic idea. By including other determinants of demand such as income of participants, availability of close substitutes, congestion, and park size and quality, he was able to estimate demand curves with greater precision.

Brown, Singh, and Castle published their extensive study of salmon and steelhead sport fishing in the state of Oregon in 1964. Although the basic travel cost approach was used, the multiple site analysis was both complex and comprehensive. The state was divided into several fishing zones which were then subdivided into income areas. An index of fishing success was used, as were variables of time, costs, and distance traveled. The model was estimated by both single and simultaneous equations. This landmark study served as the basis for many subsequent recreation research projects.

Thus, the groundwork was established for the economic evaluation of outdoor recreation. Travel cost was substituted for market price, demand curves were derived, and consumer's surplus values were calculated. However, severe statistical problems emerged and correction of these problems as well as general refinement of the standard model was needed.

Relevant variables were often omitted from models to avoid multicollinearity, but low variances associated with underspecified models resulted in inaccurate, sometimes unusable coefficients. Brown (1973) demonstrated how to cope with the omission of important variables such as distance from recreation models yet maintain good estimates of coefficients of the regression equation. His solution, ridge regression, was a method of incorporating existing information into the desired estimation procedure. The technique proved effective in reducing multicollinearity, but the models themselves were unreliable.

Brown and Nawas (1973) expanded the investigation of multicollinearity. In a study of Oregon big game hunting, two approaches were used: the traditional technique which used grouped data to describe travel cost, and a mthod using individual observations. They discovered that although the explanatory power of the individual data model was, as expected, lower than that of the grouped data, the level of significance of the variable coefficients in the former was higher. That is, the errors of the estimates were less. Since it is the value of the coefficients that is of importance to derive estimates of consumer welfare, they concluded that individual observations, while decreasing explanatory power, increased model efficiency.

Gum and Martin (1975), in an Arizona study of all types of outdoor recreation activities in the state, extended the basic model singificantly. Collected data covered a full year of activity to more accurately reflect the variety of recreation tastes and preferences. The very large sample size allowed better specification, and multicollinearity between cost and distance variables was ameliorated by using individual rather than grouped data as Brown and Nawas had suggested. Also, their specifications of the aggregation of individual demand curves to derive resource demand curves was an improvement over the basic model. Finally, their economic findings were notable. With the exception of waterfowl and predator hunting, total consumer's surplus values exceeded expenditures.

Brown, et al. (1983) later were able to show that use of individual observations also has associated biases. Since population is not uniformly distributed around a recreation site, individual observations alone incorrectly exhibit a pattern of participation. A densely populated area farther from a site may have a higher participation rate than sparsely populated areas nearer the site. On a per capita basis, however, participation was adjusted to account for the unevenly distributed population of each zone. The result was a correctly specified demand curve.

In addition to refining the existing travel cost method of evaluating the demand for and value of outdoor recreation, researchers were experimenting with alternative techniques for estimating the benefits of recreation. Some of the new procedures were attempts to obtain exact money measures of value rather than consumer's surplus which is an approximation of value (Willig, 1976). Others were taken from other disciplines of based on modifications of existing economic theory.

The willingness to pay approach in which interviewees are asked how much they would be willing to pay for the recreation experience was successfully adapted by Sublette and Martin (1975) for the state of Arizona. The travel-cost approach broke down where travel and other variable costs were low and relatively constant. Individual household willingness to pay data were collected and analyzed using stepwise ordinary least squares regression to derive the statistical demand estimates.

Edwards, et al. (1976) constructed an alternative to the basic model to more adequately meet the criteria of a meaningful theory of consumer demand:

> "1. It must provide a basis for identifying alternative hypotheses concerning properties of the consumers' preference function, and
> 2. It must suggest a procedure whereby such hypotheses can be empirically tested, i.e., whereby such hypotheses can be rejected."

While the authors admitted to shortcomings of their approach, the introduction of a procedure whereby hypotheses could be tested proved to be a controversial but classic study in the methodology of recreation economics research. Using established procedures of the scientific method, they found that they could not accept the hypothesis that recreation was a normal good given the structure of the model, but that conclusion could be attacked if the model were to include the realistic assumption that costs of recreation were functions of one another.

Martin and Gum (1977) used cluster analysis for the first time to examine the structure of recreation demand. Socioeconomic characteristics of different groups within a sample defined consumer tastes and preferences, one of the primary determinants of demand functions but the most elusive in terms of measurement. They discovered that for many types of outdoor recreation, most people would change their recreation habits only after changing their attitudes toward recreation rather than changing economic variables such as their income. The authors claimed that in order to predict future demand, some measure of changes in social attitudes, a psychological as opposed to economic variable, must be estimated.

The household production function approach to wildlife recreation was considered in a theoretical framework by Bockstael and McConnell (1981). This method analyzes the individual as both a cost-minimizing producer and a utility-maximizing consumer.

Also in 1981, Brown and Mendelsohn reported on their hedonic model. This approach related hunting and fishing participation to several quality variables such as congestion, scenic beauty, and game density. However, it was demonstrated that relatively unsophisticated hedonic models lead to incorrect valuation of the recreation experience; only fairly complex models yield usable results.

Emphasis on the quality of the recreation experience has been increasing over time. Much of this emphasis has been on water quality which directly or indirectly affects the bulk of outdoor recreation, namely swimming and fishing. Previous work summarized above used general quality measures; the following research used those which are water-specific.

Bouwes and Schneider (1979) used a regression model to estimate recreator-perceived water quality based on the Uttormark's Lake Condition Index, then used the results to derive the demand curve for visits based on the water quality and other standard variables. Thus, changes in water quality and the effect of those changes on recreation behavior could be established as well as the value of the resource.

Haneman (1980) proposed the use of the log-linear technique for the economic analysis of outdoor recreation. Water quality was the central factor in his research on water-based recreation in the Boston metropolitan area. Log-linear models are probability models used to calculate the expected value of outcomes under different conditions and are used to test hypotheses regarding relationships between and among variables. Haneman's analysis, which addressed the problem of estimating the benefits of water pollution abatement programs in the urban area, was a threefold estimation of participation, total recreation trips, and a likelihood theoretic model of the allocation of visits among sites.

Sutherland (1980, 1981) used a gravity model to overcome the limitations of the travel-cost approach in estimating demand for multiple site areas. The gravity model, capable of considering numerous substitute sites, is a distributional rather than economic model. Sutherland found that the gravity model alone was inadequate for the evaluation of water-based recreation in the Pacific Northwest and, therefore, extended the model by means of an attractions model from which he derived demand curves for each of the 179 sites in his study.

Desvouges, Smith, and McGivney (1983) compared two different approaches for estimating recreation benefits of water quality improvements. Both travel cost and contingent valuation methods were used to analyze the value of increased water quality of the Monongahela River Basin. The objective of the research was to obtain and compare estimates of value for users as well as non-users and potential future users of the Basin. That is, the study was to estimate measures of user, option, and existence value and predict recreation and related benefits of improved water quality at boatable, swimmable, and fishable quality levels. In theory, welfare measures for a price decrease or quantity increase exist such that ES (equivalent surplus) is greater than EV > CV > CS (consumers' surplus) and vice versa with but small differences between values. However, when household user values derived from contingent valuation were compared with corresponding estimates of that household's travel cost result, contingent valuation estimates overstated willingness to pay for water quality increases and travel cost overstated willingness to pay for loss of the recreation area by more than welfare economic theory predicted. Also, compensating surplus from contingent valuation was slightly less than that derived from travel cost from ordinary consumer surplus for water quality increases in accordance with theory in only one of three estimates--that of a $25 iterative bidding game. The travel cost model used was shown to be an adequate one to estimate water quality improvement benefits, but several problems of a statistical nature would need to be addressed in future studies. Among these problems were the exclusion of households who did not recreate at the site, open-ended responses, and the clumping at zero of households recreating once due to the logarithmic transformation.

Chapter III will use many of the ideas mentioned above--and some new ones as well--to analyze the structure of demand for outdoor recreation in the Pacific Northwest states of Oregon, Idaho, and Washintgon. Special emphasis will be placed on the value of improving water quality in the Region. The model will use the log-linear technique as proposed by Haneman and the same data set that Sutherland used in 1980. Hypotheses will be tested regarding the demand for water quality (Edwards, et al., 1976) and objective measures of water quality will be used (Bouwes and Schneider, 1979). However, it will not be assumed that the data set will provide a scatter plot which will yield a well-behaved demand curve as the log-linear model does not fit continuous functional forms. Rather, an expected value model will be derived based on individual responses to a series of questions regarding their recreation behavior in 1980, including whether or not they participated in recreation during the year. Data generated were categorical in nature and, therefore, not appropriate for regression analysis.

CHAPTER III

A LOGLINEAR MODEL OF WATER-BASED RECREATION IN THE PACIFIC NORTHWEST

Introduction

The relationship between environmental quality and the demand for recreation, particularly the water quality impacts upon recreation demand, is a key component in the evaluation of programs to improve environmental quality. Water pollution abatement programs are assumed to result in innumerable sociological and biological benefits but documentation and, more importantly, evaluation of these benefits in economic terms has been neither consistent nor conclusive.

Analysis of recreation data by the use of simple regression models leads to results which explain only a small fraction of the total variance of water quality values. An alternative approach based on analysis of multiway frequency tables is chosen to explore the reasons for the poor performance of past models and aid in specifying better models to be used to estimate recreation demand curves with respect to the value of improved water quality. The analysis is based on modeling the cell frequencies with a loglinear model.

The following is, therefore, an economic evaluation of the demand for water-based recreation and recreation benefits associated with improved water quality in the Pacific Northwest. A loglinear model is constructed to analyze both the structure of demand and impact of water quality changes. From these models, the value of water quality improvements estimated for the Pacific Northwest as a region can also be applied to specific sites and projects within the region.

Before proceeding, it may be useful to refer to Appendix I on the loglinear technique and Appendix II, part 1 which is a mathematical proof that water quality can be evaluated in economic terms.

The Sample

The data were originally collected for the United States Environmental Protection Agency for a water quality study and graduate thesis in statistics (Sutherland, 1981; Carter, 1981). The sample size was fixed at about 3,000 observations--75 households from 40 counties--in the Pacific Northwest states of Oregon, Idaho, and Washington. County selection was based on population size, geographic location and socioeconomic diversity.

The data were obtained by telephone interview conducted in 1980 by one survey organization in each state. Random digit dialing determined household participation in the survey. Raw data were then assembled and coded by the Oregon State University Survey Research Center to insure uniformity. A few short questions regarding the household were asked and a series of questions on the household's recreation behavior during the year were posed.

Four response categories were common to all households in the three-state region: household size, income level, number of household members above the age of 18, and whether or not the household engaged in any form of recreational activity in 1980. All responses except miles traveled one-way to a recreation site were categorical in nature.

Data on water quality were provided by the three states (Water Quality Division, Oregon, 1981; State of Idaho Department of Health and Welfare, 1980, 1982; State of Washington, 1977). These were recoded as good-excellent, average, and poor-bad water quality levels. The objective indices used by the three states were fairly compatible. Codes for facility levels of sites were assigned given information gathered from various park authorities and specialists (Helstrom Publications, 1980; Idaho Recreation Guide, 1976; Washington State Parks, 1981; Willamette Kayak and Canoe Club, 1981). A binary system was developed to indicate whether a site was primitive or relatively developed.

Tables of actual and fitted data are in Appendix III. A copy of the questionnaire is found in Appendix IV.

The General Model

The general model of recreation used is defined as

$$E_i(\text{Pacific NW trips}) = \text{prob(recreate)} \cdot E_i(\text{trips recreate})$$

where

E_i(Pacific NW trips) = the expected number of trips made by households of the Pacific Northwest for water quality level i;

prob(recreate) = the probability that a household engages in recreation; and

E_i(trips recreate) = the expected number of trips taken to sites of water quality level i by households given that the households are recreators.

Thus, there are two parts to the general model. The first calculates the probability that a household recreates by using a general log-linear model. This model provides not only the odds and subsequent probabilities required, but also information on recreating household characteristics versus those of non-recreating households.

The second part of the model estimates the expected number of trips by households to sites of differing water quality. Cell frequencies are used as the dependent variable and all indices are independent variables.

In both cases, test of marginal and partial associations of factors were used to determine which effects contributed to the overall predictive power of the model in question. Tests of k+1 and k interactions were analyzed to decide the order of the model. Thus, these two series of tests gave an indication of which effects should be included in the model and the order of the largest effect. The result was the most parsimonious model of statistical significance. The models were hierarchical so that cumulative impacts could be evaluated.

The per capita transformation suggested by Brown, et al. (1983) was not possible since the data set provided only county of residence and general recreation site visited. This inexact information precluded the adjustment as counties and sites could cover more than one zone.

The Model of Recreation Probabilities

Four variables were found to be of value in building the model of recreation probability: whether or not the household recreated (R), the number of individuals in the household (H), the annual income of the household (I), and the number of household members above the age of 18 (O). The variable O was found to be significant but did little to improve the predictive power of the model, so only R, H, and I were included. Tests of factors and associations showed the model should be no larger than order 2 and all second order effects were significant. Thus, the model selected was [RH, RI, HI]. The model had 18 degrees of freedom corresponding to significant probability levels of 0.2875 and 0.3000 for Likelihood Ratio and Pearson X^2 statistics respectively. The model was, therefore, adequate. Addition of the next higher term, the interaction RHI, would boost the model to zero degrees of freedom implying saturation. That is, there would be a parameter for each cell of the contingency table.

Estimate of parameters are in Table 1. Actual values as seen in Appendix III show that 57% of the sample recreated at some time in the year for an actual odds ratio of 1.33:1 in favor of recreation. Odds ratios from the model show predicted ratio to be 1.39:1 ($\beta^{R=yes}/\beta^{R=no}$) in favor of recreation or 58%.

The Structure of Recreation

Discussion now turns to the underlying structure of recreation in the Pacific Northwest. Results are based on odds ratios as calculated from estimates of the parameters in Table 1.

The First-Order Effects: As mentioned previously, the odds of recreating to not recreating are calulated by dividing $\beta^{R=yes}$ by $\beta^{R=no}$, or 1.180 ÷ 0.847 = 1.39:1. The remaining two effects, household size and income, reflect the characteristics of households in the sample. The most common household is composed of three or four

Table 1: Parameter Estimates λ and β and λ Divided by Its Standard Error for the Model [RH, RI, HI].

Effect	λ	λ/SE	β
R=yes	0.166	4.148*	1.180
R=no	0.166	4.148*	0.847
H=one	- 1.016	- 9.616*	0.362
H=two	0.364	7.145*	1.439
H=three, four	0.728	15.446*	2.071
H=more than four	- 0.077	- 1.365	0.926
I=less than $10K	0.754	13.265*	2.125
I=$10-$15K	0.501	88.352*	1.650
I=$15-$20K	0.404	6.284*	1.498
I=$20-$25K	0.202	3.003*	1.224
I=$25-$35K	- 0.080	- 0.858	0.923
I=$35-$40K	- 1.151	- 6.386*	0.316
I=more than $40K	- 0.631	- 6.208*	0.532
R=yes, H=one	- 0.214	- 2.026	0.807
R=yes, H=two	- 0.110	- 2.166	0.896
R=yes, H=three, four	0.066	1.398	1.068
R=yes, H=more than four	0.258	4.598*	1.294
R=no, H=one	0.214	2.026	1.239
R=no, H=two	0.110	2.166	1.116
R=no, H=three, four	- 0.066	- 1.398	0.936
R=no, H=more than four	- 0.258	- 4.598*	0.773

Table 1: Continued

Effect	λ	λ/SE	β
R=yes, I=less than $10K	- 0.272	- 4.777*	0.762
R=yes, I=$10-$15K	- 0.019	- 0.317	0.981
R=yes, I=$15-$20K	0.033	0.507	1.034
R=yes, I=$20-$25K	0.086	1.279	1.090
R=yes, I=$25-$35K	0.072	0.777	1.075
R=yes, I=$35-$40K	0.059	0.330	1.061
R=yes, I=more than $40K	0.040	0.394	1.041
R=no, I=less than $10K	0.272	4.777*	1.313
R=no, I=$10-$15K	0.019	0.317	1.019
R=no, I=$15-$20K	- 0.033	- 0.507	0.968
R=no, I=$20-$25K	- 0.086	- 1.279	0.918
R=no, I=$25-$35K	- 0.072	- 0.777	0.930
R=no, I=$35-$40K	- 0.059	- 0.330	0.943
R=no, I=more than $40K	- 0.040	- 0.394	0.961
H=one, I=less than $10K	1.399	11.459*	4.051
H=one, I=$10-$15K	0.602	4.424*	1.826
H=one, I=$15-$20K	0 080	0.514	1.083
H=one, I=$20-$25K	0.099	0.612	1.104
H=one, I=$25-$35K	- 0.940	- 3.730*	0.391
H=one, I=$35-$40K	- 0.850	- 1.679	0.427
H=one, I=more than $40K	- 0.389	- 1.523	0.678
H=two, I=less than $10K	0.114	1.478	1.121
H=two, I=$10-$15K	0.017	0.199	1.017
H=two, I-$15-$20K	- 0.075	- 0.838	0.928
H=two, I=$20-$25K	- 0.138	- 1.416	0.871
H=two, I=$25-$35K	0.136	1.170	1.146
H=two, I=$35-$40K	0.162	0.767	1.176
H=two, I=more than $40K	- 0.215	- 1.494	0.806
H=3,4, I=less than $10K	- 0.716	- 8.816*	0.489
H=3,4, I=$10-$15K	- 0.219	- 2.749*	0.803
H=3,4, I=$15-$20K	- 0.004	- 0.052	0.996
H=3,4, I=$20-$25K	- 0.044	- 0.163	0.957
H=3,4, I=$25 $35K	0.338	3.145*	1.402
H=3,4, I=$35-$40K	0.470	2.378*	1.600
H=3,4, I=more than $40K	0.145	1.167	1.156
H=four+, I=less than $10K	- 0.797	- 7.475*	0.451
H=four+, I=$10-$15K	- 0.400	- 3.770*	0.670
H=four+, I=$15-$20K	- 0.000	- 0.000	1.000

Table 1: Continued

Effect	λ	λ/SE	β
H=four+, I=$20-$25K	0.053	0.498	1.054
H=four+, I=$25-$35K	0.466	3.771*	1.594
H=four+, I=$35-$40K	0.219	0.978	1.245
H=four+, I=more than $40K	0.145	1.167	1.582

* Significant at the 95% level

individuals followed by households of two people, more than four, and only one person. Income groups ran in order from the "less than $10,000 per year" group down to "$25,000 to $35,000 per year," then rising slightly for the "greater than $40,000 per year" category showing relative distribution of households by income class in the survey.

Second-Order Effects: The second-order effects will be discussed individually below.

a. The Effect RI: Results of the multiplicative values derived from the product $\beta^{R}\beta^{I}\beta^{RI}$ are found in Table 2. The odds of recreate to non-recreate are located in the right hand column of the Table. The odds increase from less than even odds for households in the lowest income group to better than even in the next class, steadily increasing to a peak at 1.653:1 for the $20-25K group. At income levels above $25K per year, the odds of a household engaging in recreation decline slightly for each successively higher income level but never fall below the 1.5:1 ratio.

There are two theoretically sound reasons for what on the surface appears to be an indication of an inferior good (one for which consumption decreases as income increases). First, it is possible that outdoor recreation is only one form of leisure and may, indeed, be an inferior good as compared to, say, a trip to the Bahamas. As households gain income, they take more leisure. Up to $25K per year, leisure is taken in the form of outdoor recreation. Above $25K per year, however, households begin to substitute more exotic forms of leisure for outdoor recreation, though the odds of outdoor recreation are still well above even odds.

Second, time rather than income may be the binding constraint. Households earning incomes in the categories above $25K per year may be too busy making money or too exhausted after their labors to find time necessary for enjoying outdoor recreation. Also, it is possible that households in these higher income groups are two-wage-earner families and alignment of husband-wife vacation time is difficult.

b. The Effect RH: Multiplicative values of odds ratios for the effect RH are also found in Table 2. Results are fairly clear-cut.

Table 2: Multiplicative Values of the Second-Order Effects and Odds Ratios of the Model [RH, RI, HI].

The Effect RI

Annual Income	Recreate		Odds
	Yes	No	Yes:No
Less than $10K	1.911	2.363	0.809:1
$10-$15K	1.910	1.424	1.342:1
$15-$20K	1.828	1.228	1.489:1
$20-$25K	1.574	0.952	1.653:1
$25-$35K	1.171	0.727	1.611:1
$35-$40K	0.396	0.252	1.571:1
More than 40K	0.653	0.433	1.508:1

The Effect RH

Household Size	Recreate		Odds
	Yes	No	Yes:No
One	0.345	0.380	0.908:1
Two	1.521	1.360	1.118:1
Three and Four	2.610	1.642	1.590:1
More than Four	1.414	0.606	2.333:1

The Effect HI*

Annual Income	Household Size			
	One	Two	3-4	Four+
Less than $10K	3.116	3.428	2.152	0.887
$10-$15K	1.091	2.415	2.744	1.024
$15-$20K	0.587	2.000	3.090	1.387
$20-$25K	0.489	1.534	2.426	1.195
$25-$35K	0.131	1.522	2.680	1.362
$35-$40K	0.049	0.535	1.047	0.364
More than $40K	0.131	0.617	1.274	0.779

*Odds Ratios not calculated for the Effect HI

Odds in favor of outdoor recreation increase as family size increases.

Single person households at an odds ratio of 0.908:1 were the least likely to recreate although the ratio is almost 1:1. Odds increase steadily to a maximum of 2.333:1 for households of more than four individuals.

c. The Effect HI: The effect HI was used only for increasing the predictive power and significance of the model and is not of interest here. It will, however, play an important role in a later section of this paper. This effect reflects the distribution of households by income and household size in the three states.

The Interaction of R, H, and I

The model [RH, RI, HI] can now be looked at in three dimensions. Table 3 lists values and odds ratios obtained by calculating the multiplicative result of the hierarchical $\beta^{R}\beta^{H}\beta^{I}\beta^{RH}\beta^{RI}$. The odds ratios found in the right hand column indicate what the chances are that a household or group of households recreate given its income and size. The two relationships explained in the second-order effects paragraphs above still hold: odds increase with household size and increase then slightly decrease with income. A three-dimensional plot of the relationship is found in Figure 11.

Obviously, the relationship is far from simple or linear. The shape--parabolic along one axis, sigmoidal along another--would more than likely be overlooked or misspecified by a researcher using simple ordinary least squares. The loglinear model, fortunately, allows one to more correctly assess the structure of recreation by permiting different functional forms over different ranges of the data set. The drawback is that, being derived from categorical data, the function itself is not really defined. However, once the form is noticed other techniques may be used if one has continuous data to obtain functions for which calculus works.

The odds ratios of the model are seen in Table 4. These ratios indicate the relative likelihood of a household recreating given the interaction of the variables. The most common recreator household would be a family of four in the \$15-20K annual income class (14.742)

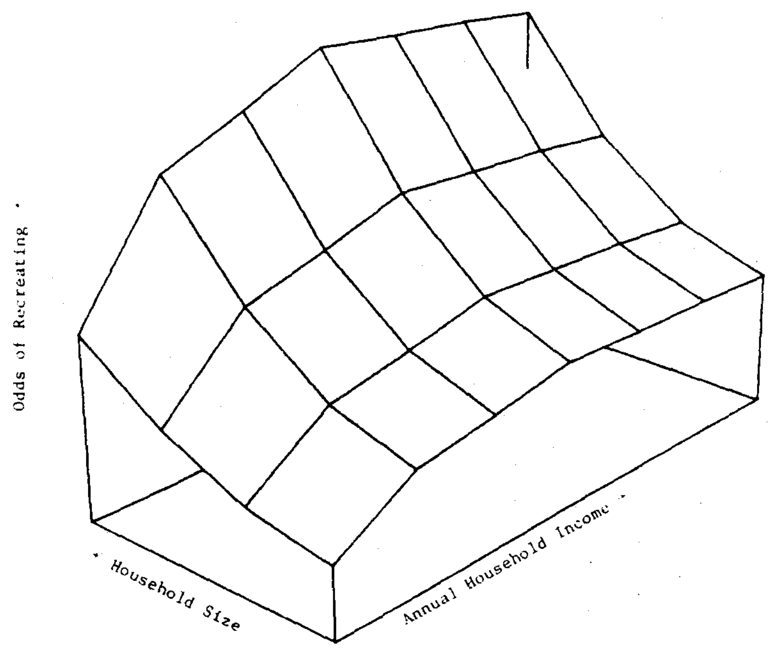

Figure 11

A Three-Dimensional Plot of the
Relationship of the Odds of Recreating,
Household Size, and Annual Household Income

Table 3: Multiplicative Values and Odds Ratios of the Effects RI and RH.

The Effect RI,RH				
Income	Household Size	R = yes	R = No	Odds Yes:No
<$10K	one	0.659	0.898	0.734:1
	two	2.907	3.214	0.904:1
	three or four	4.988	3.880	1.286:1
	more than four	2.702	1.432	1.887:1
$10-$14K	one	0.659	0.541	1.218:1
	two	2.905	1.937	1.500:1
	three or four	4.985	2.338	2.132:1
	more than four	2.701	0.863	3.130:1
$15-$20K	one	0.631	0.467	1.351:1
	two	2.780	1.670	1.665:1
	three or four	4.771	2.016	2.367:1
	more than four	2.585	0.744	3.474:1
$20-$25K	one	0.543	0.362	1.500:1
	two	2.394	1.295	1.849:1
	three or four	4.108	1.563	2.628:1
	more than four	2.226	0.577	3.858:1
$25-$35K	one	0.404	0.277	1.458:1
	two	1.781	0.989	1.801:1
	three or four	3.056	1.195	2.557:1
	more than four	1.656	0.441	3.755:1
$35-$40K	one	0.137	0.096	1.427:1
	two	0.602	0.343	1.755:1
	three or four	1.033	0.414	2.495:1
	more than four	0.560	0.153	3.660:1
>$40K	one	0.225	0.164	1.372:1
	two	0.993	0.589	1.686:1
	three or four	1.704	0.711	2.397:1
	more than four	0.923	0.262	3.523:1

Table 4: Multiplicative Values of the Effects RH, RI, and HI*.

The Effect RI,RH,HI			
Income	Household Size	R = Yes	R = No
<$10K	one	2.053	2.798
	two	9.965	11.017
	three or four	10.734	8.350
	more than four	2.397	1.270
$10-$15K	one	0.719	0.590
	two	7.016	4.678
	three or four	13.769	6.415
	more than four	2.766	0.884
$15-$20K	one	0.370	0.274
	two	5.560	3.340
	three or four	14.742	6.229
	more than four	3.585	1.032
$20-$25K	one	0.266	0.177
	two	3.672	1.986
	three or four	9.966	3.792
	more than four	2.660	0.690
$25-$35K	one	0.053	0.036
	two	2.711	1.505
	three or four	8.190	3.203
	more than four	2.255	0.601
$35-$40K	one	0.007	0.005
	two	0.322	0.184
	three or four	1.082	0.433
	more than four	0.204	0.056
>$40K	one	0.029	0.021
	two	0.613	0.363
	three or four	2.171	0.906
	more than four	0.719	0.204

*Odds Ratios Yes:No will be the same as on Table 4.

and the least common would be a single person earning $35,000 to $40,000 per year. Likewise, the most common non-recreating family would be a household of two earning less than $15K per annum and the least would be the single person with $35-$40K annually. The reason for the single person appearing in both "least common" groups is that such a person is so rare in the Pacific Northwest (refer to Table 1, the HI effect).

The Model for Recreation

The evaluation of benefits of improved water quality to recreation in the Region now proceeds to the derivation of demand for water based recreation. As water improvement programs directly affect only freshwater areas, observations for marine and non-aquatic areas were eliminated from the data set.

Water requirements of various recreation forms are different. A lake with high turbidity may be very good for boating but undesireable or poor for swimming and fishing. Thus, the data set was subdivided into recreation type--boating, camping, swimming, and fishing. It was deemed necessary to analyze a homogeneous subdivision with both high reliance on water quality and a relatively large number of observations. Trips in which households participated in more that one activity such as both camping and boating were, therefore, eliminated as a non-homogeneous recreation form. Swimming in the Pacific Northwest was done primarily very close to a household's place of residence so that demand curves would cover only a small, 30-mile or less range. In addition, there was no guarantee that swimming was done in a lake or river rather than a swimming pool. Camping at freshwater sites and boating had too few observations to warrant immediate investigation. This left fishing as the recreation form to analyze. Table 5 lists parameters for the above recreation types and combinations of types.

Variables and the Data Set

Computer space dictated that a maximum of five variables be in-

Table 5: Multiplicative Parameter β, λ Divided by Its Standard Error, and Probabilities of Recreation Types.

Type†	β	λ/SE	prob.
--	0.249	- 7.190*	0.012
S	2.573	10.299*	0.124
B	1.138	1.062	0.055
BS	0.881	- 0.786	0.043
F	3.521	14.052	0.170
FS	0.759	- 1.858	0.037
FB	1.432	2.576*	0.069
FBS	0.948	- 0.345	0.046
C	3.028	13.947*	0.147
CS	0.774	- 2.027	0.037
CB	0.294	- 6.667*	0.014
CBS	0.471	- 4.475	0.023
CF	1.902	5.473*	0.092
CFS	0.740	- 2.334	0.036
CFB	0.874	- 1.089	0.042
CFBS	1.079	0.592	0.052

†Recreators were allowed to respond to the activities camping (C), boating (B), fishing (F), swimming (S), or any combination of activities including none of the activities.

*Significant at the 95% level.

cluded in the model. These variables would be the ones which had the greatest explanatory power. An association of several variables was run to determine which of the variables would be best for inclusion in the model. Common sense and economic theory determined that miles traveled would be one of those variables. The results of the association supported this as miles (M) was one of the most significant explanatory variables. The remaining four were water quality (W), site quality in terms of facility code (S), the type of water body in question (T), and the income level of the household (I).

The data were originally arrayed in a table with several category breaks. The table was reduced in size by eliminating categories with large numbers of cells with zero frequency. For example, there were virtually no fishing trips taken to sites with bad water quality and also very few trips taken to areas greater than 100 miles from a household's residence. Observation had shown that a majority of fishing trips were one day affairs which may be one reason for the dearth of trips beyond 100 miles one way. Thus, categories with few observations were collapsed: poor and bad water quality were added to form the category bad-poor, and the few trips taken at very far distances were combined into the greater than 75 miles category. The final breakdown was as follows:

a. Miles (M), taken directly from the questionnaire
   1) less than 2 miles
   2) 2 - 10 miles
   3) 11 - 30 miles
   4) 31 - 50 miles
   5) 51 - 75 miles
   6) greater than 75 miles
b. Water Quality (W), supplied by state agencies
   1) bad-poor
   2) average
   3) good-excellent
c. Site Quality (S), determined from park documents
   1) developed
   2) primitive

d. Type (T), from the questionnaire
   1) river
   2) lake

e. Income (I), excluding missing values, from the survey
   1) less than $15,000 per year
   2) $15,000 to $25,000 per year
   3) greater than $25,000 per year

A k-test of the factors showed that all interactions at the $k < 4$ level (fifth-order effects) were not significantly different from zero for the additive form of the loglinear model and one for the multiplicative form. Thus, there existed some model using $k \leq 4$ interactions which would perform at least as well as the saturated model in the statistical sense.

An association of the five selected variables was then used to evaluate the importance of the effects. All interactions of order $k \leq 3$ were clearly significant and, therefore, would be included in the predictive model. Only two of the five fourth-order effects--MWTI and MSTI--were significant. The predictive model would be [MWTI, MSTI, WSI, WST, MWS].

The Relationship Between β and Demand

Each β is a parameter which represents a relative weight in odds awarded to a category of a variable given the actual data. The β values can then be applied to a specific sample size to obtain estimates for that sample.

Demand is defined as the relationship between price and quantity of a good given shifter variables of prices of complements and substitutes, money income, and tastes and preferences. Thus, if cell values are recreation trips, β^M parameters are estimates of recreator trips by the variable, miles traveled. If the effect β^I is added to the model β^M ($\beta^M\beta^I$), then each miles parameter is multiplied by each income level to obtain a series of demand curves shifted by income.

The β^M parameter, therefore, yields demand for recreation, all other things being equal, but in terms of odds given some total trips.

Addition of β^I, β^W, β^W, or β^T would shift β^M by an appropriate amount. Values obtained are ratios which can be applied to the same or different sample or a population.

When higher-order effects are included such as $\beta^{MS}\beta^M\beta^S$ or $\beta^{MST}\beta^{MS}\beta^{MI}\beta^{SI}\beta^M\beta^S\beta^I$, a series of demand curves shifted and twisted by the additional parameters results. Results are more complicated and effects may enhance or cancel each other but the demand curves provide more information on the relative importance to demand of each variable and interaction of variables.

The Full First-Order Model

The full first-order model [M, W, S, T, I] is not a particularly good predictive one, but it does provide insight into the relative importance of the individual variables in the absence of interactions. If the simple variables contributed nothing to the model, then there would be little variation in frequency per cell. This is not the case as is seen in Table 6. Note that all but one of the first-order parameters are significant at the 95% level. The constant term is 3.6536.

Miles: The β^M values rise from 1.472 to 2.105 for miles traveled up to 30 after which they decline sharply. This implies that, all other things equal, households fish more often as distance traveled increases up to 30 miles from residence to site, but at distances above 30 miles, households take fewer and fewer trips. A graph of the result is seen in Figure 12. This demand curve is kinked at 30 miles. It appears to contradict economic theory, but it is a representation of the data set nonetheless. The model allows the data to find that form it fits best.

If one assumes that economic theory is inviolate, then there must be some explanation for the aberration. The distortion exists only for miles categories close to the residence of the household. Some explanations which immediately come to mind are:

a. faulty data,

b. non-neoclassical theory (Georgescu-Roegen, 1967), and

c. the demand curve derived is actually a two part functinn

Table 6: The Multiplicative Parameter β and λ Divided by Its Standard Error for the Full First-Order Model [M, W, S, T, I] with Constant Term 3.6536.

Factor	Range	β	λ/SE
M	≤ 2	1.472	7.293*
	2 - 10	1.485	7.484*
	11 - 30	2.105	15.810*
	31 - 50	0.865	- 2.249*
	51 - 75	0.561	- 7.462*
	> 75	0.448	- 9.397*
W	bad-poor	0.362	-18.138*
	average	1.706	13.943*
	good-excellent	1.621	12.499*
S	developed	1.316	10.584
	primitive	0.760	-10.584
T	river	1.179	6.499*
	lake	0.848	- 6.499*
I	≤ $15K	1.005	0.113
	$15K - $25K	1.323	6.980*
	> $25K	0.896	- 2.425*
	Missing	0.840	- 3.755*

*Significant at the 95% level

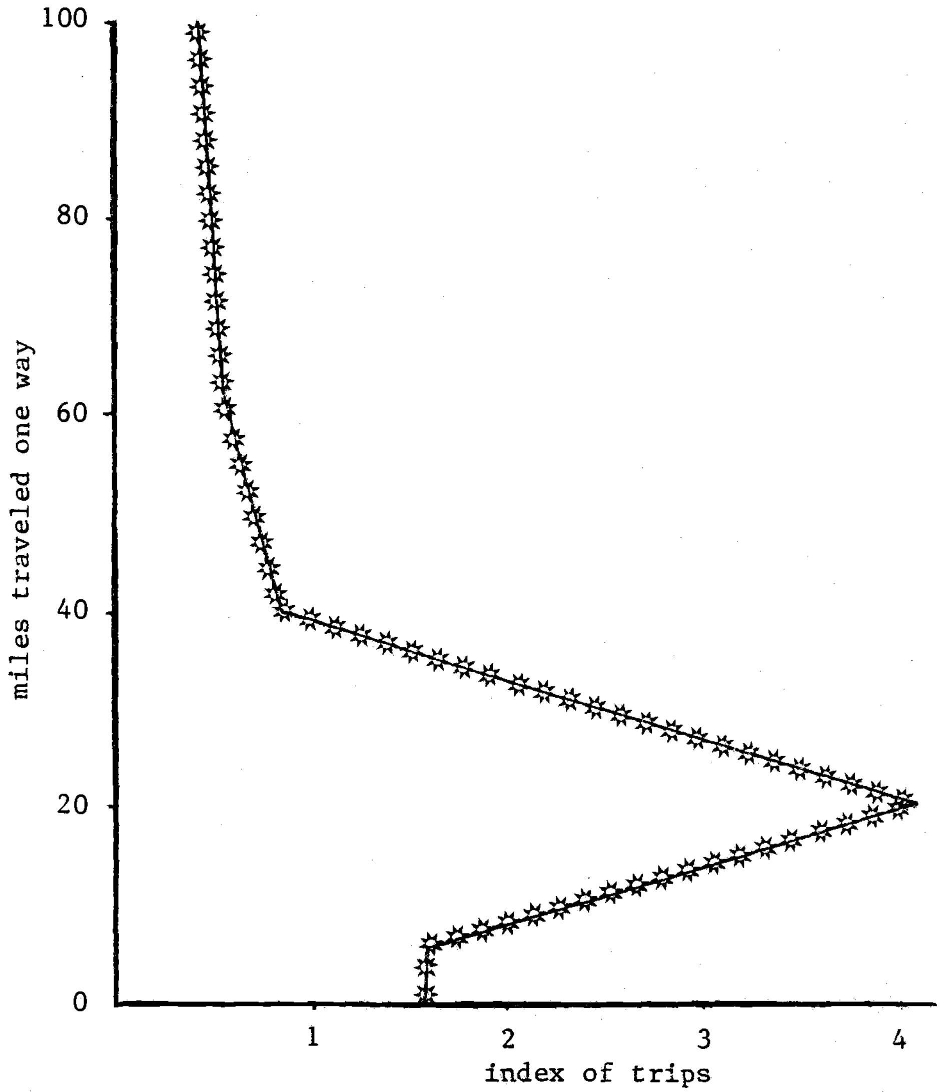

Figure 12

Plot of the Multiplicative Parameter β^M and the Categorical Miles Traveled Variable for the Model [M, W, S, T, I] where values above 30 miles are demand and below 30 miles reflect a supply restriction of some sort.

It is assumed that the data are not so faulty as to cause such an obvious distortion. Also, non-neoclassical theory would provide one with an answer but not one that is widely accepted. The most intuitively appealing is that there is some sort of supply restriction. Recreators simply need to travel a certain distance before recreational fishing opportunities become readily available.

This very likely possibility is generally overlooked in recreation studies which employ ordinary least squares. OLS fits a specific functional form to a data set when, in fact, there may be a deviation from this function. The end result is a low R^2 although coefficients may be significant. The loglinear model does not fit a single functional form to the data and, as a consequence, kinks may emerge. Thus, the original hypothesis that there may be supply problems is supported.

Water Quality, Site Quality and Type: Attendance at average water quality sites is slightly greater than that at good-excellent water quality sites. Poor-bad water quality is all but scorned. Once again, these results seem in violation of economic theory since it is assumed that better is always preferred to average. Once again, it is hypothesized that the situation is indicative of a supply restriction--there aren't enough excellent sites around and recreators must settle for less or do without.

Developed sites are attended over primitive sites by a factor of 1.75:1. This hints that there may be a tradeoff between site quality and water quality. Many good-excellent water quality sites lack facilities. This relationship may even be legislated as is the case for water bodies protected by the Wilderness Act and Wild and Scenic Rivers Act. Individual preferences for facilities may be such that improved water quality is foregone for the sake of extra facilities. The results of the water quality preference structure and the site facility structure indicates that there is some correlation between the two. This will be investigated later.

Rivers are slightly preferred to lakes for fishing purposes.

Income: The majority of recreational fishermen had household incomes between $15,000 and $25,000 per year. The second most common income group was that below $15,000 per annum.

The Facility-Water Quality Tradeoff

A simple hierarchical model [WS] was run to test the hypothesis that, other things equal, there is a tradeoff between facilities and water quality due to the presence of a shortage of sites with both facilities and high levels of water quality. A second model [WSI] was used to determine whether income played a role in the hypothesized tradeoff.

The Model [WS]: Results of the parameters are found in Table 7. All parameters are significant at the 95% level. The parameters indicate an odds ratio of 5:1 in favor of average over bad-poor water quality and 5:4 for good-excellent over average. Thus, better water quality is preferable to poor water quality in the absence of other effects. This finding contradicts that of the full first-order model which included only first-order effects. There is, therefore, the possibility of an interaction between water quality and other variables.

As expected, higher levels of facilities are preferred to lower level at 2.7:1. Since higher water quality is preferred to lower water quality and more facilities are preferred to fewer, one would anticipate that the combinations of good-excellent water quality and higher facilities would elicit the greatest response in terms of fishing trips in the absence of other barriers. However, this is not the case. A glance at the interaction shows that the most trips are taken to average sites with higher facilities, then good-excellent with low facilities, and finally good-excellent sites with higher levels of facilities. The result indicates, assuming recreators are rational and behave in accordance with utility theory, that there is some factor not included in the model which inhibits their logical response--perhaps a supply restriction on the availability of sites with both high levels of facilities and water quality. Conversely, the least attended site--bad-poor water quality with few facilities--

Table 7: Multiplicative Parameters and Multiplicative Results of the Model [WS] with Constant Term 3.5031.

First-Order Effects:

Water Quality:	Bad-Poor	= 0.314
	Average	= 1.590
	Good-Excellent	= 2.004
Site Quality:	Developed	= 1.653
	Primitive	= 0.605

Second-Order Effects:

Site Quality	Water Quality		
	Bad-Poor	Average	Good-Exc.
Developed	1.562	1.414	0.453
Primitive	0.640	0.707	2.209

Multiplicative Effects:

Site Quality	Water Quality		
	Bad-Poor	Average	Good-Exc.
Developed	0.811	3.716	1.501
Primitive	0.122	0.680	2.678

appears to be in agreement with utility theory.

The degree of attendance at sites with facilities with respect to the water quality at that site is seen in the estimates for the combination bad-poor/developed and average/primitive. If it is assumed that these types of sites are in relative abundance, then the results suggest that recreator preference for water quality is outweighed by that for higher levels of facilities. The simple odds ratio of bad-poor/developed to average/primitive is 1.562:0.707 or about 2.2:1 while the multiplicative ratio or predicted response ratio is 0.811:0.680 or about 1.2:1. Thus, participation at the latter is increased by its higher water quality level more than it is decreased by its lower facility level.

In summary, the existence of a tradeoff is suggested. Unfortunately, a specific causal relationship cannot be determined by the loglinear model as constructed. Also, the "function" relies on categorical data, and, therefore, is not differentiable. Marginal rates of substitution would be subject to gross errors given the existence of the dichotomous facility variable.

The Model [WSI]: Analysis now shifts to the model [WSI] to test the hypothesis that recreator income plays a significant role in the water quality-site quality tradeoff. All parameters for W and S variables are significant at the 95% level while only two of the four income level parameters were this significant. Parameters and multiplicative results are found in Table 8.

Ceteris paribus, preferences for better water quality are even more marked in the model. Average is preferred to bad-poor by a factor of 8:1 and good-excellent is preferred to average by 5:4 and to bad-poor by nearly 10:1. Facilities are also favored by 3.45:1 over lower levels.

Preferences for facilities by income group are remarkably stable for all but the missing category (7.68:1) at 2.69, 2.67, and 2.33:1 for less than $15K, $15-25K, and greater than $25K income groups respecitively. Thus, at least in terms of facilities, income does not affect household preferences; the majority appears to prefer recreation facilities regardless of income.

Table 8: Multiplicative Parameters and Multiplicative Results of the Model [WSI] with Constant 2.8413.

First-Order Effects:

Water Quality:	Bad-Poor	= 0.232
	Average	= 1.859
	Good-Excellent	= 2.317
Site Quality:	Developed	= 1.854
	Primitive	= 0.539
Income:	less than $15K	= 0.114
	$15K - $25K	= 0.546
	more than $25K	= 0.081
	missing	= 0.477

Second-Order Effects

Site Quality	Water Quality		
	Bad-Poor	Average	Good-Exc.
Developed	1.856	1.262	0.427
Primitive	0.539	0.792	2.342

Site Quality	Income			
	< $15K	$15K-$25K	> $15K	missing
Developed	0.885	0.920	0.823	1.494
Primitive	1.130	1.087	1.216	0.670

Income	Water Quality		
	Bad-Poor	Average	Good-Exc.
less than $15K	1.253	0.742	1.075
$15K - $25K	1.906	0.762	0.688
more than $25K	1.603	0.613	1.018
missing	0.261	2.882	1.329

Table 8: Continued

Third-Order Effect:

Income	Site Quality	Water Quality		
		Bad-Poor	Average	Good-Exc.
< $15K	Developed	0.889	1.209	0.931
	Primitive	1.125	0.827	1.074
$15K-$25K	Developed	0.741	1.247	1.083
	Primitive	1.350	0.802	0.924
> $25K	Developed	0.952	1.147	0.917
	Primitive	1.051	0.872	1.091
missing	Developed	1.597	0.578	1.083
	Primitive	0.626	1.729	0.924

Multiplicative Results:

Site Quality	Income			
	< $15K	$15K-$25K	> $25K	missing
Developed	1.839	2.944	1.654	1.321
Primitive	0.683	1.011	0.710	0.172

Income	Water Quality		
	Bad-Poor	Average	Good-Exc.
less than $15K	0.326	1.546	2.792
$15K-$25K	0.763	2.445	2.751
more than $25K	0.403	1.235	2.557
missing	0.289	2.556	1.469

Odds of developed to primitive by income group:

< $15K	$15K-$25K	> $25K	missing
2.69	2.67	2.33	7.68

Odds of good-excellent to average water quality and average to bad-poor water quality by income group:

	< $15K	$15K-$25K	> $25K	missing
good-exc:avg	1.81	1.12[5]	2.07	0.57
avg:bad-poor	4.74	3.20	3.06	8.84

The income effect on water quality was less obvious. The missing group preferred average quality to both bad-poor and good-excellent. Those in the less than $15K income group exhibited a clear preference for higher levels of water quality with ratios 1.81:1 (good-excellent to average) and 4.74:1 (average to bad-poor). The middle group, while favoring better water quality, was less decisive at ratios 1.125:1 (good-excellent to bad-poor) and 3.20:1 (average to bad-poor). The highest income group had the highest ratio of good-excellent to average at 2.07:1 but the lowest for average to bad-poor at 3.06:1.

With the exception of the missing income group, a higher level of water quality was always preferred to lower levels regardless of income class and in the absence of higher order interactions. Also, preferences for facilities by income class exhibited little variance. Thus, one cannot accept the hypothesis that income has any significant influence on the water quality-site quality tradeoff.

The Model [MWTI, MSTI, WSI, WST, MWS]

A larger model was needed to include effects associated with the supply restriction. Once the constraint was included, the factors of the supply problem would trap the disturbance resulting in demand parameters unbiased by the shortage of sites at the low end of the surrogate price. The impact of the supply problem would be more precise and the true demand curve would be identified.

Tests of association and k+1 and k tests of factors were used to derive the smallest model with the greatest predictive power, the model [MWTI, MSTI, WSI, WST, MWS] at a probability of good fit of roughly 99%. The β parameters of various conditions can be used to proportion out effects over any sample size or population such that demand curves can be obtained for any group in the Pacific Northwest. For this discussion, only β's will be considered since they are the basis for odds ratios regardless of population size of interest.

The plot of β^{M} on the abscissa and miles on the ordinate yields the general demand curve for recreational fishing when interactions are included in higher-order effects and disregarded. The demand schedule or listing of β^M is given in Table 9, with the demand curve in Figure 13. The demand curve is downward-sloping with a slight disturbance at the 11-30 mile break point. This suggests that people take fewer and fewer trips as they travel greater and greater distances in the absence of interactive effects.

Interactions are, however, present and must be investigated to discover the source of the hypothesized supply restriction indicated in the full first-order model. The second set of demand curves is demand for recreation given a specific level of water quality. The schedules are also found in Table 9 with the curves in Figure 14. Multiplicative values are rounded to the nearest tenth. This set of curves provides insight into the supply problem. As the level of water quality increases, the supply restriction becomes binding at successively farther distances. In other words, bad-poor water quality exhibits a small but downward-sloping curve with a small inward kink at 2-10 miles. The average quality curve is downward-sloping to the 11-30 mile cutpoint below which it kinks inward then outward again. Finally, the good-excellent quality relation is downward-sloping to the 31-50 mile break, then kinks inward with a small downward-sloping tail. Thus, the better the water quality, the more binding the supply problem. Yet, the downward-sloping tail of average and good-excellent water quality at less than two miles must be addressed. One explanation is that these may be the many--perhaps daily--trips tallied by households which actually live at sites such as Coeur d'Alene. A second and maybe related reason might be a problem in the definition of outdoor recreation. Households may be including children's fishing trips to city park put-and-take operations as outdoor recreation. For example, some city parks have special programs for children along urban sections of rivers. A third explanation is that there is another effect, another supply restriction.

Discussion now turns to the demand for outdoor recreational fishing given facilities. The schedule is seen in Table 10 with the curves in Figure 15. The curve for relatively primitive sites is a standard, fairly smooth downward-sloping curve. However, that for relatively developed sites is downward-sloping only to the 11-30 mile

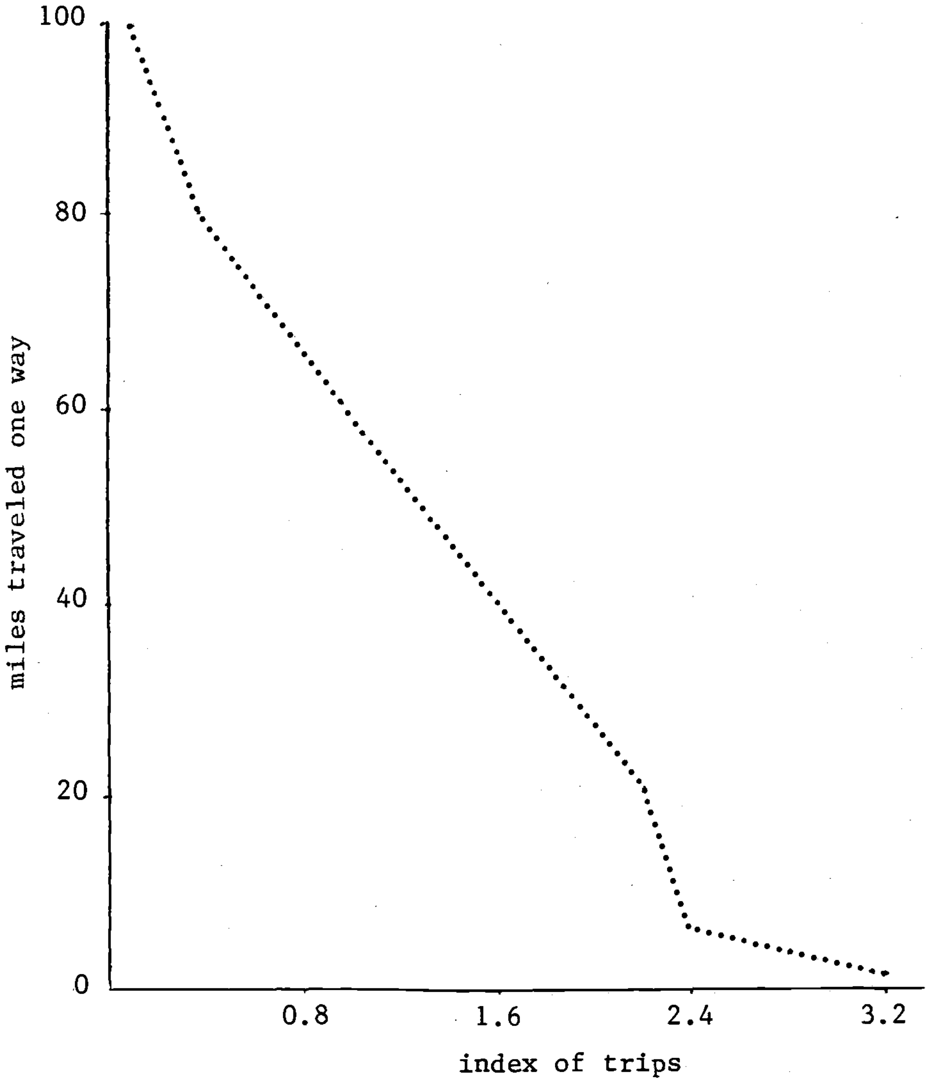

Figure 13

Plot of the Multiplicative Parameter β^M and the Categorical Miles Traveled Variable for the Model [MWTI, MSTI, WSI, WST, MWS]

Table 9: Multiplicative Parameters and Multiplicative Results of the Predictive Model [MWTI, MSTI, WSI, WST, MWS]: Demand Schedules for Freshwater Recreational Fishing for Three Levels of Water Quality in the Pacific Northwest.

First-Order Effects:

Miles:		Water Quality:	
< 2	= 3.166	Poor-Bad	= 0.049
2 - 10	= 2.436	Average	= 3.111
11 - 30	= 2.234	Good-Exc.	= 6.574
31 - 50	= 0.902		
51 - 75	= 0.428		
> 75	= 0.151		

Second-Order Effects:

Miles	Water Quality		
	Poor-Bad	Average	Good-Exc.
< 2	1.618	1.801	0.343
2 - 10	3.609	0.925	0.300
11 - 30	0.720	2.418	0.575
31 - 50	0.197	2.004	2.534
51 - 75	3.022	0.195	1.700
> 75	0.400	0.636	3.929

Multiplicative Results:

Miles	Water Quality		
	Poor-Bad	Average	Good-Exc.
< 2	0.251	17.739	7.139
2 - 10	0.431	7.010	4.804
11 - 30	0.079	16.805	8.445
31 - 50	0.009	5.623	15.026
51 - 75	0.063	0.260	4.783
> 75	0.003	0.299	3.900

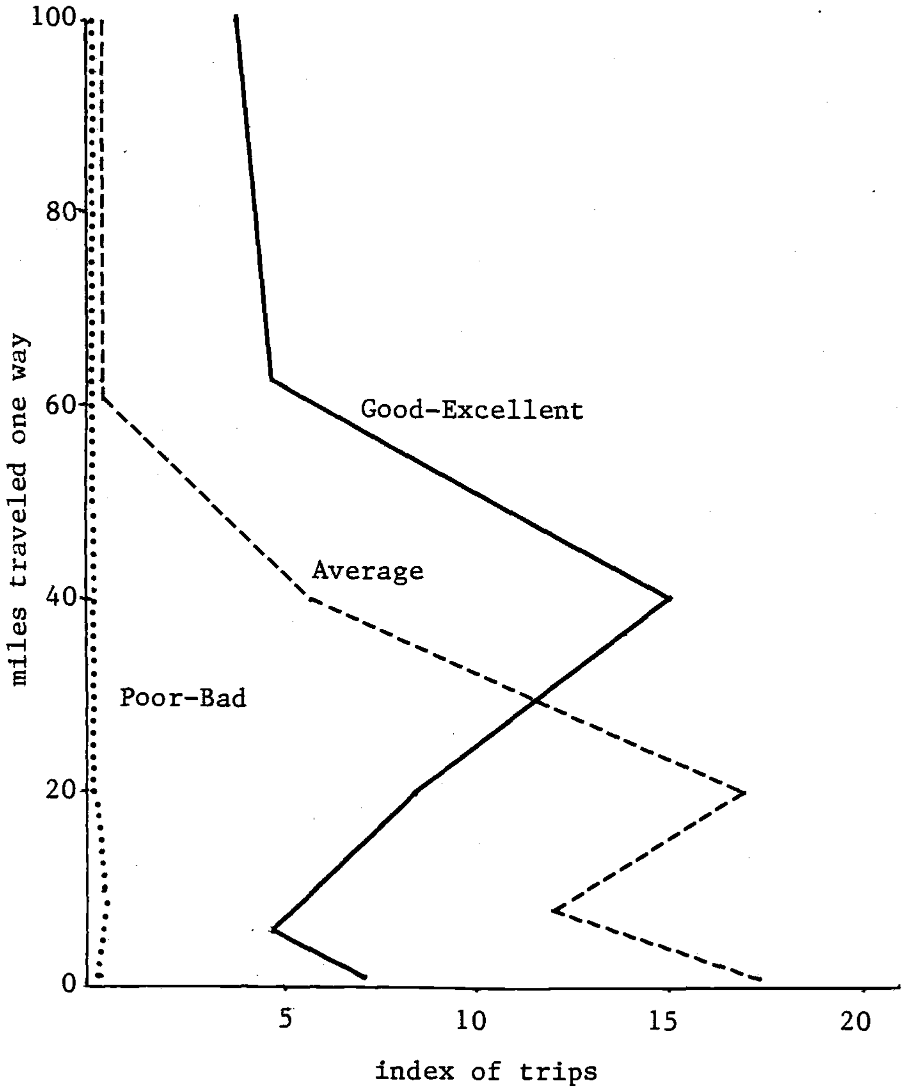

Figure 14

Plot of the Multiplicative Result of the Three Water Quality Levels and the Categorical Miles Traveled Variable from the Model [MWTI, MSTI, WSI, WST, MWS]

Table 10: Multiplicative Parameters and Multiplicative Results of the Model [MWTI, MSTI, WSI, WST, MWS]: Demand for Freshwater Recreational Fishing for Two Facility Levels in the Pacific Northwest.

First-Order Effects:

Miles:		Site Quality:	
< 2	= 3.166	Developed	= 5.114
2 - 10	= 2.436	Primitive	= 0.196
11 - 30	= 2.234		
31 - 50	= 0.902		
51 - 75	= 0.428		
> 75	= 0.151		

Second-Order Effects:

Miles	Site Quality	
	Developed	Primitive
< 2	0.193	5.185
2 - 10	0.309	3.234
11 - 30	1.419	0.705
31 - 50	2.356	0.424
51 - 75	1.020	0.980
> 75	4.915	0.203

Multiplicative Results:

Miles	Site Quality	
	Developed	Primitive
< 2	3.125	3.217
2 - 10	3.849	1.544
11 - 30	16.212	0.309
31 - 50	10.868	0.075
51 - 75	2.233	0.082
> 75	3.795	0.006

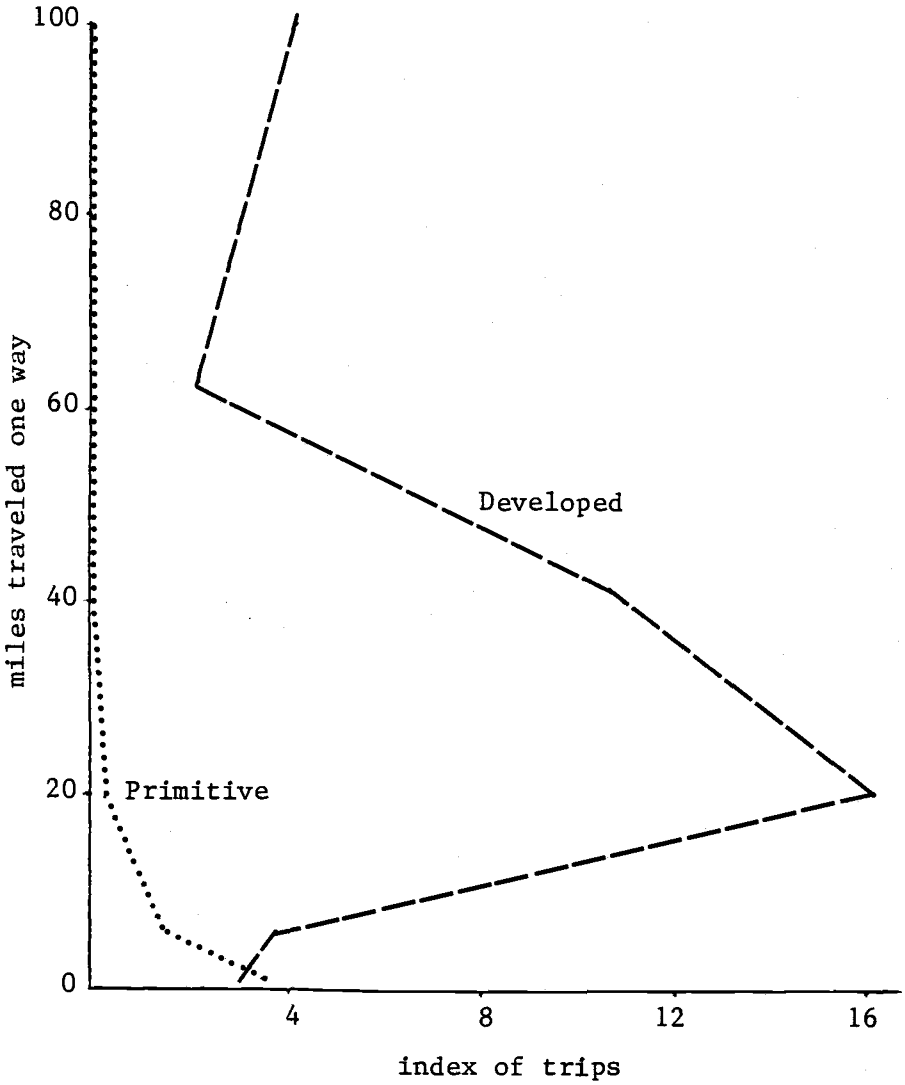

Figure 15

Plot of the Multiplicative Result of the Two Facility Levels
and the Categorical Miles Traveled Variable from the
Model [MWTI, MSTI, WSI, WST, MWS]

point becoming positively-sloped at all lower miles levels suggesting the now familiar supply restricted form. The two intersect--low facilities exceeding higher facility levels--somewhere between the less than two mile and 2-10 mile categories. Thus, it could be that households are substituting more available primitive sites for the scarce but desireable developed sites at low surrogate prices.

The big question to be answered is this: exactly what is the nature of the supply restriction regarding outdoor freshwater recreational fishing in the Pacific Northwest? While there may be no simple explanation, analysis of the miles-water quality-site quality interaction may give some clues. Demand schedules for the six water quality-site quality types are seen in Table 11 and corresponding curves are found in Figures 16a and 16b.

Figure 16a clearly depicts upward-sloping sections for all three water quality levels with the higher levels of facilities. In addition to the supply restriction form, average water quality appears preferred to good-excellent quality. Note from Table 11 that for bad-poor and average water quality levels, facilities always evoke a greater response than lack of facilities. For the good-excellent water quality level, however, the response is reversed at miles categories below 50 miles indicating a shortage of good-excellent water quality. However, the more abundant lower facility sites of Figure 16b are primarily downward-sloping with better water quality more preferred. Thus, an explanation may be as follows:

a. Recreators prefer more to fewer facilities and better to worse water quality.

b. Both characteristics are in short supply resulting in constraints which distort the derivation of demand curves at the lower end of the miles traveled index.

c. Recreators, therefore, weigh all three characteristics of the MWS interaction and select that combination which is most appealing given all constraints.

d. The lower facility level, not in short supply, exhibits negatively-sloping curves ordered by water quality while those for developed sites in short supply are

Table 11: Relative Demand Schedules for Six Water Quality-Site Quality Combinations in the Region As Derived from the Predictive Model [MWTI, MSTI, WSI, WST, MWS].[a]

Miles	Developed Sites			Primitive Sites		
	Bad-Poor	Average	Good-Exc.	Bad-Poor	Average	Good-Exc.
Less than 2	0.348	28.971	2.975	0.007	10.888	16.864
2 - 10	1.866	10.758	2.845	0.084	4.575	8.103
11 - 30	4.118	135.879	7.611	0.003	2.082	9.365
31 - 50	1.252	44.507	23.047	0.001	0.712	9.777
51 - 75	0.376	9.421	3.152	0.011	0.007	7.256
Greater than 75	0.491	19.420	5.721	0.004	0.004	2.649

[a] Odds ratios are calculated by dividing water quality values for sites with development by values for those which are relatively undeveloped for each miles category listed.

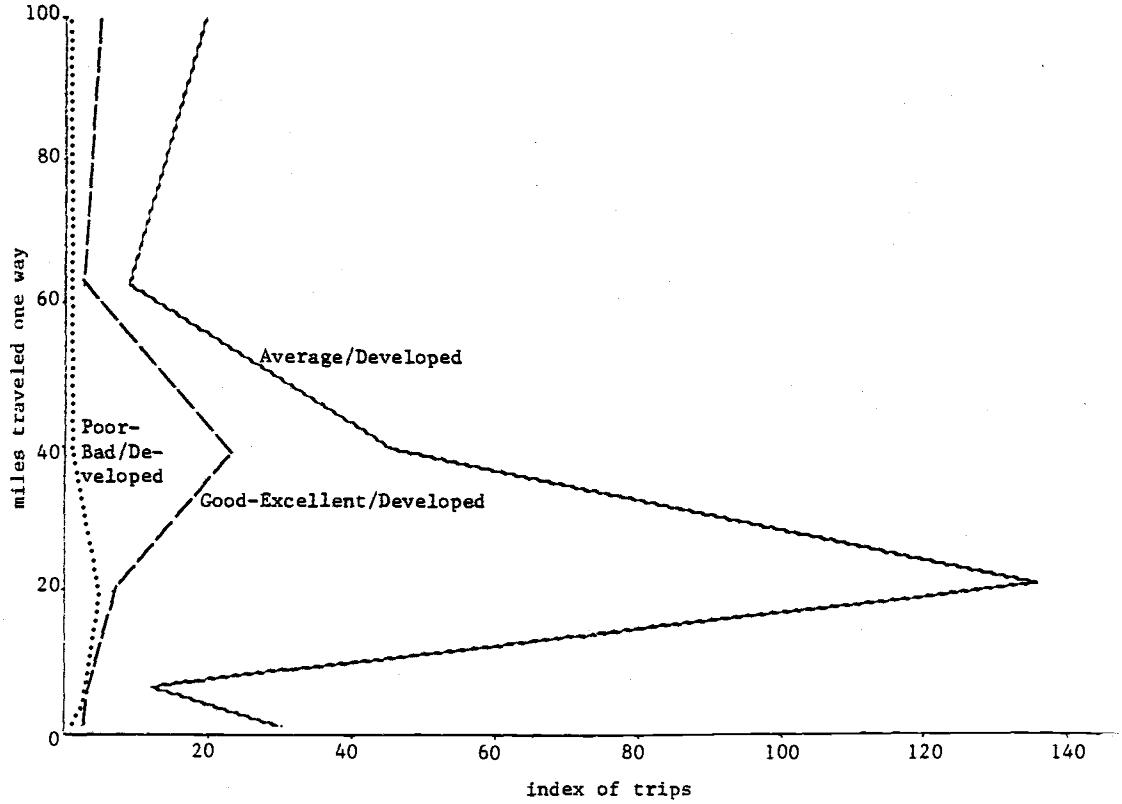

Figure 16a

Plot of the Multiplicative Result for Six
Water Quality-Site Quality Site Characterstics
and the Categorical Miles Traveled Variable for the
Model [MWTI, MSTI, WSI, WST, MWS]

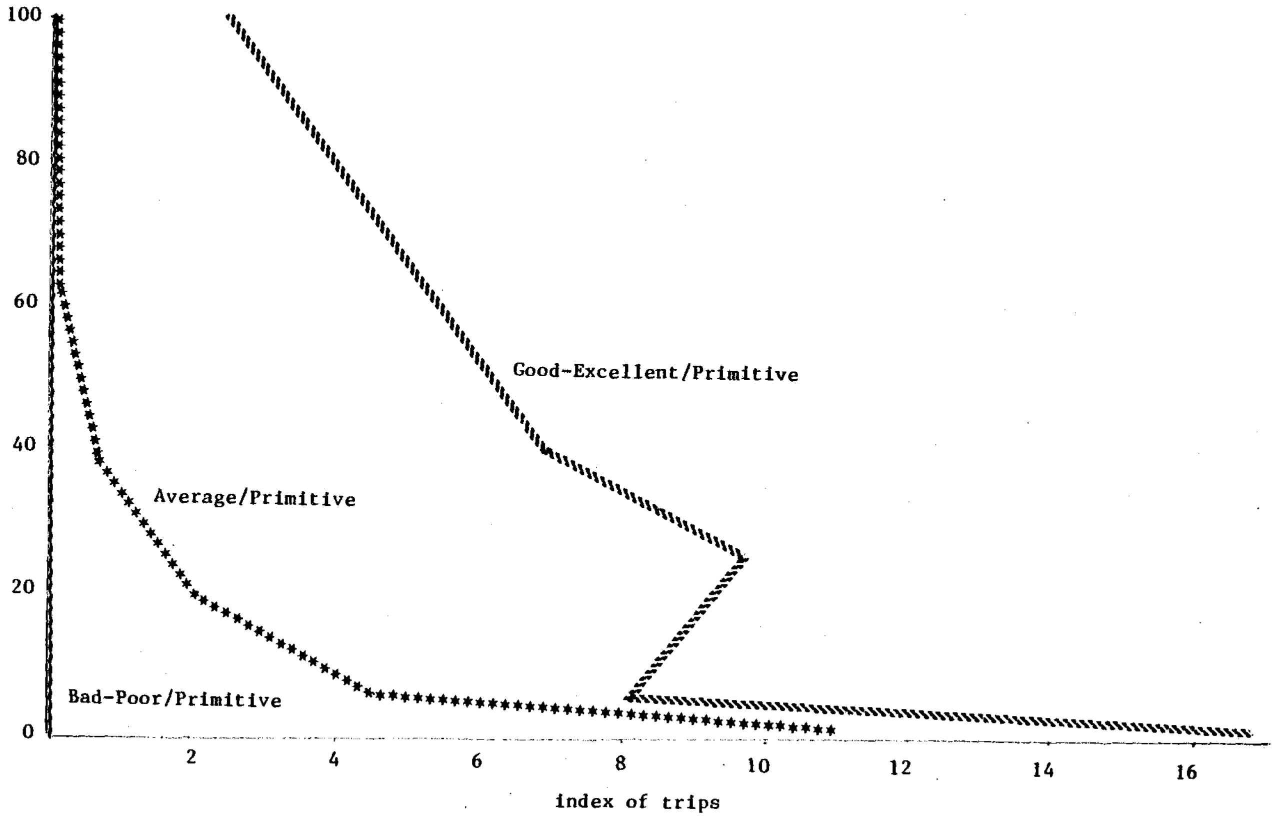

Figure 16b

Plot of the Multiplicative Result for Six Water Quality-Site Quality Site Characteristics and the Categorical Miles Traveled Variable for the Model [MWTI, MSTI, WSI, WST, MWS].

severely distorted.

e. When the facility level is higher, the binding constraint is better water quality.

f. When the water quality level is higher, the binding constraint is facility availability.

g. When miles traveled are fewer, the binding constraint is both higher water quality and developed sites.

A Final Note on the Supply Restriction

The supply restriction distorts the lower end of the demand relationship. These supply restrictions arise from the interaction of miles traveled, quality of the water, and availability of facilities. Sites preferred would be those near household residences, of good-excellent water quality, and developed. Unfortunately, such combinations are rare.

It is likely that the section of the curve below the point at which the supply constraint becomes binding is too perverted for analysis. As such, it is reasonable to consider only the upper sections of the curve which are negatively-sloped as valid and claim the lower end of the curve is simply subject to a supply restriction and, consequently, a shortage of sites with specific characteristics exists at all points below. Any recreators denied entry because of congestion at the few available sites will either do without, travel farther, or find lower quality substitutes.

The full first-order model gives parameter estimates for miles, water quality, facilities, type of site, and household income given that there are no interactive effects between or among those variables. However, the test of association indicates that there are indeed correlations. Including these effects to the fourth-order model improves the predictive power of the model as well as identifying which interactions are causing the supply problem.

When interactions are ignored, the demand curve estimated by the first-order model has an upward-sloping section and average is preferred to good-excellent water quality. Parameters for those results in Table 6 are significant at the 95% level. Since the model cannot think and knows no economic theory, it simply finds the best fit of the variables and the first-order effects absorb the impact of the supply problem as best they can. Results, when statistically significant, can be very misleading. Interactive terms such as MWS, however, adjust for interrelationships so that the supply constraint is not reflected in the first-order terms. The result of incorporating higher-order effects is a downward-sloping demand curve as seen in Figure 13 and water quality preferences consistent with utility theory.

Distortion may exist in the area of the inflection point due to recreator response to congestion as well. Suppose a household decides to attend a site but, upon arrival, finds the site filled to capacity. If the household returns home it realizes only the disutility of travel; if it continues on to another site, it will incur additional travel disutility but utility gained from recreating at an alternative site may be sufficient to minimize total disutility of the trip. Neither option is the original utility-maximizing one, but is the best that can be obtained under the circumstances. The household travels farther (pays more) than it had intended such that data points generated by their action lie above the true demand curve.

In the aggregate, these data points are trips which have been "pushed" above the true relationship and cluster in a non-normal distribution in the area of the inflection. The skewed distribution of these points implies that use of regression yields a relationship that is not BLUE. In addition, the supply restricted loglinear model will be biased since it, too, will generate parameters corresponding to a response that lies above what recreators are *ex ante* willing to pay. Thus, in the critical area, the demand curve may actually be more inelastic. For purposes of the following sections, however, it will be assumed that this distortion is negligible. However, this problem should be more fully investigated by both theoretical and empirical methods. It is doubtful that the loglinear technique would be useful for this as it analyzes only categorical data and continuous data would be required.

Welfare Effects of Water Quality Improvements

Regional Benefits

Calculation of benefits due to improved water quality was done for the predictive model. The predictive model represents the response when interactive effects are included while the full first-order model is simply a description of the response without inclusion of interactions. Recall that a total of 1598 trips were generated by the surveyed household who fished. Odds ratios on Table 9 are applied to this number yielding the values on Table 12.

The curves in Figure 17 are demand curves down to the point at which the supply constraint becomes binding and reflects a supply restriction below that point. The demand curves are extended assuming that the sloped of the curves will continue to be the same in the absence of the restriction. This is, of course, a rather heroic assumption.

When all average water quality sites in the region are improved to good-excellent levels, the impact is the shift the supply restriction outward by the amount of average water quality sites improved or the number of trips those sites can accomodate. Benefits are calculated as the area between original and extended curves above the restriction and the addition of new good-excellent quality sites below the constraint. Although the latter would technically be some sort of producer's surplus, it is interpreted as the additional value to recreators of easing the supply restriction as the lower curve is a demand response rather than a supply curve. Costs of 12.5¢ and 25¢ per mile (Brown, 1983; Shalloof and Brown, 1983; both rounded to the nearest nickel) were selected for assessing value and, therefore, 25¢ and 50¢ were applied to miles traveled to the site. Miles traveled at midpoints and extremes of the ranges were used in the sets of calculations. Different costs and assumptions dealing with the handling of the range of miles produced high and low estimate of value. Areas, trapezoid, were calculated by the formula, half the height of the trapezoid multiplied by the sum of the two bases.

The value to the roughly 296 angler household surveyed--17% of

Table 12: Estimated Trips by Water Quality Category Using Parameters of the Predictive Model

Miles	Poor-Bad	Average	Good-Exc.	Total	Supply
< 2	4	306 [478][a]	123 [569]	433 [1051]	< 204
2 - 10	7	121 [430]	83 [530]	211 [967]	204
11 - 30	1	290	146 [416]	437 [707]	436[c]
31 - 50	0	97	259	356	c
51 - 75	1	5	82	88	c
> 75	0	5	67	72	c
TOTAL	13	824 [1305]	760 [1923]	1597[b] [3241]	

[a] Value in brackets is estimated demand beyond supply restriction; unbracketed terms are estimates of the predictive model.

[b] Does not total 1598 due to rounding

[c] Sufficient supply to meet demand is available for good-excellent

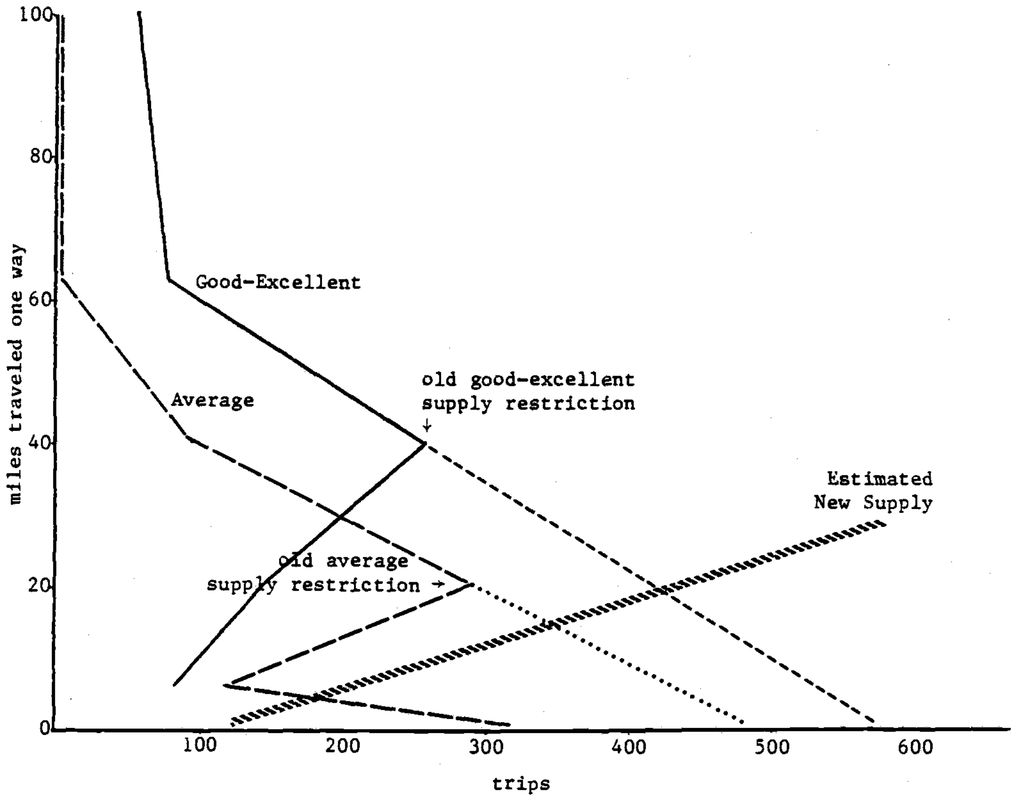

Figure 17

Regional Demand Curves for Two Water Quality Levels
and Determination of Welfare Effects of
of Water Quality Improvement from an
Average to Good-Excellent Level

the 58% of 3,000 households--of improving all average water quality sites in the Pacific Northwest to good-excellent levels was \$8.98 to \$17.95 (low and high estimate using midpoints of ranges as estimates of miles traveled) and \$17.07 to \$34.14 (low and high estimates using endpoints of ranges). This correspons to 0.5 to 1.7 additional fishing trips per household per year for an average distance traveled of 11 to 30 miles.

Table 5 show a probability of

$$\underset{(F)}{0.17} + \underset{(FS)}{0.037} + \underset{(FB)}{0.069} + \underset{(FBS)}{0.046} + \underset{(CF)}{0.092} + \underset{(CFS)}{0.036} + \underset{(CFB)}{0.042} + \underset{(CFBS)}{0.052}$$

or 0.544 that a recreation trip includes fishing as an activity. Thus, 0.544 X 0.58 = 0.3155 is the probability that any household is a fishing household. Estimates of 2.64 persons per household and 7,707,000 individuals in the three-state Region (Statistical Abstract of the United States, 1981) show that total benefits of the water quality increase to angler households per year are:

$$\frac{7,707,000}{2.64}\,(0.3155) \times \left\{ \begin{array}{lll} \$\ 8.98 & \text{(midpoints)} & = \$\ 8,270,983.08^{*} \\ \$17.95 & & = \$16,532,755.71^{*} \\ - - - & & \\ \$17.07 & & = \$15,722,236.21 \\ \$34.14 & & = \$31,444,472.42 \end{array} \right.$$

*discrepancy due to rounding error

One should note that since the loglinear technique produces a lumpy demand structure because of the categorical data set, the value estimates are extremely variable. As will be explained later, use of the loglinear method as a supplement to a technique from which continuous curves may be derived may be far more valuable than analysis using the loglinear procedure alone. Of course, since calculations did not include the remaining 45.6% of trips that did not include fishing, the estimate can be considered conservative with respect to the value of the increase to water-based recreation in general.

How do these results compare with other estimates of water quality improvement? Vaughan and Russell obtained national estimates of \$1.75 to \$16.30 per angler per year while Desvouges, et al. derived \$4.21 to \$30.88 per user per year for a similar water quality improvement. Both studies used a variety of techniques from travel cost to contingent valuation. Thus, one should not be tempted to conclude that these lower estimates are due to an unaddressed supply problem, although this may be the case for travel cost derived values. A more likely explanation for the higher Pacific Northwest estimates is that the fish in the Region (i. e., salmon and steelheal) are a higher valued species relative to the "trash" fish included in the Vaughan and Russell or Desvouges study. The individuals' perceptions of distances to be traveled in the West in general and Pacific Northwest in particular are far different from those of the rest of the Nation as well.

Also, Vaughan and Russell derived a probability of 0.28 of an individual being an angler. This is quite close to the 0.3155 household probability for this model. It may be slightly higher because of some bias from using household rather than individual responses. Another reason may be that the Pacific Northwest, with its anadromous fish population, scenic beauty, and outdoor culture, draws the fishing type of recreator.

Site Specific Demand and Value

Certain modifications were made to parameters to obtain site-specific demand curves. Of the 81 sites included in the study, 50 were of good-excellent water quality, 25 were average, and 6 were bad-poor. Likewise, 12 sites were primitive while the remaining 69 were relatively developed. The uneven distribution of site characteristics, while of no consequence in assessing demand and value of the region in aggregate, had to be considered for the site-specific case.

Parameters for water quality and site quality were divided by the appropriate number of sites in each category. The base miles parameters were left unchanged since it was assumed that recreators responded to miles traveled in the same fashion for some given water and sites quality. Because a site is a supply in itself, all recreators at the site (i. e., the ones who made it in) were assumed to be representative of a standard, downward-sloping demand curve. As such, interactive effects associated with the supply problem were ignored. The result, seen in Table 13 and Figure 18, was a set of six demand curves, each representing an "average" site of the six characteristics combinations. Values in the Table and Figure are multiplicative results which can be applied to any population size.

For purposes of argument, it was assumed that individuals at each site attend it as the minimum quality standard they will accept rather than not recreate at all. They would, however, prefer to recreate at sites of better water quality. Thus, improvements of facilities, water quality, or both implies that recreators attending the site which has been improved are the beneficiaries. The gain in improvement is the area between the curves of initial and subsequent conditions and applies only to the affected households. Using the area technique described in the previous section, welfare changes in percent of increase in value were calculated and are seen in Table 14.

Development of primitive sites causes a welfare increase of between 350% and 355% regardless of water quality. Improvement of water quality from poor-bad to average increases welfare by 1406% and 1415% for primitive and developed sites respectively. Good-excellent from average water quality, on the other hand, exhibits only a small welfare increase of just under 6%. Composite improvements produce dramatic additional benefits--6744.8% for poor-bad/primitive to average/developed and 3803.6% for average/primitive to good-excellent/developed changes.

The Assignment Problem and Indications for Policy

Calculated increases in benefits due to improved water quality should be interpreted as additional benefits to current users. There is no way of determining whether the improvement of water quality of sites will lure previous non-users to become participants although this is a very real possibility. Additional recreators would cer-

Table 13: Demand Schedules for Six Average Sites in the Pacific Northwest.

Site Quality	Miles	Water Quality: Bad-Poor	Water Quality: Average	Water Quality: Good-Exc.
Developed	< 2	1.92	29.18	30.85
	2 - 10	1.48	22.46	23.74
	11 - 30	1.36	20.59	21.77
	31 - 50	0.55	8.31	8.79
	51 - 75	0.26	3.94	4.17
	> 75	0.09	1.39	1.47
Primitive	< 2	0.42	6.42	6.79
	2 - 10	0.33	4.94	5.22
	11 - 30	0.30	4.53	4.79
	31 - 50	0.12	1.83	1.93
	51 - 75	0.06	0.87	0.92
	> 75	0.02	0.31	0.32

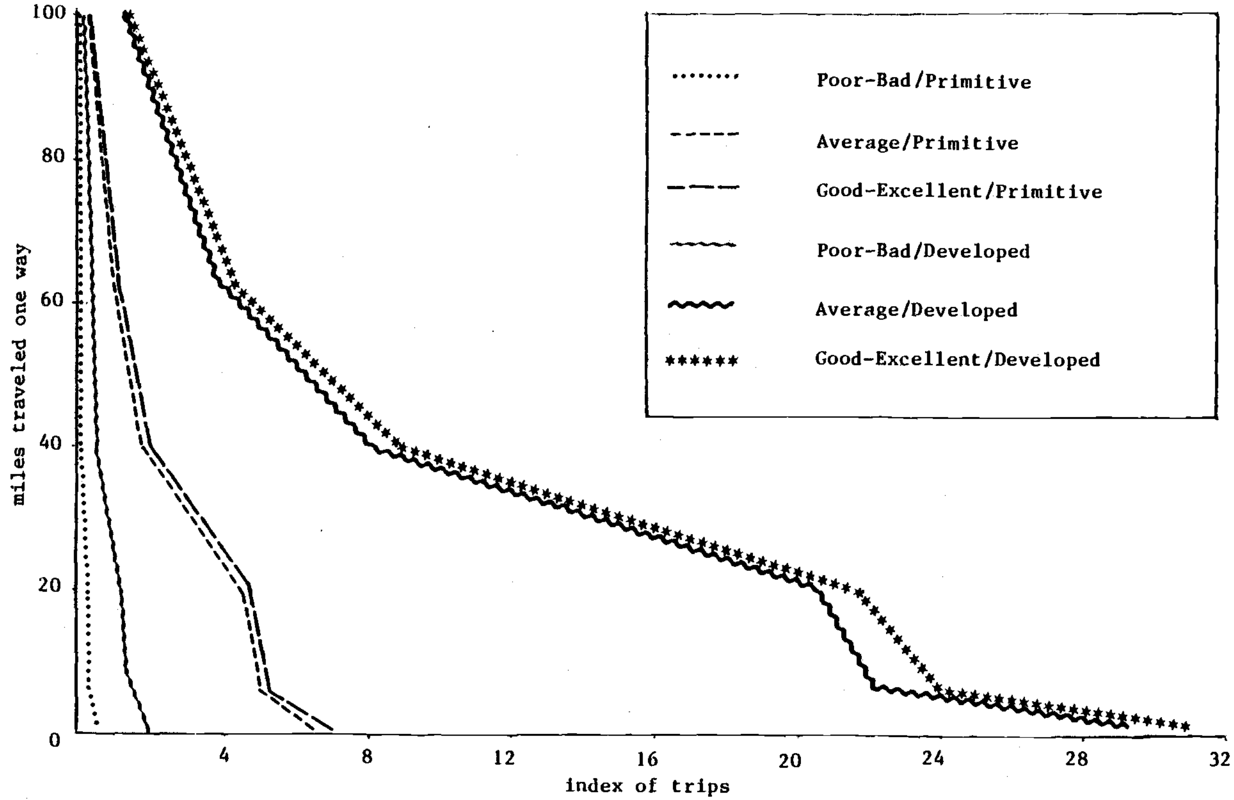

Figure 18

Six Average Site Demand Curves

Table 14: Welfare Effects of Improvements at Average Sites in the Pacific Northwest in Percent.

Original Condition	Change to	$Area^0$	$Area^1$	%Chg.
Poor-Bad/Primitive	Developed	25.26	114.12	351.8
Average/Primitive	Developed	380.60	1729.01	354.3
Good-Exc/Primitive	Developed	402.09	1828.25	354.5
Poor-Bad/Primitive	Average	25.26	380.60	1406.7
Average/Primitive	Good-Exc.	380.60	402.09	5.6
Poor-Bad/Developed	Average	114.12	1729.01	1415.1
Average/Developed	Good-Exc.	1729.01	1828.25	5.7
Poor-Bad/Primitive	Avg/Devel	25.26	1729.01	6744.8
Average/Primitive	Good-Exc/Dev	380.60	1828.25	3803.6

tainly imply greater benefits for regional and site-specific cases.

Conversely, the monetary increase as expenditures on the additional 1.7 trips per household may not actually occur since households may face income or time constraints preventing them from taking more trips. In other words, the recreating households gain the dollar equivalent of the improvement but do not necessarily spend the money. Thus, the value obtained should not be considered as an even reasonable measure of additional expenditures in the marketplace due to water quality improvement but as a welfare increase to households who participated in fishing.

Also, the effect of policy changes such as increases in entrance fees to finance site improvements in terms of welfare gains or losses to specific household types can be estimated. The first half of the general model can be used to partition regional demand by the household-income effect. Impact of the policy decision on each type of household may show that the welfare loss or gain to one family type is greater than another such that one type bears the greatest burden or reaps the greatest benefit of the improvement. Thus, the model may provide policymakers with information on the equity aspects of the change.

The loglinear approach to estimating demand and value of water-based recreation and benefits of improved water quality is of use to researchers using secondary data. Naturally, continuous data would be the most desireable and a wise individual would construct survey instruments such that as many questions as possible would allow for continuous data. Continuous data can be transformed into categorical far easier than categorical data can be made continuous. However, if only categorical data are available, the usefulness of regression is limited. Loglinear is designed to handle such data and is, therefore, the more appropriate tool in many instances.

The technique is also able to measure the extent of correlations between and among variables in the aggregate. Variables may act together to increase the demand response more than the additive effect of individual variables. If a decision is made to improve both site and water quality, the interactive term may twist the demand curve while individual effects alone only shift it. For example, in the section on site-specific benefits, the change from poor-bad/primitive to average/developed posted a welfare increase of nearly 7000%. Increases in water quality and site quality total, individually, as an increase of 1406% + 354% = 1760%, far less than the composite. The loglinear model provides more accurate measures of how the demand curve will shift if two or more characteristics of a site are changed. With correct demand curve shifters, more precise welfare measures of change are obtained. In addition, policymakers faced with limited budgets will be able to make decisions which would result in the greatest benefits given the existing condition of a recreation site and the population they serve.

Future survey instruments should include questions on non-recreators to evaluate their attitudes regarding recreation and what improvements would induce them to participate. Also, willingness-to-pay questions of recreators for water quality improvements should be compared with results of the regional benefits section. One suggestion might be to ask how many more trips the household would be willing to make to take advantage of the better water quality over the next year, and how much more the recreator would spend on capital equipment.

The Value and Limitations of the Loglinear Model

The loglinear technique is a useful tool for analyzing categorical data. Since the procedure is designed to investigate correlations between and among variables, it is especially appropriate for analysis of recreation data as many of the variables are interrelated. Recreators respond to a combination of site characteristics. Because all combinations of characteristics do not exist at all surrogate price levels, there is a supply problem.

Loglinear analysis filters out the combinations which give rise to supply restrictions. If these effects are not introduced into the model, the result is a distorted demand curve. Examination of the parameters associated with the constraint allows one to understand the structure of the supply problem and obtain estimates of the true demand relationship in the absence of the restriction

Piecewise regression on a data set would provide insight that a supply restriction exists and, since continuous data are used, would pinpoint the surrogate price at which the constraint becomes binding. However, the underlying structure would not be addressed. Also, a true demand curve could not be derived unless factors of the supply problem were introduced. Simultaneous equations would probably solve the latter situation, but the interrelationships associated with recreator response may still be unspecified. One might know what is going on, but not why.

A few strong caveats are in order. While it is possible to identify the existence of interactions and tradeoffs, one must not be tempted to calculated marginal rates of substitution of, say, water quality for site quality. The loglinear relation has the appearance of a Cobb-Douglas function, but is not a true function at all--it merely yields cell frequencies and point estimates of a relationship. Variables are not continuous and do not provide a differentiable form.

Used alone, the model is a predictive tool and gives some indication of what the demand curves should look like. If a continuous demand curves is required or if values need to be as precise as possible, the loglinear model should be used in conjunction with regression, In addition, the identification of potential supply restrictions would suggest the use of simultaneous equations, as mentioned previously.

Finally, the existence of third- and higher-order effects will increase the prdictive power of a model. Unfortunately, the presence of such effects results in the generation of a huge number of parameters and rapid loss of degrees of freedom. The addition of variables may aid explanatory power, but the amount of computer space for analysis skyrockets; there is an upper limit on both the number of cells that the routine can handle as well as a researcher's computer budget. As a consequence, the loglinear model may be inappropriate for data sets with many highly related variables or with variables with several category breaks. Conversely, the loglinear by its very name means that a sparse contingency table (one with many cells of zero frequency) cannot be analyzed. A constant may be added to each cell with a zero, but the results of the model would be overestimates. The loglinear model functions best over a somewhat limited range.

CHAPTER IV

IMPACT ON RECREATION VALUES OF DURABLE GOODS PURCHASES

The Problem

The traditional travel cost approach of evaluating recreation demand and value involves (1) statistical estimation of demand functions and (2) calculation of consumers' surplus as the entire area under the demand curve (Gum and Martin, 1975). Cost per trip and round trip mileage are common variables used as surrogate prices for this non-market good. However, these surrogate prices represent the variable costs to the recreator; fixed costs are rarely, if ever, addressed.

Virtually all forms of outdoor recreation have durable goods associated with them. One needs at least a fishing rod to fish, rifle to hunt, or boat to sail. Without these reusable items, the recreation experience cannot be enjoyed. The annual value of new boat sales alone is substantial (Statistical Abstract of the United States, 1979) and, therefore, boats are used as an example of the distortion to demand.

Durables can be rented or purchased. If rented the good is part of the variable cost of recreating. If purchased fixed costs are also incurred. The addition of fixed costs prompt the following questions:

1. What effect does renting versus owning have on the demand for recreation?
2. What is the impact on consumers' surplus of renting versus owning?
3. If an owner faces an increase in the price of owning relative to renting, what is the welfare loss associated with this price change?
4. What are the policy implications of the ownership-rental tradeoff as regards outdoor recreation?

Theoretical Framework

The theoretical framework of Deaton and Muellbauer (1981) is presented and extended to illustrate the behavior of recreators for the case of durable goods purchases. It is assumed that recreators possess only one durable at a time if they own.

Ownership of a durable can be obtained for the payment of an annual rental or fixed cost of v^* and an associated variable cost, r_s. Thus, the single period budget constraint is

$$pq + (v^* + r_s K_s)S = M \tag{1}$$

where

p = the price of all other goods,

q = the quantity of all other goods purchased,

K_s = the number of times the durable is used in a specific time period,

$S = \begin{cases} 1, & \text{if the durable good is owned,} \\ 0, & \text{if the durable good is not owned, and} \end{cases}$

M = the total income of the household.

Utility functions, assumed to be well-behaved, include q, S, and K_s. The binomial S is included to indicate a shift in the preference structure--due to added convenience or gain in utility from increased prestige of ownership--from non-ownership to ownership. The single period utility function is

$$U = V(q;\ S,\ K_s;\ \varepsilon) \tag{2}$$

where

ε = a vector of parameters differing from household to household reflecting differences in tastes or circumstances not included in the budget constraint.

Non-durable consumption is equal to M/p if the durable is not owned and $\frac{M - v^* - r_s K_s}{p}$ if it is. If u^0 and u^1 represent utility of non-ownership and ownership respectively, then

$$u^0 = \nu(\tfrac{M}{p};\ 0,\ 0;\ \varepsilon), \tag{3}$$

$$u^1 = \nu(\frac{M - v^* - r_s K_s}{p};\ 1,\ K_s;\ \varepsilon) \tag{4}$$

Households for which $u^0 > u^1$ will own while those for which $u^0 < u^1$ will not own. Threshold income $M_\tau(\varepsilon)$ is defined as the level of income relative to prices of all goods above which a utility maximizing household of type ε will opt for ownership and below which it will select non-ownership of a durable good. The household responds to relative increases in income by following the outer envelope of utility curves u^0 and u^1 of Figure 19. Otherwise, it is not maximizing its utility.

The model is now extended to include the option of renting. The budget constraint is

(5) $$pq + (v^* + r_s K_s)S + r^* K_r(1 - S) = M$$

where

r^* = the rental fee, and

K_r = the number of times the durable good is rented.

If $S = 1$, then $K_r = 0$; and if $S = 0$, then K_r = any non-negative integer from zero to n so that a household may own or rent but not own and rent simultaneously. The subsequent utility functions are

(6) $$u = \nu(q;\ K_r;\ S,\ K_s;\ \varepsilon)$$

with

(7) $$u^0 = \nu\left(\frac{M - r^* K_r}{p};\ K_r;\ 0,\ 0;\ \varepsilon\right)$$

for renting and

(8) $$u^1 = \nu\left(\frac{M - v^* - r_s K_s}{p};\ 0;\ 1,\ K_s;\ \varepsilon\right)$$

for owning. Once again, the household responds to increases in income relative to all prices by following the outer envelope of utility curves depicted in Figure 20. It does without the durable to $M_{\tau r}(\varepsilon)$, rents between $M_{\tau r}(\varepsilon)$ and $M_{\tau s}(\varepsilon)$, and owns above $M_{\tau s}(\varepsilon)$.

Welfare Effects

Given the utility theoretic framework outlined above, the original problem of determining what distortions to welfare analysis

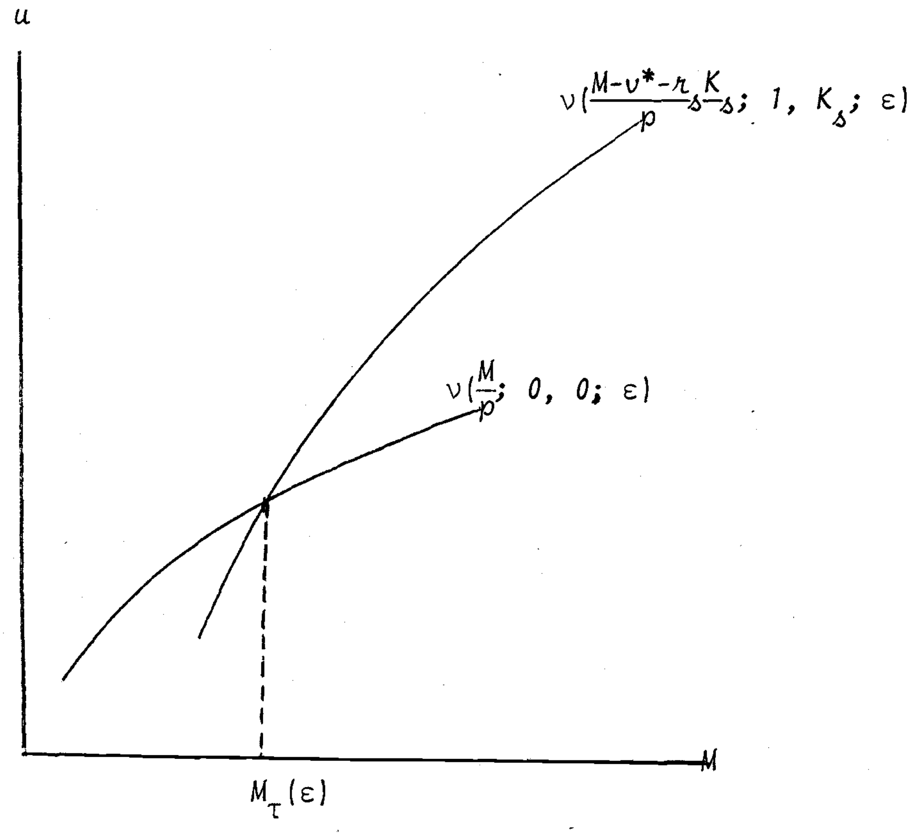

Figure 19

Hypothetical Utility Structures for Non-Ownership and Ownership of a Durable Good and Threshold Income

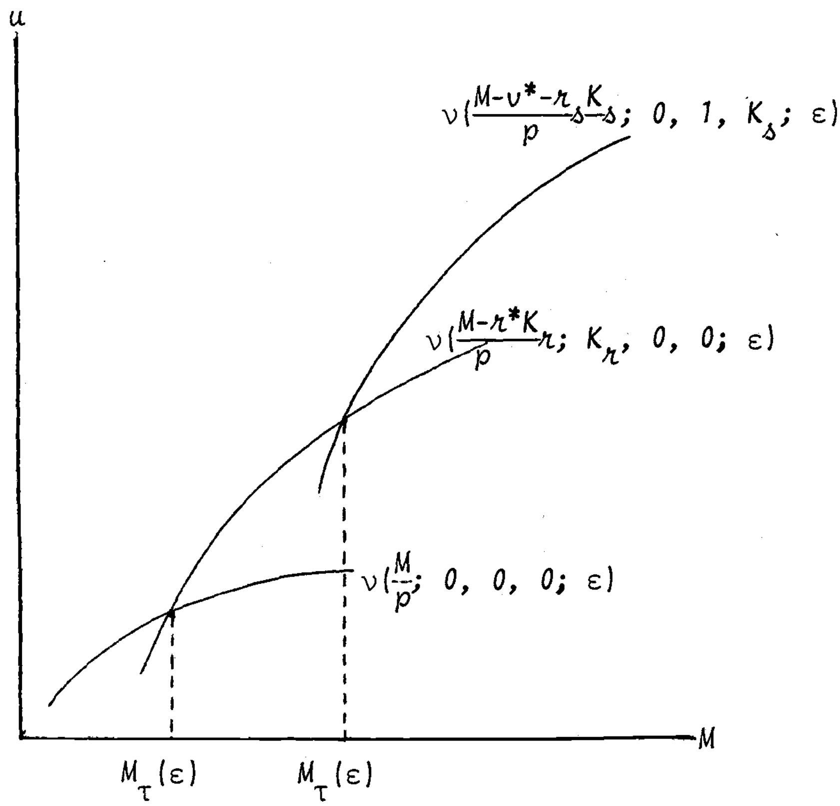

Figure 20

Hypothetical Utility Structures for Non-Ownership, Rental, and Ownership of a Durable Good and Threshold Incomes occur without consideration of durable good purchases can be addressed. It is assumed that a household of type ε with income M exists. The budget constraint is

(9)
$$pq + (\nu^* + r_s K_s)SW + (\nu^* + r_s K_s)S(1 - W) + r^* K_r (1 - S)W + r^* K_r (1 - S)(1 - E) + (\nu' + r_e K_e)E(1 - W) = M + i_e EW$$

where new terms are defined as

S = 1 if a boat is purchased, 0 otherwise,
E = 1 if a boat is already owned, 0 otherwise,
W = 1 if an existing boat is sold, 0 otherwise,
ν' = fixed ownership cost of the existing boat,
r_e = the cost per trip of the existing boat,
K_e = number of trips taken with the existing boat, and
i_e = the rate of return on the existing boat in dollars.

User cost ν^* is realized if a household (a) does not own any boat and purchases a new one, or (b) owns a boat already and sells it. User cost ν' is realized if the household (c) currently owns a boat and does not sell it. Rental fee r^* is paid if the household (d) does not own a boat and does not elect to buy a new one, or (e) currently owns a boat, sells it, and elects to rent. The household gains i_e only if it owns a boat and sells it when there is some change in relative prices. Thus two cases are apparent: the first in which a household does not currently own a boat and the second in which it does. For simplicity, it is assumed that no extra utility is realized from convenience or prestige of boat ownership. Dichotomous S exists, therefore, only in the budget constraint.

A household does not currently posses a boat and is renting one for its recreation experience. Values are $E = 0$ and $W = 0$. The budget constraint, upon substitution for E and W , is

(10)
$$pq + (\nu^* + r_s K_s)S + r^* K_r (1 - S) = M$$

Utility is given by

(11)
$$u = \nu(q, K, \varepsilon)$$

where K is the amount of recreational fishing done with a boat regardless of whether it is owned. Original budget constraints and utility levels are shown in Figure 21. The maximum K attainable by renting (K_r) is less than that for owning (K_s) since it is assumed that entrepreneurs incorporate a rate of return into their rental fee structures and incur costs that private owners do not encounter such as business taxes and accident insurance. Also, the maximum q possible with renting (q_r) is greater than that for owning (q_s) as the fixed cost of boat ownership is deducted from income leaving less available for all other goods and services. Thus, the slope of the budget constraint for renting is steeper than that for owning given r^*. The household rents a boat, consumes q_0, and fishes K_0 times. The alternative--owning a boat, consuming less at q_1, and fishing at K_1--would not maximize utility at current prices.

Now suppose the boat rental fee increases to r' while the fixed cost associated with the boat is held constant at $q_r - q_s$. The household is faced with a new budget constraint for renting but the same constraint associated with ownership as seen in Figure 22. The household selects ownership with consumption of all other goods at q_1 and fishing level K_1. Renting with consumption q_0' and fishing at K_0' is possible but not a utility maximizing option.

Analysis for Case II in which a household already owns a boat but sells it to buy a new one would be similar. Given a relative price change of some sort, the household sells the old boat, gains the sale price, and uses the additional income to buy a new boat. The new boat must be more satisfying than the old one if the household is rational. Also, if a household already owns a boat but the price structure changes such that renting is the desired option, then the decision-making process is exactly the opposite of that described above.

Table 15 shows compensating and equivalent variation of realizing v^* with new ownership given initial conditions of r^* and r'.

The non-owning household would be willing to pay

a) less than the price of the new boat to obtain u^1 from u^0 but

b) more than the price of the new boat rather than sustain

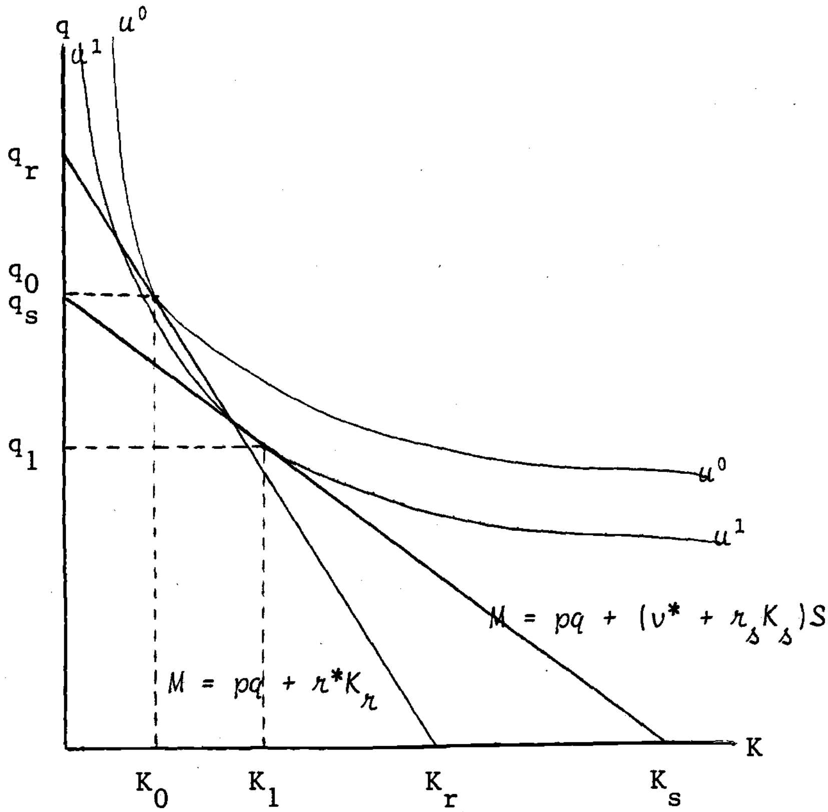

Figure 21

Utility Maximization Given Budget Constraints for Rental Versus Ownership of a Durable Good for Recreation

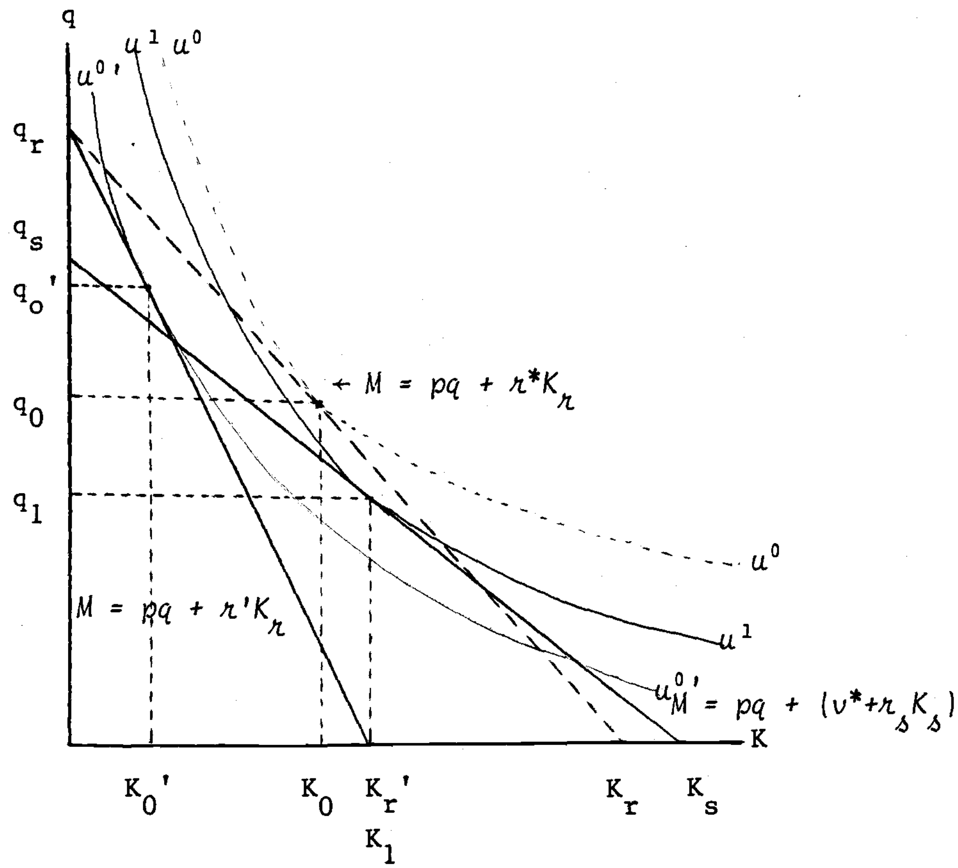

Figure 22

Utility Maximization Given Budget Constraints for
Rental Versus Ownership of a Durable Good
After a Relative Price Increase of Rental Fee

Table 15: Compensating and Equivalent Variation for Rental Fees r^* and r' with the Option to Buy a New Boat Given That the Household Does Not Currently Own a Boat.

Rental Fee r^*	Rental Fee r'
$CV = M_1 - M(v^*, u^0)$	$CV = M_1 - M(v^*, u^{0\prime})$
$CV = q_r - (>q_s)$	$CV = q_r - (<q_s)$
$CV < q_r - q_s$	$CV > q_r - q_s$
$EV = M(r^*, u^1) - M_0$	$EV = M(r', u^1) - M_0$
$EV = (<q_r) - q_s$	$EV = (>q_r) - q_s$
$EV < q_r - q_s$	$EV > q_r - q_s$

[a]Uses the formulae of Just, Hueth, and Schmitz (1982):

$$CV = M_1 - M(p^1, u^0)$$

$$EV = M(p^1, u^1) - M_0$$

the loss of utility in moving to $u^{0\prime}$ from u^1.

Thus, the household would buy a boat only at a discount to accept v^* given r^* and would pay a surcharge on v^* given the higher r'.

Durable Goods and Demand for Recreation

Household Recreation Demand

A continuous, downward-sloping demand curve for recreation given household rental of boats, D_r, can be derived by determing tangencies of indifference curves and budget constraints associated with various rental rates as described in Chapter 2. Likewise, demand for recreation given boat ownership, D_o, can be obtained. D_o lies to the left of D_r by the fixed cost of ownership subtracted from the household income. If the rental fee (r) were equal to the variable cost of recreation for ownership (v) then a household with a boat would always take fewer trips than if it rented because it would have less income with which to afford recreation. However, v is always less than r in the marketplace. Thus, the household has the choice of which demand curve along which it will be. A more rigorous mathematical proof of this is in Appendix II.

Figure 23 shows D_r and D_o for some household. Variable costs r and v exist corresponding to t_r and t_v trips per time period. The consumer's surplus of accepting r is equal to area AB while that associated with v is BCD. The change in welfare of movement from r to v is BCD - AB = CD - A. Now, recall the previous section: if the gain of accepting the lower variable cost exceeds the loss of income to purchase the durable, the recreator will switch from renting to owning. At r the household has AB; purchase of the durable moves the household inward at r to D_o and it loses A. However, ownership carries with it the lower variable cost so the price drops along D_o until v is reached. The household gains CD. The net gain is CD - A, and for the new level of v, if:

a) CD - A > 0, the household will switch from renting to owning,

b) CD - A = 0, the household will be indifferent between owning and renting, and

c) CD - A < 0, the household will continue to rent the durable.

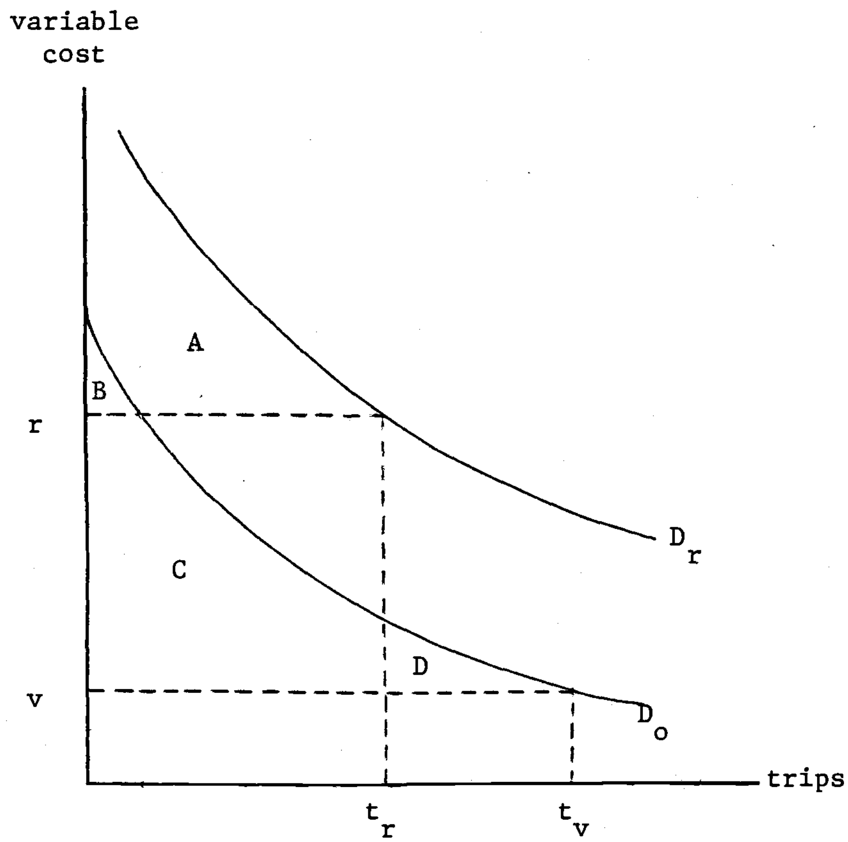

Figure 23

Demand Curves for Rental and Ownership of a Durable, Variable Cost Differential, and the Consumer's Surplus Associated with that Differential

Conversely, if the household owns and p drops to some new level, when:

d) A - CD > 0, the household will switch to renting,

e) A - CD = 0, the household will be indifferent between renting and owning, and

f) A - CD < 0, the household will continue to own the durable.

Site Demand

Suppose rental fees for boats are held at some rate but other variable costs of recreating to some site rise, such as gasoline. An owning household follows D_o curtailing site visits as the proxy price rises. Once the threshold income is reached, the household is forced to sell its boat and become a renter at the critical level p if it is to maximize utility. The change in trips taken with these increases in price is seen in Figure 24.

The horizontal gap in the site demand curve reflects the loss in trips which results from the household's decision to sell the boat. However, in terms of utility, the household is indifferent at the two trip levels, t_i and t_j. The area of the rectangle A is, therefore, an estimate of the measure of compensating variation of the price change from some price level just below p.

Distortions Due to Capital Goods

One household rents and another household with only a slightly different utility structure and the same income (or with the same utility structure but slightly more income) owns a durable as in Figure 25. If regression were used, D would be estimated although the true relationship would be the pair D_o and D_r. Since it is clear that there is no guarantee that the elasticity of D is equal to the elasticities of D_o and D_r, any policy decision to increase site fees would yield unanticipated results. For example, if site participation were high enough to warrant the construction of additional boat ramps, and if the administration were to finance the construction by charging higher fees to boat users, the price hike may be sufficiently large to force owners to sell boats and begin renting. This shift from owning to renting would result in lower revenues than planned so that the decision-makers would realize a loss.

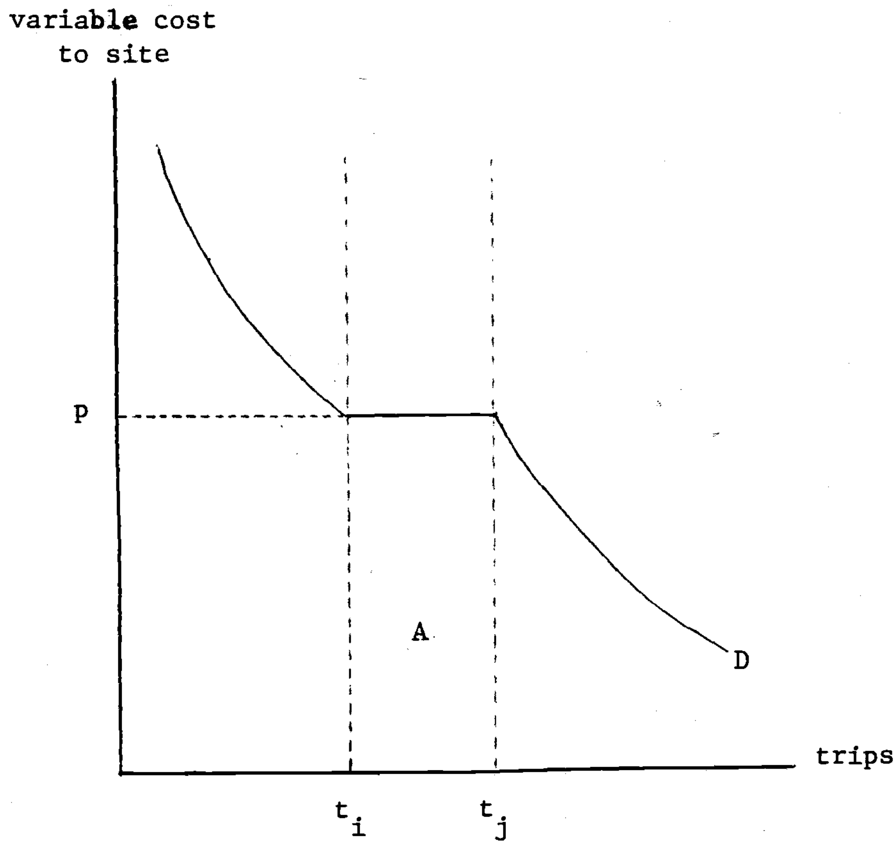

Figure 24

Derived Demand for a Site Given the Ownership-Rental
Demand Pair, Price Associated with the
Switching Point, and the Value of Boat Ownership

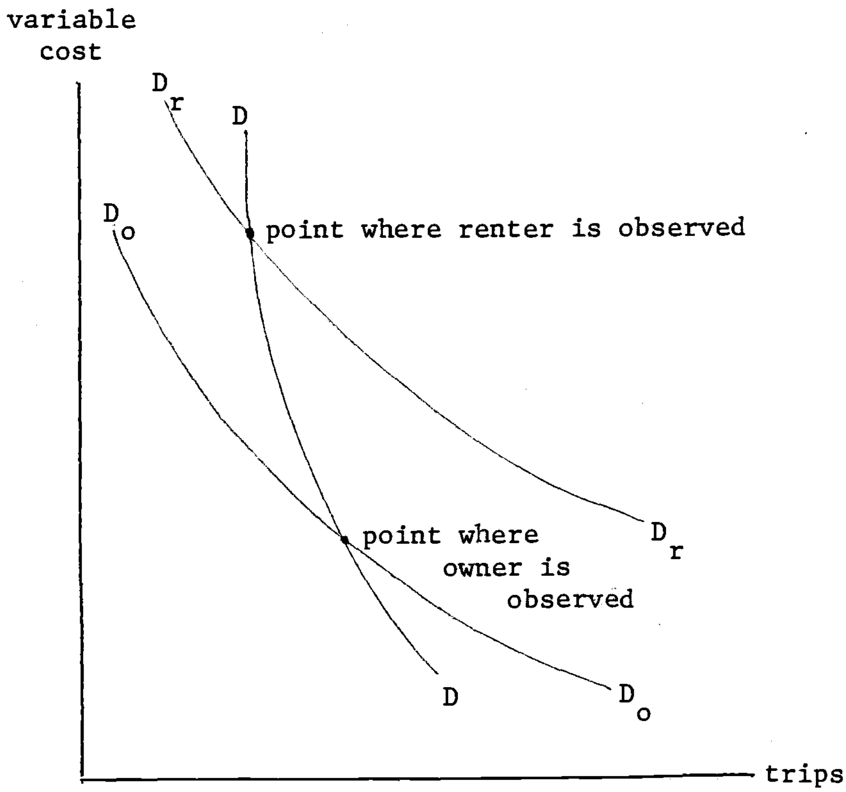

Figure 25

An Example of Distortion to Travel Cost Derived
Demand Curve for Recreation Caused by
Neglecting Capital Goods Purchases

Changes in fixed cost have similar results. The difference is that the D_o curve shifts inward or outward for a fixed cost increase or decrease respectively. Given the example above, if policymakers were to finance improvements through higher boat licensing fees, the reduction in income may be enough to force owners to sell their boats.

Rectification of the Problem

The economist must include fixed costs in recreation models to rectify the problem of distorted demand curves and incorrect values.

Use of a dummy variable--0 for non-ownership and 1 for ownership--would yield appropriate functional forms of rental-owner pairs of demand curves and subsequent site demand. Switching points could then be estimated for all individuals. All that would be required is an additional question in the survey instrument.

A second solution could be the use of the household production function approach to recreation. This model takes into account that people buy goods and services which are then used in activities which give utility. Thus, bias would be eliminated in using this technique.

Policy Implications

When a single demand curve rather than a pair of curves is estimated in a recreation study, the single curve is distorted and does not provide an accurate measure of either demand or value because elasticities of demand are incorrect. Suppose, for example, policies are enacted such that owners of durables are charged additional fees to cover the costs of outlays for expansion or improvement of site facilities. This increased burden, be it an increase in variable costs such as entrance fee surcharges to owners or increases in annual fixed costs such as license fee hikes, will distort the ratio of r to v such that some owners will sell the durable. The end result will be excess capacity at the improved site and less revenue than anticipated with which to cover expenditures on the project.

The Oregon State Legislature has proposed two bills, HB2170 and HB2190, which would increase user fees to recreational vehicle owners in the State. Copies of the bills are found in Appendix IV. Revenues from increased fees would be used to improve State parks. There has already been outcry from the RV community. It would be a valuable exercise to determine what will happen to the market for RV's as well as whether the State will achieve anticipated revenues over the next few years. Given the framework of this Chapter, one would expect that sales of RV's will decline and revenues from the fee increases will be less than expected.

Future research in the field should incorporate suggested modifications of survey instruments and evaluation techniques. A study of the impact of HB2170 and HB2190 on changes in recreation participation by RV owners and non-owners in Oregon would be timely and informative to policymakers and economists.

Naturally, if funds are limited and the activity studied does not require capital goods such as swimming and hiking, it is best that any durable good distortion be mentioned, but not included in analysis. The pair of demand curves would probably be so close as to be identical.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

Specification of the correct demand structure is of great importance in assessing the value of recreation. Welfare measures associated with changes in recreation site characteristics are only as accurate as the estimate of demand. Failure to consider real-world aspects of recreation and recreators results in misleading demand curves and incorrect measures of welfare implications of policy changes such as pollution abatement programs to improve water quality or increases in site entrance fees.

This research has addressed two distortions to recreation demand curves derived by the travel cost approach. The loglinear technique is one way to identify a potential supply restriction of site availability. If a supply restriction exists but is not accounted for, regression coefficients of independent variables will not be reliable and the explanatory power of the model will be quite low since OLS fits the best linear estimate of a scatter of points. The squaring of error terms in the supply restricted range and the backward-bending form of the constrained section of the data set preclude a good single stage OLS fit. Loglinear models can be used to locate the surrogate price range in which the supply constraint becomes binding if categorical data are available. Simultaneous equations would be the preferred tool if continuous data are available as demand curves would be less lumpy and irregular than loglinear derivations. One advantage that the loglinear models have over simultaneous equations is that the structure of the supply problem in terms of interactive effects can be identified to some degree.

The second distortion is that of omitting fixed costs of recreational durable goods purchases. This situation, when considered in a theoretical framework, shows that a recreating household actually faces two rather than one demand curve--one if a durable good associated with recreation is owned and one if the durable is not owned but rented instead--and the household is on only one demand curve at a time. Which curve the household will select depends on the ownership condition that will maximize its utility. When no distinction is made between an owner and non-owner in a travel cost model with all costs variable, regression will estimate a demand curve of the best fit of the data, but the curve will be incorrect. The single curve will be more inelastic than the true demand curve for a site as derived from the pair of demand curves and, consequently, welfare measures corresponding to a change in the surrogate price will be false. For example, if a policy change imposing or increasing entrance fees to a site is enacted, anticipated revenues will overstate actual revenues since owners have the option of selling the durable and recreating less at the higher variable cost. The amount less that the household will recreate is far less than policymakers would predict using a continuous demand curve since the true demand curve is discontinuous.

This problem is resolved if dummy variables for owning and not owning are included, a switching point for each recreator is estimated, or the household production function approach is employed.

Future studies in the field of recreation economics should attempt to minimize distortions to demand curves by accounting for potential supply problems and fixed costs of capital goods purchases. Continuous data should be collected to more accurately estimate supply restricted demand curves where loglinear models can act as a supplement to simultaneous equations. The loglinear models are valuable as a means of identifying interactive effects at the root of the restriction regardless of whether continuous or categorical data are available. However, continuous data provide smooth curves whereby results of marginal improvements can be determined. Also, estimates of marginal rates of substitution of one site characteristic such as water quality and another such as degree of development would be possible. If simultaneous equations are not used, the loglinear technique is still appropriate as a supplement to OLS. Loglinear could identify kinks and structures and OLS could be used piecewise based on loglinear results to more accurately estimate demand. A researcher may also elect to identify the point below which a supply constraint becomes binding, then apply OLS only over the unrestricted range.

Empirical work involving durable goods biases in recreation demand and value should also be undertaken. The hypothesis to be tested is whether there is a significant difference between owner and non-owner demand curves as predicted by the theoretical framework. A related test should be to determine if additional willingness to pay estimates for owners of capital goods are less than those for non-owners as the former have already invested more than the latter to more fully enjoy the recreation experience. All that would be required would be a simple adjustment to the survey instrument.

The corrections would not only provide better estimates of welfare benefits in general, but also help in assigning benefits to the appropriate recipient. For example, a change in a site from lower to higher water quality and installation of additional facilities--all financed by an entrance fee increase--may improve recreator benefit in general, but closer inspection of corrected demand curves may show that one recreator class gains much while another loses some. If the losing group is considered by society to be more "needy," then policymakers may find their laudable efforts to be more punitive than beneficial.

It is always possible to explain anything if everything is known about everybody. This ideal situation rarely if ever exists. A researcher has but one option: to estimate as best as possible by eliminating sources of distortion. Two obvious distortions to recreator demand and value are supply constraints and fixed costs of capital goods purchases.

BIBLIOGRAPHY

Bockstael, N. E. and K. E. McConnell. "Theory and Estimation of the Household Production Function for Wildlife Recreation," Journal of Environmental Economics and Management, Vol. 8, 1981.

Brown, G. and R. Mendelsohn. The Hedonic Travel Cost Method: A New Technique for Estimating the Recreation Value of Site Characteristics. Report to Division of Program Plans, United States Department of Interior. January, 1981.

Brown, Morton B. "P3F Multiway Frequency Tables--The Log-Linear Model," in BMDP Biomedical Computer Programs D-Series. W. J. Dixon and M. B. Brown, Editors. Berkeley, California: The University of California Press. 1979.

Brown, Morton B. "P4F Two-Way and Multiway Frequency Tables--Measures of Association and the Log-Linear Model (Complete and Incomplete Tables)," in BMDP Statistical Software, 1981. W. J. Dixon, Chief Editor. Berkeley, California: The University of California Press. 1981.

Brown, W. G., A. Singh, and E. M. Castle. An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery. Bulletin 78, Agricultural Experiment Station, Oregon State University, Corvallis, Oregon. September, 1964.

Brown, W. G. Effect of Omitting Relevant Variables Versus Use of Ridge Regression in Economic Research. Special Report 394, Agricultural Experiment Station, Oregon State University, Corvallis, Oregon. October, 1973.

Brown, W. G. and F. Nawas. "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions," in American Journal of Agricultural Economics, Vol. 55, No. 2. May, 1978.

Brown, W. G., C. Sorhus, B. Chou-Yang, and J. A. Edwards. "A Note of Caution on the Use of Individual Observations for Estimating Outdoor Recreation Demand Functions," in American Journal of Agricultural Economics, Vol 65, No. 1. February, 1983.

Bouwes, N. W. and R. Schneider. "Procedures in Estimating Benefits of Water Quality Change," in American Journal of Agricultural Economics, Vol 61, No. 3. August, 1979.

Bureau of the Census. Statistical Abstract of the United States (100th Edition). Washington, D. C.: United States Department of Commerce. 1979.

Bureau of the Census. Statistical Abstract of the United States (102nd Edition). Washington, D. C.: United States Department of Commerce. 1981.

Bureau of Land Management. Idaho Recreation Guide. Boise, Idaho, 1976.

Cory, D. C., R. L. Gum, W. E. Martin, and R. F. Brokken. "Simplified Measurement of Consumer Welfare Change," in American Journal of Agricultural Economics. Vol. 63, No. 4, November, 1981.

Carter, N. J. Predicting Unit Variate Values in a Finite Population. Unpublished Ph.D. Dissertation. Oregon State University, Corvallis, Oregon. March, 1981.

Clawson, M. "Methods of Measuring Demand for and Value of Outdoor Recreation," Reprint No. 10. Washington, D. C.: Resources for the Future. 1959.

Davis, J. A. "Hierarchical Models for Significance Tests in Multivariate Contingency Tables: An Exegis of Goodman's Recent Papers," in Sociological Methodology, 1973-74. Herbert Cortner, Editor. San Francisco, California: Jossey-Bass, Inc. 1974.

Deaton, A. and J. Muellbauer. Economics and Consumer Behavior. Cambridge: The Cambridge University Press. 1981.

Desvouges, W. H., V. K. Smith, and M. P. McGivney. A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements. United States Environmental Protection Agency, EPA-230-05-83-001. March, 1983.

Edwards, J. A., K. C. Gibbs, L. J. Guedry, and H. H. Stoevener. The Demand for Non-Unique Outdoor Recreational Services: Methodological Issues. Technical Bulletin 133, Agricultural Experiment Station, Oregon State University, Corvallis, Oregon. May, 1976.

Ferguson, C. E. and J. P. Gould. Microeconomic Theory (4th Edition). Homewood, Illimois: Richard D. Irwin, Inc. 1975.

Fienberg, S. E. The Analysis of Cross-Classified Categorical Data (Second Edition). Cambridge, Massachusetts: The MIT Press. 1981.

Georgescu-Roegen, N. Analytical Economics. Cambridge, Massachusetts: The Harvard Press. 1967.

Gum, R. L. and W. E. Martin. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation," in American Journal of Agricultural Economics, Vol. 57, No. 4. November, 1975.

Hanemann, W. M. "Water Quality and the Demand for Recreation," University of California, Berkeley, California. Undated Manuscript.

Hanemann, W. M. "Quality Changes, Consumer's Surplus, and Hedonic Price Indices." Working Paper No. 116, California Agricultural Experiment Station, University of California, Berkeley, California. July, 1980.

Henning's Oregon Fishing and Vacation Guide. Portland, Oregon: Helstrom Publications. 1980.

Hines, L. G. "Measurement of Recreation Benefits: A Reply," in Land Economics, Vol. 34, No. 4. November, 1958.

Hotelling, H. The Economics of Public Recreation, "The Prewit Report," Land and Recreation Planning Decision, National Park Service, Washington, D. C. 1949.

Idaho Department of Health and Welfare, Bureau of Water Quality, Division of Environment. Idaho Environmental Quality Profile. Boise, Idaho. July, 1982.

Idaho Department of Health and Welfare, Bureau of Water Quality, Division of Environment. Idaho Water Quality Status Report, 1980. Boise, Idaho. July, 1980.

Just, R. E., D. L. Hueth, and A. Schmitz. Applied Welfare Economics and Public Policy. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1982.

Knoke, D. and P. J. Burke. Log-Linear Models. Beverly Hills, California: Sage Publications. 1982.

Knetsch, J. L. "Outdoor Recreation Demands and Benefits," in Land Economics, Vol. 39, No. 4. November, 1963.

Maler, Karl-Goren. Environmental Economics: A Theoretical Inquiry. Baltimore, Maryland: The Johns Hopkins University Press for Resources for the Future, Inc. 1974.

Martin, W. E. and R. L. Gum. "Structure of Demand for Outdoor Recreation, in Land Economics, Vol. 53, No. 1. February, 1977.

Shalloof, F. and W. G. Brown. Unpublished research results, Oregon State University, Corvallis, Oregon. 1983.

State of Washington Department of Ecology. Water Quality Assessment Report 77-14: Volume III--Washington Lakes. Olympia, Washington. January, 1977.

Sublette, W. M. and W. E. Martin. Outdoor Recreation in the Salt-Verde Basin of Central Arizona: Demand and Value. Technical Bulletin 218, Agricultural Experiment Station, University of Arizona, Tucson, Arizona. June, 1975.

Sutherland, R. J. A Regional Recreation Benefits Model. United States Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, Oregon. September 25, 1980.

Sutherland, R. J. A Regional Approach to Estimating Recreation Benefits of Improved Water Quality, unpublished manuscript. Los Alamos, New Mexico: Los Alamos National Laboratory, 1981.

United States Department of Interior Fish and Wildlife Service and United States Department of Commerce, Bureau of the Census. National Survey of Fishing, Hunting, and Wildlife Asssociated Recreation, 1980 Preliminary Report. Washington, D. C. June, 1982.

Vaughan, W. J. and C. S. Russell. Freshwater Recreational Fishing: The National Benefits of Water Pollution Control. Washington, D. C.: Resources for the Future, Inc. 1982.

Washington State Parks and Recreation Commission. Washington State Parks Guide. Seattle, Washington: Craftsman Press. May, 1981.

Water Quality Division of Oregon Department of Environmental Quality. Water Quality in Oregon, 1980. Portland, Oregon. October, 1981.

Willamette Kayak and Canoe Club. The Soggy Sneakers Guide to Oregon Rivers. Corvallis, Oregon. 1981.

Willig, R. D. "Consumer's Surplus Without Apology," in American Economic Review, Vol. 66, No. 4, September, 1976.

APPENDICES

APPENDIX I

ANALYSIS OF CONTINGENCY TABLES AND THE LOGLINEAR MODEL

The system for contingency table analysis is divided into two parts: hierarchical models which use standard tests of significance to determine the overall fit of some specified model to the actual data set, and loglinear models for which parameters of odds ratios are used to predict cell values. The models used in Chapter III are both hierarchical and loglinear.

Hierarchical Models

Three concepts of hierarchical models must be defined before one can fully understand the analysis procedure (Davis, 1974).

a. Odds Ratios: the ratio of frequencies for two categories of some variable where an odds ratio of one implies equal probability. Thus (1) if the non-conditional odds ratio is not equal to one, then the marginal frequencies for two categories are not identical; (2) if second-order odds ratios are not equal to one, then the two items are not independent; (3) if second-order conditional odds ratios are not equal to one, then two items have a partial association; and (4) if third-order or higher-order conditional odds ratios are not equal to one, then the items exhibit an interaction.

b. Effects: the level of association or interaction of variables is known as an effect. Single variable effects are differences in cell frequencies that reflect the marginal distribution of one or more items. Two variable effects (association, correlation) are differences in cell frequencies that reflect an association between two variables. Three or more variable effects (interactions) are differences in cell frequencies that imply an interaction of three or more variables.

c. Model: a set of manipulated data subsets having some properties such that the set may be compared with the original model for the purpose of testing hypotheses.

These concepts blend together to establish a procedure whereby one can account for variation in cell frequencies. One hypothesizes effects which account for cell frequency differences, builds models of desired effects by setting odds ratios of all effects to appropriate values, and then compares the prediction given by the model to the actual data set.

The Loglinear Model

Loglinear models are models which rely on a particular approach to the definition between or among variables in a multidimensional contingency table based on cross-product ratios of expected cell values (Fienberg, 1981). These models are linear in the logarithm of the expected value scale, hence the name "loglinear." Although there are several analogies between interaction in these models and that of interaction in analysis of variance models, the two are not synonymous. One acts to assess effects of independent on dependent variables in ANOVA and to partition overall variability while in loglinear models, one attempts to describe the structural relationship among variables corresponding to the dimensions of the table of data to be analyzed.

Loglinear models are used to analyze categorical data. These fall into three groups: dichotomous (yes, no), non-ordered polytomous (four different types of recreation), and ordered polytomous (high, average, and low level of water quality).

When a distinction is made between explanatory and response variables, loglinear models can be converted to logit or linear logistic models. With these forms, one predicts the log-odds quantities involving the dependent variable(s) using a linear combination of effects due to the independent variable(s). These models are, therefore, more closely related to ANOVA and ordinary least squares (OLS) than are standard loglinear models. One may also use the cell frequencies themselves as the dependent variable and the variables corresponding to table dimensions as the independent variable in loglinear analysis.

Suppose one has a contingency table or cube of variables X, Y, and Z with i, j, and k dimensions respectively. Using loglinear terminology (Brown, 1979, 1981), f_{ijk} represents the observed frequency in cell (i, j, k) of the variables X, Y, and Z. The loglinear model assumes that the logarithm of the expected values is a linear function and can be written as

$$\ln(F_{ijk}) = \theta + \lambda_i^X + \lambda_j^Y + \lambda_k^Z + \lambda_{ij}^{XY} + \lambda_{ik}^{XZ} + \lambda_{jk}^{YZ} + \lambda_{ijk}^{XYZ}$$

where

F_{ijk} = the expected value of cell f_{ijk}, or $E(f_{ijk})$;

θ = the geometric mean of the number of cases in each cell of the fitted table, similar to the intercept in regression;

λ = the effects subject to the constraints

$$\sum_i \lambda_i^X = \sum_j \lambda_j^Y = \sum_k \lambda_k^Z = 0$$

$$\sum_i \lambda_{ij}^{XY} = \sum_j \lambda_{ik}^{XZ} = \sum_k \lambda_{jk}^{YZ} = 0$$

$$\sum_i \lambda_{ijk}^{XYZ} = \sum_j \lambda_{ijk}^{XYZ} = \sum_k \lambda_{ijk}^{XYZ} = 0$$

Each λ is an effect where the superscript refers to the variable or variables included in the effects. Subscripts indicate the cell of interest and are omitted when referring to the effect alone. For example, λ^X means that the effect of variable X alone is considered while λ^{XY} is the effect of both variables Y and X. The form λ_i^X simply identifies the effect of variable X in cell i. The effects are the parameters of the loglinear model which predict cell values based on variable interactions and correlations.

When antilogs are taken, the model becomes

$$F_{ijk} = \tilde{\theta}\ \beta_i^X \beta_j^Y \beta_k^Z \beta_{ij}^{XY} \beta_{ik}^{XZ} \beta_{jk}^{YZ} \beta_{ijk}^{XYZ}$$

subject to the constraints that the β's for each effect multiply to one. These β's are known as the multiplicative parameters and are standardized estimates of the expected counts or values for any cell (i, j, k). The term $\tilde{\theta}$ is the antilog of the geometric mean. It should be clear that the same maximum-likelihood estimates (MLE's) or β's for the expected cell counts will be obtained regardless of the size of the sample so long as odds ratios are identical.

The number of variables in the effect is called the order of the effect. Thus, λ^{YZ} and λ^{XY} are second-order effects and λ^{X} and λ^{XYZ} are first-order and third-order effects respectively. A full k^{th}-order model is one for which all possible k-order effects are included. In the example above, a full second-order model must include the effects λ^{XY}, λ^{YZ}, and λ^{XZ}.

When all effects are included in the model, the model is referred to as saturated. Setting specific effects in the saturated model equal to zero yields new models which can be tested for explanatory power with respect to the saturated model. Hierarchical models are those for which all componenets of a higher effect must be present but need not be saturated. Returning to the example, the third-order hierarchical model is also the saturated model, but the full second-order model includes λ^{X}, λ^{Y}, and λ^{Z}, the building blocks of λ^{XY}, λ^{XZ}, and λ^{YZ}. A non-hierarchical second-order model does not include all three first order effects.

Two statistics are used to measure the goodness-of-fit of a model. One, the Pearson chi-square, is calculated by taking the square of the difference between observed and expected values and dividing the result by the expected value. The other, the likelihood ratio statistic, is given by

$$G^2 = 2 \sum_{i,j,k} f_{ijk} \left[\ln \frac{f_{ijk}}{F_{ijk}}\right].$$

As the sample size increases and the model approaches a perfect fit, the Pearson X^2 and the G^2 approach a χ^2 distribution with degress of freedom equal to the total number of cells in the model less the number of parameters to be fit.

In addition to tests of goodness-of-fit, two other tests are employed to evaluate the importance of a particular effect to the performance of a model. The partial association of k factors examines the difference between the full k^{th}-order model and the same model with the designated effect set equal to zero. Then, if the probability levels associated with the derived measure of goodness-of-fit are close to zero, the full k^{th}-order effect is significantly different from the model lacking the effect. Consequently, that effect contributes to the overall performance of the model and is significant.

The marginal association of k factors tests the hypothesis that the k factor interaction is zero when summed over all other factors. In other words, the test of the marginal association of X and Z requires the construction of a two-way table in Z and X and analyzes the interaction between them.

Use of both partial and marginal associations of factors assists the researcher in screening effects before actual construction of a model. The procedure aids in selection of only relevant effects saving both time and money.

The computer package used for loglinear analysis in the research in Chapter III is the BMDP Statistical Software of the University of California, Los Angeles. The P3F (Brown, 1979), and P4F (1981) were both used: P3F until Oregon State University had debugged the 1981 edition in 1982, and P4F afterward.

An Example

Suppose a researcher selects 100 people for her recreatin study. Of the 100 to be interviewed, 70% are "poor" and the remaining 30% are "rich." Also, half of the interviewees in each income group are "old" and the other half are "young." Each person is asked whether or not he or she recreates. The researcher wishes to test the hypotheses that "rich" people recreate more than "poor" ones and "old" people recreate more than "young" ones. She feels that it is logical to assume that recreation is closely linked to the availability of money and time. The contingency table is seen in Table A1.1.

The researcher decides that a loglinear analysis can be used to evaluate the structure of recreation behaviour. At this point, she is not interested in how often individuals recreate, but what type of individual is more likely to engage in outdoor recreation. The

Table A1.1: Actual Data for the Example; Contingency Table of Recreation by Age by Income.

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************************
* TABLE PARAGRAPH   1  *
************************
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***** OBSERVED FREQUENCY TABLE 1

INCOME	AGE	RECREATE YES	NO	TOTAL
RICH	OLD	8	7	15
	YOUNG	12	3	15
	TOTAL	20	10	30
POOR	OLD	14	21	35
	YOUNG	24	11	35
	TOTAL	38	32	70

TOTAL OF THE OBSERVED FREQUENCY TABLE IS 100 first step of the process is to determine the number of effects needed in the model. The results of the k+1 and k tests tell her that an effect of order 2 is sufficient. Refer to Table A1.2 and note that k=1 for the k+1 test carries a probability of 0.04707 while k=2 carries a probability of 0.94461. This means that a model of order 2 is unlikely to have effects included with little or no impact on the accuracy of the model while that of order 3 is very likely to have redundant effects. This result is verified by the k test and is seen in Table A1.2b. Thus, the largest model necessary would be the full second-order model [RA, RI, AI], where R stands for the recreate variable, I the income variable, and A the age variable.

The second step is to assess the value of each effect to determine which belong in the model. The tests of association are used. The effect RA with probability of 0.0041 should be included. The effect RI is less powerful at a probability of 0.2271, but it is needed for the hypothesis test. Effect AI at 0.7327 would contribute very little to the model and is excluded. The model to be tested is, therefore, the hierarchical [RA, RI]. Results are in Table A1.3.

Results of the model are seen in Table A1.4. The model gives expected values of cell frequencies. All marginal totals sum to observed frequencies for the specified effects RI and RA but need not for the effect AI which was excluded. The model has two degrees of freedom:

8 cells - (2 levels of 3 variables = 6) = 2 degrees of freedom. The likelihood ratio probability of 0.9409 means that the fitted model is a good approximation of the actual data.

The form of the model is

$$\ln(F_{ijk}) = 2.3628 + \lambda_i^R + \lambda_j^A + \lambda_k^I + \lambda_{ij}^{RA} + \lambda_{jk}^{RI}$$

for the additive case and

$$F_{ijk} = 10.6207 \text{ X } (\beta_i^R \beta_j^A \beta_k^I \beta_{ij}^{RA} \beta_{jk}^{RI})$$

for the multiplicative case.

All parameters just balance each other since the model includes only dichotomous variables and the constraint that all parameters

Table A1.2a: k+1 Test of the Order of a Model for the Example.

***** A SIMULTANEOUS TEST THAT ALL K-FACTOR INTERACTIONS ARE SIMULTANOUSLY ZERO.
THE CHI-SQUARES ARE DIFFERENCES IN THE ABOVE TABLE.

K-FACTOR	D.F.	LR CHISQ	PROB.	PEARSON CHISQ	PROB.
1	3	19.03	.00027	18.62	.00033
2	3	9.63	.02200	9.37	.02475
3	1	.00	.94461	.00	.94467

Table A2.2b: k Test of the Order of a Model for the Example.

Table A1.2a: The k+1 Test Results

***** THE RESULTS OF FITTING ALL K-FACTOR MARGINALS.
THIS IS A SIMULTANEOUS TEST THAT ALL K+1 AND HIGHER FACTOR INTERACTIONS ARE ZERO.

K-FACTOR	D.F.	LR CHISQ	PROB.	PEARSON CHISQ	PROB.	ITERATION
0-MEAN	7	28.66	.00017	28.00	.00022	
1	4	9.63	.04707	9.38	.05237	2
2	1	.00	.94461	.00	.94467	3
3	0	0.	1.	0.	1.	

Table A1.3: Results of the Test of Association for the Example.

***** ASSOCIATION OPTION SELECTED FOR ALL TERMS OF ORDER LESS THAN OR EQUAL TO 3

		PARTIAL ASSOCIATION			MARGINAL ASSOCIATION		
EFFECT	D.F.	CHISQUARE	PROB	ITER	CHISQUARE	PROB	ITER
R.	1	2.57	.1089				
A.	1	0.00	1.0000				
I.	1	16.46	.0000				
RA.	1	8.29	.0040	1	8.17	.0043	1
RI.	1	1.46	.2271	2	1.34	.2467	2
AI.	1	.12	.7324	2	.00	1.0000	2
RAI.	1	.00	.9445				

Table A1.4: Additive and Multiplicative Parameters and Additive Parameters Divided by Their Standard Error for the Model [RA, RI] of the Example.

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****************
*   MODEL  1   *
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MODEL	D.F.	LIKELIHOOD-RATIO CHI-SQUARE	PROB	PEARSON CHI-SQUARE	PROB	ITER.
RA,RI.	2	.12	.9409	.12	.9412	2

***** EXPECTED VALUES USING ABOVE MODEL

INCOME	AGE	RECREATE YES	NO	TOTAL
RICH	OLD	7.6	6.7	14.3
	YOUNG	12.4	3.3	15.7
	TOTAL	20.0	10.0	30.0
POOR	OLD	14.4	21.3	35.7
	YOUNG	23.6	10.7	34.3
	TOTAL	38.0	32.0	70.0

***** STANDARDIZED DEVIATES = (OBS - EXP)/SQRT(EXP) FOR ABOVE MODEL

INCOME	AGE	RECREATE YES	NO
RICH	OLD	.2	.1
	YOUNG	-.1	-.2
POOR	OLD	-.1	-.1
	YOUNG	.1	.1

Table A1.4: Continued.

```
THE ABOVE MODEL IS DIRECT.

ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE
THETA(MEAN)    2.3628

ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)
EXP(THETA)    10.6207

*****  ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

           RECREATE
           ------
           YES        NO
       ------------------
          .231    -.231

*****  RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

           RECREATE
           ------
           YES        NO
       ------------------
         1.951    -1.951

*****  ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

           RECREATE
           ------
           YES        NO
       ------------------
         1.259      .794

*****  ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

           AGE
           ------
           OLD     YOUNG
       ------------------
          .050    -.050

*****  RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

           AGE
           ------
           OLD     YOUNG
       ------------------
          .472    -.472

*****  ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

           AGE
           ------
           OLD     YOUNG
       ------------------
         1.051      .951
```

Table A1.4: Continued.

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

INCOME	
RICH	POOR
-.451	.451

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

INCOME	
RICH	POOR
-3.962	3.962

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

INCOME	
RICH	POOR
.637	1.570

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

AGE	RECREATE	
	YES	NO
OLD	-.296	.296
YOUNG	.296	-.296

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

AGE	RECREATE	
	YES	NO
OLD	-2.792	2.792
YOUNG	2.792	-2.792

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

AGE	RECREATE	
	YES	NO
OLD	.743	1.345
YOUNG	1.345	.743

Table A1.4: Continued.

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

INCOME	RECREATE	
	YES	NO
RICH	.130	-.130
POOR	-.130	.130

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

INCOME	RECREATE	
	YES	NO
RICH	1.144	-1.144
POOR	-1.144	1.144

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

INCOME	RECREATE	
	YES	NO
RICH	1.139	.878
POOR	.878	1.139

must sum to zero or multiply to one cannot be violated.

Substituting for parameters will give the expected value of a cell. For example, if the researcher wishes to determine the expected value of the cell [R=yes, A=old, I=rich], then

$$F_{yes,\ old,\ rich} = (10.6207)(1.259)(1.051)(0.637)(0.743)(1.139) = 7.6$$

which is the value of the cell in the fitted table and a close approximation of the actual value of the cell, 8.

The parameters also give insight into the characteristics of the structure of recreation. The odds of recreating over not recreating are 58:42 = 1.38:1 for actual data, which is approximated by 1.259:0.794 or 1.59:1 by the parameters. Conditional odds of recreating to not recreating for wealthy individuals are 20:10 or 2:1 in actuality and estimated by the model as 0.913:0.444 or 2.06:1.

It should now be clear that the parameters are merely an index of the actual values of the data. The actual values can be reproduced by calculating back through the odds. Thus, the ratio for RI, I=poor was estimated as 1.22:1; R=yes was 1.59:1, and I=rich was 0.41:1. For the 100 observations, this means that

I=poor was 1/1.41 = 71% of 100 = 71 interviewees were poor

RI = 1.22:1 = 1.22/2.22 = 55% recreated and were poor

So, an estimated 55% of 71 is 39 of 100 recreators were poor. The actual data showed that 38 interviewees were poor and recreated.

The reliability of a parameter is given by the estimate of the parameter divided by its standard error. As is the case in most statistical analyses, the higher this value, the more reliable the parameter estimate. Referring once again to Table A1.4, estimates for the effects divided by their standard error are given. If the researcher is interested in a confidence level of 90%, then parameters for

a. R at ±0.231 are significant (±1.951)
b. A at ±0.050 are not significant (±0.472)
c. I at ±0.451 are significant (±3.962)
d. RA at ±2.792 are significant (±2.792)
e. RI at ±0.130 are not significant (±1.144).

The researcher may now test her hypotheses. She discovers that more young people recreate than old but that while evidence suggests rich recreate more than poor, such evidence is inconclusive. Neither hypothesis can, therefore, be accepted.

The model can also be run such that cell values are the dependent variable and all indices of the table are independent variables. Such a model not only gives a structure of what is involved in recreation but also provides the researcher a form more closely related to regression.

The value of this technique is that it allows for functional forms to surface that may have kinks or discontinuities which standard ordinary least squares (OLS) ignores. It also helps to identify which variables interact with each other resulting in enhancement or antagonism of facotrs. That is, if two variables increase changes of a person recreating, the combined effect may influence the person to recreate even more than either effect alone. Likewise, two variables that act negatively can work together to cause an even greater negative response than anticipated.

Loglinear does have its drawbacks. Variables are categorical rather than continuous and, therefore, not differentiable. Also, the cost of running the routine can get prohibitive as computer iteration grows exponentially with table dimensions. Thus, the model may be inappropriate if many variables are to be included. If loglinear is used as a tool to determine where discontinuities or slope changes occur or what interactive effects exist, it can be a valuable supplement to regression.

The Logit Transformation

The logit transformation is a modified regression approach to the general loglinear model in which categorical variables are analogous to continuous variables (Knoke and Burke, 1980). The logit is defined as ½ the log of the odds such that $\tilde{\beta} = 2\lambda$, $\Sigma\tilde{\beta} = 0$, and the $\tilde{\beta}$'s exactly reproduce expected odds. Parameters in the logit model are similar to the additive coefficients in regression models--positive values indicate that the independent variable increases odds on the dependents variable while negative values decrease the odds. The left hand side of the equation to be fit is Φ, the log of the conditional odds, such that

$$\Phi^{AB}_{ij} = \overset{\gamma}{\beta}{}^{A}_{i} + \overset{\gamma}{\beta}{}^{B}_{j} + \overset{\gamma}{\beta}{}^{AB}_{ij}$$

and the term θ is omitted.

One should note that some authors identify η as the "intercept," λ as the additive loglinear parameter, τ as the multiplicative parameters, and β as the logit (Knoke and Burke, 1980). In this research, the terms θ, λ, and β represent intercept, additive, and multiplicative parameters respectively. Although logit is not used, $\overset{\gamma}{\beta}$ is the logit term. Only the additive and multiplicative parameters are addressed since none of the indexed variables is defined as a dependent variable.

APPENDIX II

A MATHEMATICAL DIGRESSION

Water Quality Changes and Recreator Welfare

The current bias in the field of welfare economics is that only mathematical proofs are acceptable. Graphical manipulation in determining welfare changes and measurement of those changes, according to Maler (1974), "obviously does not prove anything, it only makes it (measurement) probable." It is the opinion of this author that both techniques are valid provided models are correctly specified. However, to be in accordance with contemporary thought, it will be shown mathematically that changes in water quality affect recreator welfare and demand if water quality is assumed to enter the recreator's utility function as a pseudo-price. In other words, if a recreator's willingness-to-pay for water-based recreat on is influenced by water quality, then changes in water quality will affect his consumer's surplus.

Just, et al. (1982) show that the change in utility is equal to the line integral of the marginal utility of income multiplied by the quantity, the change in income less the sum of goods consumed times respective prices, or

$$\Delta U = \int_L \lambda \ (dM - \sum_{i=1}^{n} q_i dp_i)$$

If this equation is blindly applied to water-based recreation in which water quality improved, *ceteris paribus*, and water quality is unrelated to the price of recreation a recreator is willing to pay, miles traveled, then $\Delta U = 0$. This conclusion seems absurd. For example, if a recreation site is suddenly subjected to pollution, say, a train of petrochemicals derails near the site and toxic substances leak into the water, then the above equation would predict no welfare loss even though the site is worthless for water-based recreation when it once was valuable.

Let α be some level of pollution such that an increase in pollution implies an increase in α and vice versa. The direct utility function for an individual recreator is

$$U \equiv U(q_1, \ . \ . \ . \ , q_n, q_\alpha)$$

where

q_i = goods consumed, goods are $i = 1 \ldots n$

q_α = the amount of water-based recreation

p_i = prices paid for good i

$p(y,\alpha)$ = the price of q_α a recreator is wiling to pay as a function f any entrance fee y and pollution level α (the distance he is willing to travel due to the pollution level of the water).

Thus,

(1a) $$\frac{\partial q_i}{\partial p_i} < 0$$

(1b) $$\frac{\partial q_\alpha}{\partial p(y|\alpha)} \cdot \frac{\partial p(y|\alpha)}{\partial y} < 0$$

(1c) $$\frac{\partial q_\alpha}{\partial p(\alpha|y)} \cdot \frac{\partial p(\alpha|y)}{\partial \alpha} < 0$$

The budget constraint is

(2) $$M = \sum_{i=1}^{n} p_i q_i + [p(y,\alpha)]q_\alpha$$

with total differential

(3) $$dM = \Sigma\ q_i\ dp_i + \Sigma\ p_i\ dq_i + q_\alpha\left(\frac{\partial p(y,\alpha)}{\partial y}dy + \frac{\partial p(y,\alpha)}{\partial \alpha}d\alpha\right) + [p(y,\alpha)]dq_\alpha.$$

Constrained utility maximization is then

(4) $$U = U(q_1, \ . \ . \ . \ , q_n, q_\alpha) + \lambda(M - \Sigma\ p_i q_i - [p(y,\alpha)]q_\alpha$$

The first-order conditions are

(5) $$U_i = \frac{\partial U}{\partial q_i} = \lambda p_i$$

(6) $$U_\alpha \quad \frac{\partial U}{\partial q_\alpha} = \lambda p(y,\alpha)$$

so that when second-order conditions hold, the ordinary demand functions are

$$(7) \qquad q = \tilde{q}(p_1, \ldots, p_n, p(y,\alpha), M).$$

Substituting (7) into the utility function yields

$$(8) \qquad U \equiv U(\tilde{q}_1, \ldots, \tilde{q}_n, \tilde{q}_\alpha) \equiv V(p_1, \ldots, p_n, p(y,\alpha), M) \equiv V$$

where V is the indirect utility function. It will be assumed that $q_i = \tilde{q}_i$ for simplicity in notation frmm this point.

Now, changes in utility can be maasured in terms of changes in prices and income:

$$(9) \qquad \Delta U = V(p_1^1, \ldots, p_n^1, p^1(y,\alpha), M^1) - V(p_1^0, \ldots, p_n^0, p^0(y,\alpha), M^0)$$

$$(10) \quad \Delta U = \int_L dV = \int_L V_m dM + V_i\, dp_i + V_{y,\alpha} \left(\frac{\partial p(y,\alpha)}{\partial y} dy + \frac{\partial p(y,\alpha)}{\partial \alpha} d\alpha \right)$$

and one knows that

$$(11) \qquad dU = dV = \Sigma(U_i\, dq_i + U_\alpha dq_\alpha) \; .$$

Substituting (11) into (10) gives

$$(12) \quad \Delta U = \int_L [\Sigma\, U_i dq_i + U_\alpha dq_\alpha]$$

Also, substituting the first-order conditions of (6) and (7) for U_i and U_α in (12) results in

$$(13) \quad \Delta U = \int [\Sigma \lambda p_i dq_i + \lambda p(y,\alpha) dq_\alpha]$$

$$(14) \quad \Delta U = \int \lambda\, [\Sigma\, p_i dq_i + p(y,\alpha) dq\ ]$$

Returning to the total differential of the budget constraint (3), the bracketed terms in (14) can be substituted as follows:

$$(15) \qquad \Delta U = \int \lambda[dM - \Sigma\, q_i dp_i - q_\alpha\left(\frac{\partial p(y,\alpha)}{\partial y}dy + \frac{\partial p(y,\alpha)}{\partial \alpha}d\alpha\right)$$

$$(16) \qquad \Delta U = \int \lambda[dM - \Sigma\, q_i dp_i - q_\alpha \frac{\partial p(y,\alpha)}{\partial y}dy - q_\alpha \frac{\partial p(y,\alpha)}{\partial \alpha}d\alpha$$

The result in (16) shows a positive increase in U if at least one of the following occurs

a) income rises;

b) prices of goods fall for at least one good i;

c) entrance fees to sites fall;

d) pollution levels decrease.

Opposites are also true.

One should see that (10) is equivalent to (16) but is superior for empirical analysis since the indirect utility function is the inverse of the budget consrraint. It is not necessary to pursue modifications to (16) for empirical measurement of welfare change given problems associated with λ (Just, et al., 1982). The models presented in this paper are allowed to have discontinuities and, as will be seen, do. For those interested, further mathematics of the issue are presented in Just, Hueth, and Schmitz (1982) and Maler (1974). The reader is cautioned to remember the additional terms $p(y,\alpha)$ and q_α if such reading is pursued.

Durable Goods and Demand

The second part of this digression is a mathematical proof that demand curves for renting and owning some durable do not intersect for some income level unless fixed costs of that durable to the private owner are equal to zero. The model assumes that both rented and owned durables have variable costs associated with use.

Demand for recreation given rental and ownership options is derived from the solution to the problems of maximizing utility given relevant budget constraints. For renting, the problem is

$$\text{maximize} \qquad U = U(q,\ F)$$
$$\text{subject to} \qquad M = pq + rF$$

while for ownership it is

$$\text{maximize} \quad U = U(q,\ F)$$
$$\text{subject to} \quad M = pq + rF + B$$

where utility (U) is a well-behaved twoce differentiable function of fishing (F) and all other goods (q); income (M) is equal to the sum of the product of all other goods and their prices (pq), the product of the variable cost of either renting (r) or owning (v) and the number of fishing trips (F), and the fixed cost of the boat (B) if the household owns. All prices and quantities are non-negative and it is assumed that the deriv tives of have the appropriate signs.

Case I: The durable is rented. The Lagrangian is solved:

$$\text{maximize} \quad U = U(q,\ F)$$
$$\text{subject to} \quad M = pq + rF$$

$$\Phi = U(q,\ F) + \lambda(M - pq - rF)$$

$$\left.\begin{aligned} \Phi_q &= U_q - \lambda p = 0 \rightarrow U_q = \lambda p \rightarrow \frac{U_q}{p} = \lambda \\ \Phi_f &= U_f - \lambda r = 0 \rightarrow U_f = \lambda r \rightarrow \frac{U_f}{r} = \lambda \end{aligned}\right\} \rightarrow \frac{U_q}{p} = \frac{U_f}{r} \rightarrow \frac{U_q}{U_f} = \frac{p}{r}$$

$$\Phi_\lambda \quad M - pq - rF = 0 \rightarrow M = pq + rF$$

$$M = pq + rF$$

$$M = pq + \frac{U_f}{U_q}(pF)$$

$$\frac{M}{p} = q + \frac{U_f}{U_q}(F)$$

$$\left(\frac{M}{p} - q\right)\frac{U_q}{U_f} = F$$

$$\left(\frac{M}{p} - q\right)\frac{p}{r} = F$$

is the Marshallian demand curve given the durable is rented.

Also, algebraic manipulation yields the demand for other goods as

$$\frac{M}{p} - \frac{r}{p}F = q.$$

Case II: The durable is owned. The Lagrangian is solved:

maximize $U = U(q, F)$

subject to $M = pq + vF + B$

$$\phi = U(q, F) + \lambda(M - pq - VF - B)$$

$$\left.\begin{aligned} \phi &= U_q - \lambda p = 0 \rightarrow U_q = \lambda p \rightarrow \frac{U_q}{p} = \lambda \\ \phi &= U_f - \lambda v = 0 \rightarrow U_f = \lambda v \rightarrow \frac{U_f}{v} = \lambda \end{aligned}\right\} \frac{U_q}{p} = \frac{U_f}{v} \rightarrow \frac{U_q}{U_f} = \frac{p}{v}$$

$$\phi_\lambda = M - pq - vF - B = 0 \rightarrow M = pq + vF + B$$

$$M = pq + vF + B$$

$$M = pq + \frac{U_f}{U_q}(pF) + B$$

$$\frac{M - B}{p} = q + \frac{U_f}{U_q}(F)$$

$$\left(\frac{M - B}{p} - q\right) \cdot \frac{p}{v} = F$$

is the Marshallian demand curve for fishing given ownership

A gebraic manipulation gives the demand for other goods as

$$\frac{M - B}{p} - \frac{v}{p}F = q.$$

Results of Case I and Case II can be compared to determine the conditions that result in intersection of the demand curves (i. e., $r = v$):

Since $p = p$ and $r = v$, one is left with

$$\frac{M}{p} - q = \frac{M}{p} - \frac{B}{p} - q.$$

Money income is a constant, so

$$-q = -\frac{B}{p} - q,$$

where the left hand side represents the rental demand and the right hand side with the term B represents the ownership demand. Clearly the only conditions which allow the demand curves to be equal is that $B = 0$. Otherwise, the rental demand curves will lie to the right of the ownership demand curve. At each price level such that $r = v$, the demand curve for renting lies outside that for owning for a specified M and positive fixed cost over a time period, B.

The dual approach provides an althrnative solution. Recall the indirect utility function V(*prices and income*) is the inverse of the expenditures function, M, wh re M is the consumer equivalent of the cost function:

Case I (rental)	Case II (ownership)
$M = M(U, p, r)$	$M - B = M(U, p, v)$
$M = V^{-1} \qquad V = M^{-1}$	$M = V^{-1} \qquad V = M^{-1}$
$V = V(M, p, r)$	$V = V(p, v, M - B)$

The Roy Equation is applied to the expenditure function to obtain Marshallian demand curves:

$$F = -\frac{\partial V \div \partial r}{\partial V \div \partial M} \qquad\qquad F = -\frac{\partial V \div \partial v}{\partial V \div \partial M}$$

Thus, two demand curves, the left representing demand for recreation under rental and the right of demand for recreation under ownership conditions, are derived. As before, the two are set equal in order to determine the relationship of one to the other.

$$-\frac{\partial V \div \partial r}{\partial V \div \partial M} = -\frac{\partial V \div \partial v}{\partial V \div \partial (M-B)}$$

$$-\frac{\partial V}{\partial r} \cdot \frac{\partial V}{\partial (M-B)} = -\frac{\partial V}{\partial v} \cdot \frac{\partial V}{\partial M} .$$

We know that the partial derivative of the indirect utility function with respect to both r and v are equal since both are prices of the recreational enjoyment. Thus,

$$\frac{\partial V}{\partial (M - B)} = \frac{\partial V}{\partial M}$$

The only time that these can be equal is if $B = 0$, just as proved previously. Also, since $(M - B)$ is always less that M for some positive B, the demand curve given rental will lie to the right (outside) that for ownership. The only way the two curves can intersect is if the fixed costs associated with the boat are equal to zero and, therefore, the boat is without license fees, storage costs, or maintenance and essentially free.

APPENDIX III

TABLES OF ACTUAL AND FITTED DATA

Table A3.1: Actual Data of Recreate-Non-Recreate Data by Household Size and Income, Missing Values Excluded

INCOME	HSIZE	RECREATE NO	YES	TOTAL
LT10K	ONE	140	60	200
	TWO	123	91	214
	FOUR	59	72	131
	MORE	30	24	54
	TOTAL	352	247	599
10K-15K	ONE	30	36	66
	TWO	72	75	147
	FOUR	71	100	171
	MORE	21	46	67
	TOTAL	194	257	451
15K-20K	ONE	14	21	35
	TWO	60	62	122
	FOUR	76	119	195
	MORE	22	72	94
	TOTAL	172	274	446
20K-25K	ONE	15	14	29
	TWO	38	56	94
	FOUR	55	105	160
	MORE	23	59	82
	TOTAL	131	234	365
25K-35K	ONE	4	3	7
	TWO	42	51	93
	FOUR	60	111	171
	MORE	23	70	93
	TOTAL	129	235	364
35K-40K	ONE	1	2	3
	TWO	15	17	32
	FOUR	22	44	66
	MORE	8	16	24
	TOTAL	46	79	125
GT40K	ONE	3	4	7
	TWO	18	19	37
	FOUR	33	47	80
	MORE	10	42	52
	TOTAL	64	112	176

Table A3.2: Fitted Data of Recreate-Non-Recreate by Household Size and Income.

INCOME	HSIZE	RECREATE NO	YES	TOTAL
LT10K	ONE	131.4	68.6	200.0
	TWO	129.8	84.2	214.0
	FOUR	68.1	62.9	131.0
	MORE	22.7	31.3	54.0
	TOTAL	352.0	247.0	599.0
10K-15K	ONE	35.3	30.7	66.0
	TWO	70.8	76.2	147.0
	FOUR	67.5	103.5	171.0
	MORE	20.4	46.6	67.0
	TOTAL	194.0	257.0	451.0
15K-20K	ONE	17.8	17.2	35.0
	TWO	55.5	66.5	122.0
	FOUR	72.1	122.9	195.0
	MORE	26.5	67.5	94.0
	TOTAL	172.0	274.0	446.0
20K-25K	ONE	14.0	15.0	29.0
	TWO	40.3	53.7	94.0
	FOUR	55.2	104.8	160.0
	MORE	21.4	60.6	82.0
	TOTAL	131.0	234.0	365.0
25K-35K	ONE	3.4	3.6	7.0
	TWO	40.6	52.4	93.0
	FOUR	60.2	110.8	171.0
	MORE	24.8	68.2	93.0
	TOTAL	129.0	235.0	364.0
35K-40K	ONE	1.5	1.5	3.0
	TWO	14.2	17.8	32.0
	FOUR	23.7	42.3	66.0
	MORE	6.6	17.4	24.0
	TOTAL	46.0	79.0	125.0
GT40K	ONE	3.5	3.5	7.0
	TWO	16.7	20.3	37.0
	FOUR	29.3	50.7	80.0
	MORE	14.5	37.5	52.0
	TOTAL	64.0	112.0	176.0

Table A3.1: Actual Data of Trips (Cells) by Miles, Water Quality, Site Quality, Type of Site, and Income of Recreator.

***** OBSERVED FREQUENCY TABLE 1

INCOME	TYPE	SQ	WQ	MILES LE2	3-10	11-30	31-50	51-75	GT75	TOTAL
LT15K	RIVER	FAC	BADPOOR	0	0	19	0	6	0	25
			AVERAGE	4	5	3	13	0	7	32
			GOODEX	0	4	0	7	0	2	13
			TOTAL	4	9	22	20	6	9	70
		LOWFAC	BADPOOR	0	0	0	0	0	0	0
			AVERAGE	1	7	13	0	0	0	21
			GOODEX	10	34	52	2	3	21	122
			TOTAL	11	41	65	2	3	21	143
	LAKE	FAC	BADPOOR	0	1	3	0	0	1	5
			AVERAGE	1	6	61	1	24	7	100
			GOODEX	2	21	5	12	8	1	49
			TOTAL	3	28	69	13	32	9	154
		LOWFAC	BADPOOR	4	0	0	0	0	0	4
			AVERAGE	0	0	0	0	0	0	0
			GOODEX	1	7	0	9	1	6	24
			TOTAL	5	7	0	9	1	6	28

Table A3.1: Continued.

15-25K	RIVER	FAC	BADPOOR	26	21	11	2	0	0 I	60
			AVERAGE	7	64	59	18	10	1 I	159
			GOODEX	6	5	13	0	0	0 I	24
			TOTAL	39	90	83	20	10	1 I	243
		LOWFAC	BADPOOR	0	0	0	0	0	0 I	0
			AVERAGE	0	15	2	0	0	1 I	18
			GOODEX	58	11	30	11	1	3 I	114
			TOTAL	58	26	32	11	1	4 I	132
	LAKE	FAC	BADPOOR	0	0	0	0	0	1 I	1
			AVERAGE	3	0	28	14	16	4 I	65
			GOODEX	1	2	23	13	9	2 I	50
			TOTAL	4	2	51	27	25	7 I	116
		LOWFAC	BADPOOR	0	11	0	0	0	0 I	11
			AVERAGE	6	Q	0	7	0	0 I	13
			GOODEX	0	0	1	2	2	0 I	5
			TOTAL	6	11	1	9	2	0 I	29

Table A3.1: Continued.

GT25K	RIVER	FAC	BADPOOR	3	16	7	2	0	0	28
			AVERAGE	10	4	7	8	3	1	33
			GOODEX	1	0	3	0	0	2	6
			TOTAL	14	20	17	10	3	3	67
		LOWFAC	BADPOOR	0	0	0	0	0	0	0
			AVERAGE	3	16	0	0	0	0	19
			GOODEX	65	7	11	14	4	0	101
			TOTAL	68	23	11	14	4	0	120
	LAKE	FAC	BADPOOR	0	0	2	2	4	1	9
			AVERAGE	1	5	31	12	1	10	60
			GOODEX	0	15	6	1	12	12	46
			TOTAL	1	20	39	15	17	23	115
		LOWFAC	BADPOOR	5	0	0	0	0	0	5
			AVERAGE	0	0	0	0	0	0	0
			GOODEX	0	29	9	7	0	0	45
			TOTAL	5	29	9	7	0	0	50

Table A3.1: Continued.

MISSING	RIVER	FAC	BADPOOR	2	0	0	4	1	0	I	7
			AVERAGE	51	0	17	5	0	1	I	74
			GOODEX	3	0	0	3	0	1	I	7
			TOTAL	56	0	17	12	1	2	I	88
		LOWFAC	BADPOOR	0	0	0	0	0	0	I	0
			AVERAGE	25	7	4	0	0	0	I	36
			GOODEX	21	0	0	0	9	0	I	30
			TOTAL	46	7	4	0	9	0	I	66
	LAKE	FAC	BADPOOR	0	1	0	0	0	0	I	1
			AVERAGE	11	12	57	7	9	6	I	102
			GOODEX	1	16	6	23	5	6	I	57
			TOTAL	12	29	63	30	14	12	I	160
		LOWFAC	BADPOOR	0	0	0	0	0	0	I	0
			AVERAGE	7	0	0	0	0	0	I	7
			GOODEX	0	0	2	0	1	6	I	9
			TOTAL	7	0	2	0	1	6	I	16

TOTAL OF THE OBSERVED FREQUENCY TABLE IS 1598

Table A3.2: Fitted Table of Trips (Cells) by Miles, Water Quality, Site Quality, Type, and Income.

MODEL

***** EXPECTED VALUES USING ABOVE MODEL MWTI,MSTI,WSI,WST,MWS.

D.F.	LIKELIHOOD-RATIO CHI-SQUARE	PROB
76	46.12	.9973

INCOME	TYPE	SQ	WQ	MILES LE2	3-10	11-30	31-50	51-75	GT75	TOTAL
LT15K	RIVER	FAC	BADPOOR	.0	.0	18.9	.0	6.1	.0	25.1
			AVERAGE	3.5	6.6	3.4	13.0	.0	7.1	33.7
			GOODEX	.5	2.3	.1	6.8	.0	1.8	11.6
			TOTAL	4.0	9.0	22.4	19.8	6.2	9.0	70.3
		LOWFAC	BADPOOR	.0	.0	.0	.0	.0	.0	.0
			AVERAGE	1.5	5.4	12.3	.0	.0	.0	19.3
			GOODEX	9.5	35.7	52.7	2.0	3.0	21.1	124.0
			TOTAL	11.0	41.1	65.0	2.0	3.0	21.1	143.3
	LAKE	FAC	BADPOOR	.3	.6	3.0	.0	.0	.9	4.9
			AVERAGE	.8	4.9	60.9	.9	24.0	6.9	98.4
			GOODEX	1.9	22.5	5.0	12.1	7.9	1.2	50.5
			TOTAL	3.0	28.0	68.8	13.0	32.0	9.0	153.8
		LOWFAC	BADPOOR	3.8	.3	.0	.0	.0	.1	4.2
			AVERAGE	.2	1.1	.0	.1	.0	.1	1.6
			GOODEX	1.1	5.5	.0	8.9	1.0	5.8	22.3
			TOTAL	5.0	7.0	.0	9.0	1.0	6.0	28.1

Table A3.2: Continued.

15-25K	RIVER	FAC	BADPOOR	25.7	21.0	11.0	2.0	.0	.0	I	59.7
			AVERAGE	5.2	63.6	59.8	16.0	10.0	1.0	I	155.6
			GOODEX	8.0	5.3	11.9	2.0	.1	.0	I	27.2
			TOTAL	38.9	89.9	82.7	20.0	10.0	1.0	I	242.6
		LOWFAC	BADPOOR	.2	.0	.0	.0	.0	.0	I	.2
			AVERAGE	1.8	15.4	1.3	2.0	.0	.9	I	21.5
			GOODEX	55.8	10.6	30.7	9.0	1.0	3.0	I	110.1
			TOTAL	57.7	26.1	32.0	11.0	1.0	4.0	I	131.8
	LAKE	FAC	BADPOOR	.0	.5	.0	.0	.0	1.0	I	1.5
			AVERAGE	3.6	.0	27.8	16.9	16.0	4.0	I	68.4
			GOODEX	.4	1.5	23.3	10.2	9.1	2.0	I	46.5
			TOTAL	4.0	2.0	51.1	27.1	25.1	7.0	I	116.4
		LOWFAC	BADPOOR	.0	10.7	.0	.0	.0	.0	I	10.7
			AVERAGE	5.4	.0	.2	4.0	.0	.0	I	9.6
			GOODEX	.6	.6	.9	4.9	2.0	.0	I	9.0
			TOTAL	6.0	11.2	1.0	9.0	2.0	.0	I	29.3

Table A3.2: Continued.

GT25K	RIVER	FAC	BADPOOR	3.0	15.9	7.2	2.0	.0	.0	I	28.1
			AVERAGE	10.7	4.3	7.2	7.8	3.0	1.0	I	33.9
			GOODEX	.4	.0	2.6	.3	.0	1.9	I	5.2
			TOTAL	14.1	20.2	17.0	10.1	3.0	3.0	I	67.3
		LOWFAC	BADPOOR	.0	.0	.0	.0	.0	.0	I	.0
			AVERAGE	2.1	15.6	.0	.3	.0	.0	I	17.9
			GOODEX	66.0	7.1	11.1	13.8	4.0	.0	I	102.1
			TOTAL	68.1	22.7	11.1	14.1	4.0	.0	I	120.1
	LAKE	FAC	BADPOOR	.1	.0	1.9	1.9	3.9	1.0	I	8.8
			AVERAGE	.9	4.6	31.0	11.5	1.0	10.0	I	59.0
			GOODEX	.0	15.4	6.1	1.6	11.9	12.0	I	46.9
			TOTAL	1.0	20.0	39.0	15.0	16.8	23.0	I	114.8
		LOWFAC	BADPOOR	5.0	.0	.1	.1	.0	.0	I	5.2
			AVERAGE	.1	.4	.2	.5	.0	.0	I	1.2
			GOODEX	.0	28.5	8.8	6.4	.0	.0	I	43.7
			TOTAL	5.2	28.9	9.0	7.0	.0	.0	I	50.2

Table A3.2: Continued.

MISSING	RIVER	FAC	BADPOOR	2.0	.0	.0	4.0	1.0	.0	7.1
			AVERAGE	51.7	.0	17.0	5.0	.0	1.0	74.8
			GOODEX	2.3	.0	.0	2.9	.0	1.0	6.2
			TOTAL	56.0	.0	17.0	12.0	1.0	2.0	88.1
		LOWFAC	BADPOOR	.0	.0	.0	.0	.0	.0	.1
			AVERAGE	24.4	7.0	3.9	.0	.0	.0	35.4
			GOODEX	21.6	.0	.0	.0	9.0	.0	30.7
			TOTAL	46.1	7.1	4.0	.0	9.0	.0	66.1
	LAKE	FAC	BADPOOR	.0	1.0	.0	.0	.0	.0	1.0
			AVERAGE	11.4	12.0	55.9	7.0	9.0	5.9	101.2
			GOODEX	.6	16.1	7.1	23.1	5.0	6.1	58.0
			TOTAL	12.0	29.1	63.0	30.1	14.0	12.1	160.3
		LOWFAC	BADPOOR	.0	.0	.0	.0	.0	.0	.1
			AVERAGE	6.6	.0	1.1	.0	.0	.0	7.8
			GOODEX	.4	.0	.9	.0	1.0	5.9	8.3
			TOTAL	7.1	.0	2.0	.0	1.0	6.0	16.1

APPENDIX IV

Final — OREGON OUTDOOR RECREATION SURVEY — 9/18/80

"Hello, I'm ____________ -- I'm working for Oregon State University and we are conducting a survey on outdoor recreation activities. I'd like to speak with the person in your household who knows the most about your family's outdoor recreation activities and who is 18 years or older.

(INT: IF ADULT WHO IS MOST KNOWLEDGABLE IS NOT AT HOME, CONTINUE SURVEY WITH ANOTHER ADULT IN THE HOUSEHOLD. IF NO ADULT IS AT HOME ASK WHEN THE MOST KNOWLEDGABLE PERSON WILL BE HOME, NOTE TIME BELOW AND CALL BACK. REPEAT FIRST LINE OF INTRODUCTION WHENEVER YOU ARE SPEAKING TO SOMEONE FOR THE FIRST TIME AND CONTINUE WITH):

Your household has been chosen by a random method and your participation is essential to the accuracy of the study. All information you give us is strictly confidential and in no way will your name or number be identified with you personally. The results are tabulated for the area as a whole, not for any one person. We want to remind you that this survey is voluntary and if there are any questions you would rather not answer, please say so and we sill skip over that one.

If you have any questions as to the results of the survey, please call the OSU Survey Research Center, the number is 503-754-3773. Okay?"

R's PHONE NUMBER ________________

Date	Time	Interviewer	Result

Code for results:

COMP Interview completed
NA No answer
BUSY Telephone busy
CB Call back (Note time)
REF Refused

Length of Interview__________(minutes)

Verified by ____________

(TURN PAGE AND BEGIN INTERVIEW)

OREGON OUTDOOR RECREATION SURVEY

1. _________ Number — During the past 12 months how many persons, including yourself have lived in your household?
   99 DK, NA

2. _________ Number — How many of these people are 18 years or older?
   99 DK, NA

2a. _________ Number — And, how many are under 18 years of age? (INT: RESPONSE TO Q. 2 AND 2a MUST EQUAL TOTAL IN Q. 1)
   99 DK, NA

3. I'd like to get a complete picture of your household. Some of these questions concern each person while others are about your hosuehold as a group. Thinking about everyone who lived in your household during the past 12 months, I would like to list each person from the oldest to the youngest just to make sure we are talking about everyone. (INT: STARTING WITH THE OLDEST GET ALL INFORMATION AND ENTER ON FIRST LINE. CONTINUE WITH EACH FAMILY MEMBER DOWN TO THE YOUNGEST).

	Relationship to "R"	First Name	Sex (Circle) Male	Female	Age Last Birthday
Person 1	________	________	1	2	________
Person 2	________	________	1	2	________
Person 3	________	________	1	2	________
Person 4	________	________	1	2	________
Person 5	________	________	1	2	________
Person 6	________	________	1	2	________
Person 7	________	________	1	2	________
Person 8	________	________	1	2	________
Person 9	________	________	1	2	________
Person 10	________	________	1	2	________
Person 11	________	________	1	2	________
Person 12	________	________	1	2	________

Now I'd like to ask you some questions about your household's outdoor recreation activities for the past 12 months.

4. Thinking back to the first of June 1980 to the present, how many trips, altogether, did you or any member of your household take for these four kinds of outdoor recreation..swimming in a lake or river, boating, fishing or camping?

   _________ Number of trips

   99 DK, NA

   (INT: IF "NONE" WRITE 0 AND SKIP TO Q. 7)

I'd like to get a little more information about where those in your household went for each outdoor recreation trip. (INT: ASK QUESTIONS 4a THROUGH 4f FOR EACH TRIP MENTIONED IN Q. 4, RECORD THE ANSWERS FOR EACH PART OF THE QUESTION IN THE TABLE BELOW. COMPLETE ALL SIX QUESTIONS FOR THE FIRST TRIP BEFORE GOING ON TO THE SECOND, THIRD, ETC.)

4a. Thinking back to the (first) (second) (third, etc) trip someone in your household took this summer, would you please tell me the name of the place they went and the state in which it is located?

4b. And, about how many miles one way did it take to travel to this destination?

4c. Also, about how many minutes did it take to travel to this destination?

4d. How many days, altogether, were you on this trip?

4e. Which person or persons in your household went on this trip? (INT: RECORD PERSON NUMBERS FROM Q. 3)

4f. Finally, which person or persons took part in the following outdoor recreation activities on this trip and how many days altogether did they spend at each activity. The first is swimming in a lake or river, including tube floating and rafting? (RECORD PERSON NUMBER AND NUMBER OF DAYS: FOR EXAMPLE IF PERSON 4 WENT SWIMMING ON THREE DIFFERENT DAYS DURING THE TRIP, WRITE 4/3)... boating, including water skiing? ... fishing? ... and camping?

	Q. 4a		Q. 4b	Q. 4c	Q. 4d	Q. 4e	Q. 4f			
							Which persons went ....? / And for how many days....?			
TRIP	Name of destination	State	Miles one-way	Minutes one-way	Length of trip (days)	Which persons went?	Swimming	Boating	Fishing	Camping
1										
2										
3										
4										
5										

TRIP	Q. 4a Name of destination	State	Q. 4b Miles one-way	Q. 4c Minutes one-way	Q. 4d Length of trip (days)	Q. 4e Which persons went?	Q. 4f Which persons went...? / And for how many days....? Swimming	Boating	Fishing	Camping
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

The next series of questions refers only to the last trip you or someone in your household took ...

5. \$ ________ /day 99 DK (SKIP TO Q. 6)	First, how much was the daily use fee, if any, for the recreation facilities used? (INT: IF NONE, WRITE 0 AND SKIP TO Q. 6)
5a. \$________ /day 99 DK	What is the maximum daily use fee you would be willing to pay for this recreation facility rather than forego using it?
6. \$ ________ 999 DK	About how much money did you spend travelling to and from your home to the recreation area on this last trip? This includes meals, gas, oil, car rental or air fare and so forth. (Just your best estimate please).
6a. 1 Enjoyed travel time 2 Prefer to shorten 9 DK	Some people feel time spent travelling to a recreation site is an inconvenience while others enjoy it. How about you? Did you enjoy the time sepnt travelling on this trip, or would you rather have shortened the travel time?
6b. \$________	About how much would you be willing to pay to shorten the total travel time for this last trip by half?

(ASK OF EVERYONE)

7. ________ Number of trips 99 DK	Now, thinking back to the first of September of last year to the first of June 1980, how many trips, altogether, did you or any member of your household take for recreation purposes? (INT: IF NONE, WRITE 0 AND SKIP TO Q. 8)

I'd like to get a little more information about where those in your household went for each outdoor recreation trip. (INT: ASK QUESTIONS 7a THROUGH THE 7f FOR EACH TRIP MENTIONED IN Q. 7, RECORD THE ANSWERS FOR EACH PART OF THE QUESTION IN THE TABLE BELOW. COMPLETE ALL SIX QUESTIONS FOR THE FIRST TRIP BEFORE GOING ON TO THE SECOND, THIRD, ETC.)

7a. Thinking back to the (first) (second) (third, etc) trip someone in your household took between last September and June 1980, would you please tell me the name of the place they went and the state in which it is located?

7b. And, about how many miles one way did it take to travel <u>to</u> this destination?

7c. Also, about how many minutes did it take to travel <u>to</u> this destination?

7d. How many days, altogether, were you on this trip?

7e. Which person or persons in your household went on this trip? (INT: RECORD PERSON NUMBERS FROM Q. 3)

7f. Finally, <u>which</u> person or persons took part in the following outdoor recreation activities on this trip and how many days altogether did they spend at each activity. The first is swimming in a lake or river, including tube floating and rafting? (RECORD PERSON NUMBER AND DAYS) .... boating, including water skiing? ....fishing? .... and camping?

	Q. 7a		Q. 7b	Q. 7c	Q. 7d	Q. 7e	Q. 7f			
							Which persons went ...? / And for hoe many days....?			
TRIP	Name of destination	State	Miles one-way	Minutes one-way	Length of trip (days)	Which persons went?	Swimming	Boating	Fishing	Camping
1										
2										
3										
4										
5										

	Q. 7a		Q. 7b	Q. 7c	Q. 7d	Q. 7e	Q. 7f Which persons went...? / And for how many days...?			
TRIP	Name of destination	State	Miles one-way	Minutes one-way	Length of trip (days)	Which persons went?	Swimming	Boating	Fishing	Camping
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

Finally, for statistical purposes only, we have a last few questions about your household...

8. ______________ First, in or near which town or city is your home located?
   Town or City
   999 Refused

---

9. ______________ And, in which county is your home located?
   County
   99 Refused; DK

---

10. Would you please tell me if the total gross income for your household in 1979 was ... (READ LIST)
   01 Less than $10,000
   02 $10,000 to $14,999
   03 $15,000 to $19,999
   04 $20,000 to $24,999
   05 $25,000 to $34,999
   06 $35,000 to $40,000
   07 Over $40,000
   99 Refused; DK

---

11. Is there anything else you would like to say about outdoor recreation?

(THANK YOU FOR YOUR COOPERATION)

APPENDIX V

TWO OREGON BILLS WITH IMPLICATIONS FOR
DURABLE GOODS PURCHASES BY RECREATORS

62nd OREGON LEGISLATIVE ASSEMBLY--1983 Regular Session

House Bill 2170

Ordered printed by the Speaker pursuant to House Rule 12.00A (5). Presession filed (at the request of Department of Transportation)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure as **introduced.**

Increases registration fees for travel trailers, campers, motor homes and mobile construction trailers.

A BILL FOR AN ACT

Relating to registration fees; amending ORS 481.450.

Be It Enacted by the People of the State of Oregon:

SECTION 1. ORS 481.450 is amended to read:

481.450. (1) The biennial registration fee for travel trailers, mobile construction trailers, campers and motor homes 6 to 10 feet in length is [*$20*] **$30**.

(2) The biennial registration fee for campers, mobile construction trailers and travel trailers over 10 feet in length is [*$20*] **$30** plus $3 a foot for each foot of length over the first 10 feet.

(3) The biennial registration fee for motor homes over 10 feet in length is [*$40*] **$50** plus $3 a foot for each foot of length over the first 10 feet.

(4) Travel trailers and mobile construction trailers are measured from the foremost point of the trailer hitch to the rear extremity of the trailer body. Campers are measured by overall length from the extreme front to the extreme rear. Motor homes are measured by overall length from front to rear extremities. Tent trailers are measured by overall length when folded for travel.

62nd OREGON LEGISLATIVE ASSEMBLY—1983 Regular Session

A-Engrossed

House Bill 2190

Ordered by the Speaker June 6
Including House Amendments dated May 16 and June 6

Ordered printed by the Speaker pursuant to House Rule 12.00A (5). Presession filed (at the request of Joint Interim Committee on Revenue)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure.

Increases vehicle registration fees for campers, motor homes and travel trailers. [*Specifies method of distributing money collected.*] **Requires Department of Transportation to establish by rule program to provide money to counties for county park and recreation areas.**

A BILL FOR AN ACT

Relating to vehicles; amending ORS 366.512, 366.540 and 481.450; and appropriating money.

Be It Enacted by the People of the State of Oregon:

SECTION 1. ORS 481.450 is amended to read:

481.450. (1) The biennial registration fee for:

(a) Travel trailers, [*mobile construction trailers,*] campers and motor homes 6 to 10 feet in length is [*$20*] **$36.**

(b) Mobile construction trailers 6 to 10 feet in length is $20.

(2) The biennial registration fee for:

(a) Campers[, *mobile construction trailers*] and travel trailers over 10 feet in length is [*$20 plus $3*] **$36 plus $3** a foot for each foot of length over the first 10 feet.

(b) Mobile construction trailers over 10 feet in length is $20 plus $3 a foot for each foot of length over the first 10 feet.

(3) The biennial registration fee for motor homes over 10 feet in length is [*$40 plus $3*] **$56 plus** $3 a foot for each foot of length over the first 10 feet.

(4) Travel trailers and mobile construction trailers are measured from the foremost point of the trailer hitch to the rear extremity of the trailer body. Campers are measured by overall length from the extreme front to the extreme rear. Motor homes are measured by overall length from front to rear extremities. Tent trailers are measured by overall length when folded for travel.

SECTION 2. ORS 366.512 is amended to read:

366.512. [*(1)*] All registration fees received by the Motor Vehicles Division for campers, mobile homes, motor homes and travel trailers shall be processed, and then transferred to the State Highway Fund, as provided in ORS 481.950.

[*(2)*] After transfer to the State Highway Fund the money shall be placed in a separate account in such fund[,] **and** shall be accounted for separately [*and shall be stated separately in the Parks and Recreation*

NOTE: Matter in **bold face** in an amended section is new; matter [*italic and bracketed*] is existing law to be omitted.

Division's biennial budget]. Such money shall not be subject to the appropriations provided for in ORS 366.525 to 366.540 and 366.785 to 366.820, but **disposition of the moneys shall be as follows:**

(1) All of the moneys in the account except those moneys described in subsection (2) of this section shall be deposited in a separate subaccount within the account under this section and shall be used by the Parks and Recreation Division for the acquisition, development, maintenance, care and use of park and recreation sites. **The moneys in the subaccount under this subsection shall be accounted for separately and shall be stated separately in the Parks and Recreation Division's biennial budget.**

(2) An amount equal to $6 for each travel trailer, camper or motor home registered under ORS 481.450 shall be deposited in a separate subaccount within the account under this section and is appropriated for the maintenance, care and use of county park and recreation sites. The moneys in the subaccount under this subsection shall be accounted for separately. The following apply to the distribution of moneys under this subsection:

(a) The appropriation shall be distributed among the several counties for the purposes described in this subsection. The distributions shall be made at times determined by the Department of Transportation but shall be made not less than once a year.

(b) The sums designated under this subsection shall be remitted to the county treasurers of the several counties by warrant.

(c) The department shall establish an advisory committee to advise the department in the performance of its duties under this subsection. The composition of the advisory committee under this subsection shall be as determined by the department by rule. In determining the composition of the advisory committee, the department shall attempt to provide reasonable representation for county officials or employes with responsibilities relating to county parks and recreation sites.

(d) The department, by rule, shall establish a program to provide moneys to counties for the acquisition, development, maintenance, care and use of county park and recreation areas. The rules under this paragraph shall provide for distribution of moneys based on use and need and, as the department determines necessary, on the need for the development and maintenance of facilities to provide camping sites for campers, motor homes and travel trailers.

SECTION 3. ORS 366.540 is amended to read:

366.540. (1) **Except as specifically provided under ORS 366.512,** the appropriation made by ORS 366.525 shall constitute the entire appropriation to be made to the counties out of revenues accruing to the highway fund.

(2) Upon satisfactory showing before the department by any county that the county has not sufficient funds with which to pay, when due, bonded indebtedness incurred for highway purposes, the department may certify to such fact. Pursuant to the certificate, a warrant shall be drawn in favor of the county against the highway fund in the amount set out in each certificate, which amount so advanced shall be deducted from the next payment due the county under ORS 366.525 to 366.540.

APPENDIX VI

WATER QUALITY AND SITE QUALITY MEASURES

Water Quality

Objective measures of water quality were provided by water divisions of each state (Idaho, 1980, 1982; State of Washington, 1977; Water Quality, Oregon, 1981). The water quality measures were relatively compatible although there was less information on Washington freshwater sites than on Oregon and Idaho sites. Variables included in the general water quality code were chemical composition, sedimentation, temperature for certain fish species, and bacteria levels.

Some weighted average employed by biologists in the state water quality divisions was used in classifying the water in lakes and rivers as excellent, good, average, poor, or bad. The five coded water quality levels were assigned to the recreation sites. There were too few sites falling in the excellent and bad categories for purposes of analysis. Thus, three levels were obtained by combining the extreme levels with the adjoining categories: good-excellent, average, and bad-poor.

Site Quality

Site quality refers to the measure of facilities available at a recreation site. Types and numbers of facilities were also provided by state documents as well as private state sources (Henning's Guide, 1980; Washington State Parks, 1981, Willamette Kayak and Canoe Club, 1981; Bureau of Land Management, 1976).

Relatively primitive facilities such as campfire grates and pit toilets scored one point while more sophisticated ones--amphitheaters and RV electrical hookups--scored two points. Availability of nearby stores, major roads, and capacity were also incorporated into the coding scheme such that greater capacity, accessibility, and opportunity for shopping added to the facility score. A cutpoint was arbitrarily selected at five facility points. Those sites above the cutpoint were classified as developed and those below as primitive.

Integration

Integration of the two quality scores can be found on the following listing. Sites with missing values were omitted from the study. The codes are representative of conditions in 1979 through 1980 and should not be used for studies past those dates as several pollution abatement programs have been successfully enacted in the Region since 1980. Also, the listing reflects average water quality and degree of development for a particular river or lake. Specific location of the recreation trip was not asked of interviewees. Since some areas have several sites of differing quality, especially site quality, an average code was assigned to all areas.

Water and Site Quality by Site and State, 1980

State	Site	Water Quality			Site Quality	
		G-Ex	Avg	P-B	Dev.	Prim.
OR	Alsea River	X				X
	Applegate River	X			X	
	Clackmas River	X			X	
	Clackmas River, Upper	X				X
	Columbia River	X			X	
	Cottage Grove	X			X	
	Cove Palisades	X			X	
	Crane Prairie	X			X	
	Crater Lake	X			X	
	Deschutes River	X			X	
	Deschutes River, East	X			X	
	Detroit Lake	X			X	
	Diamond Lake	X			X	
	Emigrant Lake	X			X	
	Fern Ridge		X		X	
	Hells Canyon		X			X
	Howard Prairie		X		X	
	Hyatt Lake	X			X	
	John Day Dam	X			X	
	John Day River	X				X
	Lake of the Woods	X			X	
	Lost Creek Lake	X			X	
	McKenzie River	X			X	
	Metolius River	X			X	
	Molalla River		X		X	
	Ochoco Reservoir	X			X	
	Phillips Lake		X		X	
	Prineville Reservoir	X			X	
	Round Butte Reservoir	X			X	
	Sandy River	X				X
	Santiam River	X				X
	Santiam River, North	X				X
	Selmac Lake	X			X	
	Siletz River	X			X	
	Silver Creek Falls	X			X	
	Umpqua River	X				X
	Umpqua River, North	X				X
	Umpqua River, South	X				X
	Wickieup Reservoir	X			X	
	Willamette River		X		X	
	Rogue River (includes Rogue Wilderness)	X				X
ID	American Falls		X		X	
	Anderson Ranch	X			X	
	Bear Lake	X			X	
	Big Smokey		X		X	

Sites, Continued.

State	Site	Water Quality G-Ex	Water Quality Avg	Water Quality P-B	Site Quality Dev.	Site Quality Prim.
ID	Boise River			X	X	
	Boise River, South Fork			X	X	
	Brownlee Reservoir		X		X	
	Cascade Reservoir		X		X	
	Coeur d'Alene	X			X	
	Coeur d'Alene, North Fork	X			X	
	Featherville Reservoir		X		X	
	Henry's Lake		X		X	
	Island Park Reservoir		X		X	
	Lucky Peak Reservoir	X			X	
	Magic Reservoir		X		X	
	Mann Creek Reservoir		X		X	
	McCall Reservoir	X			X	
	Mormon Reservoir	X			X	
	Owyhee Reservoir		X		X	
	Palisades Reservoir	X			X	
	Pine Creek	X			X	
	Redfish Lake	X			X	
	Salmon Dam	X			X	
	Snake River		X		X	
	Stanley Basin	X				X
	C. J. Strike Reservoir		X		X	
	Teton River		X		X	
	Teton Reservoir		X		X	
	Trinity Lake			X	X	
	Twin (entire area)		X		X	
	Payette Res./River	X			X	
WA*	Lake Washington		X		X	
	Medical Lake			X	X	
	Moses Lake		X		X	
	O'Sullivan Dame		X		X	
	Pend Orielle (located in ID)	X			X	
	Silver Lake	X			X	
	Snake River		X		X	
	Spokane River			X	X	
	Yakima River			X	X	

*few observations for the State of Washington due to several missing observations on either quality measure and the dominance of salt-water based recreation, especially in the northwest area of the state (Pacific Ocean, Puget Sound, San Juan Islands).