ON THE USES OF CONSUMER'S SURPLUS MEASURES

by

Irene Malinda Gordon

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Name: Irene Malinda Gordon

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Examining Committee:

Chairman: Zane A. Spindler

Jack L. Knetsch
Senior Supervisor

Thomas E. Borcherding

Mary Barker
Department of Geography
Simon Fraser University

Date Approved: November 23, 1976

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Author:

(signature)

Irene Malinda Gordon

(name)

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Abstract

The concept of consumer's surplus is often used when economists are deciding how scarce resources should be employed. This is a measure of the benefits which accrue, above the costs, to the users of the resource in question. Consumer's surplus is measured basically by two types of questions. One is "What will you pay to use X?" and the other is, "What compensation would you require to forego X?" The answers to these two questions are consistently different in dollar value.

The current explanation of the difference revolves around the fact that empirically we cannot hold the marginal utility of income constant. Although this explanation is correct from a theoretical point of view, it was felt that this reason did not account for the total observed difference between the two answers. Reference is made to an article by Henderson (1941) where the constancy of the marginal utility of income is not assumed and where Henderson claims that the measures of consumer's surplus will lie close together.

In the present essay the apparent inconsistency between the current explanation and Henderson's view is examined by discussing three topics. In the first section the theory of consumer's surplus is discussed. In the second two empirical studies were examined. In the third explanations which could aid in partially explaining the large variance between the two measures are examined.

From these discussions, implications were drawn for the usage of the two measures. A major conclusion which resulted was that the usual explanation for the variation in benefit measures, the constancy of the marginal utility of income, is not a sufficient explanation alone.

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Irene Malinda Gordon

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CHAPTER I

Introduction

Benefit-cost analysis is widely used in determining the desirability of contemplated investments. The intent of such an analysis is to give an explicit calculation of resources required for such an undertaking (usually in monetary terms) and the expected gains or benefits, given in commensurate terms. In general, a benefit-cost analysis is a comparison of the gains and the costs of investing resources in available projects. The use of benefit-cost analysis has been particularly useful in judging the economic feasibility of public actions.

The advantages of a benefit-cost analysis is that this type of study enables economists to examine problems which are difficult to evaluate. Examples of difficult evaluation problems are externalities, non-market priced goods and public goods. Since these goods are not sold in any market, no price, and consequently, no readily available monetary valuation, is associated with them. The benefit-cost analysis provides a method which is capable of including the value of both positive and negative characteristics of a good. This is accomplished by determining how a good, such as a spillover, affects society as a whole even though no market price exists (Mishan, 1975, x-xi).

Unfortunately, the measurement of the benefits and costs of resources which do not have a market value is more difficult than if a well functioning market existed. Methods vary, and reliance is often placed on indirect techniques. Indirect methods of valuation are

required where no other value such as a market price exists.

Many of the valuation techniques attempt to measure in one way or another consumer's surplus. Consumer's surplus is often represented by two measures, the compensating and the equivalent variations. These two measurements may essentially be defined by two questions.

The first question is of the type of "What are you willing to pay to continue using a resource?" This question represents the price-compensating or willingness to pay measure of consumer's surplus.

"What compensation would you require in order to stop using a resource?" is representative of the second type of question. This question is utilized to discern the price-equivalent or willingness to sell measure (Krutilla, et.al., 1972, 96-7; Hammack and Brown, 1974, 6).

Empirical studies have shown the answers to the two questions cited to be very different. For example, one study (Hammack and Brown, 1974, 27) found that the mean value to the first question was $247 while for the second question the mean value was $1,044. When referring to the values associated with the compensated variation and the equivalent variation respectively, such differences in answers might, in principle, be expected when the constancy of the marginal utility of income does not hold[1] (Krutilla and Fisher, 1975, 29; Stigler, 1966, 78-81). This has been the usual explanation offered for the variation encountered. The commonly observed differences, however, are not likely to be predicted to be as large as those found and especially not for the range of real incomes brought about by the contemplated change in resource allocations.

One explanation of the differences noted in the survey results is the method of information extraction such as deficiencies in the survey

itself. However, while shortcomings may be common, the results are consistent over all of the studies of the issue and there seems far too large a difference to be ascribed to this source.

This remaining observed variation between the two responses causes a problem of understanding as there is no reason to believe on the basis of the usual explanation that this differential should be of such a large magnitude. Economic explanations of the difference in answers have centered on the income constraint and the income effects (Krutilla and Fisher, 1975, 29-30). However, these explanations of the variance do not seem sufficient in explaining all the observed difference. Along with the problem of understanding, there is the parallel one of choosing an appropriate measure in particular instances of allocation decisions.

This essay presents another study of resource evaluation where there is a wide variation in the two observed measures. Then an attempt is made to suggest further reasons for the large differences in magnitude between the answers. This will be accomplished by examining four topics.

First, the theory of consumer's surplus will be discussed. This general discussion will primarily describe the way this theory is used in economics. The second topic will be an attempt to present two sets of survey data in order to show that the large variance in answers is not a characteristic of just one survey.

The third section describes several possible explanations for the variance such as property rights , income effects, psychic benefits and internal rates of return. The idea that the respondent may see himself in two different roles is also described in the third chapter. Finally, the essay draws conclusions and implications from the preceding discussions.

FOOTNOTES

1 The constancy of the marginal utility of money means that the income elasticity is equal to one. Another instance where the two consumer's surplus measures would be equivalent is where homothetic utility curves are involved. The concept of homotheticity involves charting the points a consumer reveals as preferred when his income is changed. If the changes in income reveal bundles of goods which can be charted on a straight line out of the origin, then the situation is a homothetic one even if the indifference curves become increasingly further apart. Samuelson refers to this principle as linear transformations of utility curves (Samuelson, 1965, 175; Harberger, 1971, 188).

This proposition then says that the two consumer's surplus measures may be equivalent even though the indifference curves are not vertically parallel. Consequently, this illustrates that the lack of the constancy of the marginal utility of money cannot cause the consumer's surplus measures to be different (T. Rader, 1972, 241).

CHAPTER II

Consumer's Surplus

Public investment projects must be evaluated in order to determine whether they will benefit the public. Evaluating public projects is a matter of comparing the costs of the project to the benefits which will result from the investment. In order to evaluate an investment it is necessary to gain a measure of the costs and benefits.

One method of measuring the consequences is to ask the beneficiaries how they would value a project. This measurement is assumed to be the area beneath the market demand curve for the outputs of the undertaking. This area under the demand curve is commonly taken to be a measure of the consumer's surplus. If the value identified as the consumer's surplus is greater than the costs of a project, then the investment will usually be undertaken.[1] Consumer's surplus,[2] then, is used in this manner to represent the aggregated[3] net welfare gain to society when a project is to be initiated.[4]

The two economists most often credited with defining consumer's surplus are Marshall and Hicks.[5] While certain aspects of Marshallian and Hicksian consumer's surplus are similar, the major differences are also of considerable importance. These differences and similarities of the Marshallian and Hicksian consumer's surplus views will be compared in the following sections.

CONSUMER'S SURPLUS AS AN AREA UNDER THE DEMAND CURVE

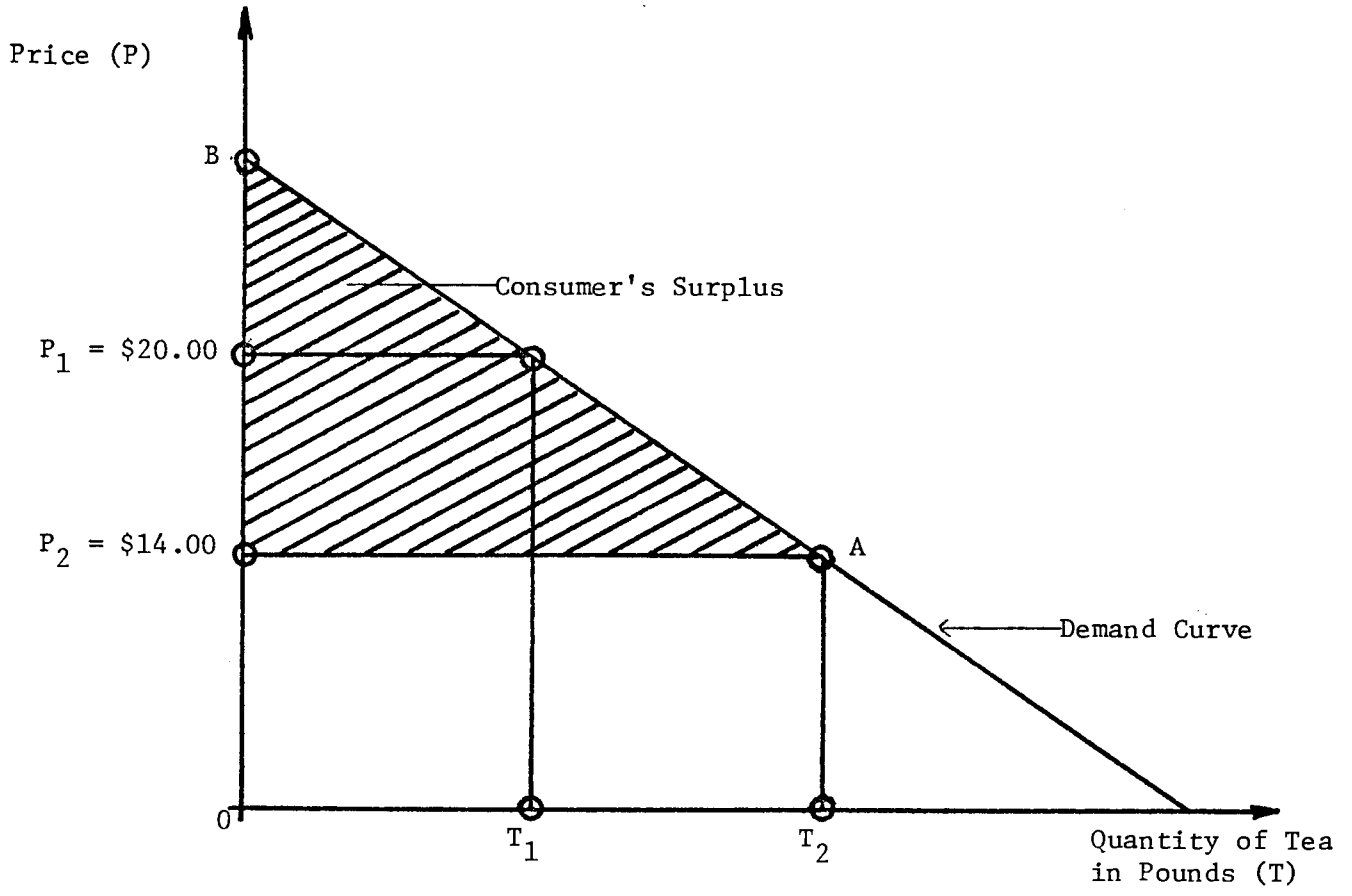


FIGURE I

Marshall's Definition of Consumer's Surplus

The term consumer's surplus was explained by Marshall as the gains derived by an individual over and above the price he pays for a good. The excess benefits are represented by what an individual would be willing to pay, above that which he does pay, rather than do without the good (Marshall, 1920, 103).

The example which Marshall employed to illustrate consumer's surplus deals with tea (Marshall, 1920, 104-5). In Marshall's example the consumer is first faced with a situation where tea costs $20.00 per pound. At this price, the individual purchases one pound of tea. If the price of tea were to fall to $14.00 a pound, the consumer in this case buys two pounds of tea at $14.00 each. Since the consumer paid $20.00 for the first pound of tea and now pays only $14.00, he saves $6.00. This $6.00 is equal to or greater than the excess benefits which the consumer derives from the first pound of tea.

Marshall's concept of consumer's surplus can be represented in a diagram. Using the figures from Marshall's example, price is on the vertical axis and tea is on the horizontal axis. The demand curve as drawn illustrates two assumptions. First, the demand curve is drawn as a straight line which implies that the good is infinitely divisible. The second assumption is that tea is a normal good.[6] This assumption ensures that the demand curve is downward sloping.

The consumer's surplus for a price of $14.00 per pound in Figure I is the shaded triangle BP_2A. This shaded area represents the excess

CONSUMER'S SURPLUS AS A VERTICAL DISTANCE BETWEEN INDIFFERENCE CURVES

(THE MARGINAL UTILITY OF INCOME HELD CONSTANT)

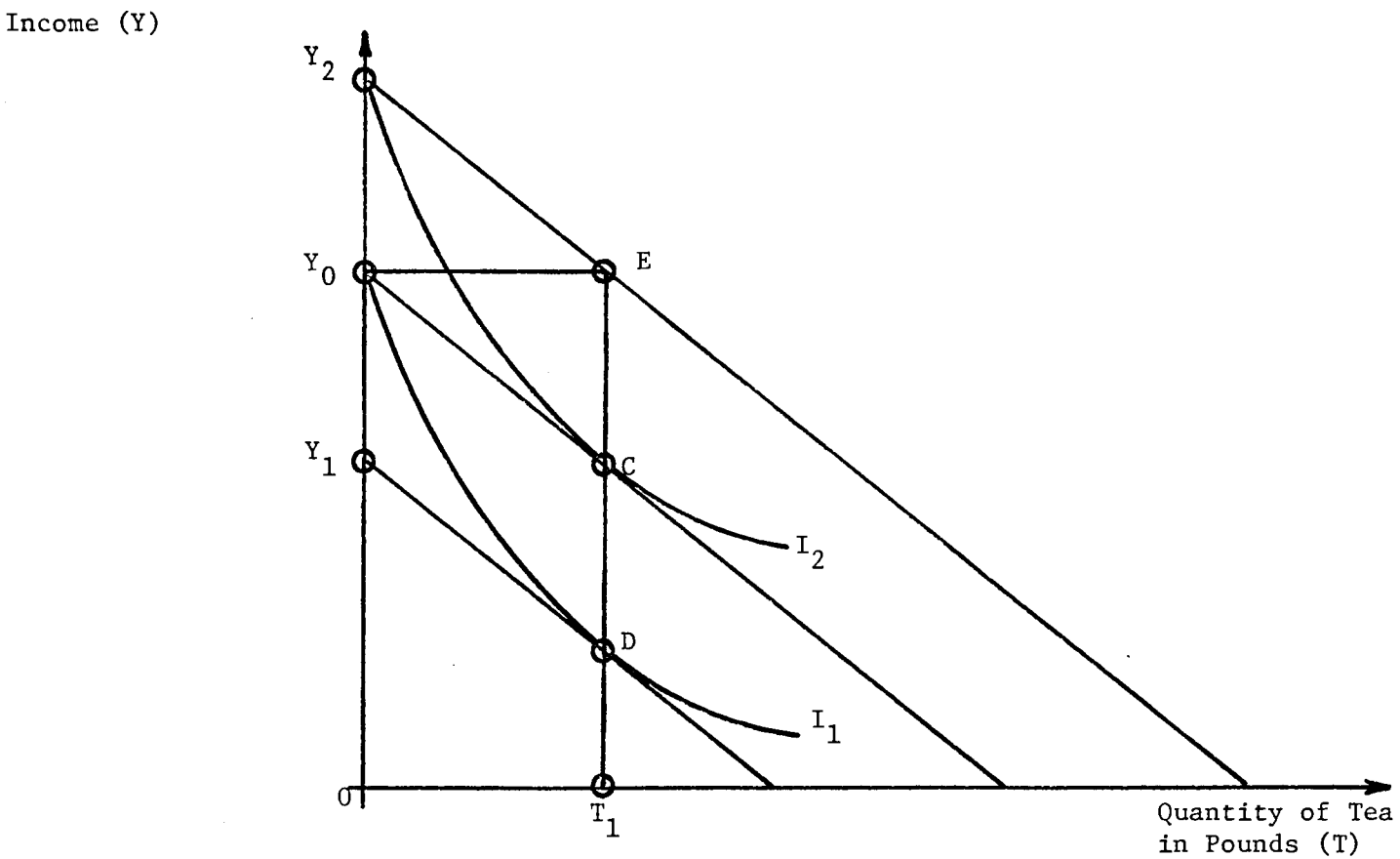


FIGURE II

benefits which the consumer derives above the price paid as described by Marshall.

Comparison of the Marshallian and Hicksian Consumer's Surpluses

A more satisfactory method of illustrating both the Marshallian and Hicksian consumer's surplus measures is through the use of indifference curves. By drawing indifference curves, the depiction and the discussion of four consumer's surplus measures, two Marshallian and two Hicksian, is made clearer.

Figure II represents the four consumer's surpluses. Marshall's consumer's surplus measures are based on "the excess of the price which (the consumer) would be prepared to pay rather than do without (the good), over that which he actually does pay" (Marshall, 1920, 103).

Hicks' two versions of consumer's surplus are drawn from the following:

> ...the best way of looking at consumer's surplus is to regard it as a means of expressing in terms of money income, the gain which accrues to the consumer as a result in the fall in price. Or better, it is the compensating variation in income, whose loss would just offset the fall in price and leave the consumer no better off than before (Hicks, 1939, 40-41).

Although Hicks and Marshall describe consumer's surplus in terms of money, these sums are not the same unless a special condition holds (Henderson, 1941, 117; Patinkin, 1963, 93-5). This special condition which must hold in order to make the Hicksian and Marshallian surpluses equal is the assumption that the marginal

utility of income is constant at least over a given range[7] (Stigler, 1966, 78-81). Stating that marginal utility of income is constant over the range of from one to two thousand dollars is to say that a consumer derives the same utility from his one thousandth dollar of income as he does from his two thousandth dollar. This means that income is not subject to diminishing marginal utility or diminishing marginal rates of substitution over this range.

Figure II has been drawn assuming the constancy of the marginal utility of income and the independence of the marginal utilities of tea and income. In the diagram, income (Y) is on the vertical axis and tea (T) in pounds is on the horizontal axis.

The marginal utility of income assumption is indicated by the fact that the distance from points C to D are equal to the distance Y_0 to Y_1 in Figure II. The fact that the distance between the two sets of points and any other set of points is the same indicates that the indifference curves pictured are vertically parallel throughout. This last statement implies that vertical distances in the centre of the diagram can always be translated to distances on the vertical axis.

Using Figure II, the four consumer's surplus measures can be pictorially illustrated. Marshall's consumer's surplus measures are C to D by definition and Y_0 to Y_2 by extrapolation.[8] The distance from C to D may be explained as follows.

The consumer starts out with OY_0 income and no tea on indifference curve I_1. In order to maximize his utility the consumer trades money for tea until he reaches point C which is tangential to indifference curve I_2. The consumer has spent a sum of money equal to the

vertical distance EC for the quantity of tea, T_1. If the individual was now allowed to keep T_1 but he had to pay more, his total willingness to pay would be equal to E to D. This is an increase of money paid equal to the distance between C and D. At D, the consumer still has T_1 quantity of tea, and is on indifference curve I_1.

Being on indifference curve I_1 indicates that this person is as well-off having paid a total of E to D for T_1 as he was when he had OY_0 income and no tea. The consumer would not be willing to pay any more than the total of E to D. If the individual did pay a sum greater than E to D, this would leave the consumer on an indifference curve below I_1. Any indifference curve lying to the left of I_1 on the graph means that the consumer has less utility than on I_1. If the consumer instead pays a sum greater than E to C but less than E to D, he will still be better off than when he was at OY_0 on indifference curve I_1. The distance from C to D then represents the maximum increase a consumer would pay out rather than do without the quantity T_1 of tea. This then is one measure of consumer's surplus.

Although Marshall does not discuss a second consumer's surplus measure directly, Henderson (1941, 119) derives and explains a second measure, Y_0 to Y_2. If the consumer was faced with a situation where he must give up all rights to purchase tea, he would want to be compensated to forego this consumption. Following along indifference curve I_2 where the consumer maximized utility at point C, a point of OY_0 is reached. This point represents a situation where the individual no longer has any tea but is on the same indifference

curve where his utility was highest. The compensation required then is equal to the distance between Y_0 and Y_2. In fact the consumer then is asking for E to C plus Y_0Y_2. He will in the Marshallian situation only receive E to C. The Y_0Y_2 surplus comes about by the consumer still having the commodity available for purchase "after deducting the sum he could set free by giving it up" (Henderson, 1941, p. 119).

The distances Y_0Y_1 and Y_0Y_2 represent Hicks' measures of consumer's surplus. Y_0Y_1 represents the surplus where an individual is allowed to continue purchasing a good in whatever quantities he chooses while giving up a portion of his income. In Marshall's first measure of consumer's surplus, the consumer is forced to continue consuming T_1. The individual in the Hicksian case will not continue consuming the same quantity as he started out consuming unless the indifference curves are vertically parallel. In Hicks' situation the consumer again starts out on indifference curve I_1 with OY_0 income and no tea. The individual moves to point C on I_2 in order to maximize his satisfaction. Now assume a law is passed which requires a license in order to consume tea. The government will receive the money from the purchase of the license, represented by the distance Y_0Y_1, and the consumer may buy whatever quantity of tea he prefers. As in the Marshallian case, assuming the constancy of the marginal utility of income, the individual would choose to continue consuming T_1 quantity of tea and maximize his utility by being at point D on I_1 (Figure II).

CONSUMER'S SURPLUS AS A VERTICAL DISTANCE BETWEEN INDIFFERENCE CURVES

(THE MARGINAL UTILITY OF INCOME NOT HELD CONSTANT)

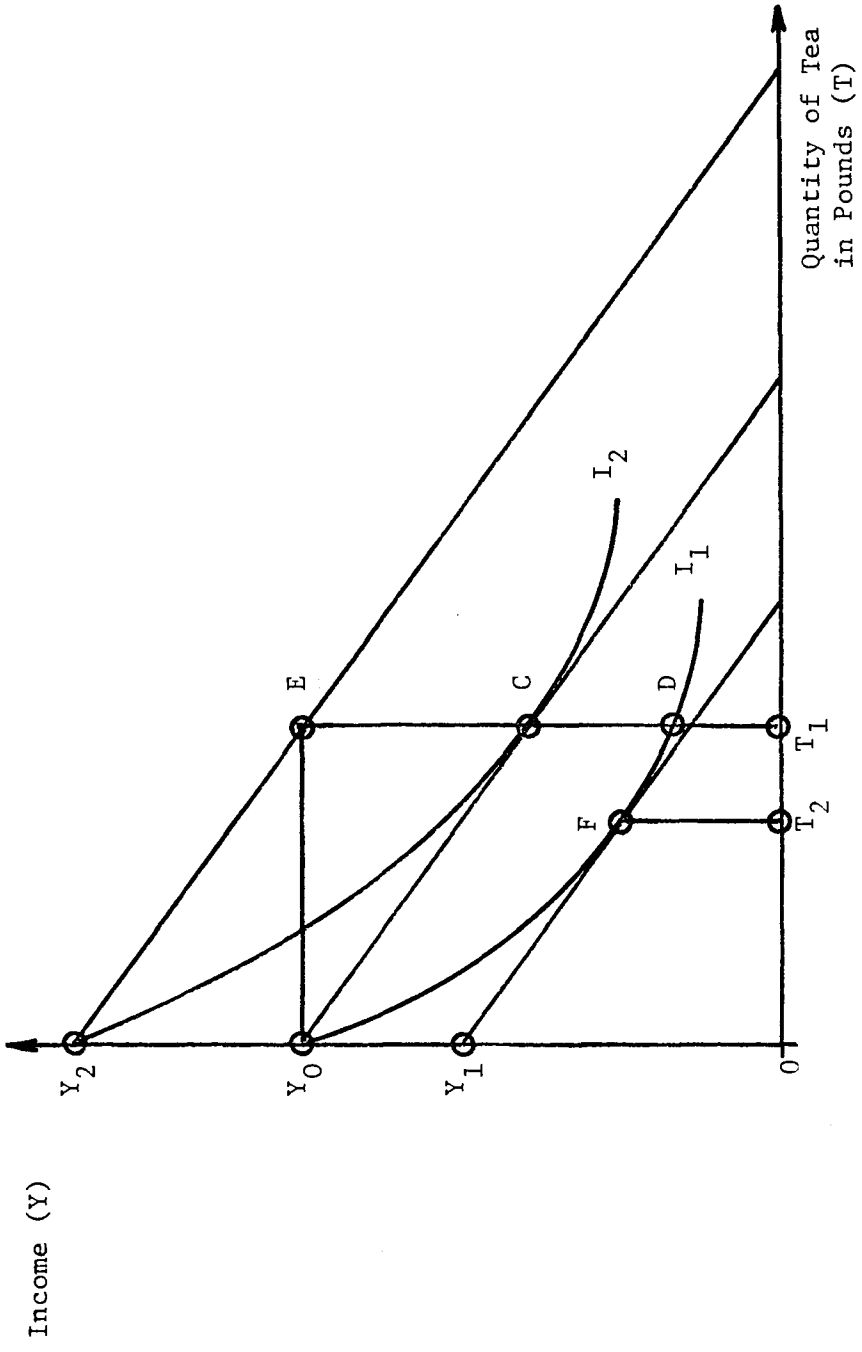


FIGURE III

If the marginal utility of income is not constant, then a situation as depicted in Figure III will occur. In Figure III the individual begins at point C having T_1 quantity of tea. In Marshall's example the consumer must continue to consume T_1 but pays a higher price for tea (E to D). The consumer will be at point D on I_1 but will not be maximizing his satisfaction.

In order to maximize his utility in this last situation, the consumer would be at point F where the budget line, Y_1, is just tangential to I_1. Point F represents the Hicksian solution when the consumer pays a license fee but chooses a new level of consumption, T_2. This Hicksian solution, called the compensating variation, where the marginal utility of income is not constant will always lie to the left of the Marshallian point (D) as long as the good in question is not an inferior good (Henderson, 1941, 118; Mishan, 1975, 417-8).

The final measure of consumer's surplus is represented by the distance Y_0Y_2 (Mishan, 1975, 418) and is named the equivalent variation of consumer's surplus. In the Hicksian formulation this is compensation which must actually be paid to the consumer in order to get him to stop consuming the good.

The equivalent variation represents the same distance as the second Marshallian surplus measure and has a similar explanation. After arriving at point C the consumer will be indifferent between consuming T_1 quantity of tea and being at point OY_2 as both C and Y_2 are on indifference curve I_2. At either point the consumer is equally well off. The difference in this measurement between the

Hicksian case and the Marshallian case is that in the Hicksian case Y_0Y_2 is actually paid to the consumer while in the Marshallian case this sum is not paid to anyone. Instead in Marshall's example the consumer is allowed to keep all of his income and the opportunity to buy the commodity. In this final comparison it should be noted that the Marshallian and Hicksian measures, Y_0Y_2, are equal. Only the way individuals are compensated differs (Henderson, 1941, p. 119).

A relationship between the four measures of consumer's surplus exists when the marginal utility of income is not assumed fixed. If the good being referred to is not an inferior good, then the Y_0Y_2 measure will be greater than the Y_0Y_1. As noted above Y_0Y_1 is greater than the CD measure.[9] Y_0Y_2 will be the largest measure because of the way that diminishing marginal utility of income affects the indifference curves.

By examining the compensating, equivalent and Marshallian consumer's surplus measures, it can be shown how the four measures are related. The relationships have been examined under conditions of constant and non-constant marginal utility of income. The issue now to be examined is what is the magnitude of difference between these measures.

Small versus Large Variance in Consumer's Surplus Measures

In a paper titled "Consumer's Surplus and the Compensating Variation", Henderson (1941) states the expected relationships between the surplus as follows. (Underlining has been added).

> The solution here suggested is that there are four alternative expressions of the consumer's surplus

> from which we have to choose one in each particular case according to the problem with which we are dealing. The solution certainly has the disadvantage of introducing complexity into a field where it is of singularly little practical importance, since we shall normally expect the four results to lie so close together that it would not matter which we chose and, in any case, when we use the concept we do so without making any pretensions of accuracy (Henderson, 1941, 121).

Clearly, Henderson believes that the four measures will be close together and he does so even though he does not assume the constancy of the marginal utility of income. Also, the changes Henderson makes in the individual's consumption are large and not the small shifts made in Marshall's discussion which more realistically allowed the marginal utility of income to be assumed to remain constant (Marshall, 1920, 103-4).

Before continuing on to a discussion of what the empirical evidence shows the relationship to be between the four consumer's surplus expressions, Henderson's reasoning should be further examined.

Given a consumer who has an income, Y, and who is consuming many goods, it is possible to establish and equate ratios between the marginal utility of the goods and the respective prices. This gives:

$$\frac{MU_A}{P_A} = \frac{MU_B}{P_B} = \frac{MU_C}{P_C} = \ldots = \frac{MU_N}{P_N} = \frac{MU_X}{P_X} = \frac{MU_Y}{P_Y} = \lambda$$

The symbol λ represents the number to which all the ratios must be equal including the ratio for money (Y). The above relationships exist for the individual unless something occurs which upsets the balance. One such disturbance could be a price change.

If the price of A falls by one-half and if B is a close substitute for A, the consumer will buy less of A and more of B. This altering of the money spent on A and B will change the relationships of $\frac{MU_A}{P_A}$ and $\frac{MU_B}{P_B}$ such that these ratios may not equal λ. In this case then, all the ratios could be expected to change, thus altering λ.

Henderson's point is different from the above explanation. In effect Henderson is saying that there could be at least two cases where λ will not change or if λ does alter, the magnitude of change will be so small as to cause only a slight divergence in the two consumer's surplus measures.

The first case is that of few substitutes. If an individual is faced with a price change for good A and he is buying no, or only a few, close substitutes, then there will be only a distributional effect. The distributional effect implies that the ratios of the few close substitutes will alter until equality is again reached with λ. If there are no close substitutes, then only the ratio of A will change and it must equal λ.

The second case represents a situation where many or all of the goods are close substitutes. In this instance a ten percent change in the price of A will cause a diffusion effect. This diffusion effect means that if P_A falls by ten percent all the ratios will change by some small amount. This means that λ will also change by a small factor. If λ changes by the magnitude of say one one-hundredth of a percent after all the ratios have stabilized, then this disruption could not cause a large difference in consumer's surplus measures.

As Henderson's logic appears to hold, the problem now becomes one of determining why, when consumer's surplus is used empirically, the variance between the measures is so vastly different. This difference is particularly evidenced when comparing the compensating and equivalent variations. The next chapter will set out not only the results of older studies but also those obtained from a new empirical study. This will be done in order to illustrate that the variance between the consumer's surplus measures is not an isolated incident but rather a widespread phenomena.

FOOTNOTES

1 In reality not all individuals have to be better off. The condition which must hold is that the gainers could compensate losers and still be better off than before the situation changed (Krutilla and Fisher, 1975, 28-9).

2 The present literature uses at least three different terms to mean approximately the same thing. The terms are consumer's surplus, consumers' surplus and consumer-surplus. The first and second are used ambiguously to mean both an individual and a society although some writers attempt to separate the terms (Hammack and Brown, 1974, 26-9; Mishan, 1975, 25-54). The third term, consumer-surplus, is used by Harberger (1971) in an attempt to avoid ambiguity but it is not clear from the article whether this purpose is accomplished.

3 Aggregation does have its pitfalls but as a measure of benefits, consumer's surplus is the best economists often have to offer as suggested by Harberger (1971).

4 Although this essay is not directly concerned with the problems involved in attempting to aggregate consumer's surplus values, it should be noted that such a problem does exist (Harberger, 1971, 787-9). This essay is an attempt to examine only the way consumer's surplus is used in a particular setting and does not concern itself with other theoretical problems of this concept (Samuelson, 1942, 75-8; Willig, 1976).

5 Most economists agree that the first discussion of consumer's surplus appeared in Dupuit's Annales des Ponts et Chaussees (1844). Marshall though is credited with explaining and popularizing the concept. For a detailed historical account of utility theory, see Stigler (1950).

6 Marshall assumed diminishing marginal utility which he thought ensured downward sloping demand curves. This condition did not prove to be necessary and sufficient as Marshall expected (Marshall, 1920, 78-85; Hicks, 1939, 26-7). Hicks, also, thought he had the necessary and sufficient condition to ensure downward sloping demand curves by assuming diminishing marginal rates of substitution (Hicks, 1939, 32). Hicks discovered that this concept did not ensure downward sloping demand curves either. Finally, the one assumption Hicks made which gave downward sloping demand curves in the aggregate was that the good represented by the curve was a normal good (Hicks, 1939, 35). This means, according to Hicks, that a negative income effect will not be so large as to outweigh the substitution effect and thereby causing a positively sloped demand curve.

7 Samuelson (1947, 99) uses the marginal utility of money and the marginal utility of income interchangeably. Samuelson, though, prefers the latter of these two terms because this term avoids the numeraire problems. (For a further discussion of problems with holding the marginal utility of income constant, see Samuelson, 1942). Mishan (1975, 417 footnote) makes a strong distinction

between the marginal utility of money and income saying that holding the marginal utility of money constant is not the same thing as holding real income constant. Real income, according to Mishan's interpretation of Hicks, is what must be held constant. Real income is held constant in Hicks' examples of compensating variations by increasing or decreasing money income. Consequently, in this essay the marginal utility of income will be used to indicate what is held constant.

8 Marshall did not specifically discuss a consumer's surplus measure of Y_0 to Y_2 but Henderson (1941, 119) illustrates how this measure can be deduced from Marshall's writing. In Henderson's words, one can suggest the Y_0-Y_2 consumer's surplus measure as follows:

> Marshall, himself, did not need to take this consideration into account since he was operating with the assumption of the constancy of the marginal utility of money which is sufficient to ensure that the two results are the same, but when we abandon this assumption the dual solution is as relevant to the Marshallian consumer's surplus as it is to the compensatory solution.

9 It should be noted that this explanation of which measure is the largest relies heavily on diminishing marginal utility. This explanation of Y_0-$Y_2 \geq Y_0$-$Y_1 \geq$ CD comes from the standard viewpoints as expressed by Henderson and Patinkin.

A criticism of this explanation deals with negative cross effects. For example:

$$P_Y^2 MU_{XX} + 2P_X P_Y MU_{XY} + P_X^2 MU_{YY} < 0$$

where P_Y is the price of good Y, P_X is the price of good X, MU_{XX} is the rate of change of the marginal utility of X with respect to X, MU_{YY} is the rate of change of the marginal utility of Y with respect to Y and MU_{XY} is the rate of change of X with respect to Y. Also MU_{XY} is equal to MU_{YX}. MU_{XX} and $MU_{YY} > 0$ and $MU_{XY} < 0$. If MU_{XY} is extremely negative, this cross-effect can cancel out the positive MU_{XX} and MU_{YY}. In order for this MU_{XY} to be sufficiently negative to cancel the other two terms out implies that the X and Y goods be either extreme substitutes or extreme compliments. Extreme substitutes would mean that the goods are so close in nature as actually to be the same composite good. If the two goods were extreme compliments such as left and right shoes and only the left shoe is sold, again MU_{XY} could be sufficiently negative to cancel out the positive MU_{XX} and MU_{YY}. Otherwise the MU_{XY} will not be sufficiently negative to cause this overwhelming of MU_{XX} and MU_{YY} (Henderson and Quandt, 1971, 31-9).

Also, as mentioned before the discussion of which consumer's surplus measures are largest is based on the usual view found in the presently accepted literature.

CHAPTER III

Two Empirical Studies

In the last chapter the notion of consumer's surplus and its use as a measure of welfare change was explained in general terms. The explanation was discussed with the intention of examining how consumer's surplus is applied in economics. The next point to consider will be how consumer's surplus is used in empirical studies. These studies offer a springboard for contrasting the theoretical relationships between consumer's surplus measures and the relationships uncovered empirically.

Using the Hicksian compensating and equivalent variations, the discussion will first outline a previously reported study (Hammack and Brown, 1974) which indicates that these two consumer's surplus measures have an unpredicted relationship. In order to verify Hammack and Brown's results, a second more recent study is also reported. The verification of the Hammack and Brown findings will serve as the launching point for causal explanations of the divergence between the theoretical and the empirical consumer's surplus relationships.

Empirical Studies and Consumer's Surplus

In 1969 a study of waterfowl hunters was undertaken in order to produce a valuation of waterfowl and wetlands (Hammack and Brown, 1974, 1). The valuation was to be used in decisions relating to the creation of new wetlands or the draining of existing wetlands. These

decisions were to be made based on the valuation of waterfowl as represented by the demand for the use of the resource and on an estimated biological supply function. The valuation or demand presentation was the side of the model which dealt with consumer's surplus and, therefore, is the side examined here.

The valuation of waterfowl was based on a survey technique which asked many questions about the respondent's socio-economic characteristics and hunting habits. The questions on the survey which were intended to be used in measuring benefits were:

> Question 6: "What is the <u>smallest</u> amount you think you would take to give up your right to hunt waterfowl for a season?"
>
> Question 8: "About <u>how much greater</u> do you think your costs would have had to have been before you would have decided not to have gone hunting <u>at all</u> during that season?" (Hammack and Brown, (1974), 91-2).

In their discussion, Hammack and Brown call Question 6 the "willingness to sell" and Question 8 the "willingness to pay" (Hammack and Brown, 1974, 6-7). The answers given to these two questions were then taken to be the two Hicksian measures of consumer's surplus.[1]

The willingness to sell (Question 6) is assumed to be the equivalent variation indicated as Y_0Y_2 on Figures II and III in Chapter II. This equivalent variation represents the compensation required to remove a resource or a good from the market and thus, from an individual's consumption bundle.

The compensating variation (Hicks, 1939, 40) is taken to be the equivalent of the willingness to pay value. This measure of consumer's

surplus is the extra amount an individual would pay in order to continue consuming a good rather than do without it. In Figures II and III in Chapter II the compensating variation is indicated by the distance Y_0Y_1.

Although Henderson discusses four consumer's surpluses, Hammack and Brown are talking about only two of these expressions. Henderson (1941, 121) expects all four measures to lie close together. If this comment is true for four measurements, then one can expect that any two of the measures will also be close together. Consequently, there should be no reason why Hammack and Brown's use of only two of the measures should cause any distress.

Knowing that Henderson's (1941, 21) theoretical discussion predicts only a small difference between consumer's surplus measures, Hammack and Brown's results need close examination. After dropping extremely high values and "not willing to sell" responses from their survey data, the sample size of 1,511 yielded a mean value for the willingness to sell (equivalent variation) of $1,044 (Hammack and Brown, 1974, 26). In contrast the mean value of the willingness to pay question was $247. This means that the equivalent variation was just over four times as large as the compensating measure. Such a variance between answers cannot be described in any way as "close".

Hammack and Brown do not pursue a vigorous explanation of the difference between the two consumer's surplus measures. Instead, Hammack and Brown, by claiming that the property rights were most realistically assigned by the willingness to pay question and that

the responses to the willingness to sell query were "too emotionally biased", decided to use only the compensating variation as a consumer's surplus measure (Hammack and Brown, 1974, 26-7).

After determining which measure of consumer's surplus to employ, Hammack and Brown set up the model for waterfowl evaluation. Such a model would point out the determinants and importance of the factors responsible for variations in the willingness to pay among different individuals. This model was $V = V(Y, U, D/Z, Z)$ where the consumer's surplus measure is represented by V. The exogenous variables are an income measure (Y), a measure of taste (U), one hunter's daily bagged waterfowl (D/Z) and the number of days the respondent hunted in one season (Z) (Hammack and Brown, 1974, 23).

The questions on the survey were designed to gather some measure of each of these variables. As pointed out earlier the consumer's surplus measure, (V), was willingness to pay. The observations of Y, D and Z came directly from answers to survey questions asked. The general measure of taste, (U), was replaced by (E). (E) was taken to be the responses to a question regarding the individual's average cost for hunting incurred per season. This replacement was made on the assumption that the more ardent the hunter, the more he will spend.

The model was run in three forms, total logarithmic, reciprocal and semi-logarithmic transformations. The best results[2] were obtained using the total logarithmic transformation while the poorest fit came from the reciprocal function. The best equation form and fit are reproduced here:

$$\ln V = 1.44 + \underset{(8.7)}{0.466}\ln Y + \underset{(4.5)}{0.168}\ln S + \underset{(5.3)}{0.141}\ln E + \underset{(7.0)}{0.308}\ln D/Z + \underset{(12.5)}{0.480}\ln Z$$

(t-values)

$\bar{R}^2 = 0.222$, $S^2 = 1.70$, n = 1511 (Hammack and Brown, 1974, 28).

An independent variable (S) was added to the model. This variable represented the total number of seasons an individual had hunted which was expected to exert a positive effect on willingness to pay because of the greater appreciation and awareness of the value offered by the opportunity.

The authors also note that other independent variables were tested. These variables, tested in dummy variable form, were level of education, whether or not the hunters paid to hunt on private land, state of residence and response to first mailing. All these variables were rejected because of insignificant t-values (Hammack and Brown, 1974, 30).

Those variables used by Hammack and Brown in the best regression, reproduced above, all had positive coefficients. This is a reasonable result when the relationship of willingness to pay to each of the independent variables is examined separately.

If income increases, it is reasonable for the individual to be willing to pay more for the right to hunt. This reasoning carries over to the relationship between willingness to pay and the average cost.

The positive coefficients associated with the number of seasons hunted, the number of days hunted per season and the number of bagged waterfowl per season are explained as follows. Individuals usually do not spend their leisure time in activities such as hunting if they are not willing to pay for the activity. Payment, however, does not always imply a monetary fee. Here, part of the payment for hunting

is the opportunity cost of participating evidenced in the days hunted per season and the total seasons hunted.

Finally, if the hunter is good at bagging waterfowl or there is a plentiful supply of game to assure greater success, then the hunter should reasonably be willing to pay more for the opportunity to continue hunting. For leisure activities this relationship can be expected to be positive as long as the activity is not an inferior good.

Hammack and Brown as noted chose to ignore the willingness to sell consumer's surplus expression because its value was "biased by the emotions of those surveyed" (1974, 26-7). Although ignoring the willingness to sell values because of assigning explicit property rights is valid, the idea of ignoring this measure on the basis that it is answered too emotionally seems to be a mistake. When viewed as a valid measure of consumer's surplus, one wonders how Hammack and Brown know that it is answered only emotionally. By not running regressions and tests on this measure, no knowledge of what can (or could) cause the extreme answers is found.

Having new data available not only offered the opportunity to verify the Hammack and Brown results but also offered the opportunity to examine the equivalent consumer's surplus variation (willingness to sell). The following section outlines the new study and procedures used.

Environment Canada's Sport Fishing Survey

In 1975 Environment Canada, Fisheries and Marine Service, under the direction of William F. Sinclair conducted a survey on

TABLE I

[Condensed from the Environment Canada's Table IV.1 reproduced in Appendix A]

Mail Survey

Total Number of Fishing License Holders	Number Drawn for Sample		Number of Usable Completed Responses	
	Number	Percentage	Number	Percentage
25,636	3192	12.5	2140	8.4

Telephone Survey

Total Mail Survey Returns Drawn for Telephone Survey			Completed Telephone Survey Interviews		
Number	Percent of Mail Returns	Percent of Fishing Licenses	Number	Percent of Sample Drawn	Percent of Fishing Licenses
1192	55.7	4.7	950	79.7	3.7

Note: The response to the mail survey was 67% which was accomplished by five mailings, one for the original survey and then four mailings of follow-up letters.

sport fishing in northern British Columbia. The survey was conducted in order to measure the economic importance of fishing to the population of the Yellowhead, B.C., region -- an area of B.C. from Prince Rupert to Prince George.

The survey was originally mailed in April, 1975, to a sample of valid 1974 fishing license holders. The surveys, follow-up letters, Environment Canada data codes and two tables illustrating the usage of the data by the government agency are reproduced in Appendix A. When the mail surveys were returned, all those containing a telephone number were contacted by phone.

The mail survey produced 2,140 usable responses. Of the 2,140, 950 were contacted a second time. Table I, a condensation of the two government tables found in Appendix A, illustrates the total surveys in terms of percentages of (1) total license holders and (2) surveys completed and returned.[3]

Before proceeding to a discussion of the regression model, one simple statistical comparison should be made between the Hammack and Brown data and the fishing survey data. In the Hammack and Brown survey the mean values for the compensating and equivalent variations were $247 and $1,044 respectively (Hammack and Brown, 1974, 26). The mean values for these two consumer's surplus measures calculated from the fishing data are $55 for the compensating variation and $24,382 for the equivalent variation.

Although the fishing data has values which have a larger variance, the equivalent variation in the hunting data was adjusted to exclude extremely large answers while the fishing data was not so adjusted.

TABLE II

Variables Selected for Regressions

Name of Variable	Model Name
Region (D)*	RD1 thru RD5
Identification Number	IDNBR[1]
Total Anglers in Family	TOTANG
Age of Household Head (D)	DAGE1 thru DAGE8
Sex of Household Head (D)	DSEX
Number of Days Fished by Household Members in 1974	HDFY74
Occupation of Household Head (D)	OCC1 thru OCC9
Gross Annual Income of Household	INCOME
Years Resided in Yellowhead	YRSRY
Days Normally Fished per Year in Yellowhead	DNFYY
Days Fished in 1974 in Yellowhead	DF74Y
Preferred Type of Fishing (D)	PTYF1 thru PTYF4
Days Fished at First Favorite Location	DFIST
Mailing Responded to by Household (D)	MAIL1 thru MAIL9
Compensation Require to Forego Usage of First Favorite Fishing Location	COMPR
Average Cost per Day for First Favorite Fishing Location	AVCPD
Willingness to Pay for First Favorite Fishing Location	WILLPA
Actual Location of Residence	REGID[1]

---

* (D) denotes dummy variable

[1]Used only for identification purposes

Since the two sets of data were not handled in the same manner, it is interesting to note the medians and the modes from the fishing survey. The median and mode for the willingness to pay, the compensating value, were $35 and $50. The willingness to sell had a median of $700 and a mode of $1,000. Clearly, what is illustrated by these values is that the differential between answers is very large no matter which statistic is chosen as an evaluator.

Since the model used in this paper was to be a rough approximation of the Hammack and Brown formulation, variables had to be singled out as useful. The variable list and the computer variable code names are reproduced in Table II.

Variables which were determined to be close approximations to the variables in the Hammack and Brown work were: (1) number of days fished by household members in 1974, (2) gross annual income of household, (3) days normally fished per year in the Yellowhead region, (4) days fished in 1974 in Yellowhead, (5) compensation required, (6) average fishing related expenditures per day of fishing and (7) willingness to pay.

A second set of variables was chosen and tested even though Hammack and Brown had found them to be insignificant. These variables are: (1) the mailing responded to and (2) the area of residence.

Finally, a third type of variable was selected. This third type was not used by Hammack and Brown but was suspected to have an effect on the respondents' consumer's surplus measures. These variables were: (1) total anglers per family, (2) age of household head, (3) sex of household head, (4) occupation of household head, (5) years resided in Yellowhead, (6) preferred type of fishing and (7) days fished at first

TABLE III

Explanation of Dummy Variables

Name of Variable	Variable Specifications
Region (RD1 - RD5)	
RD1	Prince George
RD2	Kitimat, Terrace, Prince Rupert
RD3	Smithers, Hazelton, Telkwa, Kitiwanga, Houston
RD4	Burns Lake, Granisle, Takysie Lake, Southbank
RD5	Vanderhoof, Fraser Lake, Fort Fraser, Endaka, Fort St.James, Engen
Age of Household Head (DAGE1-DAGE8)	
DAGE1	0 to 9 years
DAGE2	10 to 19 years
DAGE3	20 to 29 years
DAGE4	30 to 39 years
DAGE5	40 to 49 years
DAGE6	50 to 59 years
DAGE7	60 to 69 years
DAGE8	70 and over
Sex of Household Head (DSEX)	
DSEX	1 if a Male head of family 0 if a Female head of family

Occupation of Household Head (OCC1 - OCC9)

OCC1	Labourer
OCC2	Tradesman or Technical
OCC3	Professional
OCC4	Sales
OCC5	Clerical
OCC6	Management and Executive
OCC7	Self-employed
OCC8	Retired
OCC9	Other

Preferred Type of Fishing (PTYF1 - PTYF4)

PTYF1	Lake
PTYF2	River (or stream)
PTYF3	No preference
PTYF4	Salt water

Mailing Responded to (MAIL1 - MAIL9)

MAIL1	First mail completed
MAIL2	Second or third mail completed
MAIL3	Fourth or fifth mail completed
MAIL4	First mail incompleted
MAIL5	Second or third mail incompleted
MAIL6	Fourth or fifth mail incompleted
MAIL7	First mail recompleted
MAIL8	Second or third mail recompleted
MAIL9	Fourth or fifth mail recompleted

favorite location. These variables were chosen because they may characterize or reflect on the respondent's lifestyle and mirror differences in the values associated with fishing opportunities. Therefore, although such variables are not commonly found in regression models, it is plausible that they may influence an individual's answers to the willingness to pay and/or compensation required questions.

After matching the telephone and mail surveys, 944 surveys were available for sorting on missing data. This sorting procedure left a sample size of 785 for the regressions.

Most of the variables listed in Table II have self-explanatory names. The variables though which were used in dummy variable form need further clarification. This clarification and specification appears in Table III. The dummy variables are discrete rather than continuously quantifiable, but nevertheless may have a bearing upon explaining the dependent variable.

In order to understand the relationship of independent to dependent variables, it is necessary to suggest how the two types of variables are related. The two dependent variables were compensation required and willingness to pay. The willingness to pay relationships were primarily postulated on the basis of Hammack and Brown's regressions.

As no other study was located which attempted to use the equivalent variation in regressions,[4] its relationship to the dependent variables was a matter of speculation. Therefore, it was assumed that most variables would relate to compensation required in the same way they related to willingness to pay.

In the Hammack and Brown equation, reproduced earlier, the independent variables had positive relationships with willingness to pay. Variables in the fishing study which are close approximations to the Hammack and

Brown variables are income, the average cost per day, and the number of days fished in Yellowhead in 1974. There were no close substitutes in the fishing survey data for the hunting survey variable of the bagged waterfowl per day and the number of seasons hunted.

The expected relationships between the independent variables and the dependent variable were as follows. The age variable was expected to have both negative and positive signs depending on the age category. The older categories such as 40-49 years to 70 years and over were suspected to have positive signs. The other categories could have either sign and there was no indication before running the regressions as to what the signs would be.

The continuous, independent variables were expected to have positive coefficients especially as the numbers became larger. These variables were the total number of anglers per household and the number of days fished by the household.

Only speculations could be made concerning the signs of the coefficient of the mail variable. This variable was added basically in order to test whether those who responded first gave higher or lower answers to the willingness to pay and compensation required questions.

Having decided upon the variables to be used in the regressions and the hypothesized signs of the coefficients, the remainder of the fishing study involved attempting to reproduce the Hammack and Brown model and regression results. The following section describes the different regressions run and the results.

Regressions and Results

As described above the Hammack and Brown model was to be used as the starting point for regressions on the fishing survey data. The

TABLE IV

Willingness to Pay Regression Results

Correlation of Independent Variables with Dependent	RD1	RD2	RD3	RD4	OCC1	OCC2	OCC3	OCC4
	0.14	-0.12	-0.02	-0.02	-0.09	-0.04	-0.02	0.04
		OCC5	OCC6	OCC7	OCC8	INCOME	AVCPD	
		-0.03	0.01	0.12	-0.04	0.09	0.61	

REGRESSION 1 (Form of Willpa = a+bX)

	INTERCEPT	OCC1	OCC2	OCC3	OCC4	OCC5	OCC6	OCC7	OCC8
Coefficient	23.92	-28.98	-27.50	-22.34	-30.06	-30.16	-31.10	-5.94	-26.52
t-values	---	- 2.01*	- 2.07*	- 1.50	- 1.85*	- 1.58	- 2.16*	-0.42	- 1.25

$\bar{R}^2$	0.38		INCOME	AVCPD
D.F.	774	(Coefficient)	0.79	1.83
Std. Error	62.77	(t-values)	2.35*	21.30*

REGRESSION 2 (Form of Willpa = a+bX)

	INTERCEPT	INCOME	AVCPD
Coefficient	0.50	0.72	1.84
t-values	----	2.23*	21.65*

$\bar{R}^2$	0.38
D.F.	782
Std. Error	63.07

REGRESSION 3 (Form of LN Willpa = A+BX)

	INTERCEPT	RD1	RD2	RD3	RD4	INCOME	AVCPD	SIMPLE CORRELATIONS**
Coefficient	2.85	0.20	0.01	0.10	0.05	0.01	0.02	RD1/RD2 =-0.75
t-values	---	1.49	0.07	0.61	0.24	2.00*	21.88*	

$\bar{R}^2$	0.42
D.F.	778
Std.Error	0.69

REGRESSION 4 (Form of LN Willpa = A+BX)

	INTERCEPT	INCOME	AVCP
Coefficient	2.95	0.01	0.02
t-values	---	2.11*	23.44*

$\bar{R}^2$ 0.42
D.F. 782
Std. Error 0.69

REGRESSION 5 (Form of Willpa = LN X + LN Z)

	INTERCEPT	LTOTA	LINCO	LYRSR	LDFIS	LAVCP
Coefficient	-114.10	-2.89	11.52	0.53	10.18	43.13
t-values	---	-0.60	1.72*	0.20	3.54*	15.70*

$\bar{R}^2$ 0.25
D.F. 779
Std. Error 69.50

REGRESSION 6 (Form of Willpa = LN X + LN Z)

	INTERCEPT	LINCO	LDFIS	LAVCP
Coefficient	-112.65	10.78	10.11	42.93
t-values	---	1.64	3.54*	15.88*

$\bar{R}^2$ 0.25
D.F. 781
Std.Error 69.43

REGRESSION 7 (Form of LN Will = LN X + LN Z)

	INTERCEPT	LTOTA	LHD74	LINCO	LYRSR	LDNFY	LDF74	LDFIS	LAVCP
Coefficient	0.89	-0.04	-0.01	0.12	0.03	0.11	-0.02	0.02	0.75
t-values	---	-0.97	-0.13	2.21*	1.55	2.57*	-0.35	0.61	33.52*

$\bar{R}^2$ 0.61
D.F. 776
Std.Error 0.57

REGRESSION 8 (Form of LN Will = LN X + LN Z)

	INTERCEPT	LINCO	LDFIS	LAVCP
Coefficient	1.03	0.12	0.80	0.75
t-values	---	2.31*	3.43*	33.94*

$\bar{R}^2$ 0.61
D.F. 781
Std.Error 0.57

SIMPLE CORRELATION***
LHD74/LDNFY = 0.81
LHD74/LDF74 = 0.93
LHD74/LDFIS = 0.63
LDNFY/LDF74 = 0.83
LDNFY/LDFIS = 0.70
LDF74/LDFIS = 0.65

---

* Students t-value one tailed test: significant at 5%.
** Simple correlations between independent variables >.4, here reported for nontransformed variables.
*** Simple correlations for transformed independent variables >.4.

TABLE V

Compensation Required Regression Results

Correlation of independent variables with Dependent Variable	RD1	RD2	RD3	RD4	OCC1	OCC2	OCC3	OCC4
	0.14	-0.12	-0.02	-0.02	-0.09	-0.04	-0.02	0.04
		OCC5	OCC6	OCC7	OCC8	INCOME	DFIST	AVCPD
		-0.03	0.01	0.12	-0.04	0.09	-0.01	0.61

BEST LINEAR RESULTS PARTIALLY REPRODUCED: (Form of Compr = a + bX)

Compr = f(Region, Age, Sex, Occupation, Years Resided in Yellowhead, Preferred Type of Fishing)

$\bar{R}^2$ 0.02 The only significant t-values were for PTYF1-PTYF3 and were respectively:

D.F. 760 -5.28, -5.15, and -5.14.[1]

Std. Error 133,093.68

REGRESSION 2 (Form of LN Compr = A + BX)

	INTERCEPT	RD1	RD2	RD3	RD4	OCC1	OCC2	OCC3	OCC4
Coefficient	5.84	0.66	1.08	0.53	0.77	-1.51	-0.75	-0.90	-1.20
t-values	---	1.36	2.17*	0.93	1.13	-2.65*	-1.44	-1.53	-1.88*

$\bar{R}^2$ 0.04

	OCC5	OCC6	OCC7	OCC8	INCOME	DFIST	AVCPD
D.F. 769 (Coefficient)	- 0.95	- 1.03	- 0.98	- 0.59	0.02	0.01	0.01
Std. Error 2.45 (t-values)	- 1.28	- 1.82*	- 1.75*	- 0.70	1.86*	3.39*	3.56*

REGRESSION 3 (Form of Compr = LN X + LN Z)

	INTERCEPT	LINCO	LDFIS	LAVCP
Coefficient	-56235.22	-1036.97	24347.54	11264.66
t-values	---	- 0.08	4.45*	2.18*

$\bar{R}^2$ 0.02

D.F. 781

Std.Error 132,983.67

REGRESSION 4 (Form of LN Compr = LN X + LN Z)

	INTERCEPT	LTOTA	LHD74	LINCO	LYRSR	LDNFY	LDF74	LDFIS	LAVCP
Coefficient	1.65	0.18	- 0.11	0.37	0.07	0.19	0.26	0.67	0.46
t-values	---	1.12	- 0.51	1.61	0.84	1.08	1.14	4.98*	5.01*

$\bar{R}^2$ 0.13
D.F. 776
Std.Error 2.34

REGRESSION 5 (Form of LN Compr = LN X + LN Z)

	INTERCEPT	LINCO	LDFIS	LAVCP
Coefficient	1.92	0.45	0.94	0.49
t-values	---	2.04*	9.72*	5.34*

$\bar{R}^2$ 0.12
D.F. 781
Std.Error 2.35

SIMPLE CORRELATION**
LHD74/LDNFY = 0.81
LHD74/LDF74 = 0.93
LHD74/LDFIS = 0.63
LDNFY/LDF74 = 0.83
LDNFY/LDFIS = 0.70
LDF74/LDFIS = 0.65

Correlation of LN Indep. VARIABLE with LN Dep. Var.	LTOTA	LHD74	LINCO	LYRSR	LDNFY	LDF74	LDFIS	LAVCP
	0.10	0.25	0.09	0.07	0.27	0.26	0.29	0.10

1 Simple Correlation for the nontransformed independent variables > .4:

RD1/RD2 = -0.75
RD2/PTFY1 = -0.44
RD2/PTYF2 = 0.43
DAGE3/DAGE4= -0.41
DAGE7/OCC8 = 0.43
HDFY74/DF74Y = 0.92
HDFY74/DFIST = -0.43
DF74Y/DFIST = 0.48
PTYF1/PTYF2 = -0.87

* Students t-value one tailed test: significant at 5%.

** Simple correlations between transformed independent variables >.4.

dependent variables in the equations were willingness to pay and compensation required. The regression forms used were the simple linear form, the total logarithmic form, and the semi-log forms.

The regression results are of interest in comparing the two sets of answers. The results from only the best regression runs are produced in Tables IV and V. Not all the variables described in the previous section are listed in the two tables. The variables excluded had little or no significance in explaining the variations in the dependent variables. Where variables added little to the $\bar{R}^2$ and had insignificant t-values (less than 1.65), these were dropped.[5] The results in Tables IV and V show that the total logarithmic functions and the positive variable signs of Hammack and Brown's regressions were verified in the fishing equations.

In the fishing regressions the average cost figure was based on a per day basis while the hunting regressions were based on a seasonal basis. This fact should not theoretically affect the results. The major differences between the best Hammack and Brown equation and the best willingness to pay equation (8) are, first, different variables. There are fewer variables in the fishing regression.

The second difference is the higher $\bar{R}^2$ in the fishing equation. In part this is due to a smaller sample size for the fishing survey, n = 785 as opposed to n = 1511 for the hunting survey. A smaller sample size causes less random variation than a larger size.

The third difference is in the t-values. The fishing survey has a more significant t-value for average cost but a less significant t-value for income.

A final difference to note is in the standard error. The standard error is smaller in the fishing regressions than in the waterfowl valuation equations.

Tables IV and V list the simple correlation between not only independent and dependent variables, but also the correlations greater than $\pm$ .4000 between independent variables. This is done with the purpose of examining how interdependent the independent variables actually are. The Hammack and Brown work does not note the correlation between variables. It would be of particular interest to see if in the waterfowl equations whether the willingness to pay measure is as highly correlated to the average cost figure as it is in the fishing results.

The compensation required equations tempt one to ignore them. Ignoring the results, however, would be a mistake. These regressions show that compensation required does not appear to be highly correlated to any of the independent variables.

The implication can be made that there must be other explanations for the willingness to sell answers. This is especially applicable when it is noticed that changing the regression form adds little to the $\bar{R}^2$. The largest $\bar{R}^2$ with significant t-values is 0.12. This is an increase of 0.10 from the first equation's $\bar{R}^2$ of 0.02. This change may seem sizeable except when compared to an $\bar{R}^2$ increase from 0.38 to 0.61 for the willingness to pay equations when the form is changed from linear to a total logarithmic function.

A final set of equations was attempted. This set of regressions was based on a suggestion[6] that consumer's surplus represents net benefits derived by the consumer. Harking back to Marshall's explanation

of consumer's surplus, the measure should be the area below the demand curve less the total price paid (see Figure I in Chapter II).

Not only is this regression theoretically appealing, it is also intuitively appealing. The individuals answering the survey may have interpreted the question on willingness to pay as the <u>total</u> sum of money they would pay out. As the survey question (see Appendix A) does not specifically ask for a value net of costs, the regression as outlined therefore was reasonable.

The closest representation of the price was the average cost per day. If willingness to pay was not net of costs, then willingness to pay could be used as a substitute for the total area below the demand curve. This would lead to an equation with willingness to pay <u>less</u> average cost per day (WILAV) as the dependent variable.

Two forms were run and the single best results of these equations are reproduced below.

$$\begin{aligned}
\text{WILAV} &= 29.08 + 20.06\ (\text{RD1}) + 12.91\ (\text{RD2}) + 15.00\ (\text{RD3}) \\
\text{(t-values)} &\qquad (1.53) \qquad\quad (0.96) \qquad\quad (0.97) \\
&+ 9.28\ (\text{RD4}) - 35.99\ (\text{OCC1}) - 31.16\ (\text{OCC2}) - 28.92\ (\text{OCC3}) \\
&\qquad (0.50) \qquad (-2.34) \qquad\quad (-2.20) \qquad\quad (-1.83) \\
&- 26.64\ (\text{OCC4}) - 37.77\ (\text{OCC5}) - 32.64\ (\text{OCC6}) - 5.47\ (\text{OCC7}) \\
&\qquad (-1.55) \qquad\quad (-1.88) \qquad\quad (-2.13) \qquad\quad (-0.36) \\
&- 33.13\ (\text{OCC8}) + 0.83\ (\text{INCOME}) \\
&\qquad (-1.47) \qquad\quad (2.33)
\end{aligned}$$

$\bar{R}^2 = 0.02$, Standard error = 66.41, n = 785

The above results are interesting although somewhat disappointing. The major indication of what occurred is the $\bar{R}^2$. The adjusted coefficient of determination is low and is much less than $\bar{R}^2$'s for the

willingness to pay equations. The t-values are not very significant except for occupations 1, 2, 3, 5 and 6 and income.

There may be several reasons why the willingness to pay less average cost per day regressions are insignificant. First, there may be costs such as queueing which are not taken into account.[7] Second, the willingness to pay may actually be net of costs. This is suggested by the coding sheet in Appendix A but only 180 respondents actually stated this. Given that 605 respondents did not say that the willingness to pay was net of costs, it may be concluded that the individuals in the total sample did not understand the question. If this is the case, then this sample including the 180 responses or excluding those same responses may not be valid.

Several conclusions can be derived from this chapter. Willingness to pay is very well explained by the variables that Hammack and Brown suggest. Also, the functional form of total logarithms provides the best fit for willingness to pay equations. The compensation required, equivalent variation, is not explained by any of the variables to any significant degree. The best fit for the equivalent variation was also the total log form but even this regression had little explanatory ability.

One conclusion which cannot be made is that the two measures lie close together. As pointed out above, the means, medians and modes between the compensating and equivalent variations of the fishing data are very large. These differences for the means are larger than the Hammack and Brown result due to the fact that no observations were dropped. This, however, does not explain the large differences

between the medians and the modes. Since no reason has been located which explains all the variation between the two measures, the next chapter will attempt to offer viable explanations for the observed differences.

FOOTNOTES

1 As Patinkin (1963, 88) points out, the Marshallian consumer's surplus cannot be measured.

2 "Best results" here mean the highest $\bar{R}^2$, the largest t-values associated with coefficients and the smallest standard error.

3 Table I is an illustration of the way Environment Canada used the data. The government has recently published its study (Sinclair, 1976). This publication does not discuss the large variance between the two consumer's surplus measures.

4 That is not to say that the use of the equivalent variation is never recommended in the literature. In fact, the "willingness to sell" is considered a very legitimate measure (Krutilla, et. al., 1972; Mishan, 1976).

What was not found as indicated was an actual study which used the equivalent measure in a set of regressions.

5 Certain variables were given an extra statistical test before they were discarded. These variables were occupation, age and region. The statistical test is one outlined by Maki (1971). The test is a partial F-test defined as:

$$\frac{(R_A^2 - R_B^2)(n - k_1 - k_2 - 1)}{(1 - R_A^2)K_1}$$

This partial F-test was attempted by taking the best regressions for both the willingness to pay and compensation required equations

and then adding one of the three variables, occupation, age and region. None of these variables, even given this special test, proved statistically significant at a 5% level of significance. The results of the tests are outlined in the following chart.

1. LCOMP = f(OCC1 - OCC8, LINCO, LDF1S, LAVCP)*

$$\text{Partial } F = \frac{(.13138 - .12346)(785-8-3-1)}{(1 - .13138)8} \doteq 0.88102$$

Critical F is 1.77, therefore 0.88102 < 1.77

2. LCOMP = f(RD1 - RD4, LINCO, LDFIS, LAVCP)*

$$\text{Partial } F = \frac{(.12669 - .12346)(785-4-3-1)}{(1 - .12669)4} \doteq 0.71845$$

Critical F is 2.385, therefore 0.71845 < 2.385

3. LCOMP = f(DAGE2 - DAGE8, LINCO, LDFIS, LAVCP)*

$$\text{Partial } F = \frac{(.12959 - .12346)(785-7-3-1)}{(1 - .12959)7} \doteq 0.77872$$

Critical F is 1.805, therefore 0.77872 < 1.805

4. LWILL = f(OCC1 - OCC8, LINCO, LDFIS, LAVCP)**

$$\text{Partial } F \frac{(.61272 - .60696)(785-8-3-1)}{(1 - .61272)8} \doteq 1.4371$$

Critical F is 1.77, therefore 1.4371 < 1.77

5. LWILL = f(RD1 - RD4, LINCO, LDFIS, LAVCP)**

$$\text{Partial } F = \frac{(.60976 - .60696)(785-4-3-1)}{(1 - .60976)4} \doteq 1.39376$$

Critical F is 2.385, therefore 1.39376 < 2.385

6. LWILL = f(DAGE2 - DAGE8, LINCO, LDFIS, LAVCP)**

$$\text{Partial } F = \frac{(.60800 - .60696)(785-7-3-1)}{(1 - .60800)(7)} \doteq 0.29335$$

Critical F is 1.805, therefore 0.29335 < 1.805

* These equations compared with LCOMP = f(LINCO, LDFIS, LAVCP) from Table V.

** These equations compared with LWILL = f(LINCO, LDFIS, LAVCP) from Table IV.

6 D.R. Maki in a conversation, 1976.

7 Barzel states that free goods are usually not free. That is a zero money price may exist but waiting time, etc. will be the rationing device which replaces the dollar price (Barzel, 1974, 73).

CHAPTER IV

Explanations of Variations in Consumer's Surplus Measures

Having presented the theory of consumer's surplus and having reported an actual set of survey results using consumer's surplus measures, the question still remains to be answered: "What explains the very large differences between the two consumer's surplus expressions?"[1] This chapter is an attempt to explain how the prescription of property rights may affect the responses of individuals surveyed. Secondly, this chapter will attempt to explain how the concepts of competition and monopoly may hold clues to the variance between the compensating and equivalent measurements.

Income Elasticity as an Explanation of Variance

Before explaining how property rights may affect the consumer's surplus measurements, it is necessary to understand the difference between explicit and implicit property rights. Explicit property rights are those rights set out by law assigning the use of a resource to a certain individual or group of individuals.[2] On the other hand, implicit rights are not set out by law but rather are property rights attained through usage.[3]

When discussing the uses of consumer's surplus in economics, the principle measurements are of implicit property rights. For example the hunting and fishing surveys measured individuals' rights to use a resource which they do not own. According to Hammack and Brown, however,

the two measurements of consumer's surplus can be used to explain why there is a variance between the two answers of an individual (1974, 6-7).

Given an income elasticity greater than zero means that the willingness to sell measure will be larger than the willingness to pay measure. In this situation income changes cause corresponding changes in the demand for the good. The positive income effect feeds into a respondent's answers to the two questions in the following manner. When the individual is asked to sell his property right, his answer reflects the constraint he feels due to his income. The willingness to sell answer is not, however, constrained by the individual's income. The situation as described holds as long as the good in question is not an inferior good.[5]

The above explanation only shows that one consumer's surplus variation will be greater than the other. What is not illustrated is why the equivalent variation is so very much larger than the compensating variation, especially over a relatively small range of a person's real income. Consequently, this explanation alone appears to be less than adequate and further explanations should be examined.

Property Rights and Non-Intrinsic Benefits

Chapter III cited a correlation between the willingness to pay responses and the average cost per day of an activity. This correlation indicates that the individual is deriving benefits from fishing above his costs and if necessary, would pay out that surplus in order to continue participation in this activity.

The willingness to pay figure was usually a small dollar amount and was always less than the individual's annual income. This illustrates how the income constraint of the individual bounds his answer to the willingness to pay question.

Alternatively, compensation required was not highly correlated with any exogenous variables including average cost and income. The implication is that the compensation required is not bounded by an income constraint. In support of this statement is the fact that most individuals surveyed in the B.C. sport fishing survey cited a compensation required which was much larger than their annual income. Willingness to sell, therefore, must be based on things internal to the respondents.

There are many internal processes which may influence the willingness to sell answers. Some of these internal factors that are related to the property rights assigned may be non-intrinsic benefits, internal rates of return, option demand and strategies used to answer questionnaires.

Non-intrinsic benefits refer to benefits which are not captured by the market price but which are derived by the property right owner. An example of a non-intrinsic benefit would be the memories an individual has surrounding his ancestral home. This benefit would not accrue to someone else buying the home and therefore, would not be included in the market price.

Although non-intrinsic benefits exist when the respondent answers both the willingness to pay and willingness to sell questions, the existence of these benefits will be to influence the answers differently.

Even when the individual derives non-intrinsic benefits from a property right, he will still answer the willingness to pay question according to his income constraint. Therefore, non-intrinsic benefits may cause an inflation of the willingness to pay answer but this answer will be smaller than the compensation required response.

The willingness to sell answer may be inflated by the individual responding for two reasons. First, the individual would attempt to ensure that if his property were taken away, he would be compensated for the loss of his non-intrinsic benefits. Second, the individual would increase his response to the willingness to sell question in order to stop the expropriation of his property right.

The fishing survey dealt with a region where substitute fishing locations abound in large numbers. With so many substitutes available the individual respondents may not have a strong preference between alternative fishing areas especially when noting that some of the fishermen had been fishing for only a few seasons. The implication is that the fishermen in question probably had not formed strong emotional feelings to any one particular lake or stream. Since 673 out of the 785 respondents to the fishing survey gave answers greater than the willingness to pay mean, it can be assumed that the non-intrinsic benefits do not explain all of the difference between the willingness to pay and willingness to sell responses.

Internal Rates of Return as an Explanation

A second reason for the large variance between an individual's reponses may be due to his internal rates of return. Internal rates

of return are numbers which when used to discount returns from assets, hypothetically make the present value of returns equal to zero (Herfindahl and Kneese, 1974, 198-9).

Different views of internal rates of return would only be an influence in the question regarding willingness to sell. When an individual is faced with losing an asset, he will attempt to extract a price larger than what he would be willing to pay. This larger response to the willingness to sell question is an attempt on the individual's part to recover the future benefits he has lost by having to sell his property.

The concept of internal rates of return may also be used to explain the variance in the answers of different individuals. At age 20 an individual expects to derive benefits from his property for approximately 45 more years. This implies that his answer to the willingness to sell response will be very large. On the other hand, an individual who is middle aged has a shorter time horizon due to his present age. Consequently, the middle aged person would have a lower internal rate of return and will give a smaller answer to the question regarding the equivalent variation.

Two complications arise when discussing individuals approaching retirement age. The first complexity is due to higher investment in equipment made by individuals. This higher investment may cause the older individuals to expect not only a return from the property but also a return from their equipment.

Second, there is the fact that individuals of retirement age may place a very large value on their property rights. This second complication may be explained by the idea that retirees have more time to

enjoy their activities especially recreational pursuits and this group may be less transient in nature than younger individuals. Therefore, these individuals place a higher value on property associated with a specific use, such as a favorite fishing spot.

Two graphs have been drawn to illustrate how perceived internal rates of return may be depicted. The two graphs are displayed in Chart I. Graph A represents individuals from the fishing survey who received a $13,000 income per annum while Graph B depicts those individuals who earned a $20,000 annual income. The graphing of both graphs is of the means of the compensation required for those individuals in one age group. Since specific knowledge of the individual's age was unknown, the mid-points of each age class were used in the graphing.

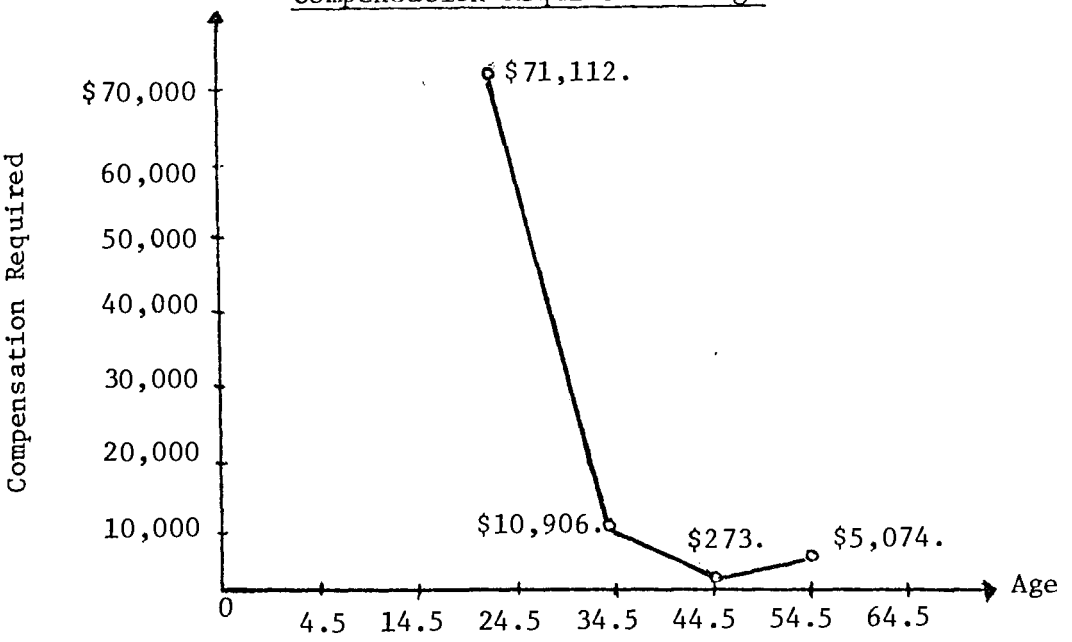
Graph A as drawn has the beginning of a U-shaped function. This functional shape fits the explanation of expected internal rates of return as discussed above. The younger individuals place high valuations on property rights because of their expected span of life. The middle aged value is lower than the young and/or older individuals. This is due to their having a shorter span than the 24.5 year olds and a lower investment in equipment than the 54.5 year olds.

The second graph (B) does not have a U-shape. It is not difficult, to explain away the point for the 20-29 age group which causes the shape problem. An income of $20,000 per year is a relatively large income being earned by such a young group of people. It may be hypothesized that these individuals spend so much of their time working that they do not fully appreciate their rights to the use of presently available fishing resources.

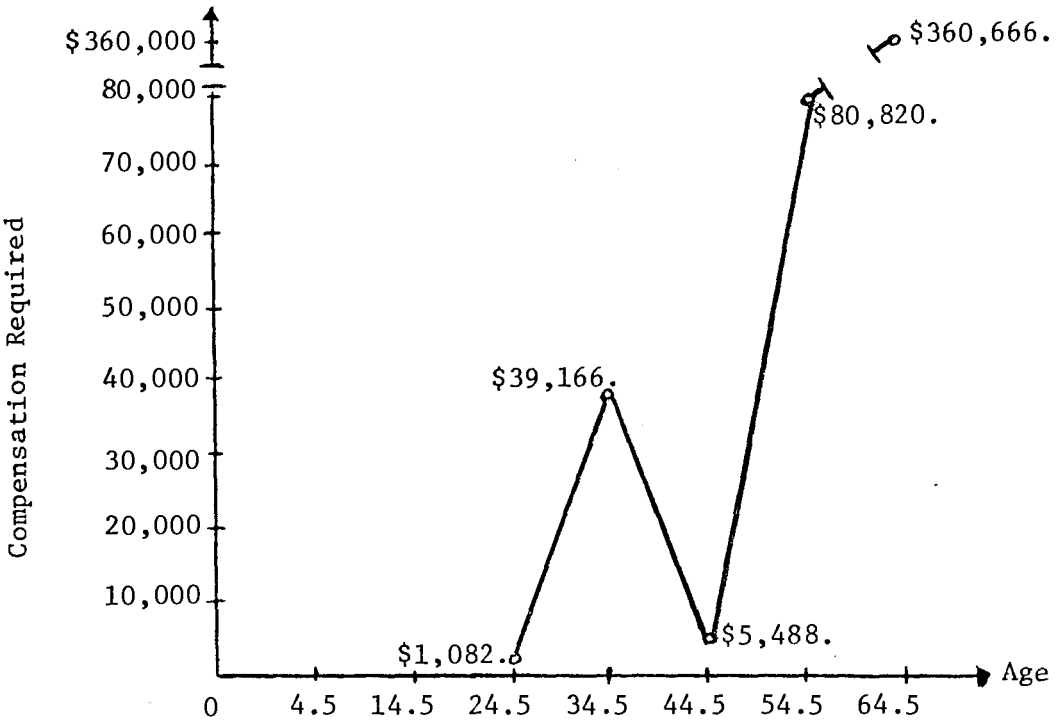
In both graphs there is a significant lack of information. The information missing is the specific ages of individuals and the number of years

CHART I

Compensation Required and Age



Graph A



Graph B

resident in the region. This lack is particularly apparent in attempting to explain the 24.5 point on Graph B. It may be that all the individuals earning $20,000 per year are closer in age to 29 than to 20. Also, it may be that this income bracket is very transient in nature. If those with a low compensation required were 20 years versus higher equivalent variations denoted by 20 year olds, or if this income bracket is very transient, then the U-shaped function might still exist in Graph B.[7]

Option Demand as an Explanation

Option demand has been suggested as an explanation of the difference between the two consumer's surplus measures. One widely accepted definition of option demand is "a willingness to pay for retaining an option to use an area or facility that would be difficult or impossible to replace and for which no close substitute is available"(Krutilla, 1967, 780).

The key to understanding option demand and its influence on the consumer's surplus measures is uncertainty. The uncertainty comes from the fact that an individual is being requested to pay for a resource which he may never use (Byerlee, 1971, 523; Cicchetti and Freeman, 1971, 528). This uncertainty factor may influence an individual's willingness to pay answer by causing the response to be lower than if the individual was certain of consuming the good. This in combination with the consumer's income constraint could cause a very low willingness to pay.

Option demand would play a role even in a fishing survey where the respondents were known fishermen. One fact noted concerned the number of times per year an individual fished. Many individuals rarely went fishing more than once or twice a year. Infrequent users may be much less willing to pay a large portion of their incomes for an activity

they may not pursue next year. The logic of the situation is that once an individual pays out his money, it is lost regardless of whether or not he uses his option to consume or not.

By analogy the uncertainty associated with option demand may also affect the answers to the willingness to sell query in two ways. Since the consumer does not have perfect knowledge, he cannot be certain that the property right he is selling is replaceable. If the property right is sufficiently unique in the respondent's mind, he may name a very large amount of money.

A second uncertainty associated with the willingness to sell question is the money. The consumer does not know if he will receive any money or when he will receive the sum. Therefore, the consumer may be naming an extremely large willingness to sell sum for two reasons. First, the individual may be attempting to halt the confiscation of the property right. Second, the consumer may be discounting the large sum named over an indefinite time period since he does not know when he will receive the payment.

Option value, like the internal rate of return, is based on the future consumption of a good. In case of surveys dealing with individuals who actually are using a resource, the presence of an option demand may be another <u>partial</u> explanation of the divergent answers. This is especially true in the case of willingness to pay responses. However, it is impossible to know with certainty whether option demand accounted for all the difference.

A serious problem arises in connection with explaining the differences when the resources in question are consumed often. This fact would

definitely affect the willingness to sell question as uncertainty would not be such a principle influence. In the case of a frequent fisherman, he is likely to know of many substitutes if he were to lose his favorite fishing location. He knows how easy it is to replace a fishing spot. Therefore, this fisherman is not as likely to name a very large sum as under circumstances of uncertainty.

Option value might be measured by approximately the same survey questions as the other measures of consumer's surplus. This implies that the individuals are given the same implicit property rights as pointed out above. Consequently, whatever is causing the variance between the consumer's surplus measures may also be the cause of the differences in option value surveys.

Strategies, Welfare Loss and Discontinuous Utility

Strategy in answering survey questions has also been suggested as an explanation of the variance between an individual's responses (T.E. Borcherding, 1976). The strategy is based on the idea that individuals might rationally overstate their compensations required.

The overstatement would occur in order to stop the expropriation of a resource for uses other than the one the individual participates in. The primary reason for such a strategy is a fear of not being compensated and yet having lost the resource by not keeping his price high. Rather than allow this to occur, the individual will overstate his benefits from the present use of the resource. This strategy is more likely to be followed, the higher the subjective probability of such an expropriation. This would cause a benefit-cost ratio based

on such answers to favor not altering the employment of the resource.

As in the case of non-intrinsic benefits, the strategy of answering survey questions may serve to explain some of the respondents' answers. The one problem which this explanation does not take into account is the large number of substitutes. As above, some individuals in the fishing survey might find their first favorite fishing location very important. For others, however, there is probably little difference between the first and second and the first and third favorite locations.

Mishan (1976) offers another explanation for the magnitudes of difference based upon the idea of a welfare loss. This explanation is derived from the situation where one could use both the compensating and equivalent variations in deciding whether to proceed with a project or not. The problem arises when one measure, for example the compensating variation, leads one to think that a project should be started. The equivalent variation in this example would suggest that the project should never be begun. Mishan (1976, 195) states that this situation is a result of the welfare loss felt by the individuals.

Although the magnitude of difference may be due to a welfare loss, Mishan does not explain why the individuals always feel this loss. In other words when an individual is faced with the loss of one of <u>many</u> fishing locations, or one of <u>many</u> small city parks, the welfare loss explanation seems to be lacking. In order to have a total explanation of the magnitude of differences, it appears that individuals' perception of facts, and not just the facts, should be examined.

Another alternative explanation of the variation between the answers may be due to the idea that the two questions are an attempt to compare

a situation which is discontinuous. That is, the individual is being asked to compare two different bundles of goods which are not in the same commodity space. For ease of exposition the two bundles would be given by $U_1 = f(X_1, X_2, \ldots, X_n, Y)$ and $U_2 = f(X_2, \ldots, X_n, Y)$. In the U_2 situation X_1 has been entirely deleted from the individual's consumption.

The willingness to pay question is an attempt to get the respondent to determine how much more he would pay for the commodity bundle U_1 that he already possesses. The willingness to sell question uses situation U_2 where X_1 has been taken away by giving the individual his requested increase in Y. This method is a means for the surveyor to attempt to force the consumer to substitute $(X_2, \ldots, X_n, Y)$ for X_1.

The individual feeling an income constraint in situation U_1 and already having X_1 will only pay a small sum of money to continue consuming X_1. In the second situation the individual does not want to substitute and is so familiar with the characteristics of X_1 that he names a very large sum of money. This sum of money is a reflection not only of his loss of X_1 but is compensation for the consumer's time which will be spent seeking out the characteristics of all other goods. This characteristics search will be the only means the consumer has of replacing X_1 adequately.

This alternative cannot be discussed using a two dimensional diagram. In fact, the problem may be such as to make it more of a Lancaster characteristics diagram with vectors for at least 3 goods, Y, X_1 and X_2 and two characteristics, C_1 and C_2.

If this is the explanation we require to understand the compensating

THREE DEMAND CURVES AND THE ASSOCIATED PRICES

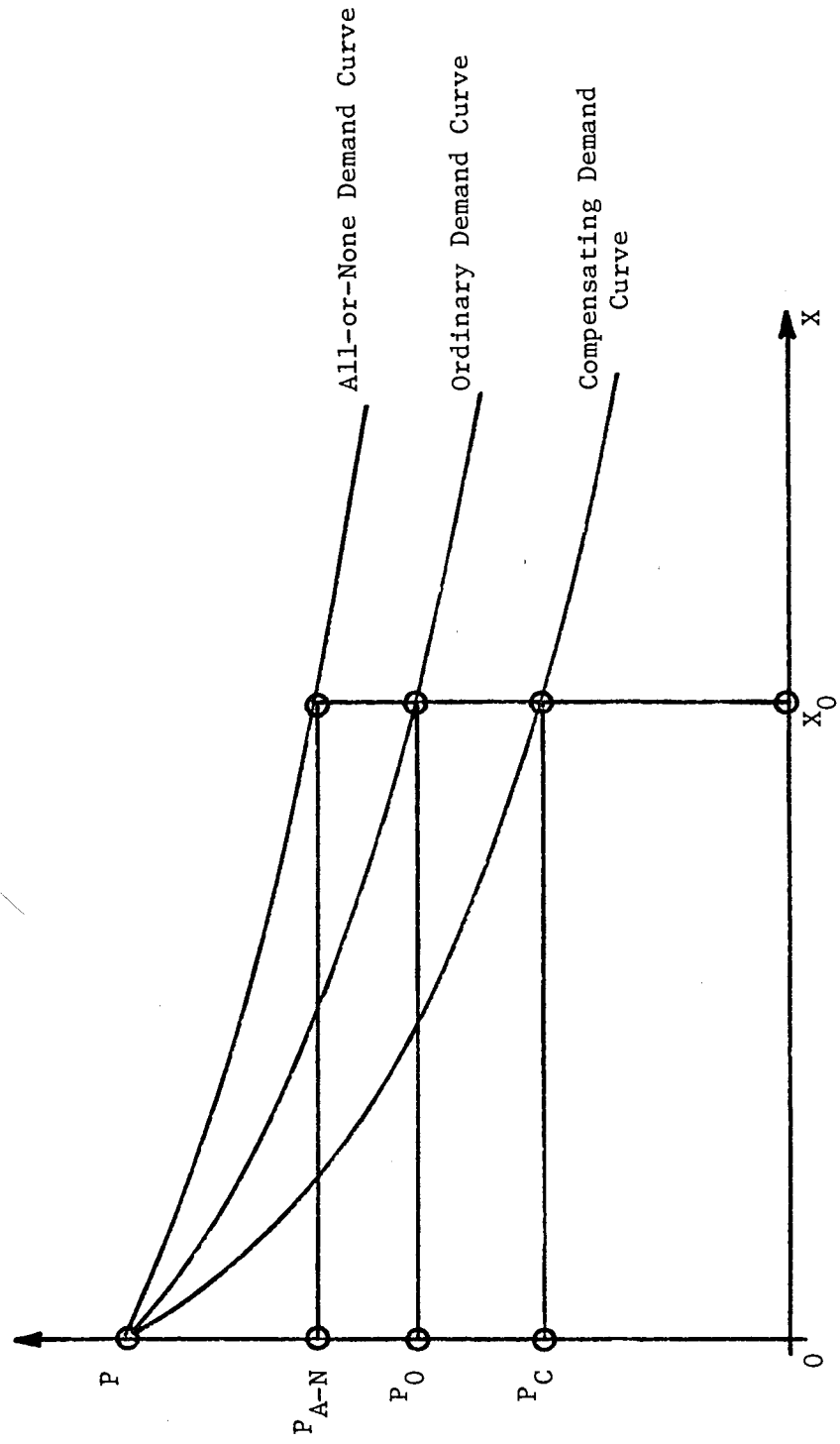


FIGURE IV

and equivalent variations, it makes the use of both measures suspicious. This is one line of argument which should be pursued further in order to determine if this criticism of the use of consumer's surplus is powerful enough to make its usage questionable.

One final explanation will be offered in the next section. The explanation will suggest that the indifference curves of an all-or-none nature offer a further means of examining the differences between the two consumer's surplus measures. One point which makes such an argument particularly interesting is that the marginal utility of income may be assumed constant and the source of difference might still be exhibited.

All or None Demand Curves

Under an ordinary situation, a consumer is given a price[8] and then he is able to say what amount of X (a composite good) he will consume. For the last unit consumed, the individual will have his marginal utility of X set equal to the price of X. In theory the consumer is assumed to have shown that he is a utility maximizer.

In the all-or-none case, the individual is confronted with a price which is equal to the total area beneath his (ordinary) demand curve for a given quantity of X. The purpose of such a price is to extract from the individual concerned all of his consumer's surplus.

The relationship of the ordinary to the all-or-none demand curve is best illustrated in a graph (Figure V). In this illustration the consumer is allowed to buy only X_0 quantity of the commodity. The price of X_0 is different for the two demand curves. The all-or-none demand curve presents a price which is the average of all the prices the consumer

CONSUMER'S SURPLUS AS A VERTICAL DISTANCE BETWEEN INDIFFERENCE CURVES AND THE ALL-OR-NONE POINT (MARGINAL TUILITY OF INCOME HELD CONSTANT)

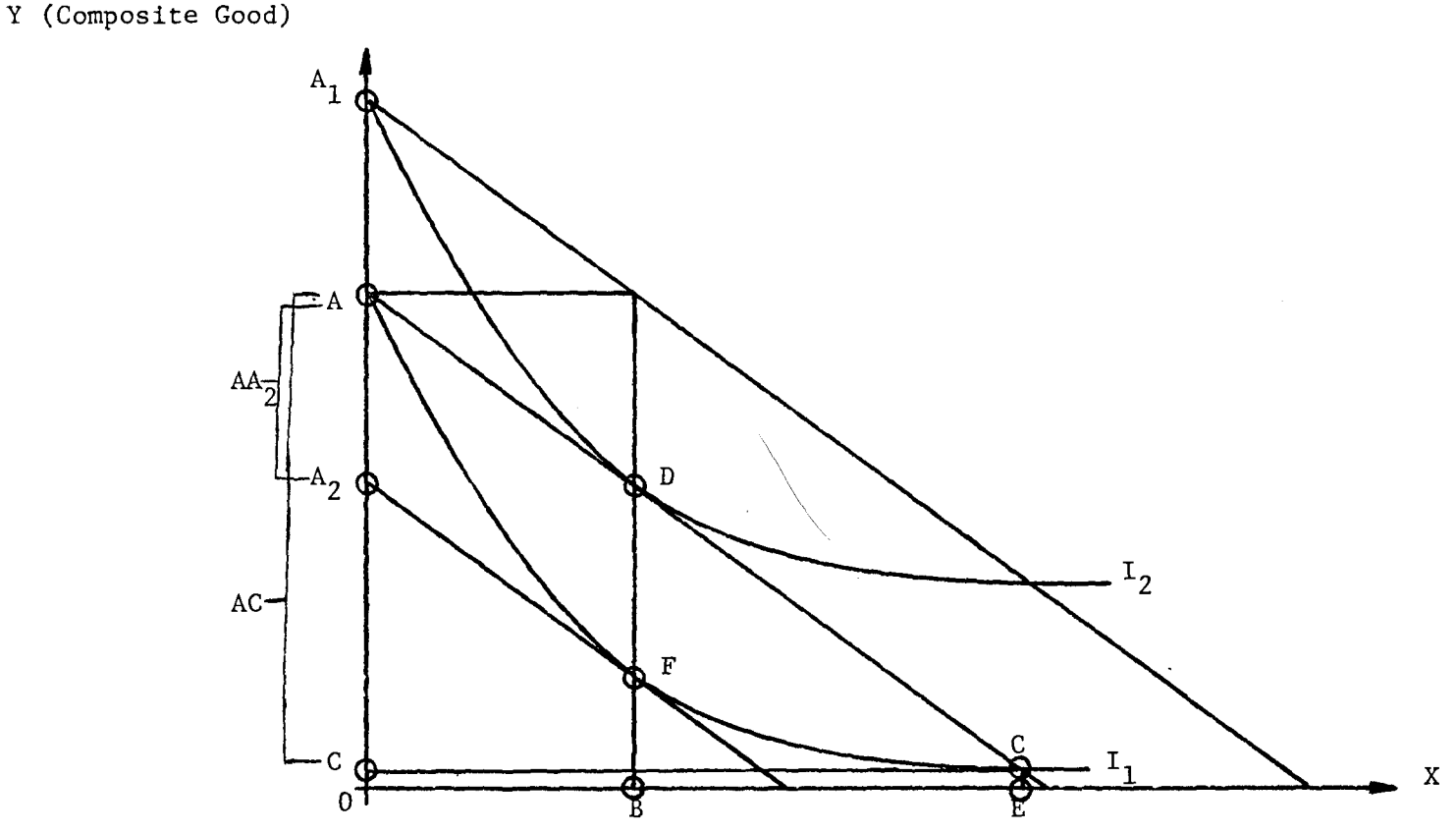


FIGURE V

would have to pay if he bought each unit of X from a discriminating monopolist. The consumer then is not paying the single price of the marginal unit for all the units of X. Instead the individual is paying the highest price he would be willing to pay if that unit of X were the only unit he could buy.

The all-or-none demand price is given by $\overline{P}_X = \sum_{i=1}^{n} \frac{X_i P_i}{n}$. This price will necessarily be higher than the marginal price given by the ordinary demand curve (Figure IV) (Patinkin, 1963, 86-7; Barzel, 1974, 82-4).

Using a figure similar to Figure II in Chapter II, the all-or-none point may be illustrated. In Figure V the consumer begins at point OA income. This point is on indifference curve I_1. The consumer in the all-or-none situation is kept on I_1, without changing the individual's income. This is the difference between the all-or-none example and the Hicksian compensating situation. It will be recalled that in the compensating situation the consumer is kept on I_1 by taking away income equal to the distance AA_2.

In the all-or-none situation then the consumer receives OB units of X but pays the price of OE units. Comparing the compensating variation, AA_2, to the all-or-none variation, AC, illustrates that the all-or-none measure will normally be larger. This difference in variation holds even when the constancy of the marginal utility of income is assumed as in Figure V.

The all-or-none variation may be used to explain the differences in the answers to willingness to pay and willingness to sell questions as follows. When an individual is answering the willingness to pay question, he sees himself at point D. He then would be willing to give

up D to F in order to continue to consume the OB units rather than do without X. The distance DF ($=AA_2$) is an income loss which the individual feels personally (Mohring, 1971, 362-3).

The willingness to sell question illicits a set of distinct personal feelings. The consumer may feel powerful in his position of being able to name the price. Referring to his own internal "indifference curve",[10] the respondent attempts to force those paying him to point C.

In order to understand why the consumer feels he can force those offering to buy the property to pay a very large sum, it is necessary to examine the concept of a discriminating monopolist. In this case the individual sees himself as the only seller of the good, or if not the only seller, the individual at least feels he has the power of holding out. If the individual is a monopolist or is a hold-out, he effectively has a power position where he might be able to gain.

Asking for the large willingness to sell sum does not indicate that the consumer actually thinks he will force the buyer to point C. The implication is that even if the individual receives only one dollar more than the going market price, he has made a gain.

In the case of the willingness to pay, not only is the consumer constrained by his income and feelings of personal loss, he also sees himself as a perfect competitor. As a perfect competitor the individual knows he will not have to pay more than the going market price for a good. Therefore, there must be something inherently different between the two situations which makes the individual see this opportunity to extract such a surplus in the first case.

If a large entrepreneur or the government wanted to remove a public property, such as a park or a lake from fishing, from individuals' consumption, they might have to compensate the consumers. When dealing with a large firm or with the state, the consumers might think of the wealth such groups possess. The consumers by extracting very large sums would be effecting a redistribution of income. Given that the consumers were relatively poorer than the firm or state, the individuals might see the large sum as "only fair". Even in the case of the state where the consumers are a part of the taxpayers and are in one sense paying themselves, the individual may think he is the only person who will receive such a large payment. If he is the only person, he will not be paying himself but all the other taxpayers will compensate him for his loss.

Given greed in the above situation coupled with feelings of power, the idea set forth is perhaps not absurd. Instead it is a rational explanation based on how individuals act. The all-or-none curve serves as a theoretical and graphical vehicle which illustrates the points on an indifference mapping that an individual consumer sees as pertinent in willingness to sell and willingness to pay cases.

The major criticism of the all-or-none measure is due to the fact that this measure pertains to a hypothetical situation (Patinkin, 1963, 88).[11] When asked for an all-or-none price, the respondents may give an answer less than the actual price they would pay rather than do without X. The counterpart of the above for compensation required deals with how an individual may attempt to extract a higher price than is

realistically available in the market. This criticism is not of the all-or-none explanation given but of the survey question used to measure compensation required.

The all-or-none explanation does not preclude other explanations of the observed differences in the alternative measures of consumer's surplus. Factors such as an asymmetry in the importance of non-intrinsic benefits, property rights, internal rates of return, option value and strategies for answering survey questions can still be the causes of variations between the two answers. It is, however, impossible to know the causes of the all-or-none consumer's surplus directly. If the factors which contribute to the all-or-none variation could be measured, then this measure could be used to explain why the answers to the willingness to pay and willingness to sell questions vary while assuming the constancy of the marginal utility of income.

One method of effectively utilizing the all-or-none formulation would be to establish a differential between the compensating price and the equivalent price. In Figure V the differential would be calculated between P_{A-N} and P_C. This differential could then be used as a dependent variable in regressions. The problem with attempting to use this price differential approach has to do with knowing the appropriate prices to use. Such an individual's indifference map is not known, the prices will only be approximate estimates of the real prices. A second problem is attempting to find out <u>exactly</u> what causes the all-or-none answers to be given to the compensation required questions.

If a specific link cannot be established between the responses to an all-or-none question and possible independent variables, then the all-or-none approach becomes empirically ambiguous. Without a link, no definite conclusions can be drawn from a specific response. The implication is that one cannot infer from an observed compensation required response any usable information. This means that measurements of consumer's surplus will only be relevant in practice where the willingness to pay question is the appropriate query. Unfortunately, the valuation of resources will be difficult to make where the willingness to sell is the theoretical measure required.[12]

FOOTNOTES

1 Note that the explanation is between the two consumer's surplus measures of one person and is not an attempt to explain the variance between different individuals' responses to the two questions. This then rules out as an explanation the idea of the inframarginal responses versus the marginal answers.

2 May not only assign the use of the property but the right to convey the property to others and the right to the "fruits" from the property.

3 In the case of implicit property rights, the individual may not be able to sell the property or reap the fruits of the property. An example of such a property is a public park. The individuals may use and enjoy a park but not sell the part nor any parts of it.

4 Given that the income elasticity is equal to zero, not only are the compensating and equivalent variations pictured by the consumer's surplus triangle (Figure I in Chapter II) but so are the Marshallian consumer's surpluses.

5 If the good in question is an inferior good, then nothing about the consumer's behavior can be guaranteed. For example an increase in the consumer's income may or may not increase the amount of an inferior good consumed.

6 This argument is also the one presented by Krutilla and Fisher (1975, 31).

7 It was hoped that internal rates of return could be calculated for all 785 individuals in the sport fishing survey. At least two

problems exist. The first is no variation in age except for eight grouped categories. The second is singling out incomes for individuals. A person who earns $3,000 cannot be expected to have the same internal rate of return as one who earns $50,000 even if the two are the same age. D.R. Maki in a discussion suggested that the dummy variables used for age would be sufficient to measure the shape of the internal rate of return curve. The problem arises that age alone appeared to have little correlation with compensation required. This does not, however, make the concept of internal rates of return useless. The fishing survey was not designed to gain the best estimates of age as noted above. Hence, attempting to calculate rates of return was dropped. It should, however, be pursued in some later study with more precise information on respondents' ages.

8 This is ordinary in a Walrasian sense (Patinkin, 1963, 86) as the consumer is confronted with a price and then asked what he would consume. A Marshallian case would be where the individual was confronted with the quantity and asked what he would pay.

9 Not only is the consumer not allowed to be a utility maximizer, he must also not be allowed to equate his marginal rate of substitution (MRS) to the price of the good (Patinkin, 1963, 86). What is essential to notice is that this decision is not a marginal one.

10 The indifference curves cannot in actuality be measured. However, what indifference curves represent can be true within each individual.

11 This criticism is one which applies to all surveys.

12 Henderson (1941, 119) points out that there exist situations

where only the willingness to sell (equivalent variation) is the measure to use. There has been some argument, though, over the usefulness of the equivalent variation. Mishan in his 1st edition of Cost-Benefit Analysis (1971) regarded the equivalent variation as not as useful as the compensating variation. However, Mishan (1976) refutes his position and elects to use the equivalent variation as well as the compensating variation. Burns (1973, 338-343) also suggests that compensating and equivalent variations have their place in describing the difference between small multiple price and income changes and large multiple price and income changes respectively.

Although these learned gentlemen see a place for the equivalent variation, the articles mentioned do not guarantee that the willingness to sell function is measurable. For proof, one must fall back on the regression analysis of the links between the equivalent variation and the exogenous variables. Before dismissing this measure, however, it would require further analysis than that presented here.

CHAPTER V

Conclusion

Attempts to apply a measure of consumer's surplus to a practical case of resource evaluation are confronted with a problem of measurement. This is especially the case for resources for which market prices are not available. One problem in particular is that of which of the alternative measures of consumer's surplus is most appropriate to each individual case. In the main, the relevant alternatives are those given by answers to two questions on the value of one resource: "What would you be willing to pay for the continued use of X?" and "What compensation would you require to forego the use of X forever?"

The answers to the two questions, when asked in surveys, vary consistently by large amounts in dollar terms. Traditional theory or consumer's surplus suggests that such a large difference should not exist. The usual reason given for any variation between them is that there is a significant income effect that brings this about. This income effect exists essentially because the marginal utility of income is not constant over the range of real income of the resource users, with and without this use. This means that as a trade-off is made between a good and income, the more of the good taken away the larger the sum of income will have to be to replace the good.

Along with this income effect, there may also be an income constraint that would explain differences in answers to the two questions. This constraint is said to restrain the willingness to

pay resources but not the compensation required answers (Hammack and Brown, 1974, 26; Krutilla and Fisher, 1975, 30).

Although the income effect and income constraint explanations may in part explain the difference between the two answers, there seems far too large a variance between the means of the survey responses to be attributed to just these. For example in the Hammack and Brown study (1974, 26-7) after discarding extreme values, the mean answers were $247 for the willingness to pay question and $1,044 for the compensation required. In the B.C. sport fishing survey presented here in detail, the mean and median were respectively $55 and $35 for the willingness to pay and $24,382 and $700 for the compensation required. With such extremely large differences in evidence, it is difficult to ascribe all the variance to just the income effect.

The B.C. sport fishing survey was subjected to a series of regressions which were an attempt to explain the two sets of answers. Although the willingness to pay (compensated variation) answers were explained reasonably well by the exogenous variables, the compensation required (equivalent variation) responses were not successfully explainable by the collected data. Consequently, reasons were examined which might further explain the two sets of answers and also, might explain the differences between the responses.

The suggested reasons ranged from the concept of expected internal rates of return to the altering of the perceived utility level and the perceived power position. These reasons as outlined were not anticipated to explain all of the variance between the two responses, but were put

forward in an attempt to illustrate how other reasons might be included in explaining the difference.

This examination of the difference and the reasons outlined may have implications for further study. It may, for example, be very useful to attempt to construct a survey which avoids some of the pitfalls of a perceived power position on the part of the respondents. This might be accomplished, for example, by asking the individual what compensation he expected others to receive for the loss of a resource. A second suggestion might be to design a survey in which the characteristics of the resource in question were valued and not the value of the particular resource itself. This procedure might avoid the problems of the inclusion of non-intrinsic benefits and the inclusion of expected rates of return of the individual surveyed. Non-intrinsic benefits refer to such things as memories and emotional feelings attached to a particular property. An internal rate of return is an influence which might cause the compensation required answer to be very large. If a resource was being forever removed from an individual's use, the person might attempt to secure a large enough sum of money in order to compensate him for the loss of many future years' benefits. In order to avoid this from influencing the survey results, the survey could attempt to ask questions about characteristics of a resource, for example the view associated with a park, instead of the resource itself.

The existence of large differences in alternative measures of consumer's surplus gives rise to speculation on which measure to use

and when. When an established use of a resource is to be disrupted, then the compensation required measure might well be suggested as being most appropriate. If a resource is to be developed or made available for the first time, then those who would gain from this project should be surveyed for their willingness to pay and this measure of value used in allocation decisions. Neither the compensated nor the equivalent variation seems to be a reliable measure of appropriate value in every instance; with this being especially the case with the present design of surveys. Another implication may be that the equivalent (compensation required) variation is not used often enough. The answers being "too large" or "emotionally biased" (Hammack and Brown, 1974, 26-7) would not seem enough justification for ignoring this measure of value.

Finally, in choosing which measure to use, a third implication may be that the income constraint on the compensated (willingness to pay) variation may induce individuals to prescribe too low a value to the resource in question. If the income constraint can be associated with making the compensated variation "realistic", the income constraint may also cause an under-valuation of a resource.

This essay has been an attempt to illustrate that further though should be given to the explanation of the differences between the empirically observed compensated and equivalent variations. Although new empirical data have been discussed along

with new explanations, no one reason can be given precedence over all others in explaining the difference. This must be left for further, more detailed research and study.

APPENDIX A

SPORT FISH SURVEY

In 1975, Environment Canada completed a survey which dealt with valid holders of fishing licenses in Yellowhead. As the first follow-up letter mailed to these fishermen states, the purpose of the survey was to measure the "socio-economic importance of fishing" to those individuals residing in northern British Columbia. From the mail survey evolved a telephone survey which re-surveyed many of the individuals who had responded to the mail survey.

Reproduced in this appendix are the two questionnaires, mail and telephone, the follow-up letters for the mail survey, the instructions to the telephone survey personnel, the coding sheets used by the Department of Fisheries for the production of their computer cards and the department's three tables. Two tables are for the mail and telephone overall results and the third table is a breakdown by stream and residence of the compensating consumer surplus price values.

This appendix will be of interest in order to understand the procedures of the department and to illustrate the type of usage the data was being put to by Environment Canada, Fisheries and Marine Department. All of the letters, data and computer cards were received from Mr. William F. Sinclair and Mr. Rob Morley.

SPORT FISH MAIL QUESTIONNAIRE

1975

Section A

This first section asks several questions about members of your household in an effort to ensure that the opinions expressed in this survey are truly representative of all the sport fishermen living in northern British Columbia and not just isolated segments of the sport fishing population.

1. Please indicate in the appropriate space the total number of males and females and the number of male and female sport fishermen (who sport fish at least once a year) who permanently reside in your household according to age.

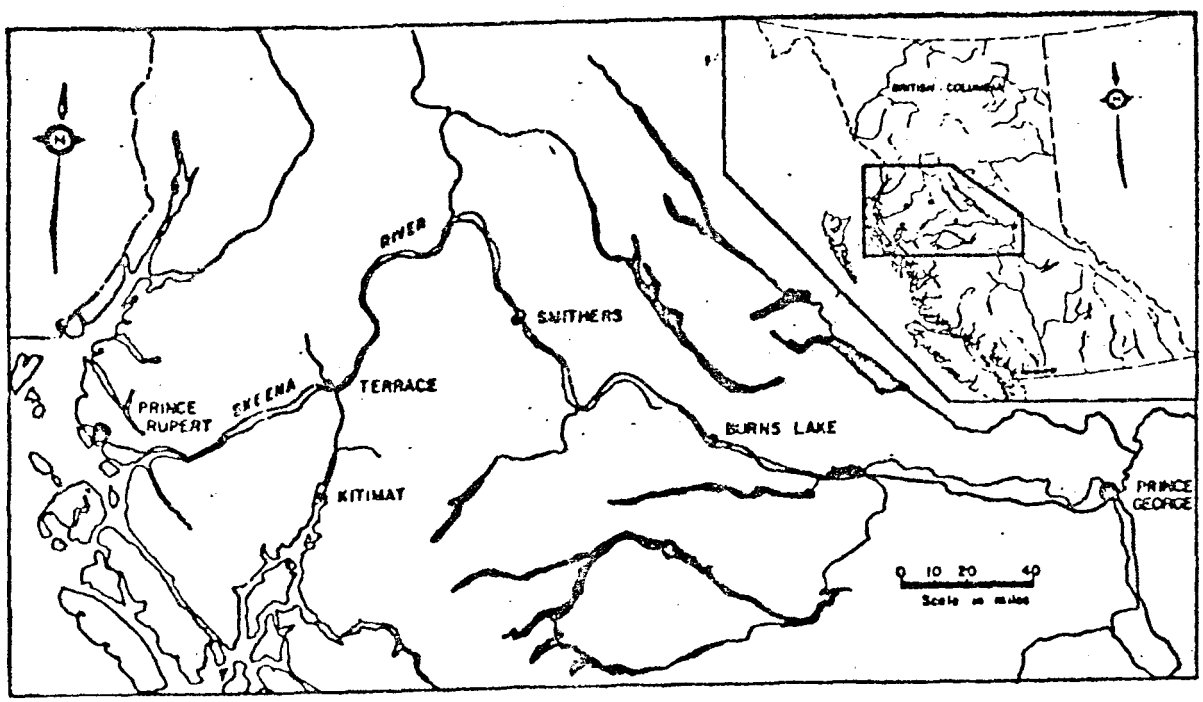
Age	Fishermen		Total Household Residents	
	Male	Female	Male	Female
0 - 9	____	____	____	____
10 - 19	____	____	____	____
20 - 29	____	____	____	____
30 - 39	____	____	____	____
40 - 49	____	____	____	____
50 - 59	____	____	____	____
60 - 69	____	____	____	____
70 and Over	____	____	____	____

2. How many days during 1974 did members of your household sport fish in the area between Prince George and Prince Rupert (see Map showing area of concern)?

_____

(no. of days during 1974)

Area of Concern



3. Please indicate (✓) which category best describes the occupation of the head of the household.

Labourer _____

Tradesman or Technical _____

Professional _____

Sales _____

Clerical _____

Management and Executive _____

Self-Employed _____

Retired _____

Other (please specify) _____

4. What is the gross (before taxes) total income of your household per year? $_____

Section B

In Section B we wish to determine the importance of sport fishing and the amount of angling effort on particular waterways located in the central northwestern areas of British Columbia. We are interested in your (you as an individual) fishing activity in the general area between Prince George and Prince Rupert. We realize that few people keep exact records of their fishing experience, but we would appreciate it if you would answer all questions according to your best estimate.

5. Please indicate how many years you have lived in Prince George or in the areas north of Prince George in British Columbia (area of concern as shown on Map). _____ (no. of Years)

6. How many days each year do you normally fish in the area between Prince George and Prince Rupert? _____ (no. of days per year)

7. How many days did you fish in the area between Prince George and Prince Rupert during 1974? _____
(no. of days during 1974)

8. Please indicate (✓) what type of fishing you prefer.
Lake_____ or River (stream) _____

9. What species of fish do you prefer to catch? Please list in order of preference (your preferred species first).

1. _____
2. _____
3. _____
4. _____

10. What is your favourite fishing river or lake and how many days do you normally fish there each year?

_____ _____
(1st favourite location) (days fished per year)

11. What would be the <u>minimum</u> annual cash payment that you would accept to <u>forego</u> forever your right to fish at your favourite river or lake? Please note that you only give up your right to fish on your favourite river of lake (for all time), but that you still could fish on any other river or lake.
$_____ per year.

12. What is your second favourite fishing river or lake and how many days do you normally fish there each year?

(2nd favourite location) (days fished per year)

13. We would like you to estimate the average cost of a day's fishing on your favourite rivers or lakes. To this end, we ask that you include any costs that you feel are directly related to your fishing trip. These costs may include travel and equipment costs but will not include any costs that would have been incurred if no fishing trip had taken place.

What is the average cost of a day's fishing:

(i) On your favourite river or lake? $ _____ per day.

(ii) On your 2nd favourite river or lake? $ _____ per day.

Section C

This is a hypothetical question which, if answered correctly, will help us to determine the value of the sport fishery to residents of central northwestern British Columbia. Please consider it carefully and answer according to your best estimate. Please note that Question 14 asks for a maximum "per day" estimate.

14. Suppose the costs of a day's fishing at your favourite river or lake were to rise. What would be the maximum amount that you would pay before you would stop fishing at your favourite river or lake altogether?

$ _____ per day.

15. Please feel free to make any comments you wish either about this questionnaire or about any ideas you may have regarding the improvement of sport fishing in the central northwestern area of British Columbia.

_____

_____

_____

_____

_____

_____

Please note your telephone number in the space provided so that we will be able to discuss your comments with you or answer any questions which might arise.

_____
Telephone Number

THANK YOU!

SPORT FISH MAIL QUESTIONNAIRE 1975

COMPUTER CLASSIFICATION AND CODING

Column	Classification	Codes
1	Place of Residence	A - Kitimat
		B - Prince George
		C - Terrace
		D - Prince Rupert
		E - Smithers
		F - Vanderhoof
		G - Burns Lake
		H - Fraser Lake
		I - Hazelton
		J - Granisle
		K - Telkwa
		L - Fort Fraser
		M - Houston
		N - Kitwanga
		Ø - Endako
		P - Fort St. James
		Q - Takysie Lake
		R - Southbank
		S - Engen
		V - Prince George

Column	Classification	Codes
2,3,4	Identification Number	Number (range 000-999)
5	Male Anglers, 0-9 years old	Number (range 0-9) X - No Response
6	Female Anglers, 0-9 years old	Same as Column 5
7	Males, 0-9 years old	Same as Column 5
8	Females, 0-9 years old	Same as Column 5
9	Male Anglers, 10-19 years old	Same as Column 5
10	Female Anglers, 10-19 years old	Same as Column 5
11	Males, 10-19 years old	Same as Column 5
12	Females, 10-19 years old	Same as Column 5
13	Male Anglers, 20-29 years old	Same as Column 5
14	Female Anglers, 20-29 years old	Same as Column 5
15	Males, 20-29 years old	Same as Column 5
16	Females, 20-29 years old	Same as Column 5
17	Male Anglers, 30-39 years old	Same as Column 5
18	Female Anglers, 30-39 years old	Same as Column 5
19	Males, 30-39 years old	Same as Column 5
20	Females, 30-39 years old	Same as Column 5
21	Male Anglers, 40-49 years old	Same as Column 5
22	Female Anglers, 40-49 years old	Same as Column 5
23	Males, 40-49 years old	Same as Column 5
24	Females, 40-49 years old	Same as Column 5
25	Male Anglers, 50-59 years old	Same as Column 5
26	Female Anglers, 50-59 years old	Same as Column 5

Column	Classification	Codes
27	Males, 50-59 years old	Same as Column 5
28	Females, 50-59 years old	Same as Column 5
29	Male Anglers, 60-69 years old	Same as Column 5
30	Female Anglers, 60-69 years old	Same as Column 5
31	Males, 60-69 years old	Same as Column 5
32	Females, 60-69 years old	Same as Column 5
33	Male Anglers, 70 or more years old	Same as Column 5
34	Female Anglers, 70 or more years old	Same as Column 5
35	Males, 70 or more years	Same as Column 5
36	Females, 70 or more years old	Same as Column 5
37-39	Household days fished in Yellowhead in 1974	Number (range 000-365) No Response - XXX
40	Occupation of household head	0 - No response 1 - Labourer 2 - Tradesman or Technician 3 - Professional 4 - Sales 5 - Clerical 6 - Management and Executive 7 - Self-employed 8 - Retired 9 - Other

Column	Classification	Codes
41 - 42	Gross household annual income	Number (range 00-99) in thousands
		XX - No response
43 - 44	Years of residence in Yellowhead	Number (range 00-99)
		XX - No response
45 - 47	Days normally fished per year in Yellowhead	Number (range 000-365)
		XXX - No response
		AAA - Not a fisherman
48 - 50	Days fished in 1974 in Yellowhead	Number (range 000-365)
		XXX - No response
		AAA - Not a fisherman
51	Preferred type of fishing	0 - No response
		1 - Lake
		2 - River (stream)
		3 - No preference
		4 - Salt Water
52	First preferred species	0 - No response
		1 - Salmon
		2 - Trout (Rainbow, Cutthroat)
		3 - Steelhead
		4 - Dolly Varden
		5 - Lake Trout (Char)
		6 - Other
		7 - No preference

Column	Classification	Codes
53	Second preferred species	Same as Column 52
54	Third preferred species	Same as Column 52
55	Fourth preferred species	Same as Column 52
56	First favourite fishing location	0 - No response
		1 - No favourite
		2 - Copper River (Zymoetz)
		3 - Kitimat River
		4 - Lakelse River
		5 - Skeena River
		6 - Douglas Channel
		7 - Telkwa River
		8 - Babine Lake
		9 - Wedeene River
		A - Kitwanga River
		B - Dala River
		C - Kildala River
		D - Uncha Lake
		E - Poplar Lake
		F - McBride Lake
		G - Nadina River
		H - Other Lakes
		I - Lakelse Lake
		J - Kalum River
		K - Tchesinkut Lake

Column	Classification	Codes
56	First favourite fishing location continued	L - Kasids River
		M - Owen Lake
		N - Kitwanga Lake
		Ø - Nass River
		P - Kalum Lake
		Q - Other Rivers
		R - Francois Lake
		S - Kispiox River
		T - Mezeadin Lake
		U - Stuart Lake
		V - Nechako River
		W - Fraser Lake
		X - Babine River
		Y - Maxan Lake
		Z - Bulkley River
		ç - Pinkut Lake
		. - Takysie Lake
		* Morice River
		(- Burns Lake
		) - Ootsa Lake
		$ - Parrott Lakes
		? - Augier Lake
		= - Stellako River
		: - Exchamsiks River

Column	Classification	Codes
56	First favourite fishing location continued	# - Cluculz Lake
		; - Nulki Lake (Tachick)
		, - Bednesti Lake
		+ - Morice Lake
		% - Dean River
		6 - Grassham Lake
		" - Norman Lake
		< - Oona and Ormand Lakes
		! - McLure Lake
		/ - Fulton River
57 - 59	Days fished per year a first favourite location	Number (range 000-365)
		XXX - No response
60 - 65	Compensation required for loss of first favourite location	Number (range 000000-999999)
		XXXXXX - No response
66	Second favourite fishing location	See Column 56
67 - 69	Days fished per year at second favourite location	See Columns 57-59
70 - 72	Average cost per day at first favourite location	Number (range 000-999)
		XXX - No response
73 - 75	Average cost per day at second favourite location	Number (range 000-999)
76 - 79	Maximum willingness-to-pay	Number (range 0000-9999)
		XXXX - No response
80	Mailing responded to	A - First Mail Completed

Column	Classification	Codes
80	Mailing responded to continued	B - Second Mail Completed
		C - Third Mail Completed
		D - Fourth Mail Completed
		E - Fifth Mail Completed
		F - First Mail Incompleted
		G - Second Mail Incompleted
		H - Third Mail Incompleted
		I - Fourth Mail Incompleted
		J - Fifth Mail Incompleted
		K - First Mail Recompleted
		L - Second Mail Recompleted
		M - Third Mail Recompleted
		N - Fourth Mail Recompleted
		Ø - Fifth Mail Recompleted

TELEPHONE ENUMERATOR INSTRUCTIONS

SUMMER SURVEY, 1975

It is intended that all telephone enumeration will take place roughly between 6:00 and 7:30 PM on weekdays in Terrace, Smithers and Prince George. Enumerators are to adhere to the 6:00 to 7:30 PM principle. However, it is expected that they will adjust their hours around that time in a manner which is consistent with their success experience. Telephone try-agains or call-backs may be carried out any time after the initial try. In other words, it is reasonable to expect that for one reason or another certain individuals are never in early in the evening. In that case, calls may be made at noon or on weekends. It is not expected that the enumerator will ever have to make calls in the morning prior to noon any day of the week.

Telephone format is as follows:

Hello, my name is _____. I am an economist with the Fisheries and Marine Service, Department of the Environment. I am calling in connection with the mail questionnaire which we sent to you in January this year. May I speak with whoever filled out the questionnaire? (Might be some explanation required here).

If the person identifies himself (or herself) as the person who filled out the questionnaire or once the person who filled out the questionnaire comes to the telephone, then you are to say:

I would like to take a few moments of your time to go over some of the answers you filled out on your questionnaire this spring. (Might take some explanation here).

You might want to clarify some points of misunderstanding about why you are calling and what the purpose of the survey was. However, proceed from here in the following manner:

One of the three questions I want to deal with is the question which asks: What would be the minimum annual cash payment that you would accept to forego forever your right to fish at your favourite river or lake? Your answer was $ _____.

Interpret - In other words, you indicated by your answer that you were willing to give up fishing at _____ (favourite location) for a cash payment of $_____ per year. Are you satisfied that this answer gives a fair indication of what value you place on your favourite fishing location?

He (or she) will either say yes or no. If he says yes then drop it and carry on with the next question. If he says no ask him whether he thinks the answer is low or high. If he says low start bidding.

(This may need some explanation about rare paintings, etc. and about how you interpret the answer but you should reach a figure that he will find satisfactory with explanation and continual bidding).

One of the questions asked was to estimate the average cost of a day's fishing at your favourite and second favourite fishing location. Your answer was that on average it cost you $_____ per day to fish at your favourite location. Are you satisfied with that answer? Do you think that is high or low? Then start bidding if he answers low.

Your answer to the second part of that question was that it was worth $_____ per day to fish at your second favourite fishing location. Once again, are you satisfied with that answer? Do you think that it is high or low?

The final question which I would like to review with you is the question that asked you: Suppose the cost of a day's fishing at your favourite river or lake were to rise. What would be the maximum amount that you would pay before you would stop fishing at your favourite river or lake? Your answer was that you wou pay up to a maximum of $_____ per day before you would stop fishing at your favourite fishing location. Do you think that that answer is a fair indication of what it would have to cost you per day before you would quit fishing at your favourite location? He will say yes or no, then ask him if it is high or low, and then start your bidding.

Is your answer to this question over and above what it costs you to fish each day? (Pause) If he (or she) does not appear to

understand go on: That is, the maximum amount you would pay is (13(i) + (14)) $_____ or (just 14) $_____?

In closing you are to thank the person for their cooperation. Say that their information will be treated strictly confidential and that it will be of the utmost value when preparing environmental impact statements or assessing the environmental consequences of particular development projects.

The four basic rules for telephone surveys are:

1. Politeness
2. Speak in a clear concise voice - it is absolutely necessary that this be done because a person who is interrupted by a telephone conversation which is not personally directed to them and by what is essentially an invasion of privacy by telephone will terminate the conversation immediately if they do not understand what the conversation is about.
3. It is absolutely essential that when there is no answer that all "no answers" be tried again several times. "Try agains" should be tried at least twice in the evening and then perhaps tried the next day during the afternoon.
4. Bidding must be realistically carried out in a casual manner and the enumerator must thoroughly understand the basic argument about why the economic evaluation of nonpriced resources is important.

PHONE SURVEY - 1975 COMPUTER CODES

Column	Classification	Codes
1	Place of Residence	A - Kitimat
		B - Prince George
		C - Terrace
		D - Prince Rupert
		E - Smithers
		F - Vanderhood
		G - Burns Lake
		H - Fraser Lake
		I - Hazelton
		J - Granisle
		K - Telkwa
		L - Fort Fraser
		M - Houston
		N - Kitwanga
		Ø - Endako
		P - Fort St. James
		Q - Takysie Lake
		R - Southbank
		S - Engen
		V - Prince George
2,3,4	Identification Number	Number (range 000-999)

Column	Classification	Codes
5	First favourite fishing location	0 - No response
		1 - No favourite
		2 - Copper River (Zymoetz)
		3 - Kitimat River
		4 - Lakelse River
		5 - Skeena River
		6 - Douglas Channel
		7 - Telkwa River
		8 - Babine Lake
		9 - Wedeene River
		A - Kitwanga River
		B - Dala River
		C - Kildala River
		D - Uncha Lake
		E - Poplar Lake
		F - McBride Lake
		G - Nadina River
		H - Other Lakes
		I - Lakelse Lake
		J - Kalum River
		K - Tchesinkut Lake
		L - Kasiks River
		M - Owen Lake
		N - Kitwanga Lake

Column	Classification	Codes
5	First favourite fishing location continued	Ø - Nass River
		P - Kalum Lake
		Q - Other Rivers
		R - Francois Lake
		S - Kispiox River
		T - Meziadin Lake
		U - Stuart Lake
		V - Nechako River
		W - Fraser Lake
		X - Babine River
		Y - Maxan Lake
		Z - Bulkley River
		¢ - Pinkut Lake
		. - Takysie Lake
		* - Morice River
		(- Burns Lake
		) - Ootsa Lake
		$ - Parrott Lakes
		? - Augier Lake
		= - Stellako River
		: - Exchamsiks River
		# - Cluculz Lake
		; - Nulki Lake (Tachick)
		, - Bednesti Lake

Column	Classification	Codes
5	First favourite fishing location continued	+ - Morice Lake % - Dean River & - Grassham Lake " - Norman Lake < - Oona and Ormand Lakes ! - McLure Lake / - Fulton River
6	Second favourite fishing location	See Column 5
7 - 12	Compensation required for loss of first favourite location Original response	Number (range 000000-999999) XXXXXX - No response
13 - 18	Compensation required for loss of first favourite location New response	See column 7-12
19 - 20	Reason for divergence in compensation required	00 - No response 01 - Misunderstood 02 - Indifferent 03 - owns property 04 - wouldn't discuss 05 - cannot place monetary value 06 - rising costs
21 - 23	Average cost per day at first favourite location Original response	Number (range 000-999) XXX - No response
24 - 26	Average cost per day at first favourite location New response	See column 21 - 23

Column	Classification	Codes
27 - 29	Average cost per day at second favourite location Original response	Number (range 000-999) XXX - No response
30 - 32	Average cost per day at second favourite location New response	See column 27-29
33 - 34	Reason for divergent costs	00 - No response 01 - Misunderstood 02 - New accessories acquired 03 - Rising costs (inflation)
35 - 38	Maximum willingness-to-pay Original response	Number (range 0000-9999) XXXX - No response
39 - 42	Maximum willingness-to-pay New response	See column 35-38
43 - 44	Reason for divergent willingess-to pay	00 - No response 01 - Misunderstood 02 - Net of costs 03 - Rising costs
45	Willingness-to-pay Net of costs	0 - No response 1 - yes 2 - no

TABLE IV.1: MAIL SURVEY 1975 RESULTS BY RESIDENCE CATEGORY

Place of Residence	Total Number of Fishing License Holders	Number Drawn For Sample		Number of Usable Completed Responses	
		No.	% of Licenses	No.	% of Licenses
Prince George	12,504	1,563	12.5	1,012	8.1
Terrace	3,184	398	12.5	262	8.2
Kitimat	2,264	283	12.5	212	9.4
Prince Rupert	1,824	228	12.5	151	8.3
Smithers	1,376	172	12.5	130	9.4
Vanderhoof	1,192	149	12.5	99	8.3
Burns Lake	1,168	146	12.5	105	9.0
Fraser Lake	440	55	12.5	31	7.0
Hazelton	368	46	12.5	32	8.7
Granisle	344	43	12.5	26	7.6
Telkwa	224	28	12.5	26	11.6
Fort Fraser	192	24	12.5	18	9.4
Houston	104	13	12.5	10	9.6
Kitwanga	96	12	12.5	11	11.5
Endako	64	8	12.5	5	7.8
Fort St. James	64	8	12.5	7	10.9
Takysie Lake	40	5	12.5	4	10.0
Southbank	40	5	12.5	5	12.5
Engen	32	4	12.5	4	12.5
Francois Lake	8	1	12.5	--	--
Cluculz Lake	8	1	12.5	--	--
TOTAL	25,636	3,192	12.5	2,140	8.4

TABLE V.1: TELEPHONE SURVEY 1975 RESULTS BY PLACE OF RESIDENCE

Place of Residence	Total Number of Fishing License Holders	Total Mail Survey Returns Drawn for Telephone Survey			Completed Telephone Survey Interviews		
		No.	Percent of Mail Returns	Percent of Fishing Licenses	No.	Percent of Sample Drawn	Percent of Fishing Licenses
Prince George	12,504	622	61.5	5.0	518	83.4	4.1
Terrace	3,184	152	58.0	4.8	120	78.9	3.8
Kitimat	2,264	143	67.5	6.3	121	84.6	5.3
Prince Rupert	1,824	84	55.6	4.6	58	69.0	3.2
Smithers	1,376	89	68.5	6.5	70	78.7	5.1
Vanderhoof	1,192	52	52.5	4.4	35	67.3	2.9
Burns Lake	1,168	50	47.6	4.3	28	5.6	2.4
Other Places of Residence	2,024	-	-	-	-	-	-
TOTAL	25,536	1,192	55.7	4.7	950	79.7	3.7

SUMMARY OF RESIDENT ANGLER DAYS BY STREAM AND PLACE OF RESIDENCE -

SHOWING PRICE COMPENSATING CONSUMER SURPLUS VALUES

	Total Angler Days/Yr.	Mean Value Per Day ($)	Annual Total ($) Value Q.9
Norman Lake	5,280	15	79,200
Bednesti Lake	5,002	21	105,042
Cluculz Lake	35,356	59(25)	2,086,004
Nulki Lake	17,438	26	453,388
Nechako River	19,569	32	626,208
Stuart Lake	25,212	25	630,300
Oona & Ormond Lakes	2,789	14	39,046
Grassham Lake	6,013	35	210,455
Fraser Lake	22,152	26	575,952
Stellako River	6,356	35	22,246
Francois Lake	28,684	31	889,204
Burns Lake	1,413	13*	18,369
Pinkut Lake	508	30	15,240
Tchesinkut Lake	5,951	17	101,167
Takysie Lake	2,019	22	44,418
Uncha Lake	3,408	33	112,464
Ootsa Lake	5,563	43	239,209
Maxan Lake	98	100	9,800
Augier Lake	138	10*	1,380*
Babine Lake	63,797	22	1,403,534
Fulton River	2,190	6*	13,140*
Owen Lake	211	-	-
Poplar Lake	742	19	14,098
Parrott Lakes	5,234	10	52,340
Morice River	26,184	43	1,125,912
Morice Lake	733	-	-
McBride Lake	211	20*	4,220
Nadina River and Lake	1,016	50	50,800
Babine River	2,043	30	61,290
Telkwa River	1,813	14	25,382
Bulkley River	32,770	30	983,100
MacLure Lake	486	20*	9,720*
Kispiox River	27,717	46	1,274,982
Kitwanga River and Lake	5,711	25	142,775
Copper River	37,819	54	2,042,226
Skeena River	120,635	28	3,377,780
Kalum River	22,637	19	430,103
Kalum Lake	521	5	2,605
Lakelse Lake	9,980	17	169,660
Lakelse River	43,921	20	878,420

	Total Angler Days/Yr.	Mean Value Per Day ($)	Annual Total ($) Value Q.9
Kitimat River	96,745	16	1,547,920
Wedeene River	897	35	31,395
Kildala River	299	-	-
Exchamsiks River	1,678	14*	23,492*
Kasiks Rivers	2,508	22	55,176
Dala River	584	15	8,760

\- no mean values available

* Q.7 mean values used

( ) without extreme value

PRICE COMPENSATING CONSUMER SURPLUS VALUES BY STREAM

Total Annual Values/Stream = total number of Yellowhead anglers who fish/each stream

X mean yearly p.c. consumer surplus

Mean yearly price compensating consumer surplus

= mean value [(daily willingness-to-pay - daily costs of fishing) X (days fished per/year/stream)]

= mean value [(telephone survey '75 Q.3(a)(ii) - Q.2(b)(ii)) X (mail survey Q.10)]

Total number of Yellowhead Anglers who fish each stream

= total angler days/stream ÷ mean number angler days at stream per angler

Mean # Angler days at Stream per angler by place of residence

= mean (mail survey Q.10 and Q.12)

Total Angler days/stream = total residence anglers by place of residence ('74 phone survey anglers as % of pop.)

X mean days fish/yr. in Yellowhead by place of residence ('75 mail survey Q.6)

X distribution of activity occurrence at each stream by place of residence (mail survey Q.10 and Q.12)

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