EVALUATION OF RECREATIONAL BENEFITS ACCRUING TO STEELHEAD ANGLERS ON THE DEAN RIVER

by

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ABSTRACT

In order to evaluate the benefits derived from the Salmonid Enhancement Program the non-marketed, intangible components of an angling experience must be determined. These intangible components are in the form of benefits to steelheaders, both before and after steelhead enhancement, and they are calculated by simulating the demand for fishing and by using the concept of consumer's surplus. A comparison of techniques commonly used in outdoor recreation studies are evaluated and estimated for British Columbia residents and non-residents using the Dean River steelhead fishery. Methods used to estimate this demand are (1) the travel cost approach and (2) the direct consumer's surplus approach. Although the estimated benefits to steelhead anglers from these methods are not equal, they both show that an increase in economic benefits occurs when the probability of catching a steelhead, on the Dean, is doubled. Gross economic values estimated by the travel cost method yielded the most satisfactory results. Benefits derived by Dean River anglers were estimated to be $456,008 in the 1978/79 fiscal year. If salmonid enhancement doubles the probability of catching a steelhead, then the gross economic value for the Dean River will be approximately $704,170.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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CHAPTER 1

DESCRIPTION OF THE STEELHEAD FISHERY

INTRODUCTION

Unlike most consumer goods, sport fishing is not generally priced in the market place. This is due to the character of recreational fishing, where the output is not usually measured by the quantity of fish caught, as in the commercial fishery, but rather by less tangible dimensions, such as experience and enjoyment characteristics of a fishing trip. The number of fish caught is only one of the characteristics of a sport fishing day which is comprised of many quantity and quality values.

Establishing values for extra-market recreational activities have been a longstanding challenge in resource economics. This thesis will focus its attention on the determination of consumers' surplus and demand curve shifts due to the enhancement of steelhead trout on the Dean River.

THE GENERAL SETTING

Description of Steelhead Trout

It is said by steelheaders that landing a steelhead trout is a memorable occasion for any angler. They are difficult to hook and once hooked, they put up a furious battle. Most steelheading in British Columbia takes place during the early winter months, before the rivers ice-up.

Steelhead trout (Salmo gairdneri) are sea-going rainbow trout. Generally they reside in fresh water for one and a half to two years

before migrating to sea. They spend another year and a half to three years in the ocean where most of their growth takes place. They then return to spawn on their home streams from June through October, if they are part of the less abundant summer-runs, or from November to March if they are the winter-run type. Although the summer-runs enter the streams at an earlier date, they do not spawn until the following winter-spring season. Unlike salmon, steelhead return to spawn a second and sometimes a third time.

The steelhead trout fishery, as defined in this study, is the stock of steelhead trout in a freshwater river and the number of anglers with the possibility of catching a steelhead. The important variable in this definition is the stock of fish, which strictly depends on the reproduction, survival, mortality, and exploitation rates[1]. Figures for steelhead stock in British Columbia are unknown, and only proxy variables may be used. This study will use the number of steelhead caught as an indication of stock, which may underestimate or overestimate the actual number of fish.

Although the number of steelhead trout is unknown, it is known that stocks are declining rapidly on the Pacific Coast from environmental damages and overfishing. In British Columbia's known 435 steelheading rivers, steelhead catch declined 69.69 percent over the eleven year period of 1967/68 to 1978/79 (see Appendix I). The most likely reasons for this decline are clearcut logging, water withdrawal, urban and industrial development, channel engineering, overfishing by commercial net fisheries for salmon, Indian food fisheries and sport anglers (Narver, 1977, 13).

Due to this overall decline of salmonid stocks, of which steelhead trout are a species, the Salmonid Enhancement Program (S.E.P.) was approved in May 1977. It has been claimed that the S.E.P. "will eventually result in a doubling of the annual catch of Canada's Pacific Salmon" (Fisheries and Environment Canada, 1978, 1). The objective of the program's first five years is to produce an increase of approximately 50 million pounds per year of salmonids, contributing to the government's national income goals as well as to regional development, native Indian needs, employment and environmental goals. Techniques, such as hatcheries, spawning channels, and fishways, will be some of the means used to achieve the production goal.

Improvement of recreational fisheries can be done in three major ways; (a) regulation of take, (b) artificial replenishment of the stocks; (c) fish population manipulation by the aquatic environment (Dill, 1978, 11).

S.E.P., using a mixture of the above techniques, provides an opportunity to restore declining steelhead runs and the possibility of re-opening streams to anglers which have been closed because of low escapement. As one steelheader puts it, "S.E.P. is the single most important human development our trophy fish will ever face in this province" (Thornton, 1978, 142).

Description of the Dean River

The Dean River has been chosen to be the focus of this thesis because it is one of British Columbia's best steelheading rivers. The Dean competes with the Copper, Bella Coola, Morice and Bulkley (shown in Figure 1) in their outstanding catch per day records. It

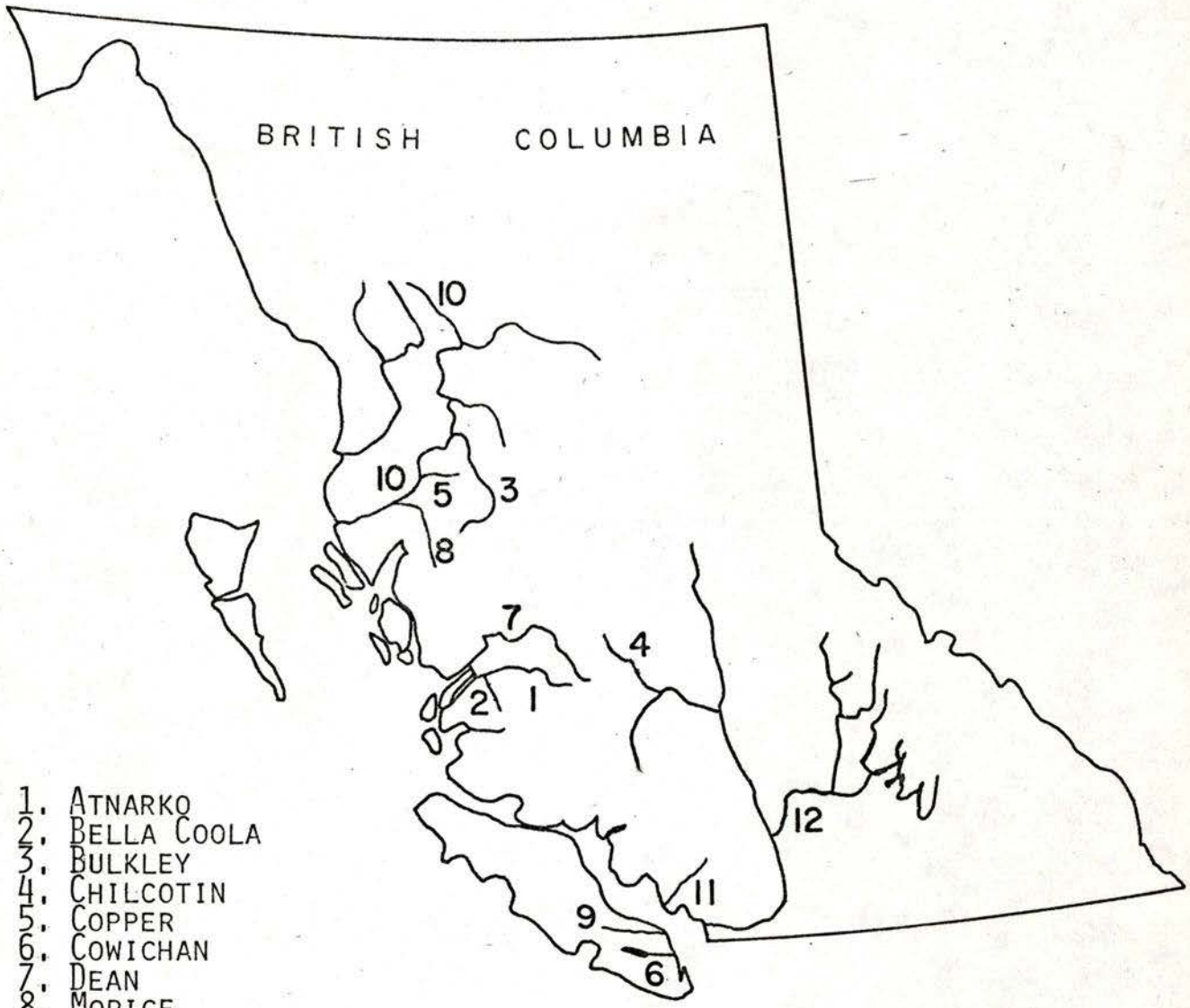

Figure 1. Major steelhead rivers in British Columbia.

has a unique situation away from any residential areas, allowing for an isolated river, free of angler congestion, and other outside influences, discussed in Chapter 3, which may bias the study's results.

Geographical setting

The Dean River is located on the West Coast of British Columbia, approximately 450 air miles northwest of Vancouver. It originates on the Chilcotin Plateau, meanders through Tweedsmuir Park and empties into the Dean Channel (see Figure 2).

The river supports natural runs of summer steelhead which makes it "internationally famous for the high quality fishing experience it provides" (Leggett et.al., 1978, 1). The Dean is utilized by resident rainbow trout, steelhead trout, coastal cutthroat trout, chinook, coho, pink and chum salmon.

Access to the Dean is by aircraft or boat. In a 1977 survey, 95 percent of anglers arrived by airplane and the remaining 5 percent arrived by boat (Leggett, et.al., 1978, 20).

Historical catch, effort and number of anglers data from 1967/68 through to 1978/79 on the Dean are outlined in Table 1.

There are a few alternative steelheading rivers in the Dean River area. Among them are the Atnarko River supporting 1,019 steelheading days in 1977/78, the Bella Coola River with 5,754 days and the Chilcotin River with 1,935 days. Among these, the Dean has the lowest days per catch ratio and supports the largest number of non-local anglers.

In order to fish for steelhead in British Columbia the following maximum catch regulations must be abided by:

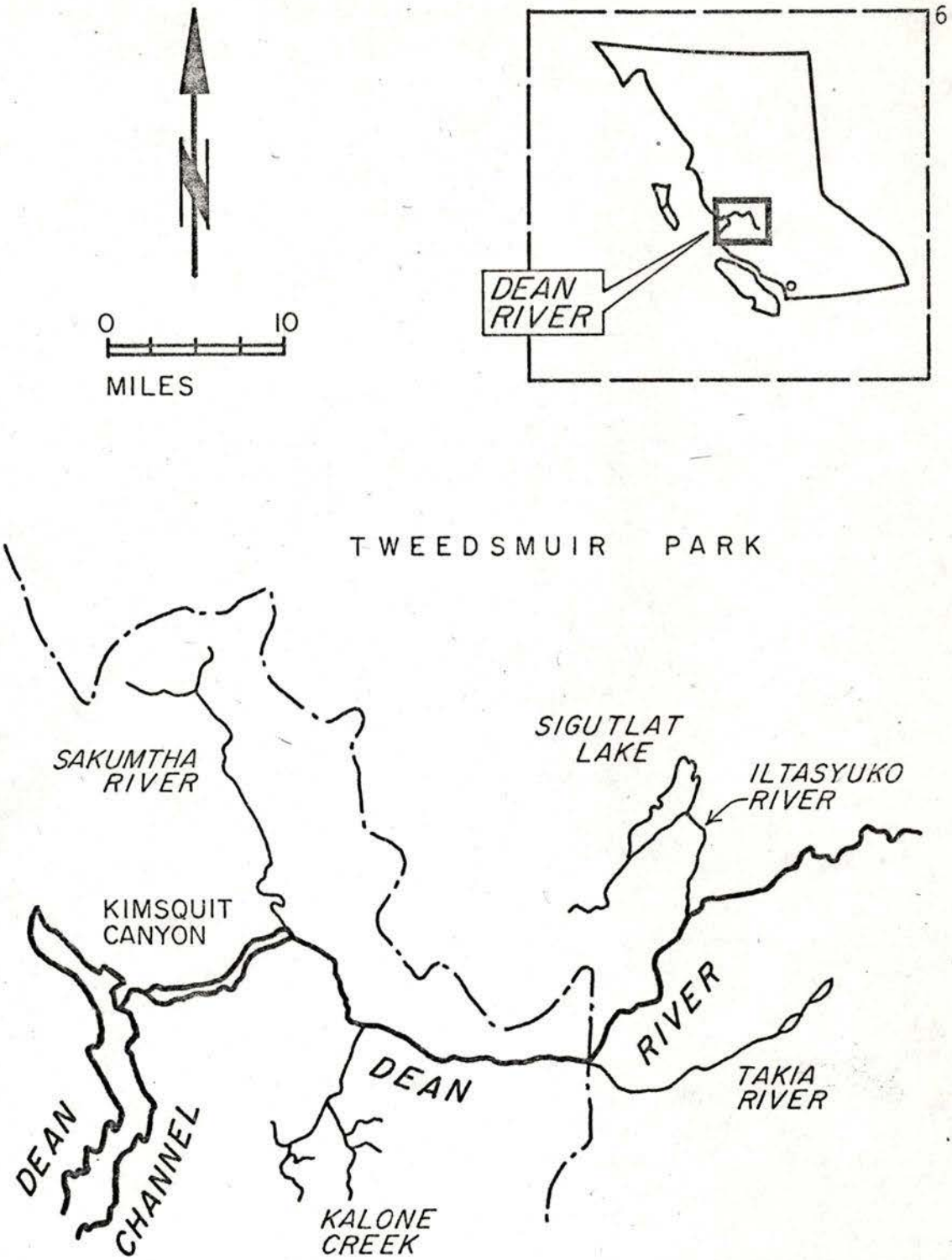

FIGURE 2. LOCATION OF THE DEAN RIVER AND MAJOR TRIBUTARIES.

a) 10 fish from all non-tidal waters by a person not a resident of British Columbia.

b) 20 fish from all non-tidal waters by a person who is a resident of British Columbia except: no more than 10 of those fish can be taken from any single river or stream.

Additional regulations exist for the Dean River and its tributaries:

1) Angling closure, (a) Within and below Tweedsmuir Park, Oct. 1 to May 31. (b) Between Iltasyuko River and Kalone Cr. (c) The (about) 1 km section between signs located about 500 m above the lower logging bridge and signs in the canyon area. - (2) Fly Fishing Only, between Kalone Cr. and Sakaumtha R., Aug. 1 to Sept. 30 - (3) Trophy Fishery, between Tweedsmuir Park - (4) Special River, below Tweedsmuir Park. (B.C. Sport Fishing Regulations, 1979/1980, 17)[2].

These regulations on catch and angling closures do not constrain most anglers. In 1978/79, Dean River steelhead trout fishermen spent an average of 5.8 days angling and not all anglers caught even one steelhead (Table 1).

Description of steelhead trout anglers

British Columbia anglers

Approximately 402,749 freshwater sport fishing licences and an additional 24,599 steelhead angling licences were purchased in 1978/79 (Appendix I)[3]. These latter figures for steelhead licences show an average decreasing trend of 2.55 percent annually from 1968-1979.

Licensed anglers fished an estimated total of 159,363 days in 1978/79[4], showing a decrease of 8.79 percent from the previous year. Catch for the year was 14,700 steelhead, a 19.43 percent decrease from 1977/78.

During this same period, angler effort, measured in angler days, fluctuated considerably, with a 28.95 percent period decline. Partly

TABLE 1

DEAN RIVER STEELHEAD STATISTICS

	SPORT ANGLING *				Number of steelhead caught by the Commercial Fishery**
Year	Number of angling days	Number of anglers	Number of steelhead caught	Days/ Catch	
1967/68	1,707	342	918	1.8	1,631
1968/69	2,419	341	712	3.4	944
1969/70	2,804	590	1,240	2.3	476
1970/71	1,777	291	497	3.6	681
1971/72	1,780	389	1,288	1.4	1,381
1972/73	2,627	456	1,452	1.8	701
1973/74	3,600	626	1,316	2.7	1,237
1974/75	3,453	712	1,132	3.0	447
1975/76	3,579	793	1,156	3.1	1,087
1976/77	3,263	754	727	4.5	547
1977/78	3,419	677	623	5.5	663
1978/79	4,204	718	617	6.8	175

* Source: Steelhead Harvest Analysis, Fisheries Management Division, Fish and Wildlife Branch

** Source: Fisheries and Marine Service. Data for Area 8[5].

due to the higher negative percentage of catch as compared to effort, angler days per catch have doubled in British Columbia, from 4.62 days in 1967/68 to 10.84 days in 1978/79.

British Columbia anglers accounted for 91.37 percent of the total angling. Non-resident Canadians accounted for 3.91 percent and the non-residents fished the remaining 4.72 percent (Fisheries Management Division, 1978/1979).

Dean River Anglers

The Data

The data used for this study was obtained from a questionnaire survey undertaken between June and September 1979 on the Dean. Anglers were personally interviewed by a steelheader employed by the Fish and Wildlife Branch of the Ministry of Environment. A copy of the questionnaire, designed by the Economics Section of the Ministry of Environment, appears in Appendix II. Results are tabulated in Appendix III, and the enumerator's observations are found in Appendix IV. All steelhead anglers found on the Dean from June 18 to August 21, 1979 were interviewed while fishing. The sample consisted of 129 interviews.

Place of residence

Of the 129 interviewed anglers, 78 (60.5 percent) were residents of British Columbia; 7 (5.4 percent) were non-British Columbia resident Canadians, and 44 (34.1 percent) were non-Canadians, as shown in Table 2 (further breakdown of residency is found in Appendix III, Table 1)[6].

The high degree of non-resident participation on the Dean reflects a special attraction the fishery holds for anglers[7].

TABLE 2

PERMANENT PLACE OF RESIDENCE OF
ANGLERS INTERVIEWED ON THE DEAN

Location	Number of Anglers	Percentage
British Columbia	78	60.5%
Vancouver Island	2	
Lower Mainland	6	
Thompson-Okanagan	12	
Kootenay	3	
Cariboo	24	
Skeena	31	
Non-resident Canadian	7	5.4%
Alberta	6	
Saskatchewan	1	
Non-residents	44	34.1%
California	15	
Florida	1	
Georgia	2	
Montana	5	
Oregon	1	
Washington	17	
Wisconsin	2	
New Zealand	1	
TOTALS	129	100.0%

Source: Table 1, Appendix III.

Sex and age of anglers

Steelheading in British Columbia is dominated by males. The survey on the Dean shows that 92.41 percent of steelheading anglers were male and only 7.59 percent were female (Appendix III, Table 2).

Not surprisingly, among the anglers interviewed and the members of their parties, the great majority of steelhead anglers, 97.10 percent, were between 16 and 65 years of age. Only 2.49 percent were over 65 and .41 percent under 16 (Appendix III, Table 2).

Income distribution

The data collected show that steelheaders are drawn from a wide range of annual incomes. The study showed 22.43 percent of anglers earning an annual income less than $5,000; 41.86 percent received between $14,000 and $25,000; 24.81 percent earned between $27,000 and $50,000; and the remaining 10.85 percent ranged between $60,000 and $150,000 annual incomes (Appendix III, Table 19). These figures can be compared with the Canadian income breakdowns for 1977, where 16.2 percent of the population earned less than $5,000; 32.4 percent earned between $14,000 and $25,000 and 20.8 percent earned over $27,000.

Expenditures of sport fishermen on the Dean

It is important, when valuing steelhead fishing, to consider the expenditures fishermen incur when steelheading. These expenditures are a partial indication of the significance of angling to the recreationist. A nominal annual licence fee is the only charge for the opportunity of fishing, yet considerable costs are incurred on travel, accommodations, meals, tackle and other goods used in the recreational activity.

As may be seen on Table 3, the 129 anglers surveyed spent a total

TABLE 3

TOTAL EXPENDITURES OF SAMPLED
DEAN RIVER ANGLERS IN BRITISH COLUMBIA

Item	Dollars
Transportation	17,314
Accomodation	15,254
Meals and Beverages	884
Groceries	4,409
Tackle and equipment	3,613
Other	160
TOTAL	41,634

Source: Appendix III, Tables 6-11.

of $41,634 in British Columbia for their fishing outing. The major expenditure item was transportation ($17,314), followed by accommodations ($15,254). No historical data are available to provide any kind of comparison.

Participation patterns

Historical data on the Dean River indicate that the number of angler-days of steelheading effort has risen at an average rate of 10.27 percent each year since 1967 (Table 1). The 129 anglers interviewed and members of their parties, spent 735 days of their total 938 trip days steelhead fishing on the Dean in 1979. Only one of the interviewed anglers had not visited the Dean in the past year, and a total of 189 trips had been made in the past year by those interviewed. In the last five years only two anglers had not fished the Dean, all others had made from one to 35 trips (Appendix III, Tables 3 and 4).

In the past twelve months anglers fished steelhead a total of 292 days in other areas of British Columbia, with the Skeena being favored after the Dean (Appendix III, Table 5).

Quality of the river sport fishery

During the interview, anglers were asked if they considered a list of the fishing and other qualities on the Dean River to be very poor (rating = 1), average (rating = 3), or very good (rating = 5). Scenic beauty and fighting quality of fish received equally high ratings (21.88 and 21.80 percent respectively), followed by the lack of crowdedness of the area (19.25 percent), number of fish expected to catch (16 percent), size of fish (13.55 percent) and finally, ease of access (7.51 percent) (Appendix III, Table 15).

When the Dean was compared to other steelhead fishing areas by rating the same list of river qualities, natural beauty was the outstanding feature of the Dean, receiving 25.51 percent of the score. Ease of access and lack of crowdedness ranked next (18,90 and 16.24 percent respectively), followed by fighting quality of fish, expected size of steelhead, expected catch and finally facilities (Appendix III, Table 16).

Sport fishing was the main reason for 97.67 percent of the interviewed anglers to have travelled to the Dean. Steelheading was the main objective for 95.35 percent of the anglers, for with the absence of steelhead, they would not have visited the Dean River (Appendix III, Tables 12 and 13).

DIRECTION OF THE STUDY

In order to study the benefits of the Salmonid Enhancement Program to the Province and the Federal government, studies must be undertaken to determine present and enhanced demand for steelhead fishing. The next chapter develops the theory of consumer's surplus in order to put a value to the intangible benefits of freshwater steelhead fishing. Chapter 3 discusses the most popular valuation techniques used in outdoor recreation, developing the framework for the valuation of steelhead trout fishing in particular. Possible demand curve shifts due to enhancement, are examined in Chapter 4. The valuation models are empirically estimated in Chapter 5, finding the value of steelhead fishing on the Dean River, and the shift in angling demand due to enhancement. The last chapter outlines the limitations, recommendations and conclusions of the study.

FOOTNOTES

[1]Survival rates for hatchery steelhead are 4 percent and for natural stocks 15 percent as estimated by the Fish and Wildlife Branch, 1979.

[2]Where; Angling Closure is defined as "no person shall fish for, catch, kill or have in possession any fish". Fly fishing only means "angling with a rod which is attached to a reel, a fly line connected directly to the reel or attached to a backing line connected to the reel, a leader, and not more than two artificial flies". Trophy fishery refers to "waters specially managed to produce a quality fishery for large fish". Two specific rules always apply to waters so designated:
1. Single hook restrictions. 2. Natural bait ban. Special Rivers refers to "any person age 16 or over who is not a resident of Canada requires a supplementary "Special river angling licence" (25.00 dollars) in addition to his basic annual angling licence.

[3]Angling licence fees are defined in the British Columbia Sport Fishing Regulations Synopsis 1979/1980 for non-tidal waters are as follows:

Angling License type	B.C. residents		Residents of Canada	Non-Canadian
Age	16-64	65+	16 and over	16 and over
Basic Angling:				
Annual	$5.00	$1.00	$5.00	$15.00
Short term	*	*	*	6.00
Steelhead:	$3.00	$3.00	$10.00	$10.00

* Not applicable.

[4]One angling day is defined as an angler fishing any part of the day.

[5]Most of Fisheries and Marine Services catch statistics in Area 8 are Dean River bound (T.D. Wilkinson, Fisheries Technician, August, 1979, personal communication).

[6]These statistics are fairly close to the 1978/79 breakdown of angling on the Dean from the Steelhead Harvest Analysis. In 1978/79, 54.46 percent of steelheaders were British Columbia residents, 37.88 percent were non-resident Canadian and 7.66 percent were non-residents of Canada.

[7]Sinclair (1972, 56), in his study on the British Columbia Sport Fishery states that the non-resident's choice of either tidal or fresh water fishing is influenced by the knowledge of fishing opportunities they have acquired on prior visits to the Province.

CHAPTER 2

THE THEORY OF CONSUMER'S SURPLUS

INTRODUCTION

Changes in environmental quality, caused by the Salmonid Enhancement Program, can affect the welfare of individuals by altering the characteristics of a fishing day. This chapter focuses on two basic issues. The first is the definition of various measures of showing changes in economic welfare expressed in monetary terms. The second is the discussion on how these changes of welfare could be measured theoretically and practically for the Dean River fishery.

ALTERNATIVE MEASURES OF CONSUMER'S SURPLUS

Following economists Alfred Marshall and Jules Dupuit, consumer's surplus may be defined as:

> The excess of the price which {the individual} would be willing to pay rather than go without the thing, over that which he actually does pay, is the economic measure of this surplus of satisfaction. It may be called consumer's surplus (Marshall, 1920, 124).

The validity of the concept of consumer's surplus has been seriously questioned by many leading economists because it is not a unique measure. Paul Samuelson (1947, 198), for example, stated that "... the Marshallian concept of consumer's surplus does not refer to any one thing, but to at least half a dozen interrelated expressions." This problem can easily be shown by use of indifference curves. Four different measures of consumer's surplus are shown in Figure 1, depicting two indifference curves for a given angler. Assuming a reduction in the cost of an angler day from p_1 to p_2,

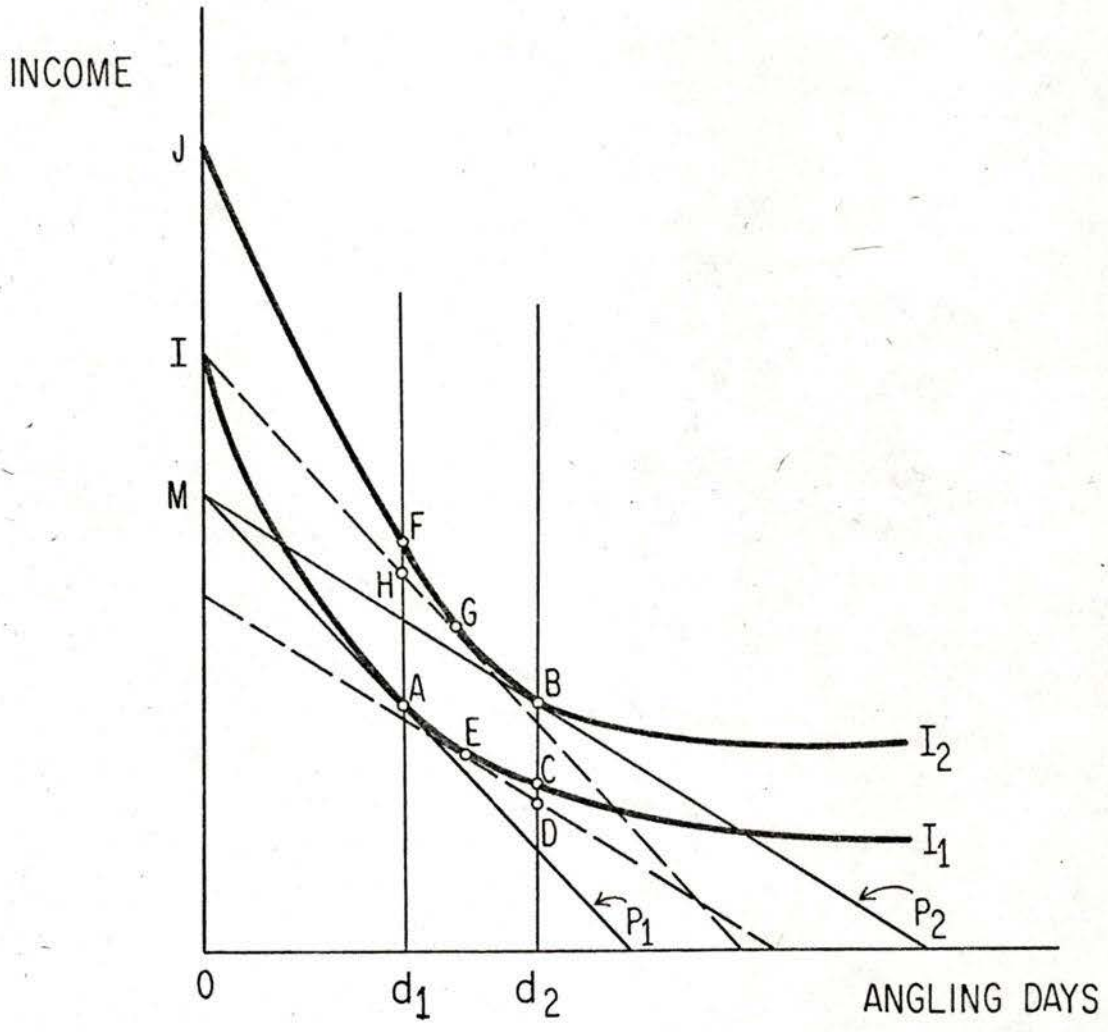

FIGURE 1. FOUR CONSUMER'S SURPLUSES BY USE OF INDIFFERENCE CURVES

the angler will, in response to the change, shift from his first consumption bundle A on indifference curve I_1 to consumption bundle B on I_2 as a result of both substitution effects (from A to E) and income effects (from E to B). The welfare benefits to the angler because of this reduction in price can be measured in a variety of ways.

a) Quantity compensating variation

This measure of consumer's surplus asks what compensating payment would the fisherman be willing to make in order to keep on fishing d_2 days at p_2 per day, instead of paying p_1 per day. At p_2 he will move to point B, and will consume d_2. BC will be in the individual's surplus as he is as well of as before at point C if he is constrained to fish d_2 days. This quantity compensating variation can be interpreted as the amount the angler would be willing to pay for the opportunity of fishing d_2 angling days at p_2 instead of p_1. It should be emphasized that this measure does not allow the angler to adjust the quantity he consumes.

b) Price compensating variation

The angler would not be asked what compensating payment will make him indifferent between the original situation and the opportunity of purchasing a variable number of angling days at the new price p_2, in other words his willingness to pay for the opportunity to fish any number of days he chooses at p_2 per day. Consumer's surplus would be distance BD, which is equal to the change in the area under the constant real income demand curve (D_{R1} in Figure 4) and above the price (Freeman, 1979, 41), discussed later in this chapter. It is

also interesting to note that both quantity and price compensating variations would be equal if the indifference curves were vertically parallel. Both measures are usually found by asking the individual direct questions concerning his willingness to pay, although Pearse, as will be seen in Chapter 3, has suggested an indirect method of estimating the price compensating variation.

c) Quantity equivalent variation

This measure asks what change in income is required, given the original price, p_1, and consumption level d_1, in order to make the angler as well of as he would be with the new price, p_2. In other words, assuming consumption is fixed at d_1, how much would he accept in lieu of a price reduction from p_1 to p_2. This consumer's surplus would be equal to the vertical distance between both indifference curves at consumption level d_1, that is, distance AF in Figure 1. If the price was p_1 and consumption was d_1, and the availability of angling was reduced to zero, then the angler would need to be compensated MI in order to leave him at his original welfare level. The quantity equivalent variation is closely related to the price equivalent variation discussed below, the only difference being in the restriction on the adjustment of the consumption of angling days in the former case.

d) Price equivalent variation

This measure asks what change in income (given p_1) would lead to the same utility change as the change in the price of angling days. As shown in Figure 1, the angler could reach utility level I_2 at point G thus he would have to be compensated AH in order that he agree to

forego the change from p_1 to p_2. If complete removal of the resource is considered the price equivalent variation and quantity equivalent variation are identical.

Both equivalent variations require a payment to be given to the individual and are often found by asking him his willingness to sell a given commodity.

All the above measures of consumer's surplus would be equal to each other and the area under the money income demand curve if the indifference curves were vertically parallel; meaning that there is no income effect, or the marginal utility of income is constant.

e) Consumer's surplus as the area under the money income demand curve

Consumer's surplus may also be thought of as the amount a perfectly discriminating monopolist may extract from a consumer. For example, if the maximum price an angler is willing to pay for his first angling day is $8.00; the maximum price he is willing to pay for his second day is $6.00; the maximum for the third is $4.00, and so on, then the monopolist is extracting the maximum amount the consumer is willing to pay without reducing his price for any of the previous angling days. These daily sums, also called 'marginal valuations' (Mishan, 1976, 25) are shown in Figure 2. If the price for each angling day were fixed at $4.00 (i.e., the perfect price discriminator was eliminated) then the shaded area in Figure 2 would be the angler's consumer's surplus.

Assuming that angling is a perfectly divisible normal good, and that there is a fixed price for each angling day, Figure 2 may be converted into a smooth demand curve shown in Figure 3, where the

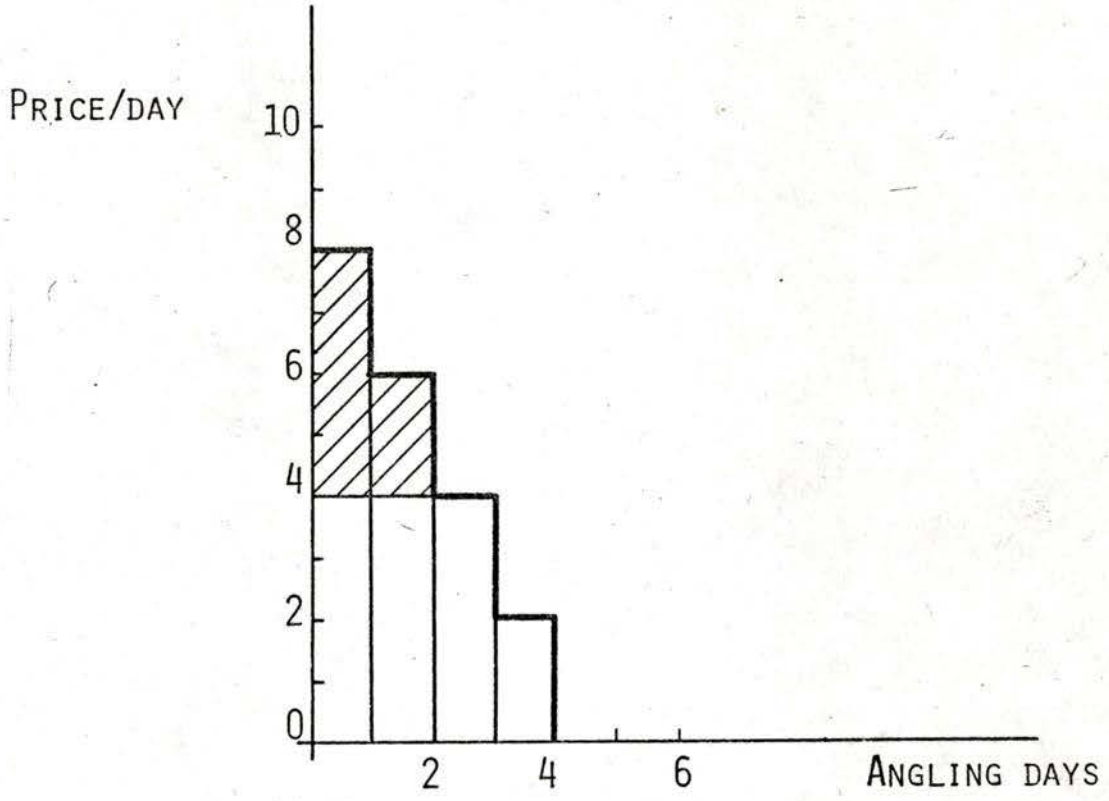

FIGURE 2. CONSUMER'S MARGINAL VALUATION FOR EACH ANGLING DAY.

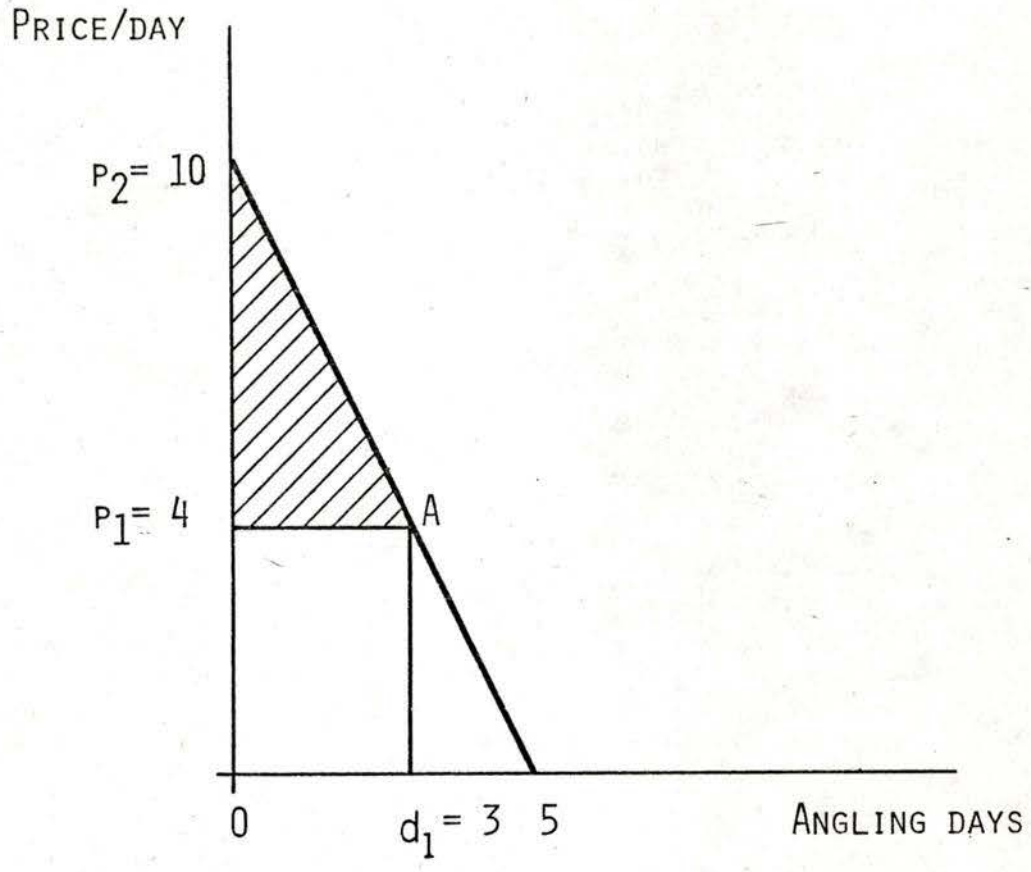

FIGURE 3. CONSUMER'S SURPLUS AS THE AREA UNDER THE DEMAND CURVE.

individual will fish 3 days at \$4.00, paying \$12.00 (area Op_1Ad_1) and receiving \$9.00 (area p_1p_2A) of consumer's surplus which is equal to the amount of money he would have paid to the price discriminating monopolist over what he actually pays. For a nonmarketed good, with free access, such as steelhead fishing in British Columbia, the whole area under the demand curve is a measure of consumer's surplus. This is equal to the total amount the angler would have been willing to pay for the 5 angling days he presently consumes without charge.

There has been a great controversy over this measure of consumer's surplus because the area under the demand curve illustrated in Figure 3 will only correspond to a normal constant money income demand curve if the marginal utility of money income is assumed constant, or, in other words, if there are no significant income effects. If significant income effects do exist, then by being able to purchase all the fishing days at the same price, the angler's real income would increase as the price per day fell, increasing the number of angling days consumed by greater amounts than those shown in Figure 3. Similarly if the price per day increased so that all units must now be purchased at a higher price then the number of angling days consumed would decrease by more than those shown in Figure 3.

The relationship between the constant real income demand curve, and a money income demand curve is shown in Figure 4. The angler depicted here starts with a given income and buys successive angling days at the maximum price he is willing to pay for each day. His constant real income demand curve D_{R1} will always lie below the money income demand curve at lower prices and above it at higher prices.

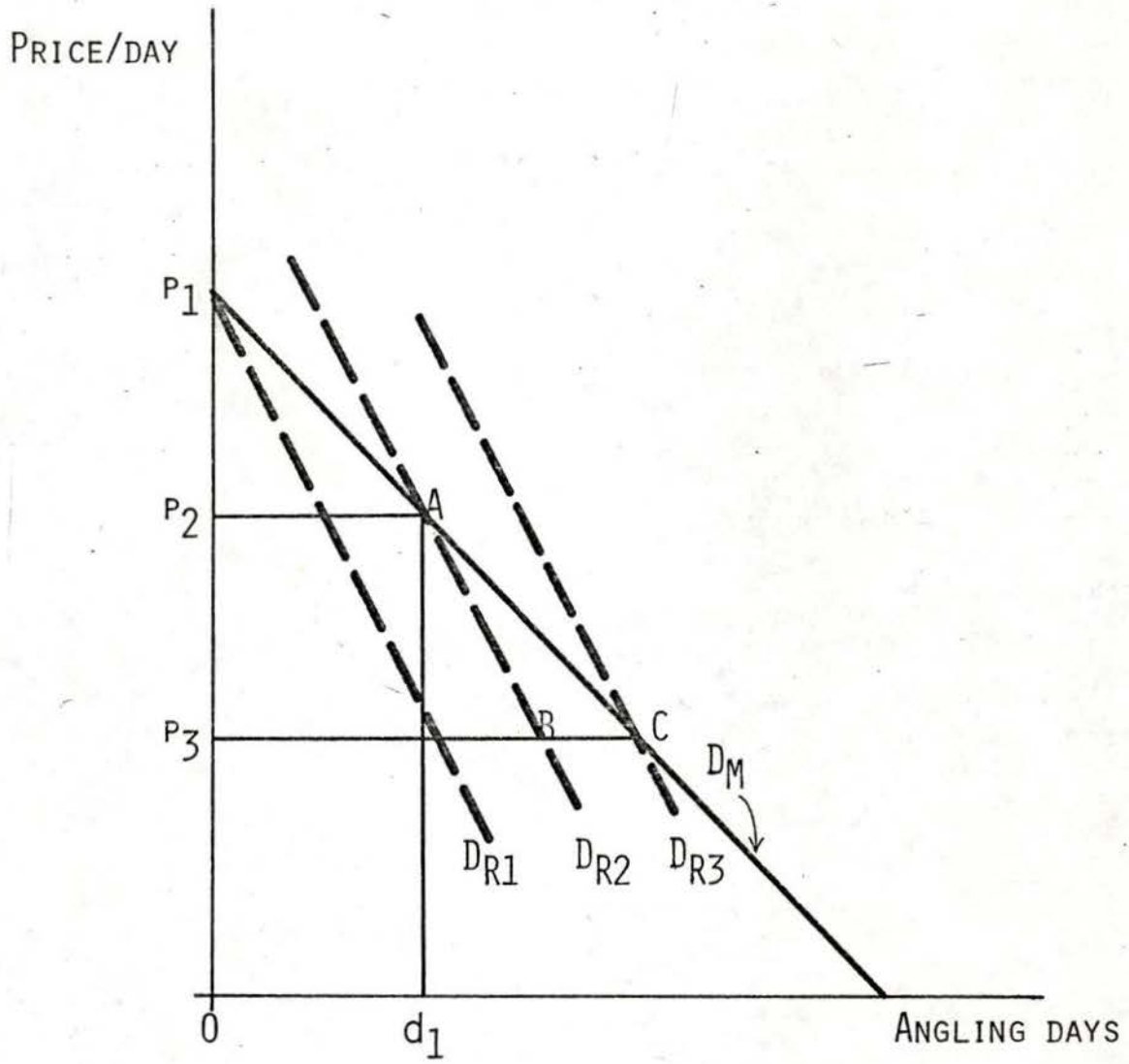

FIGURE 4. RELATIONSHIP BETWEEN A CONSTANT REAL INCOME DEMAND CURVE AND A MONEY INCOME DEMAND CURVE.

Real income will increase along a money income demand curve as prices fall; at p_2 the constant real income demand curve shifts to D_{R2}, and at p_3 to D_{R3}. Drawing a demand curve through the points where the horizontal price line intersects the constant real income demand curve yields the money income demand curve D_M.

As can be seen, the areas under the constant real income demand curve and the money income demand curve are not the same. If the price falls from p_2 to p_3 the maximum the fisherman is willing to pay to receive this fall in price is area p_2ABp_3 which is equal to the price compensating variation discussed above, but the change in consumer's surplus as the change in the area under the money income demand curve and above p_2 is area p_2ACp_3, overestimating consumer's surplus by area ABC.

Since the early 1970's several important articles have been published reviewing the usefullness of this measure of consumer's surplus. Mishan in his Cost-Benefit Analysis, stated that,

> ... the smaller the income effect, the closer is the coincidence of the three measures (two compensating variations and the equivalent variation). For a zero income effect the measures coincide. Goods having zero income effects are hard to come by, but for a great many purposes the income effect involved is small enough for economists to make use of the area under the demand curve as a close approximation of the relevant benefit or loss (Mishan, 1976, 429).

Other conclusions of this type may be found in Willig's "Consumer's Surplus Without Apology" (1976), and in David Winch's article on "Consumer's Surplus and the Compensation Principle" (1959). The latter, although written before 1960, concludes,

> Re-examination of the {area under the money income demand curve} shows that it does yield an accurate measurement of consumer's gains and losses from price changes, even when the marginal utility of money is not constant (Winch, 1959, 422).

Willig derived a rigorous expression relating the price compensating variation to the area under the money income demand curve. His expression provides a method of calculating the differences between the measures for given prices, quantities and incomes.

Willig's derivation depends on the income elasticity of demand and consumer's surplus as a percentage of income. If the following conditions are met,

$$(1) \quad \left| \frac{\bar{n}\, CS}{2Y_o} \right| \leq .05$$

$$(2) \quad \left| \frac{\underline{n}\, CS}{2Y_o} \right| \leq .05$$

$$(3) \quad \left| \frac{CS}{Y_o} \right| \leq .9$$

then the rule of thumb for the price compensating variation is,

$$(4) \quad \frac{\underline{n}\,|CS|}{2Y_o} \leq \frac{CV - CS}{|CS|} \leq \frac{\bar{n}\,|CS|}{2Y_o}$$

where, CS = consumer's surplus as the area under the demand curve and between two prices (positive for a price increase and negative for a price decrease).

CV = compensating variation corresponding to the price change

Y_o = consumer's base income

$\bar{n}$ and $\underline{n}$ = respectively the largest and smallest values of the income elasticity of demand in the region under consideration.

Consumer's surplus (CS) as a percentage of income depends on the size of the price change, the price elasticity of demand and the expenditure of this good as a percentage of total income. Condition (3) may be interpreted as a measure of the proportional change in real income due to a price change which in turn says that the smaller the price change and the smaller the proportion of income spent on the good, the smaller CS/Y_0 will be. Conditions (1) and (2) will most likely be satisfied when consumer's surplus as a percentage of income is small, or when the income elasticity of demand is small. Thus if conditions (1), (2) and (3) hold, then formula (4) places observable bounds of the percentage error of approximating price compensating variation with the observable area under the demand curve. For example, on the Dean the consumer's measured income elasticity of demand is .26 and their surplus area under the demand curve between the old and new price is .5 percent of income, then the compensating variation is within .06 percent of the measured consumer's surplus[1].

In general, Willig showed that

> ... in most applications the error of approximation will be very small. In fact, the error will often be overshadowed by the errors involved in estimating the demand curve. The results in no way depend upon arguments about the constancy of the marginal utility of income (Willig, 1976, 589).

THE APPROPRIATE CONSUMER'S SURPLUS

Each of the five concepts of consumer's surplus mentioned above measures something different and they each have a different meaning. The question now lies on finding the appropriate one to use for this

study. The problems of using the area under the demand curve and above the price were discussed above. The relevance of the other four measures are evaluated in this section.

In the case of a non-priced resource, willingness to sell, or the minimum amount an individual would have to be paid to give up the consumption of a good and leaving him as well off as before, should be used when a resource is presently used to generate wildlife-based experiences but a possible transfer to incompatible uses is being considered; for example, if it were proposed that the Dean River be purposely dried up to be used as a highway, then equivalent variation measures should be used. Thus, equivalent variations are only relevant when measuring society's losses from reductions in the availability of angling days. The Salmonid Enhancement Program does not deal with reductions in availability, consequently equivalent variations are not used here.

If a transfer of a resource from some other purpose to the production of wildlife-based experiences is being considered, then willingness to pay measures should be applied; for example, if enhancement is increasing the resource-base experience, then compensating variation measures should be used. The quantity compensating variation would not be an appropriate tool to be used for measuring the benefits of steelhead enhancement due to its restrictive fixed quantity assumption. The price compensating variation, which is equal to the change in the area under the constant real income demand curve and above the price, would then be the relevant measure to use. An approximation to this measure would be the area under the money income

demand curve and above the price.

The final consideration in the selection of the appropriate measure of consumer's surplus is whether it can be calculated from the available data. To obtain data for the price compensating measure, anglers must be asked directly what they are willing to pay for the opportunity of angling on the Dean or a method such as Pearse's must be used. Unfortunately, the data obtained from the questionnaire does not provide the necessary kind of information. Instead, it is set up in such a way that it obtains each individual's demand curve by asking him how many days he would fish at a given set of prices and his travel expenses. This information can be used to estimate his money income demand curve either indirectly by use of the travel cost method or by the use of the direct methods discussed in Chapter 3. Thus the frequently used area under the normal money demand curve is the only available measure.

SUMMARY AND CONCLUSIONS

The above description outlines five different measures of consumer's surplus showing that the appropriate measure to be used depends on the situation being studied and the data available for the estimation. Steelhead enhancement will presumably increase the benefits received by anglers while allowing them to adjust freely the number of days they wish to fish, making the price compensating variation the appropriate measure to use if anglers were directly asked the price they would be willing to pay to fish on the Dean River. Due to data limitation, the area under a money income demand curve must be used as an approximation of the price compensating variation. The

compensating variation is likely to be within .06 percent of the measured consumer's surplus.

FOOTNOTE

[1]Income elasticity of demand and consumer's surplus as a percentage of income were estimated from the data obtained in Chapter 5.

CHAPTER 3

VARIABLES AND TECHNIQUES USED IN THE ESTIMATION OF OUTDOOR RECREATION DEMAND

Although many argue against the valuation of outdoor recreation because of the so called "intangible values" associated with the activity, techniques estimating monetary benefits date back to at least, 1927 (Wehrwein, 1927). Since then, many valuation methods have evolved for estimating the benefits of outdoor recreation. This chapter discusses the variables which affect the demand for sports fishing and discusses the most commonly used valuation techniques, focusing on the determination of consumers benefits.

VARIABLES AFFECTING DEMAND CURVES

The previous chapter on consumer's surplus has developed a price-quantity demand curve on a two dimensional surface. Yet, it is known that demand is not composed strictly of a price and the number of fishing days and that, on the contrary many other variables, such as scenic beauty, fishing experience, etc., are involved in an individual's fishing trip.

Although all variables which conceivably affect demand may not always prove to be significant in demand analysis, it is worthwhile to discuss some of the potential demand determinant variables. The literature in the past ten years has attempted to determine exactly what variables are indeed significant. The following discussion will illustrate the complexity of variable determination by showing the disparities in the literature, leading to the conclusion that each

site and its particular circumstances must be studies individually and that a nation-wide demand equation is virtually impossible.

It is highly unlikely that steelheaders, and anglers in general, would fish in streams in which they knew no fish existed. However, it has been shown that catching a fish is not the sole purpose of most angler trips[1]. Therefore although the satisfaction derived from fishing stems in part from the existence and expectation of landing a fish, it goes beyond the actual catching of the fish.

Research has shown that outdoor fishing is used not only as a sport, but also as an escape from the everyday pressures of life. Bryan (1974) for example, shows that among a possible of fourteen choices, "to take it easy and get rid of tensions, change from working pressures, and change from home pressures" ranked second, fourth and seventh respectively (Bryan, 1974, 14). Driver and Knopf (1976) also discuss this issue in the study where they find that fishing is widely used as a temporary escape[2]. If these people were looking for an excuse to escape from the pressure of life, enhancement presumably would give the fisherman a greater excuse for each outing.

A recent study by Morey points out that "few studies for recreational sites explicitly consider the site's physical characteristics. Even those studies which consider site characteristics do not explicitly incorporate them into the utility function" (Morey, 1979, 2). This lack of identification of characteristics is due to the difficulty of quantifying them. In another context, Morey found that they were definitely significant when recreationists are choosing a place to go skiing.

This reasoning can be transferred to fishing areas. If the scenic surroundingson the Dean River were destroyed, then anglers would no longer fish on the Dean. This can be seen by the importance of scenic beauty in choosing a place to go steelheading.

Most studies show income to be a significant variable of demand. Among these studies are Campbell Gilmour's valuation of outdoor recreation in Souwthoothe Valley, Idaho (1973, 51); Robert Davis' study on hunting in Maine (1964, 396); Gillespie and Brewer's work on St. Louis' water oriented outdoor recreation (1969, 3); Sewell and Rostron's study on recreational fishing in British Columbia; and, Haw and Mathews' finding when estimating recreational use of surplus hatchery coho (1969, 493).

Education[3], age, sex and occupation have been variable included in several studies, and in most cases have been found to be statistically insignificant to the demand estimation (Sewell and Rostron, 1970, 57; Gillespie and Brewer, 1969, 3; and others).

Intuitively it would seem correct to believe that as population, leisure time, equipment, investment in a recreational activity and experience increase, so would the demand for the given activity (Clawson and Knetsch, 1966; Dill, 1978). The relative importance of each of these factors varies from one place to another and from one time period to another. These, however, are important factors for estimating the present demand curve, but will be assumed to be constant in the estimation of the enhanced demand curve for the Dean River.

Distance travelled is another variable which may be a determinant of demand in some areas. Sewell and Rostron in their study of salt

water sport fishermen showed that most fishermen tend to travel a short distance (1970, 94), yet in the case of the Dean, on average, anglers travelled 592 miles[4] which supports William Sinclair's observation that "not all anglers fish exclusively in their areas of residence" (1972, 56).

The most controversial variable is 'success'. Many researchers believe that catch is not a very important factor for anglers, but most of the studies involved do not estimate demand curves per se, making the level of significance unavailable. Bryan's study (1975) of the Capilano, and this study of the Dean, both show that the prospect of catching a fish was the major reason for angler's visits. Haw and Mathews (1969, 495) found catch to be significantly correlated with willingness to pay. Talheim, when studying angling in Michigan found that:

> Anglers apparently prefer salmon-steelhead angling with higher catch rates to that with lower catch rates. This is indicated by three factors, (1) the demand is greater for the former, (2) anglers are quite willing to switch from lower catch-rate angling locations to high-catch-rate locations, but not vice-versa, and (3) a stronger positive relationship between personal income per capita in the angler's origin county and the demand for higher-catch-rate angling (Talheim, 1973, 188).

The importance of 'success' in hunting has been determined in several studies. Stankey et.al., explain it as follows:

> Success, defined as the taking of an animal, constitutes a significant component of a satisfactory hunting experience, at least within the particular big game hunting group surveyed. As success ratios decline, those satisfactions might be heightened in the face of reduced probabilities of success, there is probably a threshold to the extent to which there satisfactions play a supplementary role (Stankey, et.al., 1973, 240).

Other studies suggest the opposite. Moeller's study found that:

> Fishermen interviewed in this study show that elements of natural environments, water quality, natural beauty, and privacy while fishing- were more important to their overall enjoyment of a typical 1-day fishing trip than either the size or number of fish caught. These factors were given consistently high ratings regardless of the group studied (Moeller, 1972, 1256).

It is interesting to note that Moeller also found that the size and number of fish caught were more important for fishermen with less experience, and for younger fishermen.

VALUATION TECHNIQUES FOR OUTDOOR RECREATION

Studies in the late 1950's and early 1960's focused on comparing recreation benefits with the costs incurred in providing the facility. In all cases, this type of methodology has inadequately estimated benefits, for this reason they will not be included here[5].

A set of more reliable valuation methods have been developed measuring demand for outdoor recreation by market simulation. Among the most commonly used are, the indirect travel cost techniques, and the direct consumer's surplus approaches.

Indirect travel cost techniques

I) Hotelling-Clawson-Knetsch approach

Theoretical Framework:

The indirect travel cost method was first proposed by Harold Hotelling in a letter to the National Park Service, in 1949. The Hotelling valuation technique was further developed by Marion Clawson (1959) and Jack Knetsch (1963)[6]. The more refined publication of the travel cost method was published in Economics of Outdoor Recreation by

Clawson and Knetsch (1966). Due to its developers, the method is also known as the Hotelling-Clawson-Knetsch (HCK) approach[7].

Hotelling measured the benefits of recreation participation by defining "concentric zones around each park so that the cost to travel to the park from all points in one of these zones is almost constant" (Hotelling, 1947). Average travel cost and participation may then be determined for each geographic area, permitting the plotting of a simulated, site-specific demand curve for different prices[8].

Assume, for illustration purposes, that Table 1 refers to the Dean River; that all anglers are located in four different towns with populations of 1,000, 2,000, 4,000 and 10,000; that the costs for angling in the Dean are chiefly for travel, including not only transportation but also the additional costs for meals, lodging, and other expenses; that one group of anglers, on average, has similar preferences to the average of another group of anglers; and, that anglers react rationally to changes in entrance fees to a given area (Clawson and Knetsch, 1966).

TABLE 1

Hypothetical Demand Schedule for the Dean River

Town	Population	Cost/day	Number of days	Angling days/1000 population
1	1,000	$ 25	200	200
2	2,000	50	300	150
3	4,000	75	400	100
4	10,000	100	500	50

The HCK demand estimation would then be the determination of the rate of use by dividing angling days from a specific town by the population of that town and relating this to the cost of traveling to the Dean River, and to increases in costs in the form of gate fees. This relationship may be found by estimating the equation of the line relating the cost per angling day and the number of angling days per thousand population. In this case, the equation would be $D/1000 = 250 - 2C$, where D is the rate of angling days per thousand and C is the cost of each angling day. With the imposition of entrance fees, which is incurred above present costs, attendance rates will decrease as shown by Table 2.

TABLE 2

Attendance Record with the Imposition of Entrance Fees

Town	Entrance Fees				
	$ 0	25	50	75	100
1	200	150	100	50	0
2	300	200	100	0	0
3	400	200	0	0	0
4	500	0	0	0	0
Totals:	1,400	500	200	50	0

The demand curve may be seen on Figure 1.

Benefits to society may be calculated, after the demand curve is established, by integrating the area under the demand curve, yielding a monetary value for consumer's surplus as was discussed in Chapter 2.

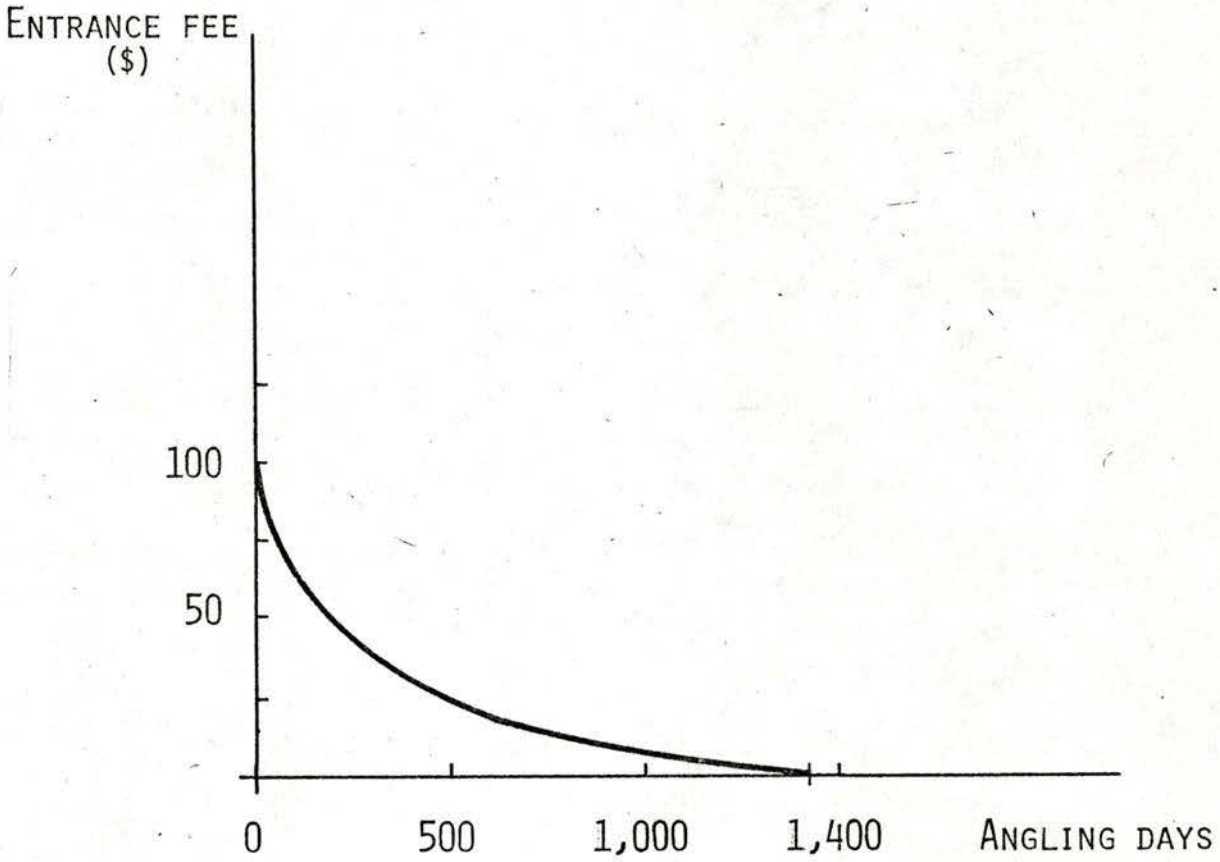

FIGURE 1: HYPOTHETICAL DEMAND CURVE FOR THE DEAN RIVER.

Mathematically, the demand curve would be given by total days (q) as a function of total costs per day (c), where c_i would equal the cost per vistor from town i; c_o would be the cost to residents of the town whose visit cost was zero; and p_i equal the population in town i. The aggregate consumers' surplus for the recreational site would then be represented by:

$$(1) \quad \Sigma\, p_i \int_{c_i}^{c_o} f(c)dc$$

where: $q = f(c)$

Weaknesses of the Travel Cost Method:

A) Limitations due to assumptions:

1) Similar preferences among the zones

A basic weakness of the travel cost method is the assumption of similar preferences among the various defined zones. If zonal differences did exist, the technique would be invalid. The literature generally accepts zonal preferences to be fairly constant although biases in the demand curve estimation may occur. A few of these biases are:

a) The estimated demand curve may be biased downward due to the fact that people's tastes may be determined by their place of residence and thus a concentration of enthusiastic recreationists may live nearest the area under study (Laub, 1971, 50). Alternately, an upward bias may occur due to on-site surveys encompassing the more active or more fervent participants excluding the attitudes and opinions of the less devoted participants (Sinclair and Morley, 1975).

b) Similar preferences also assumes that no recreational alternatives are available for the individual to choose from. For example, if town

3, in Table 1, is located closer to a second river and travel cost would be $50.00 instead of $75.00, the differences in visitation among the towns may be influenced by the substitutable river (Krutilla and Fisher, 1975, 198).

c) A third bias may develop due to consumer's enjoyment of different features of the outdoor recreation activity. In fact, he may receive different experience from the same trip. For example, an individual may travel to the Dean River to take underwater photographs of steelhead instead of angling for steelhead[9]. It should be noted that the experience of travel itself may have a negative or positive value depending on an individual's interests, comfort, etc.

Other biases from this similar preferences assumption may occur mainly because of the lack of information as to why individuals decide to visit, or return to, and area.

2) Rationality with respect to entrance fees:

So far, in British Columbia, access to all rivers has been free of charge. A hypothetical fee simulation (i.e., finding the demand by use of a hypothetical fee increase) may also bias the demand curve because anglers will simulate responses to a fee imposition and fee increases. A priced fishery may reduce the number of users due to their aversion to the concept of entrance fees which they feel should not exist.

3) Assuming the costs of the recreational experience are chiefly for travel:

The assumption that the costs of the recreational experience are chiefly for travel to the particular site is extremely limiting and in

most cases unrealistic to the vacationing consumer[10].

Travel cost (C), as assumed by HCK, would be a function of the constant cost per mile (x) times the number of miles travelled (M), so that,

$$(2) \quad C = xM$$

HCK assume that x excludes all expenses which would have been incurred if the outing would not have taken place, as well as any extra expenditures such as, the ticket cost to visit a point of interest, an extravagant dinner or traveling down a meandering road creating a longer distance, etc., which are, for many people, important features of the recreational experience. It has also been assumed that individuals are traveling by car. This, however, may not always be the case, and the mode of travel may vary widely. Thus in most situations, x will be much higher than the one used in this technique[11]. It should be kept in mind that the cost of travel to the site may vary considerably, depending on the number of people sharing the costs of transportation; the larger the group, the lower the cost of travel per individual.

A second disadvantage to the above mentioned assumption is the difficulty of handling multiple purpose trips. For Dean River anglers, this constraint is not applicable since most fishermen in the survey indicated that sport fishing was the main purpose of their trip[12], but in the case of vacationers going to several national parks, the travel cost technique would not be an accurate estimation of demand.

Research has indicated that this limiting assumption makes the travel cost method an inappropriate one for measuring the demand for

recreation in low density wilderness areas due to its aggregation of "homogeneous" trips (Smith, 1975; Cheshire and Stabler, 1976).

B) Limitations due to other factors:

1) Data limitations:

The travel cost method is based on ex-post travel cost data which eliminates those users who do not incur travel expenses.

Due to the nature of the data, ".. cost methods at their best can cope with willingness-to-pay net benefits, and hence generally yield theoretically inappropriate underestimates of values where willingness to sell is the logical choice" (Hammack and Brown, 1974, 14).

2) Lack of explanatory variables:

Although mentioned in Clawson and Knetsch's 1966 Economics of Outdoor Recreation, socio-economic characteristics of consumers were not included in the travel cost method. Brown, Singh and Castle included a few socio-economic variables such as family income, education, occupation, etc. in their estimation of demand by use of the travel cost method (Brown, et al., 1964).

Several attempts have been made to include quality variables to the travel cost method for the purpose of estimating the contribution of wildlife to the recreational activity (Capel and Pendey, 1973; Stevens, 1966). Quality variables usually refer to success per unit of effort and reflect the consumptive side of the recreational experience[13]. Most studies so far, omit the non-consumptive features of recreation (Langford and Cocheba, 1978), thus omitting sentimental and option values from the demand estimation.

3) The value of travel time bias:

Another fundamental problem with this method is the difficulty of capturing the value placed on travel time (Cesario, 1976, 32). Failure to include this value biases the demand curve downward (Cesario and Knetsch, 1970). The discrepancy results from the idea that resistance to traveling longer distances to visit recreational areas is due to added money costs. Obviously this is a misleading assumption, for it is more realistic to assume that travel time is to some extent a constraint. To overcome this problem, several researchers have used travel time valuations in arbitrary ways, resulting in higher demand curve estimations. But, no assurance has been made as to the elimination of the bias (Cesario and Knetsch, 1970; Kavanagh, 1972; Brown and Nawas, 1973; Knetsch, 1974; Brown and Hansen, 1974; Cesario, 1976).

Other studies have solved this bias problem by assuming that trips must be approximately the same length for each individual (Cicchetti, et al., 1972; Krutilla and Fisher, 1975, 198).

4) Land values not captured in the market simulation:

If forestry, mining, or environmental qualities relating to land are being valued, their increased values due to enhancement would not be captured in the market simulation questionnaire (National Marine Fisheries Service, 1973, 22).

5) Zonal estimations:

Zonal estimations have been omitted from this empirical study for a number of reasons. Firstly, the data, as collected, does not provide specific residency information for non-British Columbians, making the population for eight, out of fifteen concentric circles equal if one

were to use the population of their State of residency. This problem is shown in Table 3. Secondly, if one looks at the plotted data in Figure 2, it can be noted that the exclusion of population, yields a better regression fit. Thirdly, quality considerations should be looked at for each individual, lessening the impact of the similar preferences among zones assumption. And, fourthly, the use of angling days divided by population was also criticized

TABLE 3

SUMMARIZED DATA FOR THE DEAN RIVER

Area	Population	Days	Days/pop.	Cost	Miles	Income	Cost/day
1	2467	15	6	$ 15	35	$25,000	$ 1
2	2467	5	2	179	145	21,000	36
3	2467	20	8	178	183	25,000	9
4	2467	15	6	163	220	25,000	11
5	2467	32	13	243	290	26,000	8
6	2467	8	3	298	320	24,000	25
7	2467	14	6	213	379	24,000	15
8	3751	43	12	319	410	53,000	7
9	2467	35	14	180	475	14,000	5
10	2283	11	5	270	545	21,000	24
11	2329	5	2	155	555	25,000	31
12	753	57	76	496	790	67,000	9
13	951	15	16	373	950	21,000	25
14	5347	73	14	857	1100	69,000	12
15	4277	20	5	391	2180	21,000	20

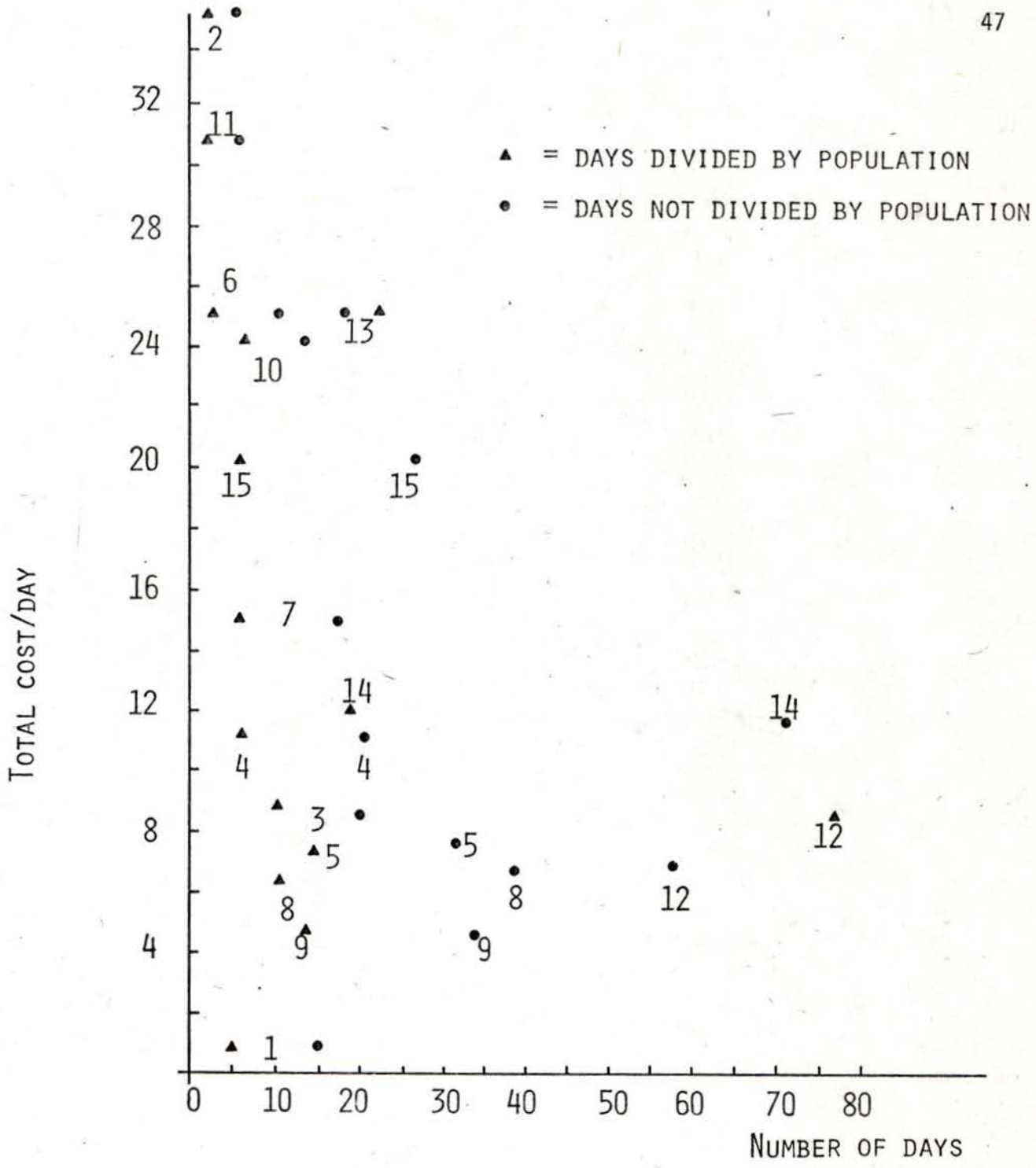

FIGURE 2: DIFFERENCES BETWEEN DAYS DIVIDED BY POPULATION AND DAYS NOT DIVIDED BY POPULATION FOR THE DEAN RIVER SAMPLE.

by Flegg (1976, 361) who in his concluding remarks states:

> The conventional practice of using visits per caput as the dependent variable in demand functions seems bound to result in spurious estimates of benefits, as well as strongly biased estimates of the elasticity of visits with respect to the explanatory variables (1976, 361).

Conclusion

Although the HCK technique has these numerous biases and limitations, it is a method capable of producing reasonably acceptable demand and consumer's surplus estimations. Among the better studies are: Brown et al's (1965) estimation of the net economic value of the salmon and steelhead sport fishery in Oregon; Burt and Brewer's (1971) application to water based recreation in the state of Missouri; Krutilla and Fisher's (1975) calculation of the demand for ski recreation in California; Smith and Kavanagh's (1969) measurement of trout fishing benefits at Grafham Water, Huntingdonshire; and, Brown et al's (1976) steelhead and salmon valuation on the Columbia River.

II) The Pearse Method

Theoretical Framework

Peter Pearse (1968) presented a method of indirectly estimating the price compensating valuation by evaluating non-priced recreational resources in such a way that it "avoids some of the restrictive assumptions of established methods" (1968, 90). Specifically, he focused his analysis on the recreationists themselves, by classifying them into distinct income groups with similar preferences instead of homogeneous population groups as used by HCK.

Following the Pearse terminology, two fishermen "m" and "x" belong to the same income group but live in two different areas and make one trip a year to a given site. These anglers can be depicted on the same indifference map. Figure 3, which is similar to Figure 1 in Chapter 2, shows the anglers' income on the vertical axis and the number of fishing days on the horizontal axis. Recreationist m and x are illustrated to have an annual income of $80.00 and parallel price lines MT and ET' respectively[14]. Each angler fishes P' (3.6 days) and P (5 days). Respectively, the fixed cost of travel to and from the site would equal D - E and D - M, where individual m lives further away than x. Individual m is considered to be the marginal user, for if his travel costs were greater than D - E, he would not travel to that site. "At a fixed cost greater than {DE fishing} would yield a lower utility than none at all (since indifference curve {I} passess through {D})" (Pearse, 1968, 91). On the other hand, individual x, the intramarginal visitor, would be willing to pay distance ME in addition to his travel cost for an entrance fee rather than forgo his visit[15]. The anglers who would continue using the facility after a licence fee was imposed would consist of all those fishermen whose fixed cost (DM) plus the entrance fee (ME) would be less than or equal to (ED). In other words, the maximum toll visitors would pay would equal ED - MD, which is equal to his consumer's surplus (ME).

Pearse valuation weaknesses:

A) Limitations due to assumptions:

1) Similar preferences among income groups

Although Pearse does not use similar preferences among specific

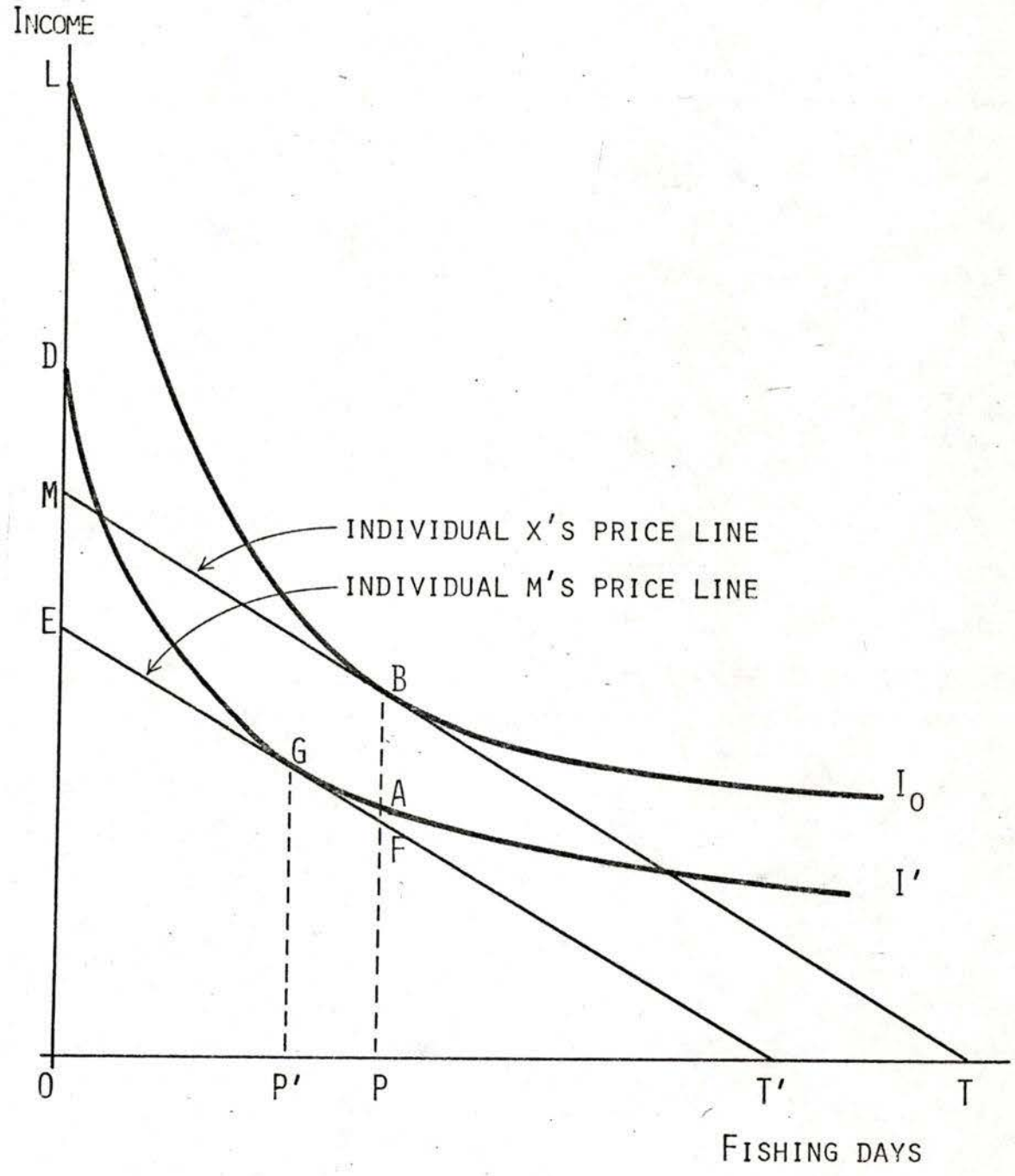

FIGURE 3: EQUILIBRIUM LEVEL OF RECREATION CONSUMPTION AS SHOWN BY THE PEARSE METHOD.

population areas, as assumed by HCK, he is limited by assuming similar preferences among each income group, which implies an equal level of gross benefits within that income group. This may bias the estimation either upward or downward. For example, if there is an avid fisherman traveling the longer distance, considered by the analysis to be the marginal consumer, the whole income group of this individual may be assumed to be enthusiastic recreationists, creating an overestimation. Underestimates might occur if the individual traveling the long distance is not really the marginal user (Laub, 1971, 62).

Pearse's methodology may also be biased by the fact that consumers, although being in the same income group, receive different recreation experiences due to traveling different routes to the recreation site. Information as to why individuals choose a certain route or their rationale for going fishing in the first place, are often not available.

2) Recreationists response to tolls:

It is assumed by Pearse that fishermen respond to a toll in the same way they respond to an increase in the price of travel. A biased estimation may occur due to this hypothetical response pattern.

3) The sole purpose assumption:

In the same way as the HCK methodology, the Pearse technique is also limited to singe purpose trip evaluations.

It should be noted that the last two assumptions are common in all indirect valuation techniques.

4) Assumption regarding the marginal consumer:

Pearse assumed that the fisherman with the highest fixed costs in

a given income group is a marginal consumer. The estimate for the 'highest fixed costs' may be sensitive to the choice of income class limits (Laub, 1971, 63). This may be seen by referring back to Figure 3. If consumer x's income were OL and m's income OD, they would both be marginal consumers for their respective income groups, yet Pearse assumes them to be in the same group thus widening the range of the income group which in turn, decreases the number of groupings. As Laub pointed out, "Limiting the size of income classes and expanding their numbers to minimize the importance of this problem necessitates increasing the sample size to allow for a reasonable number of observations in each class to ensure capturing the marginal users" (Laub, 1971, 64).

Fischer (1975) also confirms this point in his finding that Pearse's consumers' surplus estimates were significantly affected by the number of income categories chosen. Fewer income categories yielded higher consumers' surplus.

Conclusion

The Pearse method does not seem to have been used by other researchers. Pearse himself, in conjunction with Laub, in the evaluation of the Kootenay Lake sport fishery, employed a different approach involving direct consumer questioning of the maximum willingness to pay and/or willingness to sell, of the "minimum annual compensation each would accept for exclusion from the fishery" (Pearse and Laub, 1969, 23)[16].

Although Pearse's method is not used, he is credited with his proposition that the conclusion arrived at by a sample of anglers should refer only to the angler population, not to the population as a whole, as was the case prior to his article[17].

Direct Consumer's Surplus Techniques:

I) The Davis Approach:

Conceptual Framework:

The Davis method, also known as the interview technique, directly uses measures of consumers' surplus estimated by the willingness to pay for on site recreation in the Main woods (Davis, 1964)[18].

The Davis interview technique includes a bidding game in which respondents react to increases in costs for the visiting area. Willingness to pay is then developed by finding the points where "the user switched his reactions from inclusion to exclusion (or vice versa)" (Davis, 1964, 395). This willingness to pay figure is then regressed on the number of years of acquaintance with the area (as a variable for taste), household income, and the length of visit (as a measure of quality). Demand curves are then derived "simply by arraying the responses of willingness to pay per household unit and cumulating downward" (1964, 396).

Discussion of the Davis approach:

One of the most often found criticisms on direct consumer's surplus approaches is the fact that willingness to pay questions are "hypothetical" and thus yield "hypothetical answers" (Scott, 1965, 37). There is also the danger of having respondents misrepresent their preferences because of a number of reasons: a) the respondent might exaggerate the value to protect the site, and, b) as Samuelson (1954, 389) stated, "it is in the selfish interest of each person to give false signals to pretend to have less interest" when he believes he will have to pay in accordance with his answer. Davis set up his

questionnaire in such a way that this did not happen, by phrasing the questions in terms of travel cost instead of the imposition of tolls. It is generally agreed that a well designed survey will yield reasonable results. In any case, it is felt that "failure to elicit accurate responses in all cases does not necessarily mean that statistical estimates will be biased. It may simply result in a larger statistical variance" (Cocheba and Langford, 1978, 494).

A further bias to this kind of study may occur because of the length of stay of individuals on a site where selected interviewing is taking place. Visitors who stay longer are more apt to be interviewed than the shorter-stay visitors. Beardsley (1971) suggests that weighting each measured characteristic by the length of stay could be a possible correction measure for this bias.

In general, the technique is theoretically sound and can estimate both willingness to sell and willingness to pay fairly accurately. This is demonstrated by the variety of applications of the technique since the Davis 1963 dissertation (Cicchetti and Smith, 1973; Hammack and Brown, 1974; Meyer, 1974; McConnell, 1977). The method has the advantage of capturing option demand values, defined as the amount an individual would be willing to pay to assure future access for himself to a resource, where the supply of the commodity is uncertain and there is a positive likelihood for demand.

The method also allows the researcher to isolate the effects of price changes on the consumer. The basic need is a well designed questionnaire.

II) The Hammack and Brown interview technique

Theoretical Framework:

Hammack and Brown's (1974) model studies the relationship between the value of a recreational day and the value of the bagged waterfowl, by use of a direct interview technique.

Following the Hammack and Brown explanation, assume that: 1) anglers do not distinguish between age or sex of steelhead; 2) the catch probabilities are reasonably constant for all steelheaders on each river fished during the season, and anglers are aware of their probabilities; 3) all anglers fish steelhead at only two sites during the season; 4) fishermen are aware of all relevant costs at the beginning of the season; 5) anglers are constrained by the number of leisure days in a year and the number of days steelhead are running up the rivers. From these assumptions, steelheaders will choose rivers which maximize their total net welfare, with his expected catch, number of days on the river and costs known to them in advance.

Anglers could be faced with two constraints, one due to a limited catch regulation, and the other due to a limited number of angling days available per year.

The effects of a catch constraint may be seen graphically on Figure 4, where a steelheader's costs are depicted on the vertical axis and catch perriver on the horizontal axis. The angler is assumed to have a diminishing marginal utility creating the downward sloping demand curve (BD) and a constant marginal cost curve (AM). If the catch constraint regulation did not exist, the fisherman would catch OH fish, the point where his marginal gross benefits equal his marginal

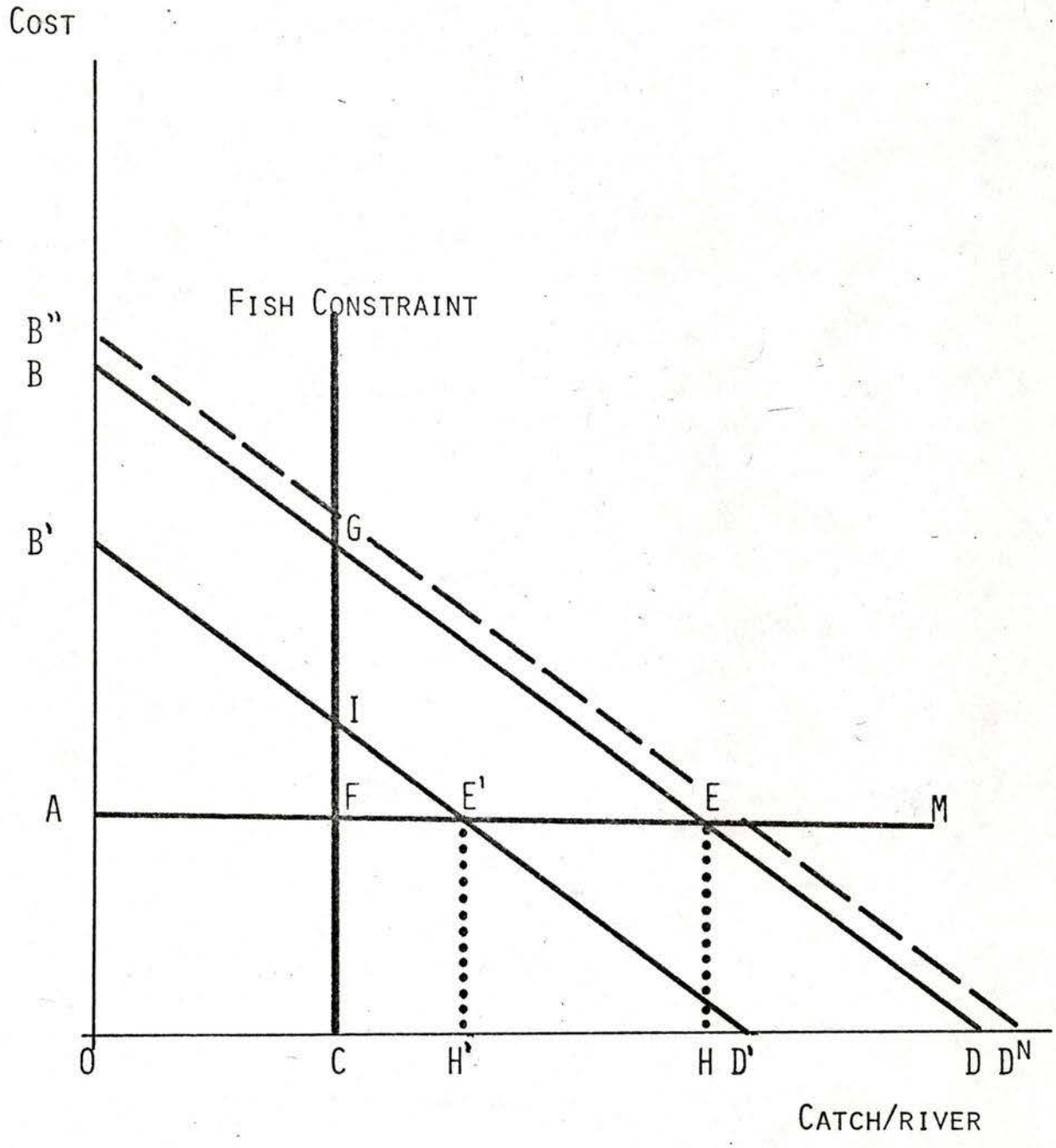

FIGURE 4. A FISHERMAN'S DEMAND AND COST CURVES FOR CAUGHT STEELHEAD.

costs. But since he could be regulated to a maximum number of steelhead per season on each river, he may only catch OC steelhead. The angler would then be maximizing his net benefits by equating his marginal gross benefits to his marginal costs up to his seasonal constraint. For the angler's first river, his cost would be represented by area OAFC and his benefits by area ABGF.

If the fisherman has reached his limit on the first river, he may go fishing on a second river. Since his marginal utility is diminishing and marginal costs constant, the benefits derived from the second river must be less than those of the first river, this, moving the demand curve downwards (B'D').

Under the assumption that anglers are constrained by catch regulations which have been implemented to allow for steelhead escapement, a quality change to the fishery due to enhancement could increase the annual catch constraint, shifting the vertical line GC to the right, and increasing the consumer's benefits (assuming demand stays the same).

Hammack and Brown also derived net benefits and costs from a fishing day. Figure 5 illustrates this by depicting days on the horizontal axis and costs on the vertical axis. Line C'D' represents the fisherman's income-compensated demand curve for his number of angling days per year. Area O'A'B'F' represents the costs of a day's fishing. If the angler were not constrained by time, he would fish up to O'E' days, where his marginal costs are equal to his marginal gross benefits.

The net benefits of the anglers first day would equal area A'C'R'B', while the net benefits for the second day will equal B'R'G'S'. If the individual received more holidays the next year the day constraint

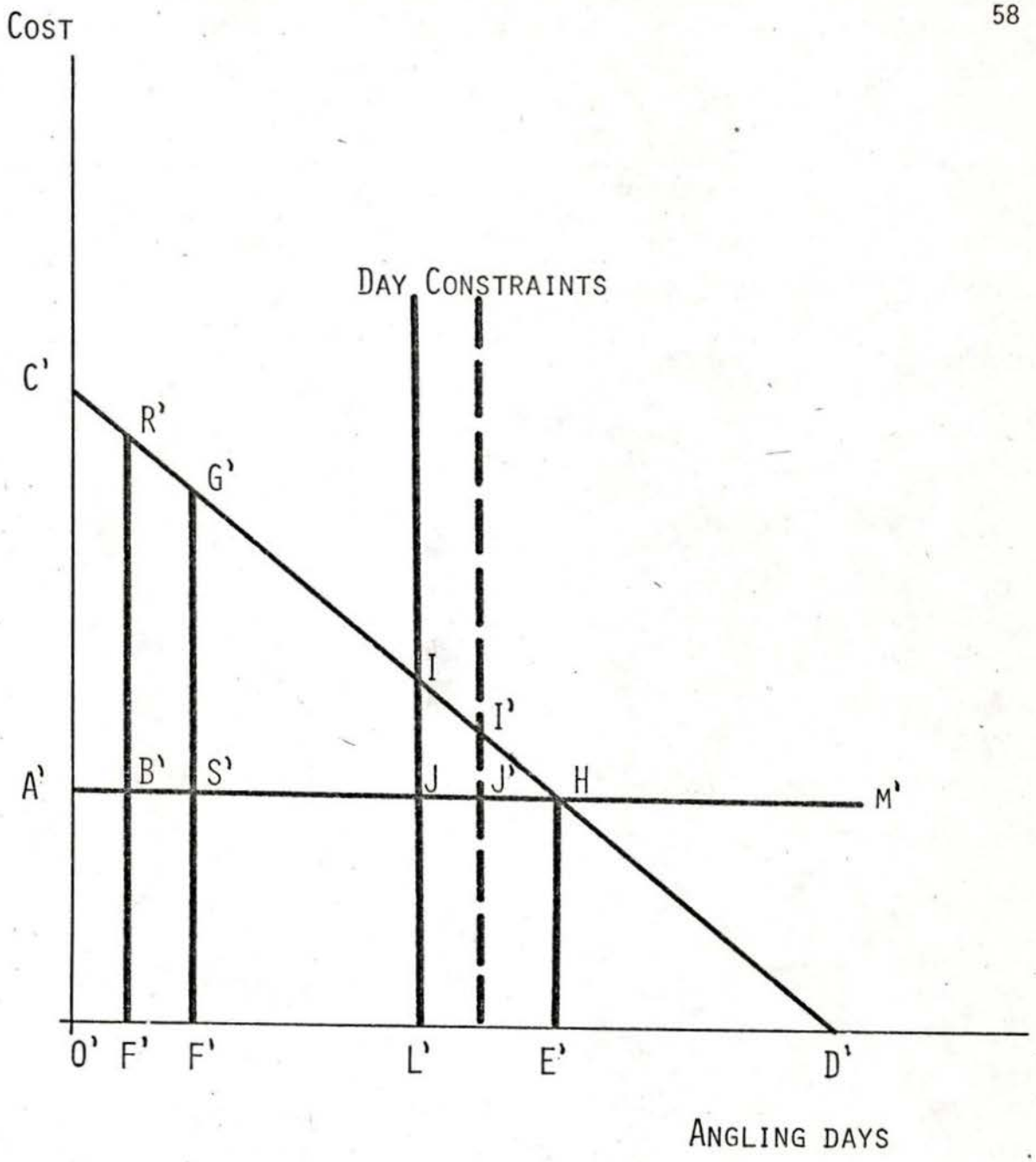

FIGURE 5. DEMAND AND COST CURVES FOR STEELHEAD ANGLING DAYS.

could move to the right, increasing his net benefits, if the angler chooses to spend his extra vacation time angling for steelhead on the Dean.

It should be noted that, if the catch constraint in Figure 4, were on a per day basis, area ABGF would equal A'C'R'B' in Figure 5, for the fisherman would receive the same amount of benefits per day under both constraints.

Hammack and Brown showed the effect of a change in quantity and quality constraints. Assume the number of days constraining the angler in Figure 5 is increased by a day, area A'C'IJ would increase to A'C'I'J'. Area JII'J' would cause the demand curve in Figure 4 to shift to the right, to B''D'', because an increase in the allowable fishing days could increase the number of steelhead caught. A similar effect would result if the catch constraint would be increased, changing the quality of a fishing day.

Most Dean River anglers were not limited by institutional regulations. Yet, as pointed out by McConnell (1975, 330) "recreationists must act as if they are constrained by the time available for them to recreate", thus limiting them to a given number of days.

Under the assumption that catch probabilities are constant for each angler, a time constraint would limit the probable number of fish caught. For example, an average angler in the 1978/79 season would have spent 6.8 days angling to catch one steelhead. If enhancement doubled the number of fish on the Dean and we assume a constant number of angling days, it could be hypothesized that days per catch would be half, 3.4 days.

If anglers are truly constrained by the time available to fish and the days needed to catch one fish, the Hammack and Brown quality margin would work as depicted in Figure 6, where the angler is constrained to 6.8 fishing days, allowing him the probability of catching one fish. This angling trip would yield $61.00 (area A) of benefits to the angler. Once enhancement decreased the probable days per catch ratio to 3.4, areas B in Figures 6a and b, would be the individual's increased benefits ($38.00) shifting the demand curve in 6a to the right.

Although these constraints are not regulatory, most anglers are still subject to one or both constraints, making the net benefits to fishermen of the marginal steelhead or day positive.

In summary, Hammack and Brown simultaneously incorporated a daily catch limit and the length of a fishing trip into their model. These two constraints have the potential of keeping the angler from maximizing his net benefits from fishing. A change in the catch limit while the time constraint remains the same, will improve the quality of the fishery by increasing the value of each fishing day.

Mathematical formulation:

The above formulation may be described in mathematical form as follows:

$$(3) \qquad S = f(Y,T,C/D,D)$$

where:

S = a measure of willingness to pay

Y = a measure of monetary income

T = a measure of taste(s) or preference(s)

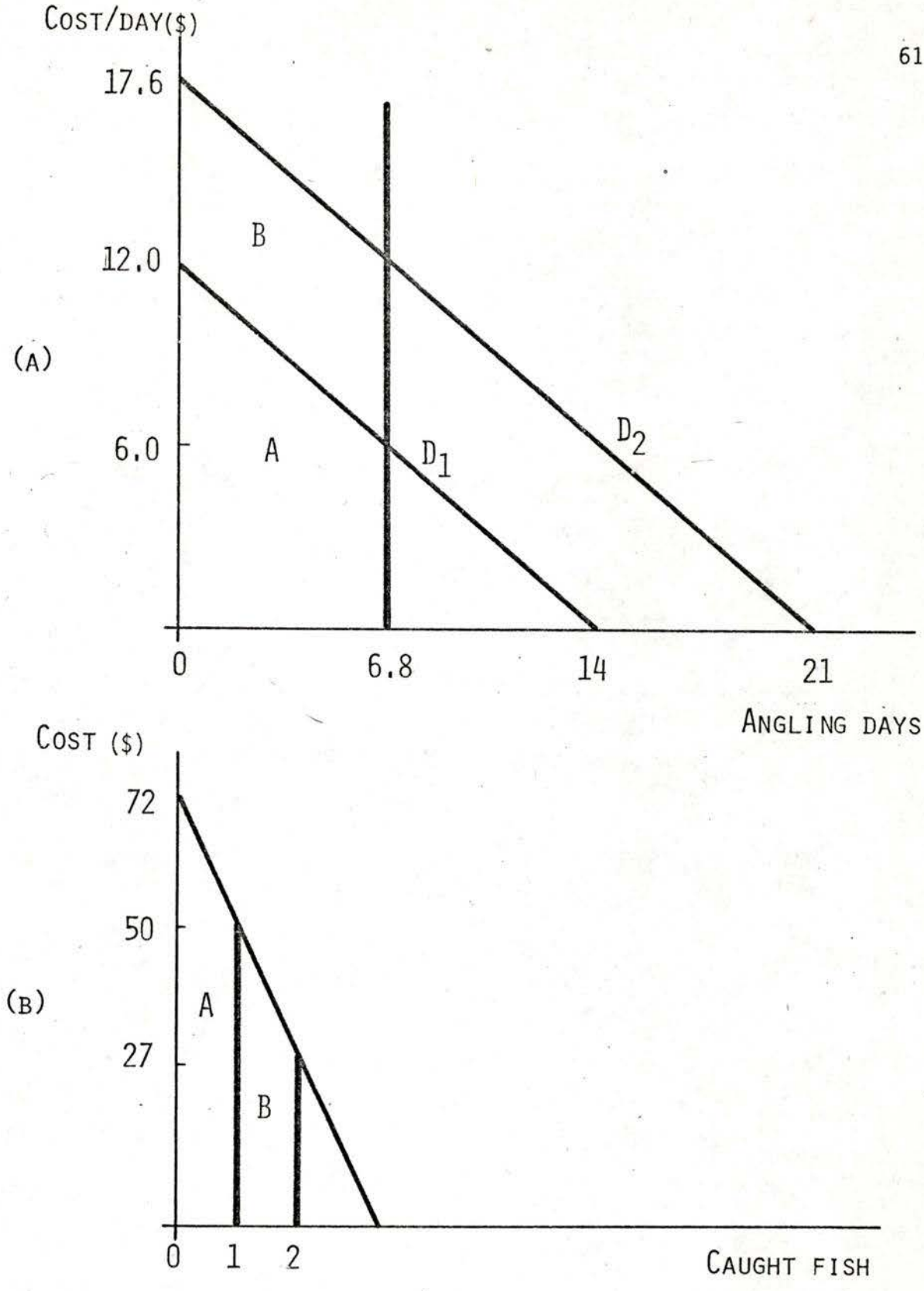

FIGURE 6: WORKING OF AN ACTIVE CONSTRAINT, FOLLOWING THE HAMMACK AND BROWN MODEL.

D = number of angling days[19]

C = number of steelhead caught during the year[20]

The function estimates total net benefits as the dependent variable. The first partial derivative of the function will determine the quality and quantity margins[21].

The quality margin, being the increase in the value of a steelheading day resulting from an additional catch per day with the number of angling days remaining constant, is approximated in the following way:

a) taking the first partial derivative of the consumer's surplus measure (S) with respect to catch per day (C/D), denoted by:

$$(4) \qquad \frac{\partial S}{\partial (C/D)}$$

giving the marginal value of an additional steelhead taken on each day the individual angles during the season.

b) dividing equation (4) by the number of angling days per year yields a quality margin for steelhead fishermen; thus,

$$(5) \qquad \frac{\frac{\partial S}{\partial (C/D)}}{D} = \text{quality margin}$$

The same steps may be followed to arrive at a quantity measure approximation. The increase in value of catching an additional steelhead due to an increase in time spent on the river, holding constant the number of steelhead caught each day would be:

$$(6) \qquad \frac{\frac{\partial S}{\partial D}}{C/D} = \text{quantity margin.}$$

Study limitations and improvements:

The major limitation to the Hammack and Brown valuation technique mentioned in the literature is it's inability to measure the collective good dimensions (i.e., the variables other than catch, such as non-consumptive values, etc.), of outdoor recreation. The method strictly measures the value of an additional bagged bird or caught fish (Langford and Cocheba, 1978). Hammack and Brown believed that,

> ... the scope of valuation questions may be limited in such a way that subsidiary satisfactions of the recreation day (such as exercise and exposure to natural surrounding) are effectively excluded ... Hence the reported net benefit may be attributed to the water fowl bagged (Hammack and Brown, 1974, 16-17).

Although they recognized that the reported net benefits may not be attributed to catch if various satisfactions of the recreation day are synergistic (Hammack and Brown, 1974, f.25), they argued that the necessary data can be collected in such a way to isolate the value of wildlife from other sources of value.

This collective good dimension was incorporated into the Hammack and Brown model by Langford and Cocheba (1978) in their model for waterfowl valuation. They included variables for the value of consumer's surplus measured by households instead of individuals; before-tax household income; number of seasons hunted by household, as a variable of taste; household's bagged waterfowl (or catch) during a given season; hours hunted during the season; and a measure for unsuccessful and successful opportunities.

With the inclusion of variables other than catch, Langford and Cocheba modified the Hammack and Brown model, retaining the main features of valuing the marginal stock, but included additional sources

of benefits derived from bagging or catching wildlife as well as the additional benefits obtained from the actual experience.

A second limitation to the Hammack and Brown model deals with the inability to cope with situations in which more than the assumed number of constant outings per season take place, specially in regard to those outings where the enjoyment of different site quality variables occurs (e.g., beach users and anglers who make multiple trips to a site per season) (McConnel, 1977, 188).

Summary and conclusions:

In an attempt to develop the conceptualization of wildlife valuation, this chapter has presented the most important valuation techniques found in the literature. The HCK travel cost method and the direct consumer's surplus method have the greatest potential, although they each have their shortcomings. It has been found that both types of studies yield similar results (Knetsch and Davis, 1977; Capel and Pandey, 1973). The use of both methodologies provides a worthwhile check on the validity of the findings. Differences may occur if the definition of the fitting equations and cut-off points are not the same.

Both the indirect and direct consumer's surplus techniques use questionnaires. Unfortunately, most surveys undertaken need refinements to reduce the possible errors and biases. These shortcomings are due to respondents' biases, sampling errors and non-response errors (Filion, 1978).

The questionnaire used for this thesis fails to include questions on the number of steelhead caught in the past year. The lack of this

information does not allow for the estimation of the quality and quantity margins.

The empirical estimation of demand curves and benefits by use of the travel cost method and the direct willingness to pay method will be determined in Chapter 5, for both the present and enhanced Dean River fishery. Before this can be done, the demand curve shifts due to a change in one characteristic of a fishing experience, keeping all other variables constant must be discussed.

FOOTNOTES

[1]Among the studies emphasizing this point are: Sewell and Rostron, 1970; Driver and Knopf, 1976; Sinclair and Sweitzer, 1973; Tombleson, 1978; Langford and Cocheba, 1978.

[2]It should be noted, however, that this study does not include success characteristics.

[3]Education was found significant only when entered as a quadratic variable (Gillespie and Brewer, 1969, 3).

[4]Average air miles traveled to the Dean River.

[5]Among these methods are, the Gross Expenditure Method, (Mahoney, 1960), the Cost Approach (Trice and Wood, 1958); the Gross National Product Approach (Lerner, 1962); Market Value (British Columbia, 1964); and others.

[6]Trice and Wood (1958) used Hotelling's travel cost suggestion to estimate an average cost of travel per visitor day. This average was then subtracted from the 90th percentile level to obtain consumer's surplus, or what they termed "free value received" (1958, 206). The limitations to this technique is the discomfort created by the "travel cost per visitor day - number of visitor days" as a proxy for actual price-quantity relationships (Brown et al., 1965). A second limitation lies on the determination of consumer's surplus, which is not believed to be a theoretically sound technique.

Ciriacy-Wantrup (1952) contributed in the quantification of a demand schedule for outdoor recreation. His suggestion was to question individuals on the amount of money they were willing to pay for additional quantities of a collective extra-market good (1952, 240-242).

[7]Following the Cicchetti et al. (1973, 1109) terminology.

[8]Implicitly assumed in a homogeneous population.

[9]Krutilla and Fisher (1975, 198) dismiss this as a problem. They assume that no matter what the purpose for the trip, the characteristics of the site influenced the demand for the site.

[10]The validity of this assumption undoubtedly varies depending on the type of recreation under consideration. If a fisherman would like to be angling at 5 a.m. he will, most probably, get no satisfaction from travel. Yet if a family is going on a picnic, they would hopefully enjoy the travel time as well as the recreation on site (Hammack and Brown, 1974, 12).

[11]The cost of expenses, other than travel costs such as hotels and meals which are invariably different between recreationists should also be excluded from the analysis. For example, a fisherman may pay $25.00 for a hotel room, and consider it as $10.00 benefit, thus $15.00 have been lost in the analysis which would create a downward bias in the demand curve (Hammack and Brown, 1974, 12).

[12]Other studies such as Sinclair's research of Lakelse Lake also show that most visitors travel to the site solely for recreational purposes (1974, 44).

[13]An interesting examination of the systematic relationship between the number of recreation visits to a given area and the areas physical characteristics is developed in Seneca and Cicchetti (1969). They demonstrate a strong relationship between visits and several recreation facilities measures, such as: land and water acres, parking facilities, etc., to emphasize the production phenomena that have policy implications for outdoor recreation problems.

[14]Parallel price lines assume similar preferences among individuals in the same income group to ensure similar onsite costs among the same income groups.

[15]This measure (EM) is also known as the "compensating variation" as explained in the chapter on consumer's surplus.

[16]Pearse and Bowden (1971) also use this method in The Value of Freshwater Sport Fishing in British Columbia, Report no. 5; The Value of Resident Hunting in British Columbia (1972), Report no. 6; and others, prepared for the British Columbia Fish and Wildlife Branch.

[17]For example, Clawson (1959) in his Methods of Measuring the Demand for, and Value of, Outdoor Recreation, multiplied his estimates by total population.

[18]Davis first presented his method in The Value of Outdoor Recreation: An Economic Study of the Maine Woods, unpublished Ph.D. thesis, Harvard University, 1963.

[19]An angling day equals one angler fishing any part of a day. This may bias the consumer's surplus estimation since there is a higher probability for an angler to catch a steelhead if he fishes ten hours a day instead of two.

[20]Using catch as a success measure is a customary measure used by Stevens, 1966; Capel and Pandey, 1972, and 1973; Hammack and Brown, 1974; Langford and Cocheba, 1978 and Cocheba and Langford, 1978.

[21]Assuming that the first partial derivative is positive and the second partial derivative is negative assuring strict concavity.

CHAPTER 4

POSSIBLE DEMAND CURVE SHIFTS DUE TO ENHANCEMENT

Introduction

There is a tendency in literature evaluating benefits (or losses) for recreational resources, with a limited amount of data, to assume demand curve shifts to be parallel to the demand curve under present conditions. An example of this kind of study is Masse and Peterson's (1977) evaluation of incremental benefits from enhancement. The reasoning behind this shift was that as "the expectations of the sport fishermen are raised, their catch success improves and they are therefor willing to pay more for the experience and consume more at each price" (1977, 4). Masse and Peterson developed a model estimating the change in effort (number of angler days) due to a change in salmonid stocks. An identical shift was assumed on the willingness to pay axis due to the inability to determine price changes because of lack of data (Masse, personal communication). This chapter attempts to show that no a priori assumption as to how a demand curve will shift is possible.

Demand curves, as referred to in this section, are defined as the relationship between the amount of angling days that will be demanded (consumed) over a specific time period at various prices, assuming all other influences remain constant. The slope of the demand curve will be negative, reflecting the diminishing marginal utility derived from each succeeding angling day.

A demand curve exists for each individual using the fishery, with its shape and position being determined by his income, tastes, price for the fishing day, as well as the prices of other goods, socio-economic conditions, leisure time, mobility, value sought, etc. The aggregated demand curve will be the horizontal summation of all the individual demand curves, and its shape will reflect the combination of the above mentioned determinants.

Basic model:

The following model presents a tool from which demand curve shifts may be determined for the Dean River fishery, assuming all aspects of the fishery except quality are held constant (alternative models may be found in Appendix V). By using a total benefits curve and a total cost curve[1], demand curves, or the marginal benefit curve of the consumer may be determined as pictured in Figure 1.

The total benefits curve (TB) relates the benefits received by an individual for the use of the Dean River, to the number of days he spends on the river. TC shows the individual's total costs accrued in order to gain access to the river. Consumer's surplus will be maximized at the point where the change in total benefits minus the change in total costs equals zero (i.e., where the slope of TB equals the slope of TC). Distance AB, in Figure 1, reflects the fisherman's maximized consumer's surplus and shows the number of days an individual will consume at zero price (d_o in Figure 1) in order to maximize his utility. The maximum price per day this individual will pay for the minimum amount of fishing is found by hypothesizing increases in price (TC curve pivoting to the left) until the point where the individual's total

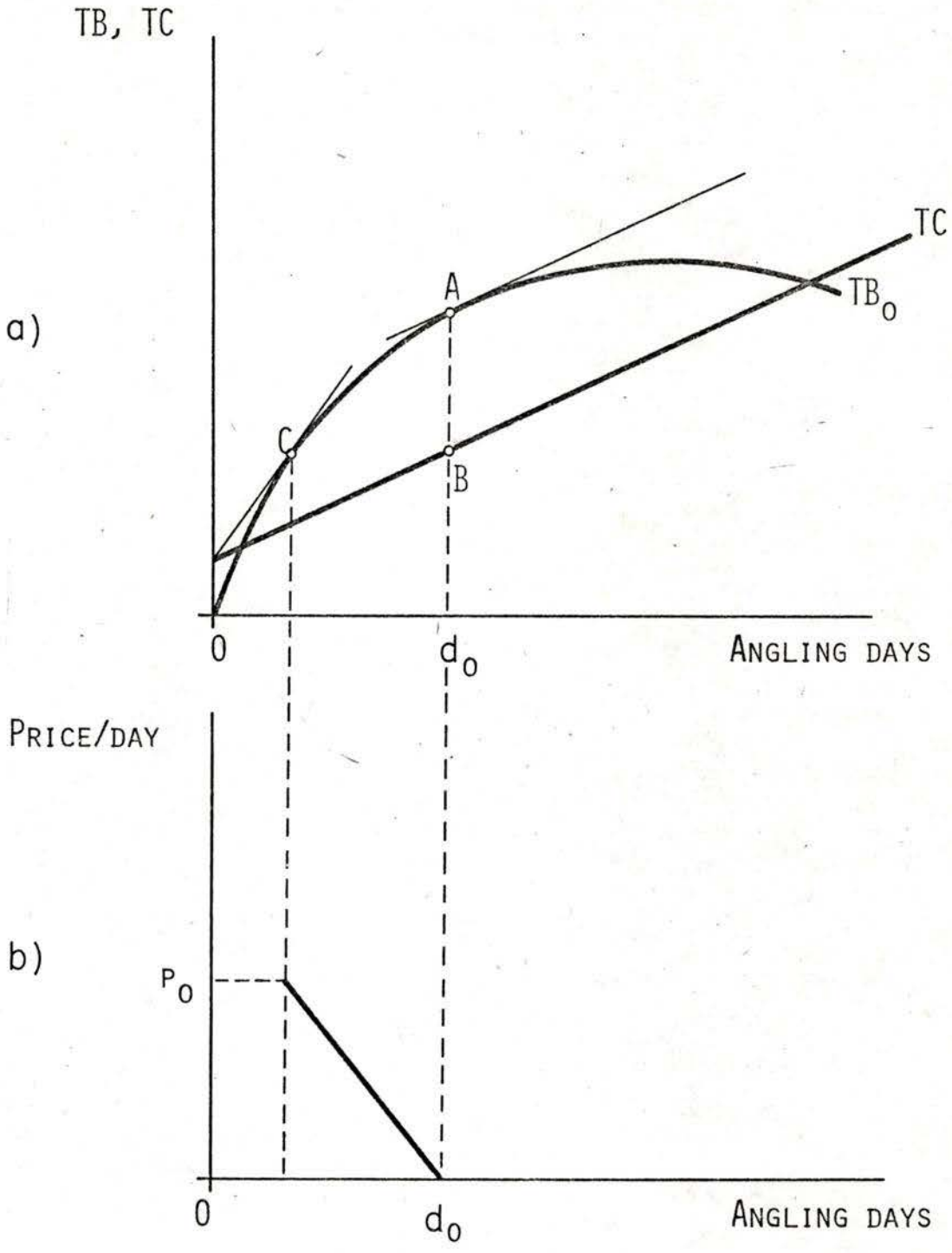

FIGURE 1. DETERMINATION OF AN INDIVIDUAL'S DEMAND CURVE FROM A TOTAL BENEFITS AND TOTAL COSTS CURVE.

cost curve is tangent to his total benefits curve, which is found at intersection C, in Figure 1a, showing the maximum price an individual is willing to pay for the use of the area under present conditions (i.e., before enhancement)[2].

Once the maximum price is determined (slope of TC'), and the number of days an individual would fish at zero price (d_0), the individual's demand curve may be estimated as illustrated in Figure 1b, by line p_0d_0, assuming straight line demand curves.

Demand curve shifts increasing total benefits:

Using the simple framework outlined above, demand curve shifts due to enhancement of the Dean, keeping all other variables constant, may be determined by shifting the total benefits curve under the assumption that the Salmonid Enhancement Program will change individuals' total benefits by altering one quality characteristic of a fishing day, namely, doubling the probability of catching steelhead. The measure of benefit from the given level of enhancement is determined by the change in total consumer's surplus.

The direction and magnitude of the demand curve shifts will depend entirely on the shape of the shifted total benefits curves. These shifts depend on the different ways fishermen react to enhancement. Some anglers may be willing to pay an equal extra amount for each day they fish, shifting the demand curve parallel as shown in Figure 2 by demand curve D_1. Others may more highly value the opportunity of hooking the first steelhead relative to others and are willing to pay relatively more for the first few fishing days, as shown by the less elastic demand curve D_2 in Figure 3. Contrary to the

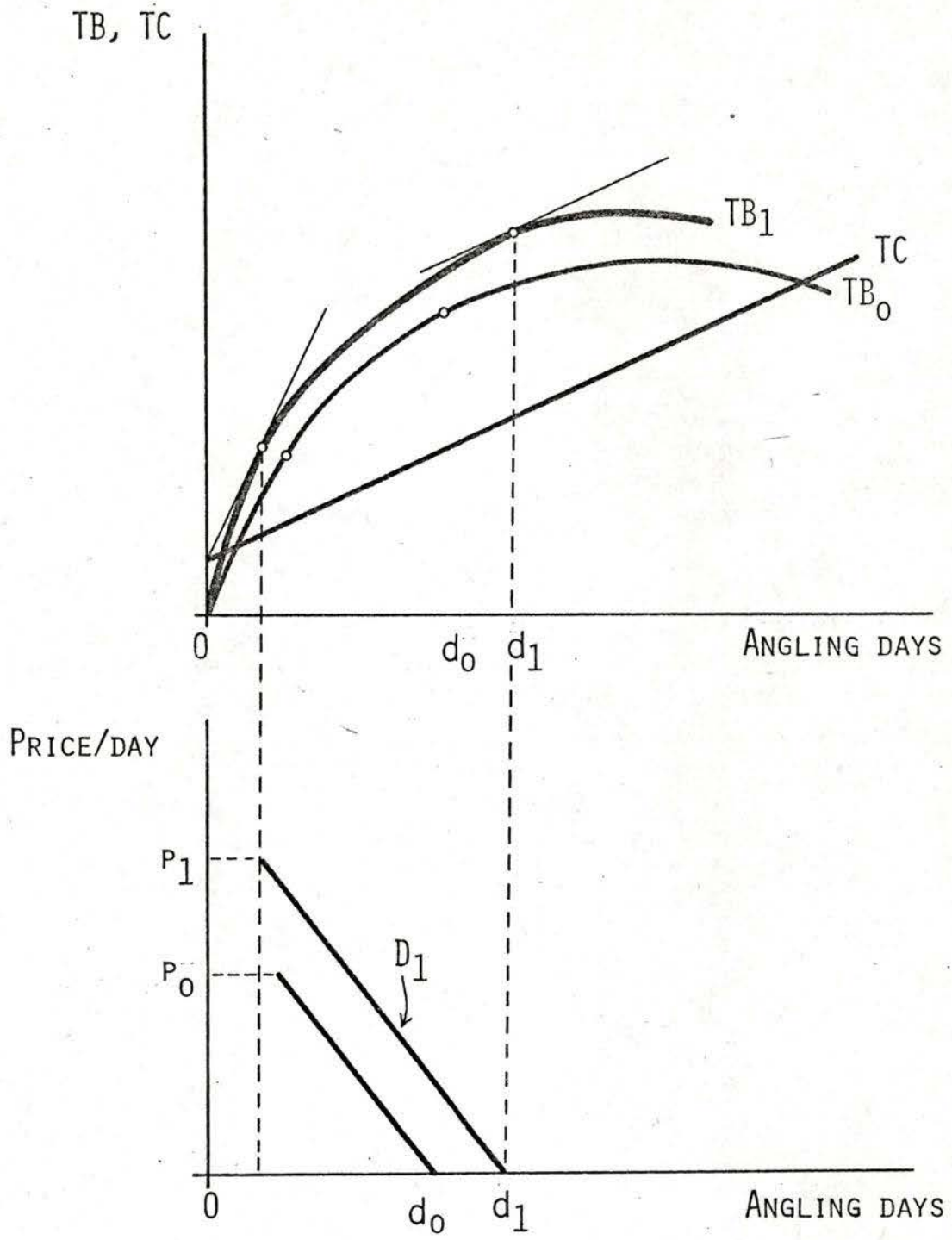

FIGURE 2. PARALLEL DEMAND CURVE SHIFTS.

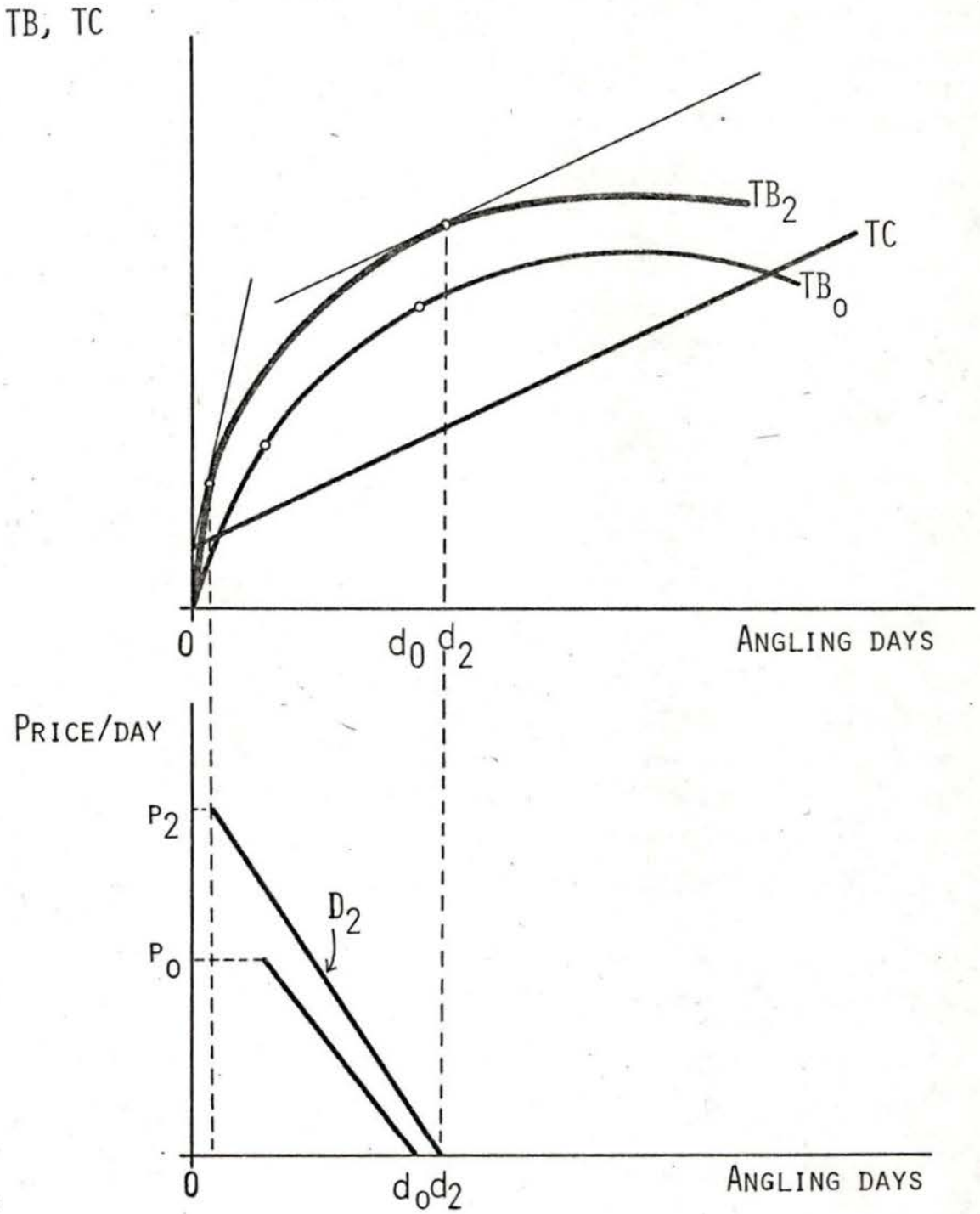

FIGURE 3. DEMAND CURVE SHIFTING MORE ON THE PRICE AXIS THAN ON THE QUANTITY AXIS.

latter, other anglers may increase their valuation of recreation days more as the number consumed increases and thus are only willing to pay a small amount more for the first few days, increasing their additional willingness to pay for each day they fish; thus the number of angling days consumed at zero price increase in a greater proportion than the limit price, as shown by the more elastic[3] demand curve D_3 in Figure 4. Finally, there are those individuals who increase benefits with demand curves that intersect the original demand curve as shown by D_4 in Figure 5, where the steelheaders are willing to pay more for the first few fishing days but decrease their number of fishing days as a means of steelhead preservation, or because they quickly tire of catching fish. It should be noted that intersecting demand curves may have a negative, neutral or positive effect on consumer's surplus, depending on the area to the right of the curves' intersection being smaller, equal or greater than the area to the left of the intersection. In Figure 5, the area to the right of the intersection is greater than that of the left, increasing the angler's benefits.

Because of the heterogeneous sample of anglers, many other demand curve shifts increasing total benefits because of steelhead enhancement are conceivable by use of this model but will not be presented here.

Demand curve shifts decreasing total benefits:

Steelhead enhancement may not be viewed as a benefit by all anglers. Some anglers might receive a disutility from enhancement. Perhaps, they feel that angling for hatchery fish is not a challenge, thus they are not willing to pay as much as they did before enhancement, such fishermen may also decrease their number of fishing days. Others may

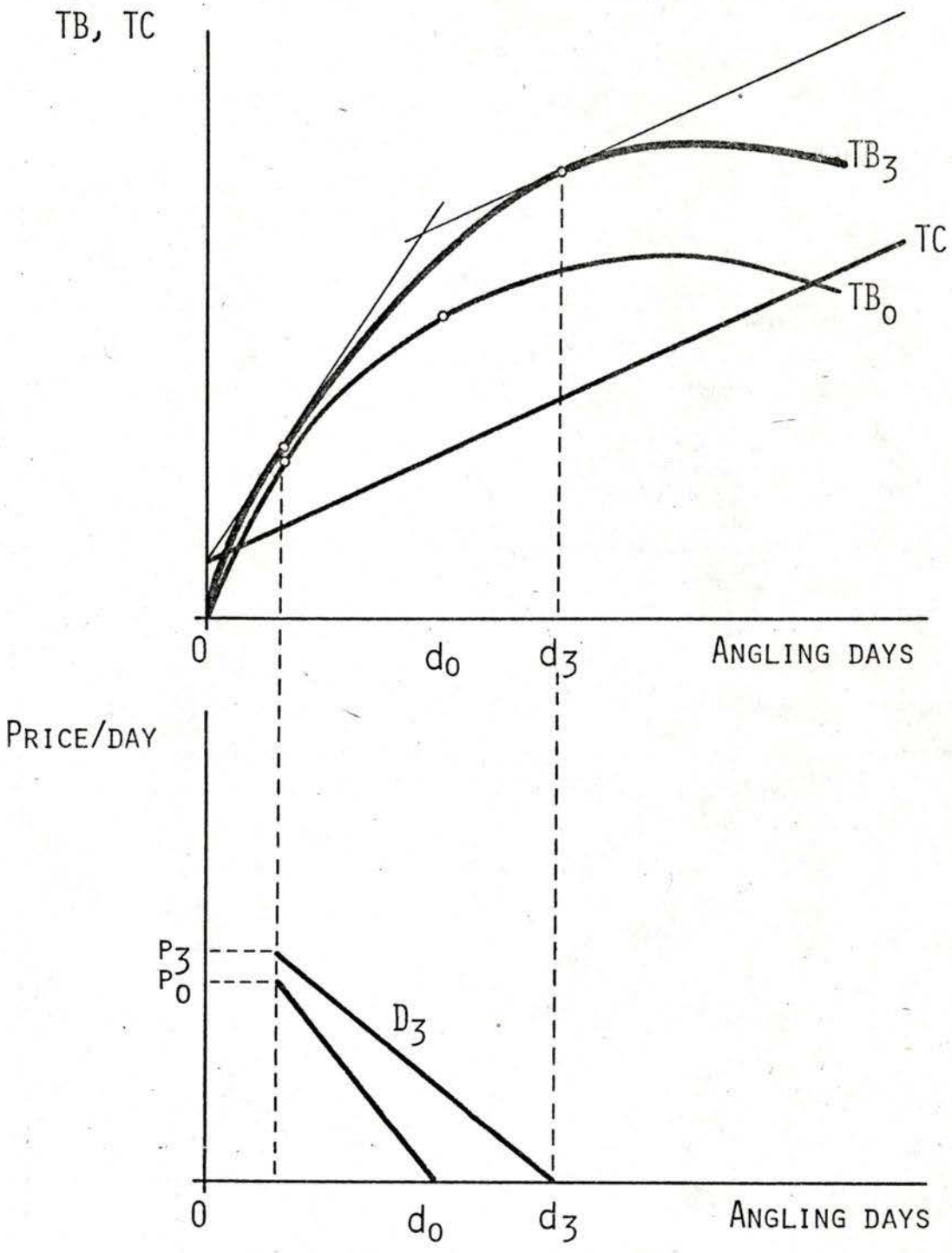

FIGURE 4. DEMAND CURVE SHIFTING MORE ON THE QUANTITY AXIS THAN ON THE PRICE AXIS.

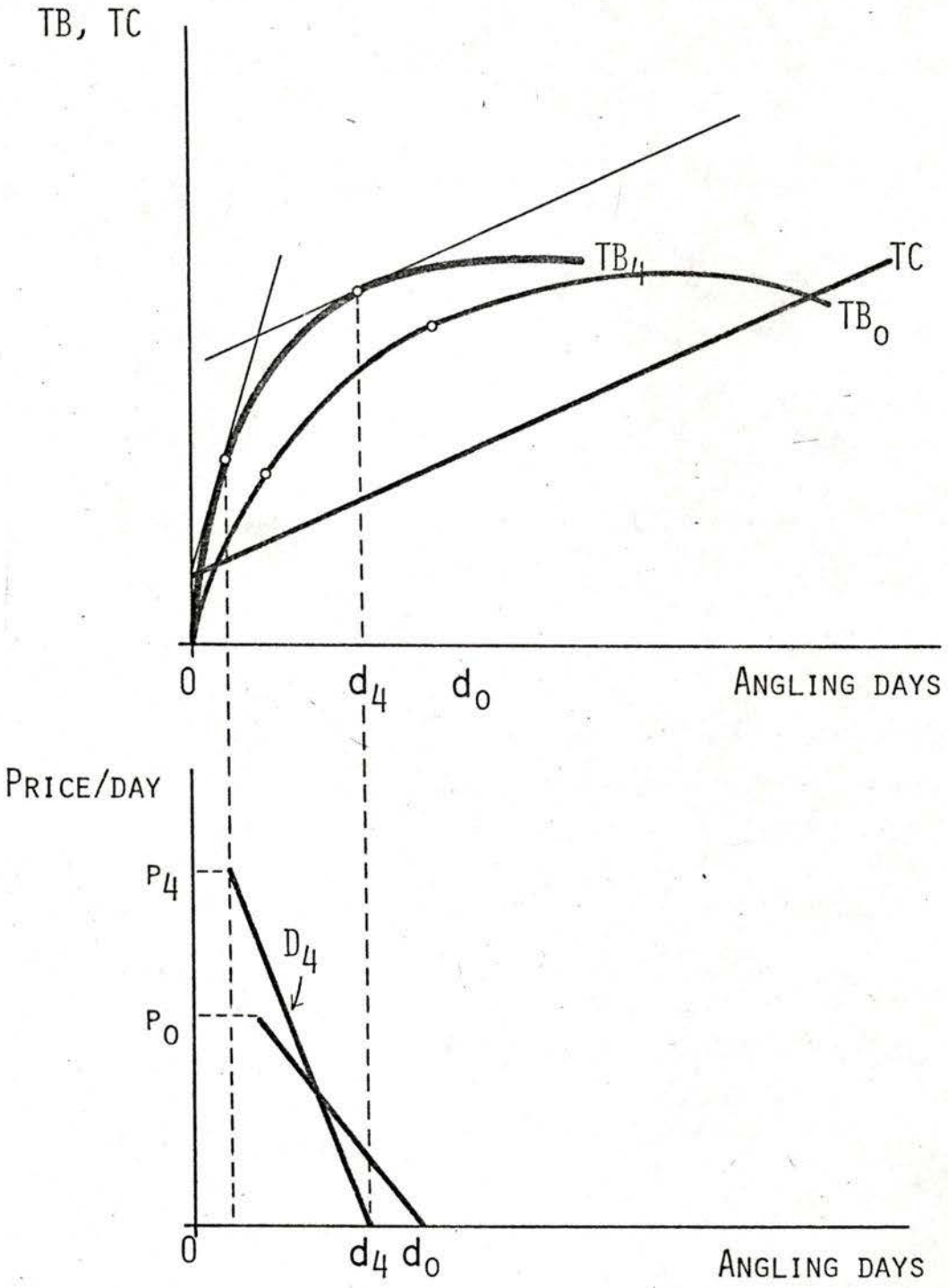

FIGURE 5. INTERSECTING DEMAND CURVES.

be negatively affected by the increase in angling days generated by other steelheaders, creating a congested fishing ground, eliminating some of the special characteristics of the fishery. For these anglers, consumer's surplus after enhancement may decrease.

Demand curve shifts decreasing fishermens' total benefits may also be shown by use of the simple model used above. In these cases, the total benefits curve shifts downwards from TB_0 to TB_5, as in Figure 6, decreasing both the willingness to pay and the number of angling days consumed by the steelheader. The magnitude and direction of the demand curve shifts will, again, depend on the shape of the decreased total benefits curve.

Conclusion

This chapter has reviewed the possible demand curve shifts which could occur because of enhancement on the Dean, when all other variables remain constant.

Theoretically, demand curve shifts could take any of the forms mentioned in this chapter, making any a priori judgement as to the shape of the shifted aggregated demand curve impossible. Parallel demand curve shifts, as used in the literature, may occur, but they could also overestimate or underestimate the value of any project if it is assumed that a parallel shift will take place. The following chapter will empirically determine the demand curve shifts for the sampled Dean River fishery, allowing for a more accurate conclusion to be made on this chapter. The results reflect the present Dean River fishery use only. No estimates for new entrants are included in this study.

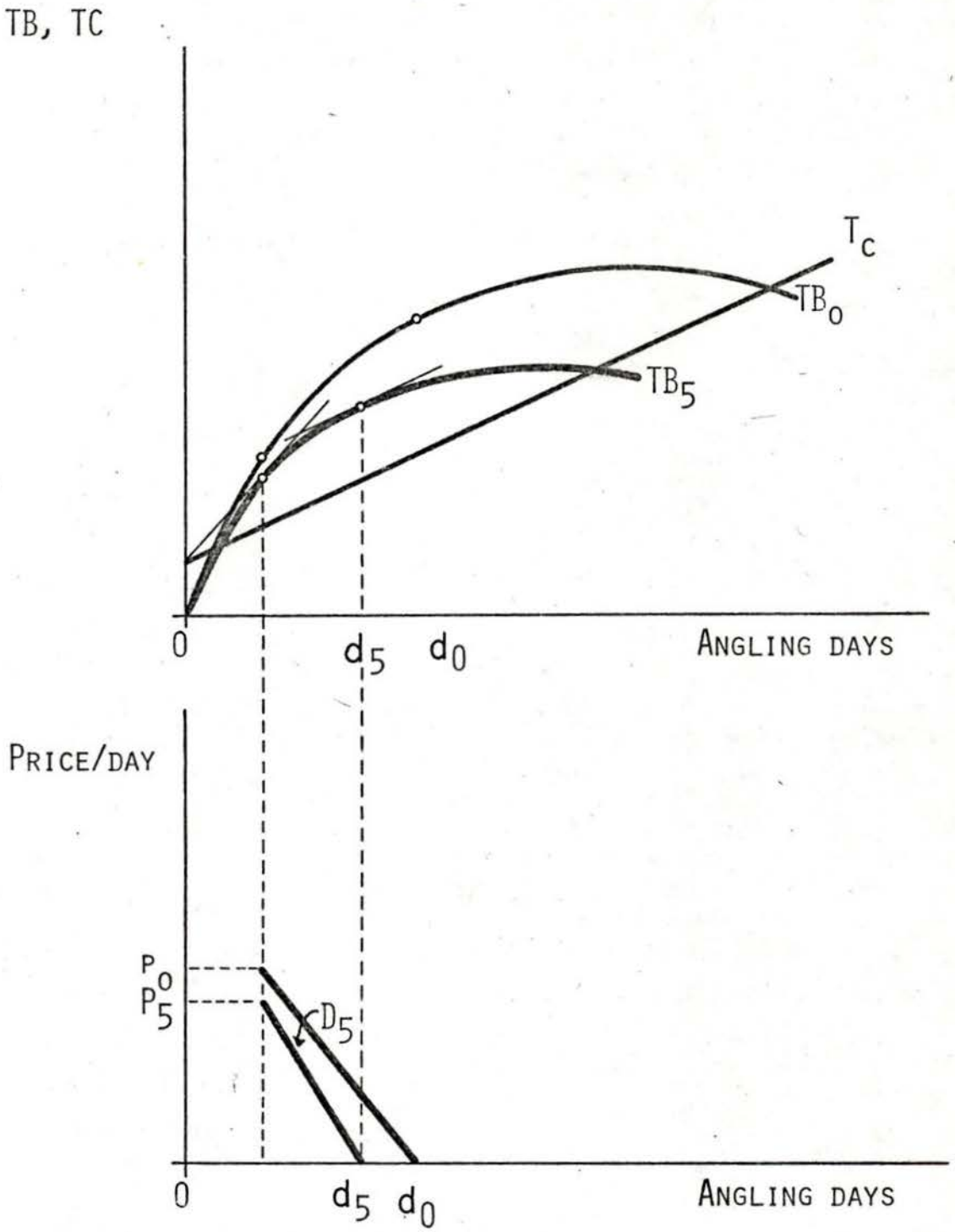

FIGURE 6. DEMAND CURVE SHIFTS DECREASING TOTAL BENEFITS.

FOOTNOTES

[1]The use of total benefit and total cost curves in analysing quality aspects of common property was used by Haveman (1973) in his study on congestion and pollution. G.R. Walter (1979) also uses this approach when discussing travel cost and recreational benefits.

[2]If one assumed no fixed costs, the demand curve would intersect the price axis.

[3]A more elastic demand curve would show a change in the quantity demanded greater than the proportional change in the opposite direction.

CHAPTER 5

EMPIRICAL ESTIMATION OF DEMAND CURVES AND CONSUMERS' SURPLUS FOR THE DEAN RIVER FISHERY

The empirical estimates of the individual travel cost and willingness to pay functions based on the sample of anglers on the Dean River are estimated in this chapter, using the data derived from a questionnaire undertaken by the Fish and Wildlife Branch of the Ministry of Environment.

ESTIMATION OF DEMAND CURVES BY USE OF THE TRAVEL COST METHOD

The model:

The basic demand function for recreation on the Dean River stemming from the travel cost method discussion in Chapter 3, may be specified as follows:

$$(1) \qquad D_{ji} = f(C_j, Y_j, M_j, X_j)$$

where:

D_{j1} = number of angler days from the jth zone as a variable for quantity of angling effort before enhancement.

C_j = generalized costs of travel per trip for individuals from the jth zone (Travel expenses and out of pocket expenses).

Y_j = gross annual income for anglers from the jth zone, as a variable of the ability of individuals to visit the Dean.

M_j = distance, measured in miles from the place of residence to the Dean River.

X_j = a number of socio-economic characteristics such as age, angling success, experience (assumed to be the number of trips to the Dean in the last five years), etc. These variables were later omitted due to their insignificance.

D_{j2} = number of angler days from the jth zone after enhancement.

It would be expected that the number of days spent on the Dean would vary directly with the number of miles traveled. Generalized travel costs would be inversely related to the number of days. Income would be expected to be positively related to days since it is hypothesized that as an individual earns more income, he will be able to spend more days steelhead fishing on the Dean.

The data:

Data on travel costs, income, number of days and socio-economic characteristics were obtained directly from the questionnaire. Distance traveled was determined by 'air miles' from the place of residence[1].

Individuals with no income or travel expenses were excluded from the sample due to the omission of the most important variables of the model - travel costs and income[2]. The remaining sample consisted of 100 observations of which 60 were British Columbia residents and 40 were non-residents.

Observations were then grouped into 15 zones, defined by concentric circles of 50 miles, originating at the Dean. Summarized data may be found in Table 3, Chapter 3.

Travel cost method results:

Numerous combinations of demand equations were estimated using linear, exponential and double-log functional forms. The demand

equation yielding the best results was the following exponential function:

$$(2)\quad \ln D_1 = 1.4559 + .00036989M + .000019Y - .0105C/D_1$$

	(.2053)	(.00019)	(.000006)	(.0018)
	7.1008*	1.8721**	2.9736**	-5.6321*

$R^2 = .7442 \quad \bar{R}^2 = .6744 \quad F = 10.665^*$

$n = 15$

Standard errors of the regression coefficients are the figures in parenthesis. The signs of the coefficients were as expected. The level of significance of the t-statistics is determined by * if it is significant at the 1% level, ** at 5%, and *** at 10% significance. The F statistic has * if significant at 1% and ** if significant at 5%.

Once the equation is estimated, the demand curve for angling on the Dean can be found by incrementally increasing the value of the price variable while holding all other variables constant, as shown in Table 1. The demand curve as estimated by this method is illustrated by D_1 in Figure 1.

The same model was estimated for the Dean River after enhancement was introduced. The variable for the number of angling days in the past year was replaced by the days an angler would have spent fishing on the Dean if his possibilities of catching a steelhead were doubled.

The estimated demand function was:

$$(3)\quad \ln D_2 = 1.7369 + .00031M + .0001Y - .00606C/D_1$$

	(.3628)	(.00034)	(.0001)	(.00329)
	4.8008*	.90981	.87655	-1.8418**

$R^2 = .2374 \quad \bar{R}^2 = .2194 \quad F = 1.141$

$n = 15$

TABLE 1

ANGLER DAYS ESTIMATED AT
INCREASING PRICES WHILE HOLDING
OTHER VARIABLES CONSTANT AND USING
AGGREGATED DATA

Cost/Day	Days without enhancement	Days with enhancement
$ 0	142.30	186.95
50	84.19	138.08
100	49.80	101.98
150	29.46	75.72
200	17.43	55.92
250	10.30	41.30
300	6.09	30.51
350	3.61	22.53
400	2.13	16.64
450	1.26	12.29
472	1.00	
864		1.00

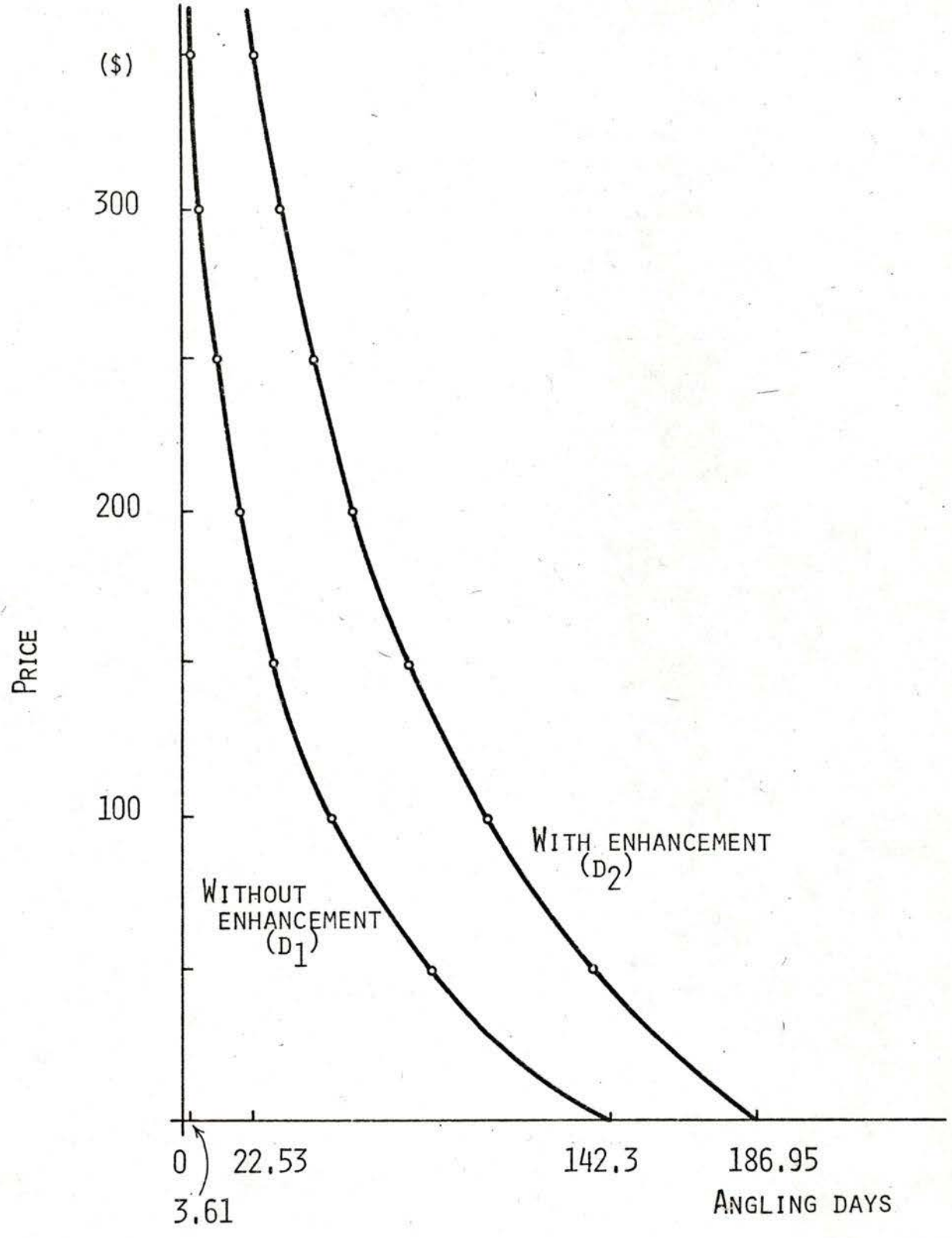

FIGURE 1: DEMAND CURVE ESTIMATIONS BY USE OF THE TRAVEL COST METHOD FOR PRESENT AND ENHANCED USE ON THE DEAN BY USE OF AGGREGATED DATA.

All coefficients in equation (3) had the expected sign. The number of miles traveled and income coefficients were only significant at the 20% level.

Diagramatically this demand curve may be seen by D_2 in Figure 1.

Consumers' surplus estimations for both demand curves were found by intergrating the area under the demand curves[3]. Consumers' surplus under present conditions on the Dean equals $9,870.00, while with enhancement consumers' surplus equaled $16,241.00.

Multiplying the average of these figures times the total number of angling days on the Dean in 1978/79, consumers' surplus equaled $292,178.00 ($69.50 X 4,204 days). Consumers' surplus after enhancement would equal $365,117.40 ($86.85 X 4,204 days). Thus enhancement increases angler benefits by $72,939.40.

The impact of aggregation:

The impact of aggregation on the estimation of recreational demand function (i.e., dividing the sample into 15 groups), has been discussed by Brown and Nawas (1973) and by Flegg (1976). The argument in both these studies is that by using highly aggregated data, "biased and inefficient estimates of cost-elasticities and spuriously high values for R^2" will occur (Flegg, 1976, 353).

The travel cost method was re-estimated using the 100 observations and omitting aggregation completely. The results from this method were:

(4) $\ln D_1 = 1.1953 - .00428C/D_1 + .000006Y + .0004M$

(.134) (.00065) (.000002) (.00018)

8.9059* -5.57* 2.1675** 2.2349**

$R^2 = .2561$ $\bar{R}^2 = .2329$ $F = 11.018*$

$n = 100$

(5) $\ln D_2 = 1.3774 - .00285C/D_1 + .000006Y + .00009M$

(.535) (.00088) (.000003) (.00020)

8.9718* -3,2426 1.9694*** .44383

$R^2 = .1136$ $\bar{R}^2 = .0859$ $F = 4.101**$

$n = 100$

As a result of disaggregating the data, R^2 estimates decreased by .49. It could be said that the better fit from the aggregated data is due to the lower variation in the data. Obviously 15 observations will vary less than 100 observations. Thus, it must be noted that R^2 is a misleading measure for concluding on the explanatory power of these regressions[4].

Defining 'cost-elasticities' in the same way as Flegg, the cost elasticities would equal the bC_j's in aggregated and non-aggregated estimations. The difference between these is a narrowing effect of -.40 from the disaggregated to the aggregated equation, supporting the Flegg argument that "aggregation introduces a strong negative bias into the estimated cost-elasticity" (1976, 358).

The estimates for consumers' surplus are much greater when using disaggregated data. Consumers' surplus was estimated to be $54,020.00 before enhancement and $85,750.00 after enhancement. Making total benefits on the Dean in 1978/79 equal to $456,008.00 and the benefits derived from enhancement equal to $248,162.00.

Price quantity relationships holding income and distance traveled

constant for the disaggregated data are shown on Table 2, and illustrated on Figure 2.

Differences between British Columbia Residents and Non-residents:

When estimating the benefits to British Columbia from enhancement, it is best to divide the Dean River anglers into British Columbia residents and non-residents. The reason for this, is that the benefits to British Columbia from non-resident anglers are the expenses they incur in the Province, not the benefits derived in the form of consumers' surplus. It is felt that these benefits do not stay in the Province and hence should not be included as such. However, a comparison of residents and non-residents will show how the different groups react to enhancement.

The same equation as used in the previous section was used for the new estimation. The sample size for non-residents was 40, while for residents it was 60. Table 3, presents the regression results.

The distance traveled and income was expected to be significant for both groups. Number of miles for non-residents was expected to be inversely related to the number of days spent on the Dean under the assumption that the longer the time spent in traveling, the fewer fishing days left in the trip.

It is interesting to note that income was not an explanatory variable for British Columbians, while distance traveled was non-explanatory for non-residents.

Distance may be less significant for both groups due to the fact that air travel was the most common mean of transportation, thus time was not a great constraint.

TABLE 2

ANGLER DAYS ESTIMATION WITH
NON-AGGREGATED DATA

Price/day	Days without enhancement	Days with enhancement
$ 0	498.00	512.00
50	402.00	445.00
100	324.00	386.00
150	262.00	334.00
200	212.00	289.00
250	170.00	251.00
300	138.00	218.00
350	111.00	189.00
400	89.00	164.00
450	72.00	142.00
500	58.00	123.00
1451	1.00	8.00
2189		1.00

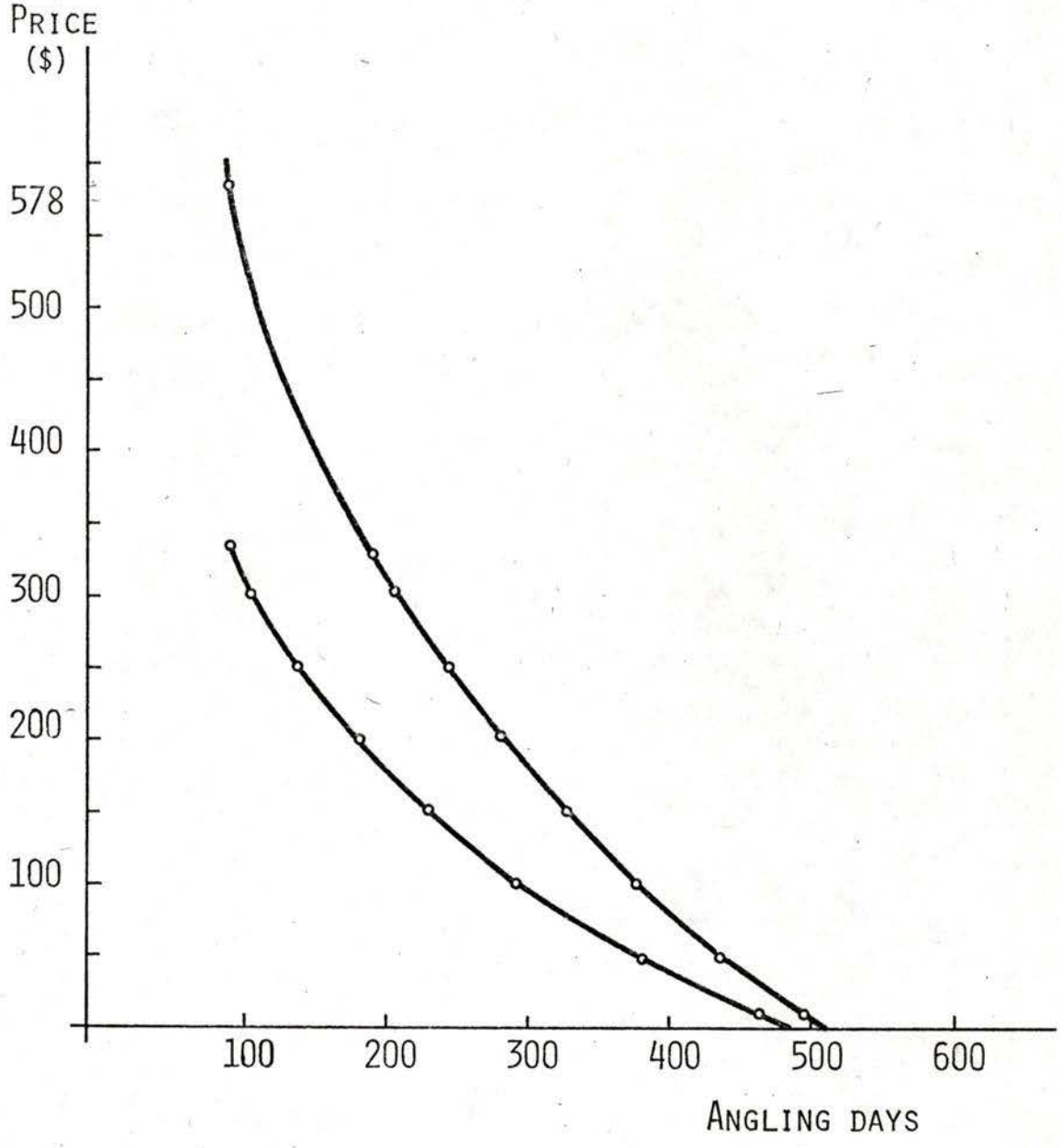

FIGURE 2: ESTIMATED DEMAND CURVES BY USE OF THE TRAVEL COST METHOD AND DISAGGREGATED DATA.

TABLE 3

ESTIMATED REGRESSION COEFFICIENTS
FOR B.C. RESIDENTS AND NON-RESIDENTS

	a	bC/D	cY	dM	R^2	$\bar{R}^2$	F
Residents:							
Under present conditions	1.4066	-.0060	-.0000	.0016	.36	.32	10.35*
	(.4782)	(.0012)	(.0000)	(.0010)			
	2.941**	-5.0641*	-.8036	1.744***			
	n = 60						
After enhancement	1.5543	-.0039	-.0000	.0005	.12	.07	2.46
	(.5962)	(.0015)	(.0000)	(.0012)			
	2.607**	-2.656**	-.1216	.4538			
	n = 60						
Non-Residents:							
Under present conditions	1.5866	-.0032	.0000	-.0000	.27	.21	4.43**
	(.2912)	(.0009)	(.0000)	(.0002)			
	5.4478*	-3.3995*	1.489***	-.1346			
	n = 40						
After enhancement	1.4465	-.0022	.0000	-.0000	.15	.08	2.14
	(.3311)	(.0011)	(.0000)	(.0003)			
	4.3691*	-2.0108**	1.7183**	-.2155			
	n = 40						

Income was inversely related to the number of days on the Dean for British Columbians. This relationship may be due to the idea that as income becomes larger, residents vacation out of the Province, or do not spend their time steelhead fishing on a stream they could use on long weekends.

Consumers' surplus varied considerably between both groups as shown in Table 4. The differences are explained by the area under the demand curves for each group, illustrated in Figure 3. The mean of the variables used are outlined in Table 5, and it should be noted that they are much larger for non-residents than residents.

The percentage increase in benefits because of steelhead enhancement is considerably higher for non-residents. The increased benefits to the Province from the additional benefits to residents of British Columbia comes to $112,000.20.

The shift in demand curves for both groups is worth mentioning, for the differences are considerable. Residents showed an increase in the maximum price paid from $980.00 to $1,478.00, a change of $198.00; and, a decrease in the number of days from 357 to 318, a decrease of 39 days. Non-residents increased the maximum price from $1,649.00 to $2,334.00 an increase of $675.00 and a decrease of 25 angling days. This could be due to the basic principle that as price increases, the quantity consumed would decrease. This decrease in the number of days may also be explained by the enumerators observation that "if twice the opportunity of catching steelhead were possible very few anglers could find the extra time to fish any more days" (Appendix IV, 5), and by use of regression analyses, the fitted curve would show a decrease

TABLE 4

CONSUMERS' SURPLUS
FOR RESIDENTS AND NON-RESIDENTS*

	RESIDENTS		NON-RESIDENTS	
	Sample	Total	Sample	Total
Before enhancement	$32,635.20	$295,861.80	$27,201.00	$134,896.50
After enhancement	40,086.00	407,862.00	42,764.00	243,200.50
Benefits of enhancement	7,451.00	112,000.20	15,563.00	108,304.00
Percentage increase	22.8%	37.9%	57.2%	80.3%

* Of the 4,204 angling days on the Dean in 1978/79, 967 days were angled by non-residents (Fisheries Management Division, 1978/79).

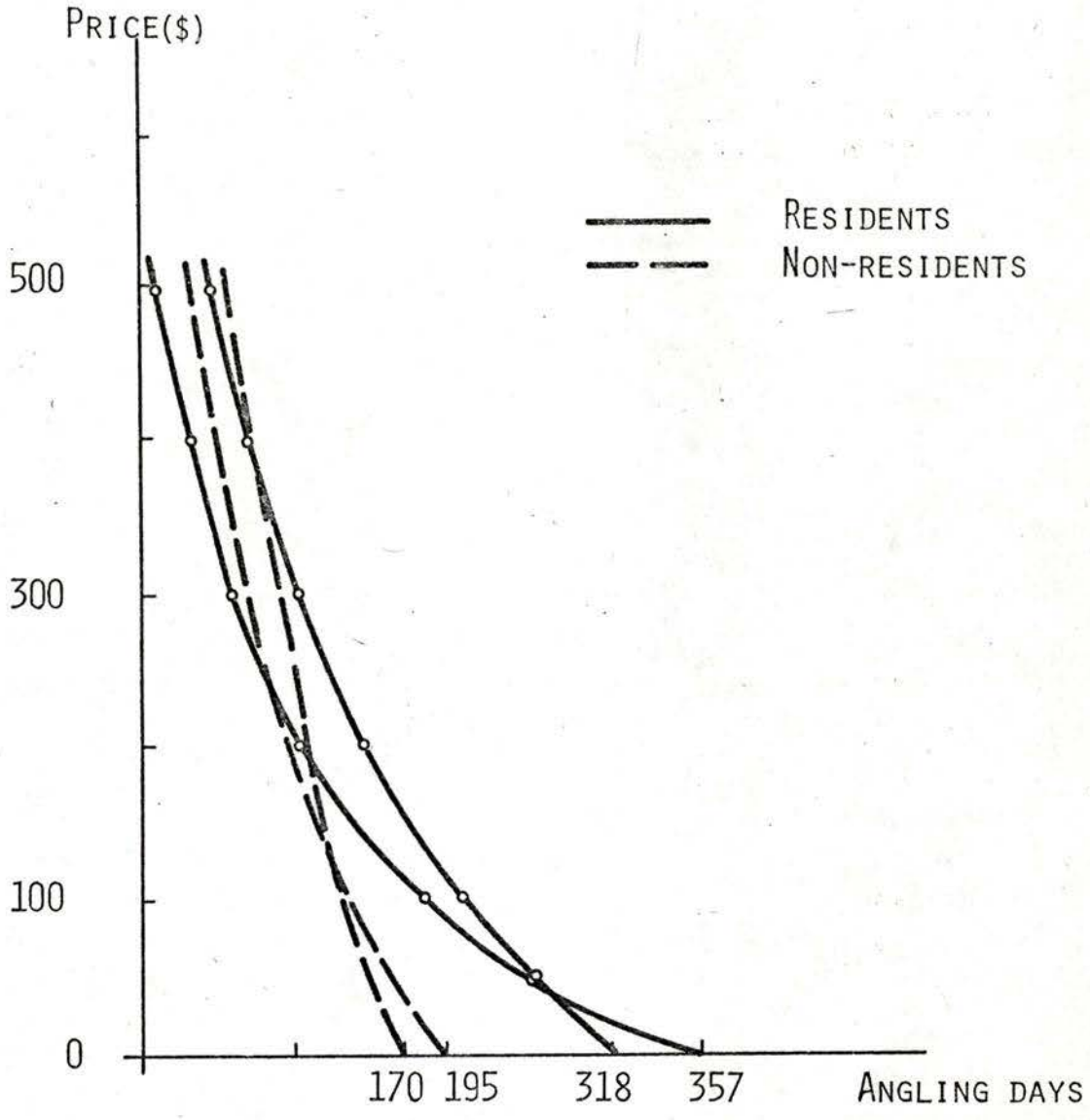

FIGURE 3: DEMAND CURVE ESTIMATION FOR RESIDENTS AND NON-RESIDENTS FOR BEFORE AND AFTER ENHANCEMENT BY USE OF THE TRAVEL COST METHOD.

TABLE 5

COMPARISON OF AVERAGE INCOME, DISTANCE
TRAVELED AND COSTS PER DAY
FOR RESIDENTS AND NON-RESIDENTS

	Residents	Non-Residents
Cost/Day	$ 84.70	$ 160.93
Income	$ 24,100	$ 52,525
Distance (Miles)	236.08	883.88
Days spent on Dean in past 12 months	4.1	5.08
Days spent with enhancement	5.3	5.58

in the number of fishing days.

EMPIRICAL ESTIMATION BY USE OF THE DIRECT CONSUMER'S SURPLUS APPROACH

As mentioned in Chapter 3, the direct consumer's surplus techniques or willingness to pay (WTP) method, consists of asking the angler to react to increases in the costs per day to visit the Dean River[5]. The empirical estimation of the individual willingness to pay function based on the Dean River sample will be presented in this section.

Aggregating the maximum price individuals were willing to pay per day and the number of days they would angle at that price on the Dean, yields the relationship shown on Figure 4 and Table 6. This two dimensional price-quantity relationship shows an increase in effort of 139 days and the maximum price anyone is willing to pay to be $499.00. The shift to the right of the demand curve after enhancement shows the increased benefits to the angler.

Estimating each individual's demand curve, the area under it and adding them up, gives a crude estimate of consumers' surplus for the sample, as shown on Table 7. The correct measure for consumer's surplus should be the price compensating surplus found by asking individuals what they would be willing to pay in order to fish on the Dean. The estimation of willingness to pay using a modified direct consumer's surplus approach will be developed here.

The model:

If willingness to pay is defined as a measure of benefits, or consumer's surplus reflecting the site's quality characteristics for the specific season of the interview, then willingness to pay may be

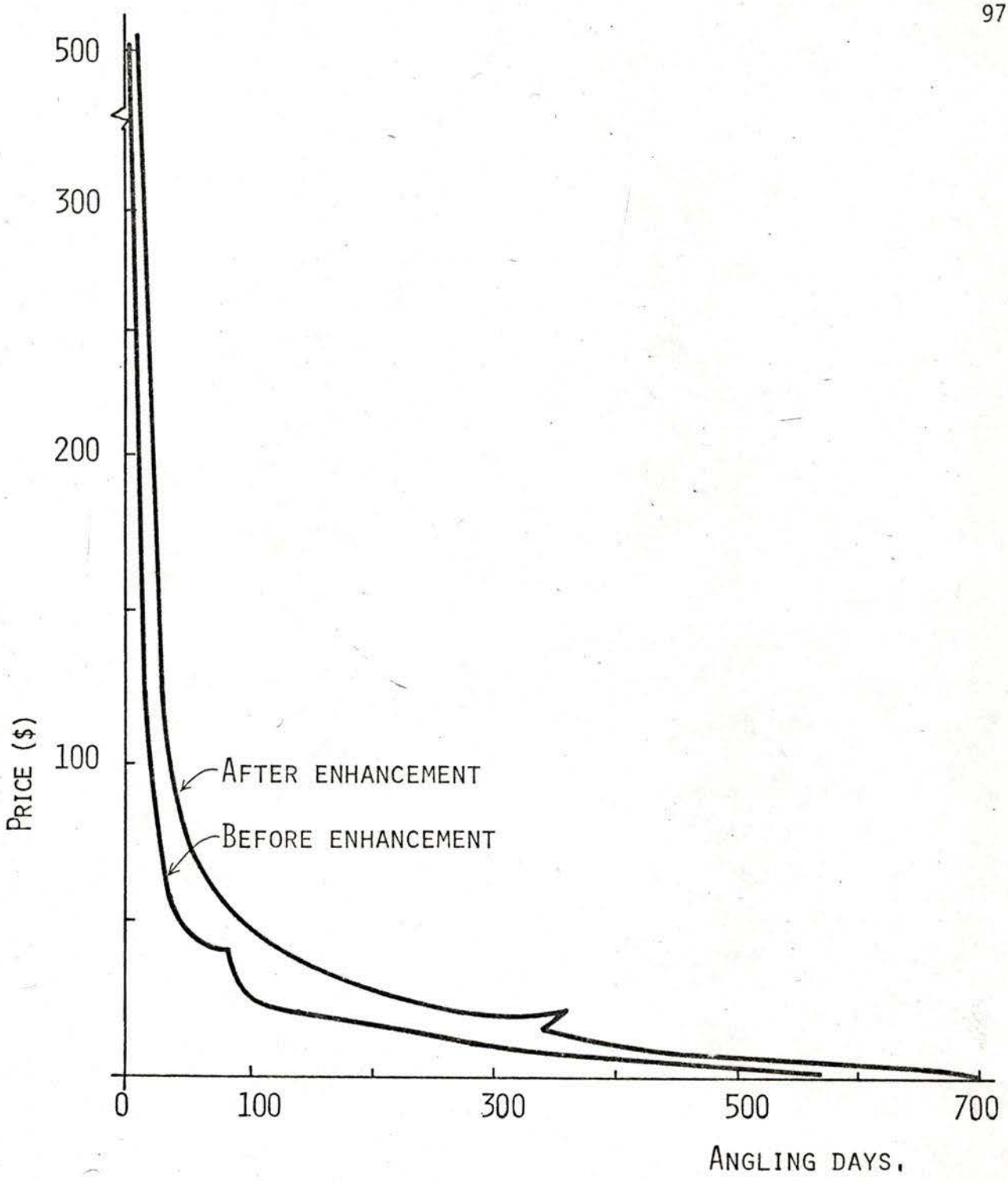

FIGURE 4: WTP OF CONSUMERS ON THE DEAN RIVER UNDER PRESENT AND ENHANCED CONDITIONS.

TABLE 6

ANGLERS WILLINGNESS TO PAY

Charge	Days without enhancement	Days with enhancement
$ 1.00	531	665
5.00	382	526
10.00	271	404
15.00	219	343
20.00	151	363
25.00	114	219
30.00	89	179
40.00	83	131
50.00	46	100
75.00	22	58
100.00	21	36
200.00	15	20

TABLE 7

CONSUMERS' SURPLUS FOR
THE SAMPLED DEAN RIVER ANGLERS

Consumers' Surplus	100 Observations	Residents	Non-residents
Before enhancement	$ 8,238	$ 3,778	$ 4,460
After enhancement	13,674	6,729	6,945
Benefits of enhancement	5,436	2,951	2,485
Percentage increase	66%	78%	56%

determined by the following model:

$$(6)\quad WTP_i = a + bY + cEx + dC + eD$$

where:

WTP_i = willingness to pay for angling on the Dean.

i = 1 before enhancement
2 after enhancement

Y = individual gross income

Ex = angling experience as a proxy variable for preference.

C = total expenditures

D = days angling in the past year

Data for the independent variables were obtained directly from the questionnaire. WTP was calculated for each individual by finding the area under his demand curve.

C in this model is viewed as a proxy variable for tastes and preference in the sense that an individual's expenditures reflect his willingness to go without some other goods, in order to go fishing[6].

It should be kept in mind that this model, although it follows the Davis approach, and a modified Hammack and Brown model, does not provide comparable consumer's surplus information because the willingness to pay data was not directly asked to anglers, a proxy variable was used instead. The sign of the variables is expected to meet the restrictions stated in Chapter 3, namely, that the first partial derivative of WTP with respect to any of the independent variables be positive and that the second partial derivative be negative. On the postulation that an increase in any of these variables increases the amount of satisfaction derived from the angling experience.

Linear, exponential and double-log functional forms were tested. In most cases the linear and exponential functions yielded better fits (i.e., higher R^2's) than the double log function, but negative coefficients resulted for the independent variable D, making the first partial derivative value of willingness to pay with respect to the number of angling days negative, thus implying that anglers should not have been fishing at all. For this reason the double log function was used.

Using data from 100 questionnaire responses, the following equations were estimated:

(7) $\ln WTP_1 = -6.2378 + .809171nY + .464911nD_1 + .131271nC -$

(2.6385)	(.2649)	(.34051)	(.22544)
-2.3641**	3.0546*	1.3653***	.58227

.463621nEx
(.56514)
-.82037

$R^2 = .1588$ $\quad \bar{R}^2 = .1234$ $\quad F = 4.483^*$

$n = 100$

(8) $\ln WTP_2 = -6.1371 + .888031nY + .0664041nD_2 + .15691nC +$

(2.5439)	(.2554)	(.32830)	(.21735)
-2.4125**	3.4769*	.20226	.7117

.02241nEx
(.54487)
.04116

$R^2 = .1501$ $\quad \bar{R}^2 = .1144$ $\quad F = 4.196^*$

$n = 100$

These equations were re-estimated omitting both the experience and total expenditures variables because of their low level of signifance. The new results are:

(9) $\ln WTP_1 = -6.5092 + .916441nY + .264091nD_1$

(2.5703) (.25051) (.19683)

-2.5325* 3.6583* 1.3463***

$R^2 = .1418$ $\bar{R}^2 = .1241$ $F = 8.013*$

$n = 100$

(10) $\ln WTP_2 = -5.9692 + .94471nY + .124701nD_2$

(2.4585) (.24008) (.18002)

-2.4280* 3.9349* .69272

$R^2 = .1465$ $\bar{R}^2 = .1289$ $F = 8.324*$

$n = 100$

Willingness to pay was estimated for the sample as a whole and for residents and non-residents. Table 8 shows the willingness to pay estimations for present and enhanced conditions. In all cases consumers' surplus increased considerably with enhancement.

Differences between the residents and non-residents were as in the travel cost method, quite considerable. Regression results are as follows:

Residents:

(11) $\ln WTP_1 = .99585 + .149131nY + .316401nD_1$

(6.1819) (.6113) (.27039)

.16109 .24395 1.1702

$R^2 = .024$ $\bar{R}^2 = -.01$ $F = .689$

$n = 60$

(12) $\ln WTP_2 = 3.3058 + .0155951nY + .0508611nD_2$

(6.2335) (.61888) (.25731)

.53033 .025199 .19767

$R^2 = .0007$ $\bar{R}^2 = -.0344$ $F = .020$

$n = 60$

TABLE 8

WILLINGNESS TO PAY ESTIMATES
FOR BEFORE AND AFTER ENHANCEMENT

	Total users		Residents		Non-residents	
	Sample	Total	Sample	Total	Sample	Total
Before enhancement	$ 18,959	$ 138,858	$ 4,674	$ 61,503	$ 11,987	$ 57,101
After enhancement	34,440	252,744	8,474	111,514	17,159	81,740
Value of enhancement	15,481	113,886	3,800	50,012	5,173	24,639
Percentage increase	82%		81%		43%	

Non-residents:

(13) $\ln WTP_1 = -6.7864 + .996341nY - .010371nD_1$

(2.8988) (.27392) (.28301)

-2.3411***3.6374* -.03665

$R^2 = .2653$ $\bar{R}^2 = .2255$ $F = 6.679*$

$n = 40$

(14) $\ln WTP_2 = -6.6921 + 1.023411nY + .2057611nD_2$

(2.2085) (.21092) (.20659)

-3.0301* 4.8518* .99598

$R^2 = .4251$ $\bar{R}^2 = .3941$ $F = 13.68*$

$n = 40$

WTP, from these equations bears no relationship to income and angling days for British Columbia residents. The function that best reflected residents' behaviour was:

(15) $\ln WTP_1 = -1.2382 + .00609M + 2.4055A + 2.64T + .0924D_1$

(1.0171) (.00221) (.94005) (1.371) (.0764)

-1.2173 2.7555* 2.5589* 2.3224**-1.2116

$R^2 = .2696$ $\bar{R}^2 = .2020$ $F = 3.986**$

$n = 60$

where:

M = number of miles traveled

A = Age of the individual

T = trips to the Dean per year

D = number of days on the Dean per year.

This relationship points out that age, miles traveled and the number of trips per year are more significant than the number of days spent on the Dean.

On the other hand, WTP for non-residents, specially under enhancement, is related to income and angling days.

The only conclusion that can be made from the results of the resident and non-resident willingness to pay estimation is that it does not determine, in a satisfactory way, the willingness to pay for the individual groups.

Summary and Conclusions:

In an attempt to estimate empirically demand curve shifts and benefit changes from enhancing the Dean River steelhead fishery, this chapter has focused on the travel cost technique and on the direct consumer's surplus approach.

The travel cost method provided estimates for pre- and post-enhancement demand curves showing that anglers are willing to pay a considerably higher price for a very small increase in angling days.

Dividing anglers by British Columbia residents and non-residents proved to be a useful exercise. The difference between users was considerable. The most striking revelation was the small negative change in the number of angling days by the non-resident and resident users, with a tremendous increase in consumers' surplus.

Re-grouping anglers by income groups, number of days spent fishing and other major variable similarities would most probably give further insight into demand curve shifts and the behaviour of different groups of people.

The direct interview technique followed by Hammack and Brown was modified to suit the available data obtained from the questionnaire. Consumers' surplus was estimated for the sample as a whole and the sample divided by residency. The regression for the whole sample yielded satisfactory results, but the divided sample showed poor

relationships. Nevertheless, consumers' surplus estimates were obtained by using this approach providing some comparisons for the travel cost techniques shown on Table 9.

Travel cost estimates are much greater than willingness to pay estimates. Making any conclusion as to the exact value of the Dean River fishery impossible. The percentage increase of benefits due to enhancement is much greater for the willingness to pay estimates for the sample as a whole and residents. The opposite occurred for non-residents.

The travel cost model, as specified in this chapter, gives more confidence to the estimated consumers' surplus estimates, because the regression does explain the variables for the three samples tried. If one goes back to the weaknesses of the travel cost method stated in Chapter 3, it can be said that several of these do not hold for the case at hand, namely: (a) the disaggregation of the data from the conventional model allows for variable preferences among the zones, (b) for the Dean River, travel costs are strictly for travel, (c) anglers in this sample have a single purpose for their trip, and, (d) socio-economic variables were included in the study although they were found to be insignificant.

The lack of data restricts the use of the Hammack and Brown model which is basically interested in valuing the relationship between the value of a recreational day and the value of the catch from that day.

This leads to the conclusion that if a choice is to be made as to which consumers' surplus value is 'more correct', it would have to be those estimated by the travel cost technique, although they are so much greater.

TABLE 9

COMPARISON OF CONSUMERS' SURPLUS
FROM TRAVEL COST AND WILLINGNESS TO PAY
FOR THE 1978/1979 DEAN RIVER FISHERY

	Before enhancement	After enhancement	Percentage change
Whole sample:			
TC	$ 456,008	$ 704,170	54%
WTP	138,858	252,744	82%
Residents:			
TC	295,862	407,862	38%
WTP	61,503	111,514	81%
Non-residents:			
TC	134,896	243,200	80%
WTP	57, 101	81,740	43%

The important conclusions to be made from this chapter are that the non-parallel demand curve shifts are different for British Columbia residents and for the non-residents, and that in all cases, enhancement increases the benefits received from the steelhead fishery anywhere between 38% to 82% depending on which group of people is being studied and what method of estimation is used.

FOOTNOTES

[1]For non-residents of British Columbia, the State capital was used as a place of origin, assuming they traveled first to Vancouver and then continued onto the Dean River.

[2]It was also convenient to exclude them when estimating exponential and double-log functions since when taking the log of zero, the computer assumed an invalid operation.

[3]Integration was done by the following formula:

$$\int_0^{max} ae^{-bP}\, dD$$

$$\frac{-ae^{-bD}}{b} + \frac{a}{b}$$

$$- \frac{a(\text{inv ln} - (b)(D^{max}))}{b} + \frac{a}{b}$$

[4]Smith and Kavanagh argue the contrary by rationalizing that "in large zones individual differences in factors such as income are likely to cancel out so that in this respect there are no great differences between zones" (1969, 325). Unfortunately this is not the case for anglers on the Dean River.

[5]The questionnaire also attempted to provide information on willingness to sell. Unfortunately, highly emotional responses were obtained when anglers were asked their willingness to sell. A total of 99 (76.74%) anglers refused to answer the question or felt that no amount of money could be paid to them to give up fishing steelhead on the Dean.

[6]It could be argued that C should be multiplied by some factor to reflect the round trip expenses. It has been assumed that most anglers purchase round-trip airline tickets and travel to the Dean with enough food and other needs to get them home again, since there are few facilities on site (only 9% of interviewed anglers stayed at the guided camps).

CHAPTER 6

STUDY LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

The demand for steelheading on the Dean River has expanded tremendously in the past 12 years. Not only have the total number of days spent increased fourfold, but the number of days per catch have increased by five, from 1.8 to 6.8. This increase in effort and decrease in catch is a Province-wide phenomenon and has led directly to the inclusion of steelhead into the Salmonid Enhancement Program.

Determining a value for an intangible good, namely the fresh water steelhead fishery, and the variations in its demand because of a change in one of its quality characteristics has been the focus of this study.

The value of fresh water angling cannot be directly calculated in the market place. The reason for this is that recreational values arise from the quantity as well as the quality, of the angling experience of which catch is only one component.

In the past, the value derived from a free good, or the benefits received over and above the price paid for a good has been defined as consumer's surplus. There are several distinct measures of consumer's surplus with the most used in resource economics being the area under a money income demand curve as well as compensating (or willingness to pay) and equivalent (willingness to sell) variations.

Under the assumption that income effects are negligible for fresh water angling, the price compensating variation is equal to the area under the money income demand curve and above the price line.

Numerous attempts have been made in the past to develop methods of tangibly valuing the extra-market recreational resources. The most popular technique has been the travel cost method employing the different costs for travel of the users as a proxy for prices. The second widely used technique is the direct consumer's surplus method which relies on data collected by directly questioning individuals on estimates of their consumer's surplus derived from a recreational site and/or activity.

The travel cost method yields a demand curve from which consumers' surplus is easily derived, while the direct willingness to pay method gives a measure for consumers' surplus from the estimated regression.

Estimating angler benefits is by no means the only reason for estimating demand. Demand estimates indicate which factors influence participation in angling, and provide a means for forecasting, future angling pressure and benefits, depending on assumptions about the casual factors, population, accessibility, quality of fishing, and socio-economic characteristics.

Many factors determine the demand for fresh water angling. Among the socio-economic elements are the individual's income, education, age, and occupation. This study found that among such variables used, the only significant one was income, although other factors such as the quality of a site were also strong determinants of demand. The change in angler benefits because of an enhanced fishery may change the individual's demand for that fishery. No a priori determination of the demand curve shift is predictable because of the heterogeneous nature of anglers and their different perceptions of enhancement.

In the summer of 1979, one hundred and twenty nine individuals were interviewed to elicit some of the possible factors influencing the demand for Dean River steelheading. Twenty nine of these were omitted because the respondents did not answer the necessary questions or had no income or expenses when traveling to the Dean. The remainder formed the sample for the empirical estimation by use of direct and indirect consumer's surplus techniques. A variety of functional forms were tested and the one yielding the most significant results was chosen. The results strongly suggest that consumers' surplus is affected positively by steelhead enhancement. Results also showed different behavioural patterns between British Columbia residents and non-residents, specifically when their willingness to pay figures were estimated.

A major limitation to this kind of study lies in the numerous assumptions required in order to estimate the benefits by the travel cost and willingness to pay methodologies. These were discussed in Chapter 3. A major assumption which has been overlooked so far is that angling substitution effects are not important. Although, generally speaking angling probably has no perfect substitutes, steelheading on the Dean River has many close substitutes, be it by the availability of similar streams or by the availability of alternative fish species. Determining substitution effects for each individual is virtually an impossible task. Thus, for practical purposes, it was necessary to assume all substitution effects to be insignificant[1].

It must be noted that the empirical results are based on a survey of limited scope and are only relevant to the Dean River, for their

validity depends entirely on the data used for the analysis. The questionnaire design is thus extremely important. Several modifications to the questionnaire could be made to extend the information and allow for more complete estimations. Steelhead catch per individual both kept and released is a crucial variable to determine the marginal values of steelhead and of a steelheading day.

Catch and number of days data should also be collected for different levels of enhancement. This study estimates benefits derived from the doubling of steelhead on the Dean. Compensating variation should be found for each level of enhancement as well as for the present conditions.

Other less important, data needed would be the total number of yearly holiday days and the travel mode of each individual.

A second limitation stemming from the questionnaire is the emphasis on the time specification 'so far today'. The data provided by these questions are not usable because they do not include a complete angling day's characteristics.

Many assumptions and questionnaire design problems are implicit in this kind of study, but the above mentioned are a few of the most notable.

Many areas of this thesis need further research. The first is the inclusion of non-consumptive values, option values, and existence values. Non-consumptive values arise from the benefits received from the perceived availability of steelhead. Option values are the benefits associated with the ability to elect to participate in steelhead angling. And, existence value, as the name specifies, is the benefits associated with a resource's continued existence regardless of

participation. Since these intangible values are not included in the present study, it must be recognized that the estimated benefits are incomplete and the total value of the resource may consequently be underestimated.

A second area for further research is the inclusion of a capacity constraint on the river. Enhancement may change the amount of angling effort on the Dean. If this new effort is very great, the benefits derived from the angling experience may decrease because of a change in quality, counteracting the effects of increased catch. For example, if the area became highly congested, there could be a decrease in consumer's surplus for some individuals, as well as a decrease in effort.

The methodology outlined in this thesis is useful in determining the benefits of enhancement, but it has several limitations due to its analytical assumptions and data problems, which constrain the accuracy of the estimations. Interdisciplinary cooperation is necessary between biologists and economists, to acquire further knowledge of steelhead stocks, and more accurate catch to escapement ratios. The validity of the assumption that catch probabilities would double (or increase) with enhancement, will depend upon the return of steelhead and their comparability with natural stocks. Biologists are much more qualified to determine these factors than economists.

The estimation of benefits provided here should be looked at only as benefits accruing directly to the Dean River fishery, yet the effects of enhancement may be felt by parties other than anglers, and these benefits have not been included in this study. Secondary benefits through regional income changes induced by increased angler expenditures

or travel to the area need to be considered, as well as the impact on land and other outside values.

This study has not attempted to identify the costs of enhancement on the Dean, and it has not approached the determination of a benefit-cost ratio. The values determined for steelhead enhancement should not be used as a "price" for the fishery for their accuracy is questionable, and future participation rates, as well as the number of enhanced fish are not known.

Although it would have been ideal, this study was not meant to solve any of the many problems involved in the management of resources. Instead it has provided some insight to demand response, showing that parallel demand curve shifts due to enhancement are an incorrect assumption, and that benefits increase by the Salmonid Enhancement Program's proposal to double the number of steelhead.

In order to derive more concise conclusions from the approaches used in this study, additional catch and willingness to pay data are needed, as well as follow-up studies after enhancement has actually changed the quality of the fishery. Alternatively, willingness to pay data could be obtained indirectly by playing a bidding game with the anglers to find the point where they would switch from inclusion to exclusion in the fishery, or, to eliminate the hypothetical nature of the derived benefits, the data could be found by actually charging entrance fees to the Dean before and after enhancement to measure the effects on demand.

FOOTNOTE

[1]It could be argued that anglers were free to substitute rivers and species since the questionnaire asked how much they were willing to pay for each steelhead angling day assuming all other systems remained free of charge.

BIBLIOGRAPHY

Anderson, Lee G. (1977). The Economics of Fisheries Management. Baltimore: The Johns Hopkins University Press.

Beardsley, Windell (1971). "Bias and Noncomparability in Recreation Evaluation Models". Land Economics, Vol. 42, pp. 175-180.

Becker, G.S. (1965). "A Theory of the Allocation of Time". Economic Journal, Vol. 75, pp. 493-517.

British Columbia, Department of Recreation and Conservation, Game Management Division, Fish and Game Branch (1964). "Inventory and Evaluation of the Wildlife Resources of British Columbia", in Inventory of the Natural Resources of British Columbia, D.B. Turner, ed., The British Columbia Natural Resources Conference, pp. 560-574.

British Columbia, Ministry of Environment, Fish and Wildlife Branch (1979). British Columbia Sport Fishing Regulations Synopsis 1979/1980 for Non-Tidal Waters. Queen's Printer.

Brown, Gardner M, Jr.; Charbonneau J. John, and Hay Michael J. (1978). The Value of Wildlife Estimated by the Hedonic Approach. Working Paper No. 6, Division of Program Plans, U.S. Fish and Wildlife Service.

Brown, William G. (1977). "Monetary Value of the Columbia River Fishery" in Columbia River Salmon and Steelhead, Ernest Schweibert, (ed.) pp. 189-195.

Brown, William G. and Nawas, Farid (1972). "'A New Approach to the Evaluation of Non-Priced Recreational Resources', A Reply". Land Economics, pp. 403-405.

Brown, William G. and Nawas, Farid (1973). "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions". American Journal of Agricultural Economics, Vol. 55, pp. 246-249.

Brown, William G.; Larson, Douglas M.; Johnston, Richard S., and Wahle, Roy J. (1976). Improved Economic Evaluation of Commercially and Sport-Caught Salmon and Steelhead of the Columbia River. Oregon Agricultural Experiment Station, Special Report 463, Corvalis.

Brown, William G., Singh, Ajmer, and Castle, Emery N. (1964). An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery. Technical Bulletin 78, Agricultural Experiment Station Oregon State University, Corvallis.

Brown, William G., Singh, Ajmer, and Castle, Emery N. (1965). "Net Economic Value of the Oregon Salmon-Steelhead Sport Fishery." Journal of Wildlife Management, Vol. 29, No. 2, pp. 266-279.

Bryan, Richard C. (1974). The Dimensions of a Salt-Water Sport Fishing Trip or What do People Look for in a Fishing Trip Besides Fish?. Environment Canada, Fisheries and Marine Service, Southern Operations Branch, Pacific Region.

Bryan, Richard C. (1975). A Survey of Customer Values, Perceptions and Future Management Options as they Relate to the Capilano River Sport Fishery. Environment Canada, Fisheries and Marine Service, Southern Operations Branch.

Burt, Oscar R. and Brewer, Durward (1971). "Estimation of Net Social Benefits From Outdoor Recreation." Econometrica, Vol. 39, No. 5, pp. 813-827.

Burns, Michael (1973). "A Note on the Concept and Measure of Consumer's Surplus." American Economic Review, Vol. 18, No. 3.

Capel, R.E. and Pandey, R.K. (1973). Demand Estimation in Planning for Intensive Resource Management: Deer and Moose. In Transactions of the 38th North American Wildlife Conference, pp. 389-403.

Capel, R.E. and Pandey, R.K. (1972). "Estimation of Benefits from Deer and Moose Hunting in Manitoba". Canadian Journal of Agricultural Economics, pp. 7-16.

Capel, R.E. and Pandey, R.K. (1973). "Evaluation Demand for Deer Hunting: a Comparison of Methods". Canadian Journal of Agriculture Economics, Vol. 21, pp. 6-14.

Cesario, Frank J. (1976). "Value of Time in Recreation Benefit Studies." Land Economics, Vol. 52, No. 1, pp. 32-41.

Cesario, F.J. and Knetsch, J.L. (1976). "A Recreation Site Demand and Benefit Estimation Model." Regional Studies, Vol. 10, pp. 97-104.

Cesario, Frank J. and Knetsch, Jack L. (1970). "Time Bias in Recreation Benefit Estimates." Water Resources Research, Vol. 6, No. 3, pp. 700-704.

Cheshire, P.C. and Stabler, M.J. (1976). "Joint Consumption Benefits in Recreational Site 'Surplus'; an Empirical Estimate." Regional Studies, Vol. 10, pp. 343-351.

Chiang, Alpha C. (1974). Fundamental Methods of Mathematical Economics. 2nd edition. New York: McGraw-Hill Book Company.

Cicchetti, C.J. (1972). "A Multivariate Statistical Analysis of Wilderness Users." in Natural Environments: Studies in Theoretical and Applied Analysis, ed. J.V. Krutilla, Baltimore: Johns Hopkins University Press.

Cicchetti, C.J.; Fisher, A.C.; and Smith, V.K. (1973). "Economic Models and Planning Outdoor Recreation." Operations Research, Vol. 21, pp. 1104-1113.

Cicchetti, Charles J. and Smith, Kerry V. (1973). "Congestion, Quality Deterioration and Optimal Use: Wilderness Recreation in Spanish Peaks Primitive Area." Social Science Research, Vol. 2, pp. 15-30.

Cicchetti, Charles J. and Smith, Kerry V. (1976). The Costs of Congestion: An Econometric Analysis of Wilderness Recreation. Cambridge, Mass.: Ballinger Publishing Company.

Cicchetti, C.J.; Smith V.K.; Knetsch, J.L. and Patton, R.A. (1972). "Recreation Benefit Estimation and Forecasting: Implications of the Identification Problem." Water Resources Research, Vol. 8, No. 4, pp. 840-850.

Ciriacy-Wantrup, S.V. (1952). Resource Conservation: Economics and Policies. Berkeley: University of California Press.

Clawson, Marion (1959). Methods for Measuring the Demand for and Value of Outdoor Recreation. Washington, D.C.: Resources for the Future.

Clawson, Marion and Knetsch, Jack L. (1966). Economics of Outdoor Recreation. Baltimore: The Johns Hopkins Press.

Cocheba, Donal J. and Langford, William A. (1978). "Wildlife Valuation: The Collective Good Aspect of Hunting." Land Economics, Vol. 54, No. 4, pp. 490-504.

Cormier, M.C. and Tuomi, A.L.W. (1968). The Freshwater Dependent Fisheries of the Maritime Provinces: An Economic Appraisal and Forecast. Ottawa: Department of Fisheries of Canada.

Crutchfield, James A. (1962). "Valuation of Fishery Resources." Land Economics, pp. 145-154.

Davis, Robert (1964). "The Value of Big Game Hunting in a Private Forest." Transactions of the North American Wildlife Conference, Vol. 29, pp. 393-403.

Dill, William A. Patterns of Change in Recreational Fisheries: Their Determinants. Paper 1, Session 1, Recreational Freshwater Fisheries, Their Conservation, Management and Development. A Water Research Center Conference.

Driver, B.L. and Knopf, R.C. (1976). "Temporary Escape: One Product of Sport Fisheries Management." Fisheries, Vol. 1, No. 2, pp. 21-29.

Dupuit, J. (1844). "On the Measurement of the Utility of Public Works." Readings in Welfare Economics by K.J. Arrow and T. Scitovsky, eds. Illinois: Richard D. Irwing, Inc. pp. 255-283.

Ekelund, R.B. and Hebert, R.F. (1975). A History of Economic Theory and Method. New York: McGraw-Hill Book Company.

Ellis, J.B. and VanDoren, C.S. (1966). "A Comparative Evaluation of Gravity and System Theory Models for Statewide Recreational Traffic Flows." Journal of Regional Science, Vol. 6, No. 2, pp. 57-70.

Fawcett, Margot J., ed. (1979). The 1979 Corpus Almanac of Canada. Toronto: Corpus.

Ferguson, C.E. and Gould, J.P. (1975). Microeconomic Theory. Fourth edition. Illinois: Richard D. Irwin, Inc.

Filion, F.L. (1978). Sources of Error in Surveys. Canadian Wildlife Service, Ottawa.

Fischer, David W. (1975). "Willingness to Pay as a Behavioural Criterion for Environmental Decision Making." Journal of Environmental Management, Vol. 3, pp. 29-41.

Fish and Wildlife Branch (1978/79). Summary of Revenue Derived from the Sale of Various Licences, Collections, etc.

Fisher, A.C. and Krutilla, J.V. (1972). "Determination of Optimal Capacity of Resource-Based Recreation Facilities." Natural Resources Journal, Vol. 12.

Fisheries and Environment Canada; and Fisheries and Marine Service (1978). The Salmonid Enhancement Program. Vancouver: Fisheries and Environment Canada.

Fisheries Management Division (1967-1979). Steelhead Harvest Analysis. Fish and Wildlife Branch.

Flegg, A.T. (1976). "Methodological Problems in Estimating Recreational Demand Functions and Evaluating Recreational Benefits." Regional Studies, Vol. 10, pp. 353-362.

Freeman, Myrick A. (1979). The Benefits of Environmental Improvement; Theory and Practice. Baltimore: Johns Hopkins University Press.

Gaudet, Jean-Louis., ed. (1972). First European Consultation on the Economic Evaluation of Sport and Commercial Fisheries. Organized by the Ministry of Agriculture and Fisheries of the Netherlands with the Support of EIFAC. The Hague.

Gillespie, Glenn A. and Brewer, Durward. (1969). An Econometric Model for Predicting Water-Oriented Outdoor Recreation Demand. U.S. Department of Agriculture and the Missouri Agricultural Experiment Station. Washington, D.C.

Gilmour, Campbell M. Jr. (1973). A Statistical Estimation of the Demand for and Value of Outdoor Recreation in the Sawtooth Valley and Mountain Area, Idaho. Water Resources Research Institute, Moscow, Idaho: University of Idaho.

Gordon, D; Chapman, D.W. and Bjornn, T.C. (1973). "Economic Evaluation of Sport Fisheries - What do They Mean?" Transactions of the American Fisheries Society, Vol. 102, No. 2, April 1973.

Gordon, Irene M. and Knetsch, Jack (1979). "Consumer's Surplus Measures and the Evaluation of Resources." Land Economics, Vol. 55, pp. 1-10.

Gordon, Irene M. (1976). "On the Uses of Consumer's Surplus Measures." Unpublished M.A. Thesis, Simon Fraser University.

Groves, David L. and Kahalas, Harvey (1976). "Recreational Expectations." Regional Studies, Vol. 10, pp. 193-200.

Gum, Russell L. and Martin, William E. (1977). "Structure of Demand for Outdoor Recreation." Land Economics, Vol. 53, No. 1, pp. 43-55.

Hammack, J. and Brown, G.M. Jr. (1974). Waterfowl and Wetlands: Toward Bioeconomic Analysis. Baltimore: Resources for the Future, Inc.

Haveman, Robert H. (1973). "Common Property, Congestion and Environmental Pollution." Quarterly Journal of Economics, Vol. 87, pp. 278-287.

Haw, Frank and Mathews, Stephen B. (1969). "Recreational Use of Surplus Hatchery Coho Salmon." Transactions of the American Fisheries Society, Vol. 98, No. 3, pp. 487-496.

Hicks, J.R. (1943). "The Four Consumer Surpluses." The Review of Economic Studies, Vol. 11, pp. 31-41.

Hicks, J.R. (1941). "The Rehabilitation of Consumers' Surplus." The Review of Economic Studies, Vol. 8, pp. 108-116.

Hicks, J.R. (1948). Value and Capital. Second edition, Oxford: Clarendon Press.

Henderson, A. (1941). "Consumer's Surplus and the Compensating Variation." The Review of Economic Studies, Vol. 8, pp. 117-121.

Hotelling, Harold (1949). "Land and Recreational Planning Division, National Park Service." The Economic's of Public Recreation, The Prewit Report. Washington, D.C.

Kavanagh, N.J. (1972). Empirical Studies of Demand for Angling, in First European Consultation on the Economic Evaluation of Sport and Commercial Fisheries, by Jean-Louis Gaudet, ed. The Hague.

Knetsch, Jack L. (1974). Outdoor Recreation and Water Resources Planning. Water Resources Monograph 3.

Knetsch, J.L. (1963). "Outdoor Recreation Demands and Benefits." Land Economics, Vol. 39, No. 4, pp. 387-396.

Knetsch, Jack L. and Davis, Robert K. (1977). "Comparisons of Methods for Recreation Evaluation." in Dorfman, R. and Dorfman, N. Economics of the Environment: Selected Reading. New York: W.W. Norton and Company Inc.

Knopf, Richard C.; Driver, B.L. and Bassett, John R. (1973). Motivations for Fishing. Paper Presented at the 38th North American Wildlife and Natural Resources Conference, Washington, D.C.

Krutilla, John V., ed. (1972). Natural Environments: Studies in Theoretical and Applied Analysis. Baltimore: The Johns Hopkins University Press.

Krutilla, J.V. and Fisher, A.C. (1975). The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources. Baltimore: Johns Hopkins University Press. Resources for the Future, Inc.

Krutilla, John V. and Cicchetti, Charles J. (1972). "Evaluating Benefits of Environmental Resources with Special Application to the Hells Canyon." Natural Resources Journal, Vol. 12, No. 1, pp. 1-29.

Lancaster, Kelvin (1971). Consumer Demand. New York: Columbia University Press.

Lancaster, Kelvin J. (1966). "A New Approach to Consumer Theory." Journal of Political Economy, Vol. 74, pp. 132-157.

Langford, W.A. and Cocheba, D.J. (1978). Valuation Problem: A Critical Review of Economic Approaches. Canadian Wildlife Service Occasional Paper Number 37.

Laub, Michael E. (1971). The Economic Evaluation of Non-Marketed Recreational Resources. Ph.D. Thesis, University of British Columbia.

Layard, P.R.G. and Walters, A.A. (1978). Microeconomic Theory. New York: McGraw-Hill Book Company.

Leggett, J.W.; Westover, W.T. and Ladd, M. (1978). Survey of the 1977 Dean River Steelhead Fishery. British Columbia Fish and Wildlife Branch, Technical Report F-78-4.

McConnell, Kenneth C. (1977). "Congestion and Willingness to Pay: A Study of Beach Use." Land Economics, Vol. 53, No. 2, pp. 185-195.

McConnell, Kenneth E. (1975). "Some Problems in Estimating the Demand for Outdoor Recreation." American Journal of Agricultural Economics, pp. 330-334.

Mahoney, J. (1960). "An Economic Evaluation of California's Sport Fisheries." California Fish and Game, Vol. 46, No. 2, pp. 199-205.

Marshall, A. (1920). Principles of Economics. London: MacMillan and Co. Ltd.

Masse, William D. and Peterson, Ken (1977). Evaluation of Incremental Recreational Benefits from Salmonid Enhancement. Appendix 6 to the Economic Rationale for S.E.P.

Mathews, Stephen B. and Brown, Gardner S. (1970). Economic Evaluation of the 1967 Sport Salmon Fisheries of Washington. Washington Department of Fisheries, Technical Report No. 2.

Meyer, Phillip A. (1974). Comparison of Direct Questioning Methods for Obtaining Dollar Values for Public Recreation and Preservation. Technical Report Series 110, PAC 17-75-6. Vancouver: Environment Canada.

Meyer, P.A. (1976). Perceptions on Recreation and Sport Fisheries of the Chilliwack/Vedder River. Vancouver: Environment Canada and Department of Recreation and Conservation.

Meyer, Philip A. (1974). Recreational and Preservation Values Associated with the Salmon of the Fraser River. Pacific Region: Environment Canada, Fisheries and Marine Services.

Meyer, Philip A. (1980). "Recreational Fishing Values at Risk" Recent Developments in Compensatory Methodology in the United States and Canada. California, Oak View: Center for Natural Areas.

Meyer, Philip A. (1978). Updated Estimates for Recreation and Preservation Values Associated with the Salmon and Steelhead of the Fraser River. Pacific Region: Fisheries and Environment Canada, Habitat Protection Directorate.

Meyer, Philip A. (1979). The Value of Fish and Wildlife of San Francisco Bay: A Preliminary Survey. California: The California Water Policy Center.

Meyer, Philip A. and Phillips, Susan D. (1977). Local Perceptions Concerning Recreation on the Coquitlam River. Habitat Protection and Fish and Wildlife.

Mishan, E.J. (1976). Cost-Benefit Analysis, new and expanded edition, New York: Praeger Special Studies.

Moeller, George H and Engelken, John (1973). Fishermen Expectations and Pay-Lake Profits. USDA Forest Service Research Paper NE-264, Forest Service, U.S.

Moeller, George, H. and Engelken, John H. (1972). "What Fishermen Look for in a Fishing Experience." Journal of Wildlife Management, Vol. 36, No. 4, pp. 1253-1257.

Morey, Edward R. (1979). The Demand for Site-Specific Recreational Activities: A Characteristics Approach. University of British Columbia: Resources Paper No. 33.

Narver, David W. (1977). "The Disgraceful Decline of our Finest Sport Fish." B.C. Outdoors, Vol. 3, No. 5, pp. 10-16.

Narver, David W. (1978). The Future of Steelhead Angling in British Columbia. Paper presented at the Northwest Regional Conclave Federation of Fly Fishermen, Kamloops.

Narver, David W. and Taylor, Gerry D. (1979). Wild Trout Management in British Columbia. Paper presented at the Wild Trout II Symposium, Wyoming: Yellowstone National Park.

Norton, G.A. (1970). "Public Outdoor Recreation and Resource Allocation: A Welfare Approach." Land Economics, Vol. 46, No. 4, pp. 414-422.

Oakland, W.H. (1972). "Congestion, Public Goods and Welfare." Journal of Public Economics, Vol. 1, pp. 339-351.

O'Connor, R. and Whelan, B. (1972). Economic Evaluation of Visiting Salmon Anglers (Preliminary Results). In, First European Consultation on the Economic Evaluation of Sport and Commercial Fisheries, by Jean-Louis Gaudet, ed. The Hague. pp. 36-74.

Pearse, Peter H. (1968). "A New Approach to the Evaluation of Non-Priced Recreational Resources." Land Economics, Vol. 44, pp. 87-99.

Pearse, Peter H. (1969). "Towards a Theory of Multiple Use: The Case of Recreation Versus Agriculture." Natural Resources Journal, Vol. 9, pp. 574.

Pearse, Peter H. and Laub, Michael E. (1969). The Value of the Kootenay Lake Sport Fishery. Study Report No. 3 on the Economics of Wildlife and Recreation prepared for the British Columbia Fish and Wildlife Branch.

Pearse Bowden Economic Consultants Limited (1970). The Value of Non-Resident Sport Fishing in British Columbia. British Columbia Fish and Wildlife Report No. 5.

Pearse Bowden Economic Consultants Limited (1971). The Value of Freshwater Sport Fishing in British Columbia. British Columbia Fish and Wildlife Report No. 6.

Pindyck, Robert S. and Rubinfeld, Daniel L. (1976). Econometric Models and Economic Forecasts. New York: McGraw-Hill Book Company.

Randerson, P.F. and Edwards, R.W. An Economic Evaluation of Recreational Fishing in Areas in Wales. Paper 12, Session 4. Presented at the Water Research Center Conference.

Reid, David J. (1974). The Importance of Sport Fishing to the North Mailand Coast and North Central Areas of British Columbia: An Economic Survey. Pacific Region: Fisheries and Marine Service.

-----A Report to the National Marine Fisheries Service in Fishing Economics at Moscow, Idaho and Madison, Wisconsin, University of Idaho, (1973).

Samuelson, P.A. (1961). Foundations of Economic Analysis. Cambridge: Harvard University Press.

Samuelson, P.A. (1954). "The Pure Theory of Public Expenditures". Review of Economics and Statistics, Vol. 36, pp. 389.

Schweibert, Ernest (ed.) (1977). Columbia River Salmon and Steelhead. Proceedings of a Symposium Held in Vancouver, Washington. American Fisheries Society, Washington, D.C.

Scott, Anthony (1965). The Valuation of Game Resources: Some Theoretical Aspects. Canadian Fisheries Report, No. 4, pp. 27-49.

Seneca, Joseph J. (1969). "Water Recreation, Demand and Supply." Water Resources Research, Vol. 5, No. 6, pp. 1179-1185.

Seneca, Joseph J. and Cicchetti, Charles J. (1969). "User Response in Outdoor Recreation: A Production Analysis." Journal of Leisure Research, Vol. 1, Summer, pp. 238-245.

Sewell, W.R.D. (1970). Forecasting the Demand for Recreational Fishing in Canada: Problems, Methods, and Data Requirements. Background paper Prepared for a Symposium on Sports Fisheries Statistics and Evaluation. Sponsored by the Department of Fisheries and Forestry.

Sewell, W.R.D. and Rostron, J. (1970). Recreational Fishing Evaluation: A Pilot Study in Victoria, British Columbia, Ottawa: Department of Fisheries and Forestry.

Silberberg, Eugene (1978). The Structure of Economics: A Mathematical Analysis. New York: McGraw-Hill Book Company.

Sinclair, William F. (1972). The British Columbia Sport Fishermen. Pacific Region: Department of the Environment, Fisheries Service.

Sinclair, William F. (1979). "The Economic and Social Impact of the Kemano II Hydroelectric Project on British Columbia's Fisheries Resource." Salmon Studies Associated with the Potential Kemano II Hydroelectric Development, Vol. 7.

Sinclair, William F. (1974). The Socio-Economic Importance of Maintaining the Quality of Recreational Resources in Northern British Columbia: The Case of Lakelse Lake. Vancouver: Evergreen Press.

Sinclair, William F. and Morley, R.W. (1975). "Statistical Bias Problem in On-Site Surveys: The Severity of the Problem and Its Potential for Solution." Journal of Fisheries Research Board of Canada, Vol. 32, No. 12, pp. 2520-2524.

Sinclair, William F. and Sweitzer, Obert (1973). The Economics Value of the Yukon Sport Fishery. Fisheries and Marine Service, Pacific Region: Department of the Environment.

Smith, Robert J. and Kavanagh, N.J. (1969). "The Measurement of Benefits of Trout Fishing: Preliminary Results of a Study of Grafham Water, Great Ouse Water Authority, Huntingdonshire." Journal of Leisure Research, Vol. 1, pp. 316-332.

Smith, Kerry V. (1972). "The Effects of Technological Change on Different Uses of Environmental Resources." In, Natural Environments: Studies in Theoretical and Applied Analysis, J.V. Krutilla, ed. Baltimore: The Johns Hopkins University Press.

Smith, Kerry V. (1975). "Travel Cost Demand Models for Wilderness Recreation: A Problem of Non-Tested Hypotheses." Land Economics, Vo. 51, No. 2, pp. 103-111.

Spargo, R.A. (1971). Evaluation of Sport Fisheries an Experiment in Methods. Ottawa: Economics Branch, Fisheries Service, Department of the Environment.

Spargo, R.A. (1965). "Methods and Techniques of Evaluation of Sport Fishing." Canadian Fisheries Report, No. 4. Ottawa: Department of Fisheries, Queen's Printer. pp. 53-69.

Stankey, G.H. (1972). "A Strategy for the Definition and Management of Wilderness Quality," in Natural Environments: Studies in Theoretical and Applied Analysis, J.W. Krutilla, ed. Baltimore: Johns Hopkins University Press.

Stankey, George H.; Lucas, Robert C. and Ream, Robert R. (1973). Relationship Between Hunting Success and Satisfaction. Transactions of the 38th North American Wildlife Conference, pp. 235-242.

Statistics Canada. Income Distribution by Size in Canada, Preliminary Estimates. Ottawa: Ministry of Industry, Trade and Commerce, 1978.

Stevens, Joe B. (1966a). "Angler Success as a Quality Determinant of Sport Fishery Recreational Values." Transactions of the American Fisheries Society, Vol. 95, No. 4, pp. 357-362.

Stevens, J.B. (1966b). "Recreation Benefits From Water Pollution Control." Water Resources Research, Vol. 2, pp. 167-181.

Talhelm, Daniel R. (1973). Defining and Evaluating Recreation Quality. in Transactions of the 38th North American Wildlife and Natural Resources Conference. Washington D.C.

Talhelm, Daniel R. (1978). Evaluating Angling Quality and Management Benefits in the U.S. Recreational Freshwater Fisheries, Their Conservation, Management and Development. A Water Research Center Conference, Paper 16, Session 4.

Thorton, Barry M. (1978). Steelhead: The Supreme Trophy Trout. Saanichton: Hancock House Publishing Ltd.

Tombleson, P.H. (1978). The Angler's Point of View. Recreational Freshwater Fisheries, Their Conservation, Management and Development. A Water Research Center Conference, Paper 4.

Trice, Andrew H. and Wood, Samuel E. (1958). "Measurement of Recreation Benefits." Land Economics, Vol. 34, pp. 196-207.

Ullman, E.L. (1968). "Geographical Prediction and Theory: The Measure of Recreation Benefits in the Meramec Basin." In, Geography and the American Environment. S.B. Cohen, ed. Voice of America Forum Lectures.

Ullman, Edward L. and Volk, Donald J. (1962). "An Operational Model for Predicting Reservoir Attendance and Benefits: Implications of a Location Approach to Water Recreation." Papers of the Michigan Academy of Science, Arts and Letters, Vol. 47, pp. 473-484.

Walter, G.R. (1979). Travel Costs and Recreational Benefits. Unpublished Manuscript.

Walters, Susan, ed. (1979). 1979 Canadian Almanac and Directory. 132nd year of publication. Toronto: Richard de Boo Limited.

Wehrwein, G.S. (1927). "Some Problems of Recreation Land." Land Economics, Vol. 3, pp. 163-172.

Wilkinson, Paul F. (1973). "The Use of Models in Predicting the Consumption of Outdoor Recreation." Journal of Leisure Research, Vol. 5, pp. 34-48.

Willig, R.D. (1976). "Consumer's Surplus Without Apology." The American Economic Review, Vol. 6, pp. 589-597.

Winch, David M. (1959). "Consumer's Surplus and the Compensation Principle." The American Economic Review, Vol. 15, pp. 395-423.

Wolfe, R.I. (1972). "The Inertia Model." Journal of Leisure Research, Vol. 4, pp. 73-76.

The World Almanac and Book of Facts (1978). New York: Newspaper Enterprise Association, Inc.

APPENDIX I

BRITISH COLUMBIA STEELHEAD SPORT DATA

Year	B.C. Total[1] Catch (Estimated)	% Change in Catch/ Year	B.C. Total[1] Angler Days (Estimated)	% Change in Angler Days	Steelhead[1] Licenses[4]	% Change of Licenses/Year	Days/ Catch
1967/68	48,508		224,300		39,388		4.62
1968/69[2]	41.303	- 14.85%	189,300	- 15.60%	39,775	.98%	4.58
1969/70	37,092	- 10.19	249,452	31.77	45,824	15.20	6.72
1970/71	33,919	- 8.55	232,664	- 6.72	43,750	- 4.52	6.86
1971/72[3]	36,704	8.21	184,987	- 20.49	26,253	- 39.99	5.03
1972/73	35,782	- 2.51	203,393	9.94	28,992	10.43	5.68
1973/74	32,482	- 9.22	208,105	2.32	31,315	8.01	6.40
1974/75	27,807	- 14.39	196,751	- 5.45	24,390	- 22.08	7.08
1975/76	31,490	13.24	219,797	11.71	29,594	21.29	6.98
1976/77	20,168	- 35.95	186,381	- 15.20	25,539	- 13.70	9.24
1977/78	18,246	- 9.52	174,721	- 6.26	25,409	- .50	9.58
1978/79	14,700	- 9.38%	159,363	- 8.79%	24,599	- 3.19%	10.84
Average %		- 19.43%		- 2.07%		- 2.55%	
Total Change		- 69.69%		- 28.95%		- 37.55%	

[1]Source: Steelhead Harvest Analysis, Fish and Wildlife Branch, Victoria, B.C.

[2]Angler license price increased $1.00.

[3]Steelhead license price increased from $ .25 to $2.00.

[4]Steelhead license price increased from $2.00 to $3.00.

APPENDIX II

MINISTRY OF ENVIRONMENT

SOCIO-ECONOMIC STEELHEAD ANGLING SURVEY

1979-80

Interview _____ Interviewer _____

Interview Location _____ Time of Day _____

Day of Week _____ Date _____

1. Where is your permanent place of residence? _____

2. Have you been interviewed earlier this year on this survey? _____

3. How long have you been steelhead fishing here today? _____ hrs.

4. How much longer do you expect to be steelhead fishing here today? _____ hrs.

5. Catch so far today:

	Caught	Kept
- Steelhead	_____	____
- Other	_____	____

6. Weight kept fish and enter below.

	Weight (Kilograms)	
Steelhead Kept	_____	_____

7. What are the ages of the steelhead fishing and other members of your party?

	Number of Steelhead Anglers		Total Number In Party (Vehicle)	
Age	Male	Female	Male	Female
0 - 15	____	_____	____	_____
16 - 65	____	_____	____	_____
65 & Over	____	_____	____	_____

8. How would you rate your fishing success today?

0 Poor ____ 1 Fair ____ 2 Good ____ 3 Excellent ____

NON-LOCAL RESIDENTS OF THE AREA

1. How many days will you be on this trip from start to finish? _____

2. How many days have you spent so far on this trip?
   - in this area _____
   - in B.C. (non-B.C. residents only) _____

3. How many more days do you expect to spend on this trip?
   - in this area _____
   - in B.C. (non-B.C. residents only) _____

4. How many days have you fished for steelhead so far this trip?
   - in this area _____
   - in B.C. (non-B.C. residents only) _____

5. How many more days do you expect to fish for steelhead on this trip?
   - in this area _____
   - in B.C. (non-B.C. residents only) _____

6. How many trips have you made during the past 12 months to this area to fish steelhead? _____ trips.

7. During the past 12 months, how many days did you fish steelhead in: (including today)?

	Days
a) Dean River	_____
b) Remaining Central Coast (Bella Coola, Chilcotin, etc.)	_____
c) Thompson-Okanagan	_____
d) Lower Mainland	_____
e) Vancouver Island	_____
f) Skeena	_____

8. How many trips have you made during the past 5 years to this area to fish steelhead? _____ trips.

9. Please try to estimate how much you have spent in B.C. on the following items on this trip so far:

   a) Transportation (to the area, etc.) _____
   b) Accommodation _____
   c) Meals and Beverages (in restaurant) _____
   d) Groceries _____
   e) Tackle and equipment _____
   f) Other (specify) _____

   TOTAL INDIVIDUAL EXPENDITURES _____

10. What is the main reason for this trip?

   Visiting friends and/or relatives _____
   Sport fishing _____
   General vacation or pleasure _____
   Business _____
   Other (specify) _____

11. Would you have made this trip if steelhead fishing were not available?

   Yes _____ No _____.

12. (If yes) Is your stay in this area any longer than it would have been if steelhead fishing were not available?

   If yes, how many days? _____.

13. How important are each of the following factors, to you, in choosing a place to go steelhead fishing? Please rate from a scale of 1 to 5.

   1 = of no importance
   2 = of some importance
   3 = important
   4 = very important
   5 = extremely important

   _____ a) Natural or scenic beauty of the area
   _____ b) Number of fish you can expect to catch
   _____ c) Size of fish you can expect to catch
   _____ d) Fighting quality of the fish you expect to catch
   _____ e) Crowdedness of the area
   _____ f) Ease of access
   _____ g) Facilities of the area (restaurants, hotels/motels, camping, tackle and grocery stores, and so on).

14. Are there any other factors that you consider to be important in choosing a place to go steelhead fishing? Please list and rate factors as above.

	Factors	Importance
a)	_____	_____
b)	_____	_____
c)	_____	_____
d)	_____	_____

15. How would you score this location, for steelhead fishing regarding each of these factors relative to other steelhead areas you are familiar with?

1 = very poor
2 = poor
3 = important
4 = good
5 = very good

_____ a) Natural beauty

_____ b) Expected number of steelhead

_____ c) Expected size of steelhead

_____ d) Fighting qualities of steelhead

_____ e) Crowdedness on the grounds

_____ f) Ease of access

_____ g) Facilities

_____ h) Others (a) if listed in question 14.

_____ i) " (b) " " " "

_____ j) " (c) " " " "

_____ k) " (d) " " " "

16. The following are hypothetical questions that are designed only to determine how valuable the steelhead fishery in this area is to you. You may find these questions difficult to answer, but your answers are extremely important.

i) Supposing daily charges were levied for steelhead fishing in this area just as entry fees are charged for movies, sporting events and so forth. Assume also that all other fishing areas available to you remain available at current costs. Earlier you said that you fished steelhead _____ days in this area during the past 12 months including the trip you are now on. How many days would you have fished

if you had been charged?

	Days		Days
$ 1.00/day	_____	$20.00/day	_____
$ 5.00/day	_____	$25.00/day	_____
$10.00/day	_____	$ /day	_____
$15.00/day	_____	$ /day	_____
		$ /day	_____

At what daily charge would you have stopped coming to fish steelhead in this area? _____

ii) If last year your chances of catching a steelhead were twice as good in this area, how many days would you have fished last year? _____ days. How many days would you have fished if you were charged?

	Days		Days
$ 1.00/day	_____	$20.00/day	_____
$ 5.00/day	_____	$25.00/day	_____
$10.00/day	_____	$ /day	_____
$15.00/day	_____	$ /day	_____
		$ /day	_____

Under these conditions, at what daily charge would you have stopped coming to the area to fish steelhead? _____.

iii) Suppose these steelhead stocks remain as they are at present, but your opportunity to fish them has been taken away from for all time. You could continue to use the area and water for any other activity (except fishing) for which you use it now. Please note that all other fishing areas remain available and continue to remain available as they are at present.

ALTERNATIVE (A): What is the minimum daily payment that you would accept to feel equally satisfied for each day you intended to fish but could not fish this area? $ _____

ALTERNATIVE (B): Would you feel equally satisfied with your loss of angling opportunity if you were offered, for each day you intended to fish, a daily payment of:

$ 1	_____	$ 20	_____
$ 2	_____	$ 25	_____
$ 5	_____	$ 30	_____
$ 10	_____	$	_____
$ 12	_____	$	_____
$ 15	_____	$	_____

Minimum acceptable daily payment $ _____

iv) What is your gross annual individual income? $_____
(This is a very important but voluntary question)

---------- END INTERVIEW HERE ----------

APPENDIX III

SUMMARY OF SELECTED QUESTIONS FROM THE SOCIO-ECONOMIC STEELHEAD ANGLING SURVEY ON THE DEAN RIVER

This Appendix will outline the responses of relevant questions for this thesis. Questions specifying the amount of time or a judgement strictly based on the interview day, have not been included due to their inability to account for the recreation time in general. For example, question 8 on page 1, "How would you rate your fishing success today?" may be answered "poor" due to the fact that the angler has only been on the river for an hour. The same goes for question 5 on page 1; "Catch so far today?" again, time spent on the river will influence the response.

TABLE 1

PLACE OF RESIDENCE OF SURVEYED

DEAN RIVER BRITISH COLUMBIAN ANGLERS

Location in B.C.	Sub-total	Area Totals
Vancouver Island		2
Victoria	1	
Port Alice	1	
Lower Mainland		6
Vancouver	5	
Sechelt	1	
Thompson-Okanagan		12
Kelowna	2	
Enderby	1	
Vernon	1	
Penticton	4	
Kamloops	4	
Kootenay		3
Creston	1	
Nelson	2	
Cariboo		24
Quesnel	12	
Williams Lake	8	
100 Mile House	3	
Central Coast	1	
Skeena		31
Fort St. James	2	
Vanderhoof	3	
Prince George	25	
Houston	1	
TOTAL:		78

TABLE 2

AGE AND SEX OF STEELHEAD FISHERMEN

AND MEMBERS OF THEIR PARTIES

Age	Steelheaders		Members in Party	
	Male	Female	Male	Female
0 - 15	2	-	2	-
16 - 65	434	34	436	39
65 & Over	12	-	20	1
Sub-totals	448	34	458	40
TOTAL	482		498	

Note: This may be an overestimated calculation since more than one member of each party may have been interviewed, causing overlaps in the number of members in each party. "Members" refers to steelheaders and non-steelheaders.

TABLE 3

NUMBER OF DAYS SPENT ON TRIP;

IN THE DEAN AREA; AND, STEELHEAD FISHING

Number of Days	Number of Anglers' Total Trip Length (days)	Number of Anglers in the Dean Area	Number of Anglers Steelhead Fishing on the Dean
0	1	1	1
1	6	6	7
2	10	10	9
3	-	-	4
4	10	18	16
5	25	24	29
6	14	20	17
7	17	28	31
8	22	7	-
9	5	-	-
10	3	4	8
11	4	4	1
12	-	-	1
13	2	2	3
14	4	2	2
15	2	1	-
16	-	1	
17	2	-	
21	-	1	
23	1		
80	1		
TOTALS:	938	780	735
averages	7.27	6.05	5.7

TABLE 4

NUMBER OF STEELHEADING TRIPS MADE TO THE DEAN RIVER AREA DURING THE PAST YEAR AND FIVE YEARS

Number of Trips	Number of Anglers Who Visited in the Last Year	Number of Anglers Who Visited in the Last Five Years
0	1	2
1	105	45
2	11	26
3	5	14
4	1	8
5	1	20
6	1	-
7	2	-
8	-	2
9	2	-
10		2
12		1
15		3
22		1
25		1
30		1
35		3
TOTALS:	189	546

TABLE 5

NUMBER OF DAYS IN THE PAST TWELVE MONTHS INTERVIEWED PEOPLE FISHED STEELHEAD IN BRITISH COLUMBIA

Location	Days	Number of Anglers
Dean River	548	128
Remaining Central Coast	65	15
Thompson-Okanagan	3	2
Lower Mainland	30	5
Vancouver Island	30	5
Skeena	164	18
TOTALS	840	163

TABLE 6

MONEY SPENT IN BRITISH COLUMBIA FOR TRANSPORTATION

Dollars	Number of Anglers
0	10
1 - 20	6
21 - 40	8
41 - 60	12
61 - 80	11
81 -100	14
101-120	3
121-140	8
141-160	9
161-180	5
181-200	12
221-240	10
241-260	9
261-280	5
281-300	6
400-420	1
TOTALS:	
$17,314	129
average: $134.20	

TABLE 7

MONEY SPENT IN BRITISH COLUMBIA

ON ACCOMMODATIONS

Dollars	Number of Anglers
0	99
1 - 10	5
11 - 20	5
350 - 400	6
660 - 2,100	14
Total: $15,254	129

TABLE 8

MONEY SPENT IN MEALS AND BEVERAGES IN BRITISH COLUMBIA

Dollars	Number of Anglers
0	76
5 - 20	46
21 - 40	3
41 - 60	4
Total: $884	129

TABLE 9

MONEY SPENT IN BRITISH COLUMBIA

ON GROCERIES

Dollars	Number of Anglers
0	24
1 - 20	29
21 - 40	31
41 - 60	26
61 - 80	11
81 - 100	4
101 - 150	4
Total: $4,409	129

TABLE 10

MONEY SPENT ON TACKLE AND EQUIPMENT

IN BRITISH COLUMBIA

Dollars	Number of Anglers
0	56
1 - 10	8
11 - 20	15
21 - 40	17
41 - 60	16
61 - 80	7
81 - 100	4
125 - 150	3
151 - 200	3
Total: $3,613	129

TABLE 11

MONEY SPENT ON MISCELLANEOUS ARTICLES

BY INTERVIEWED ANGLERS

IN BRITISH COLUMBIA

Dollars	Number of Anglers
0	125
30	2
50	2
Total: $ 160	129

TABLE 12

MAIN PURPOSE OF THIS TRIP

Reason	Number of Anglers
Sport Fishing	126
Business	2
No Answer	1
	129

TABLE 13

WOULD YOU HAVE MADE THIS TRIP IF STEELHEAD WERE NOT AVAILABLE?

Answer	Number of Anglers	%
Yes	6	4.65
No	123	95.35

TABLE 14

IMPORTANT FACTORS IN CHOOSING A PLACE

TO GO STEELHEAD FISHING

Factor	Number of Anglers 0	1	3	5	Rating
Natural of scenic beauty	1	6	40	82	536
Number of fish expected to catch	1	29	66	33	392
Size of fish	1	52	50	26	332
Fighting quality of fish	1	7	39	82	534
Crowdedness of the area	1	21	42	65	472
Ease of access	1	104	20	4	184

TABLE 15

THE DEAN RIVER SCORE AS COMPARED TO OTHER STEELHEAD FISHING AREAS

Factor	Number of Anglers 0	1	3	5	Rating
Natural beauty	2		1	126	663
Expected number of steelhead	33	40	34	22	252
Expected size of steelhead	41	17	37	34	298
Fighting quality of steelhead	47	5	16	61	358
Crowdedness	4	36	39	50	403
Ease of access	4	11	56	58	469
Facilities	115		1	13	68

TABLE 16

ANGLERS WILLINGNESS TO PAY

Hypothetical Charge per day	Days under Present conditions	Days with a doubled Chance of catching Steelhead
$ .00	548	687
1.00	531	665
5.00	382	526
10.00	271	404
15.00	219	343
20.00	151	363
25.00	114	219
30.00	89	179
40.00	83	131
50.00	46	100
75.00	22	58
100.00	21	36
200.00	15	20
500.00	0	0

TABLE 17

CHARGE AT WHICH INDIVIDUALS WOULD STOP ANGLING

FOR STEELHEAD ON THE DEAN RIVER

Dollars	Number of anglers at present conditions	Number of anglers with doubled expected catch
$ 1	7	6
5	28	21
10	31	24
15	11	9
20	9	11
25	11	8
30	6	5
40	1	9
50	12	15
60	3	1
70	-	1
75	1	2
80	-	1
100	6	7
150	1	4
200	-	1
250	1	3
500	1	1

TABLE 18

COMPENSATION NEEDED TO GIVE UP THE RIGHT TO FISH ON THE DEAN RIVER

ALTERNATIVE A: 85.3% of those people interviewed did not give an answer to this question.

ALTERNATIVE B: Only 13 people gave a value in the ranges provided on the questionnaire.

MINIMAL ACCEPTABLE DAILY PAYMENT

Dollars		Number of Anglers	
$ 1		1	
2		1	
5		2	
10		2	
15		1	
20		7	
25		2	
40		3	
50		4	
80		2	
100		4	
250		1	
9999999	(no Value)	99	(76.74%)

TABLE 19

GROSS ANNUAL INCOME OF INDIVIDUALS

INTERVIEWED ON THE DEAN RIVER

Income	Number of Anglers
0	26
1,500	1
4,000-4,500	2
14,000	1
15,000	1
17,000-17,500	3
18,000	6
20,000	7
21,000	2
22,000	6
23,000	2
24,000	3
25,000	23
27,000	3
28,000	2
30,000	8
33,000	1
35,000	6
40,000	7
45,000	2
50,000	3
60,000	1
80,000	3
90,000	2
100,000	5
125,000	1
150,000	2

APPENDIX IV

ENUMERATOR IMPRESSIONS OF THE 1979 DEAN RIVER SOCIO-ECONOMIC STEELHEAD ANGLING SURVEY

by

Ray Billings
Fish and Wildlife Branch
Victoria, B.C.

August 23, 1979

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ENUMERATOR IMPRESSIONS OF THE 1979 DEAN RIVER SOCIO-ECONOMIC STEELHEAD ANGLING SURVEY

INTRODUCTION

From June 18 to August 21, 1979, a socio-economic steelhead angling survey was conducted by the economic planning division of the Ministry of Environment on the Dean River. The purpose of this survey was to gather information to determine angler preferences and derive a monetary value of the recreational steelhead fishery for use in future steelhead management programs in the province. The same socio-economic survey was conducted on the Thompson, Cowichan, Nanaimo and Atnarko-Bella Coola Rivers prior to the Dean River study and will also be employed on two Skeena River tributaries in 1979.

The purpose of this report is to describe the preliminary impressions of the Dean River study regarding the survey in general, angler response, attitudes and experience and angler values regarding this particular steelhead fishery. A brief comparison is also made between this survey and previous surveys of the Thompson, Cowichan, Nanaimo and Atnarko-Bella Coola Rivers. No attempt is made to interpret actual results of this survey as the data has yet to be processed. All matter discussed in this report is based only on enumerator impressions and not on factual data.

RESULTS AND DISCUSSION

1. Study Location

The Dean River is situated on the central coast of British Columbia approximately 300 miles north-west of Vancouver and 100 miles south-east of Prince Rupert (Figure 1). Bella Coola is the nearest community to the study area and is approximately 50 miles south-east of the Dean River. No roads connect the two areas.

The Dean River originates on the Chilcotin Plateau and flows west through the Coast Mountains and drains into Dean Channel. Steelhead angling occurs from the mouth of the Dean River upstream approximately 22 miles to the sport fishing boundary at Kalone Creek (Figure 1).

2. Survey Method

The 22 mile sport fishing section of the Dean River was previously divided into 4 zones for use in creel census surveys by the Cariboo Region of the B.C. Fish and Wildlife Branch. These same zones were used in this socio-economic steelhead angling survey (Figure 1). All steelhead anglers were interviewed while fishing and answers were recorded on prepared survey forms and later coded for use in a computer program.

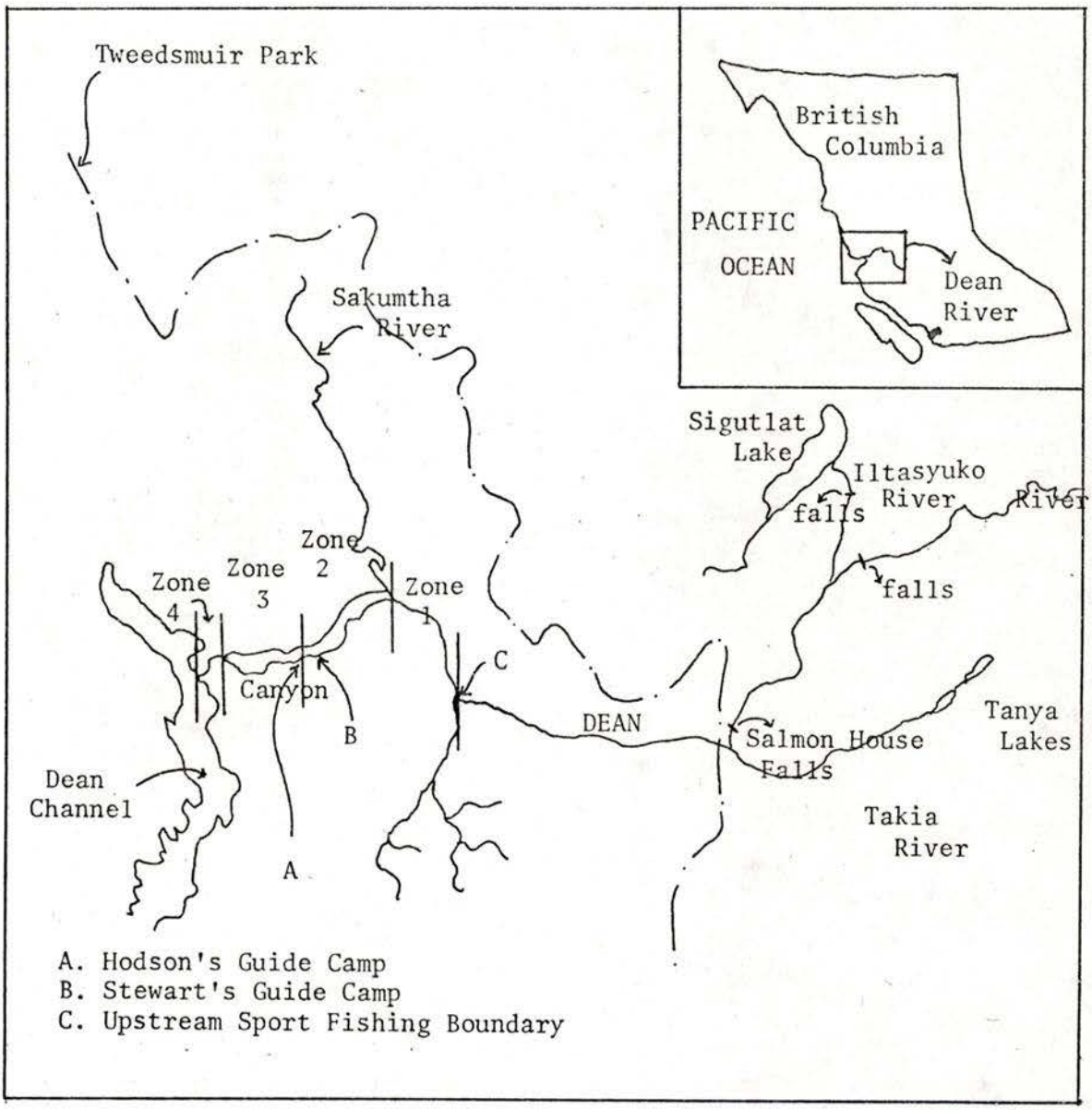

Figure 1. Location and Survey Boundaries of the Dean River, British Columbia.

3. Survey in General

A total of 132 interviews were completed on the Dean River. Because an intensive creel census survey was carried out at the same time as this socio-economic survey, no repeat interviews were made. As there is only one permanent resident of the Dean River Valley, all anglers were classed as non-local residents. A total of 78 British Columbia residents (mostly Cariboo region) were interviewed as well as 7 out of province Canadian anglers (6 Alberta; 1 Saskatchewan) and 47 non-residents of Canada (46 USA; 1 New Zealand). The Dean River summer run steelhead fishery attracted people from both North America and Europe. Approximately 25 European (German and Austrian) anglers fished the Dean River during this survey period but none could speak the language well enough to be properly interviewed. All of these European anglers were parts of various charter operations. Of the 132 anglers interviewed, 118 camped at the Dean River and 14 were clients of the two guide camps.

Access to the Dean River area was by either private or charter plane or by boat. Once in the area, anglers had to either walk to the river or pay to be driven by Felix, the only resident of the Dean River Valley. Only a few trails exist on the Dean River although the Fish and Wildlife Branch is presently constructing more. Several road washouts prevented anglers from being drive past mile 6 on the old logging road along the river so anyone wishing to go beyond this point (other than guided anglers) must walk. The guides used jet boats to move their clients into the upper river areas.

From June through until the first week of August, almost all camping anglers fished in zone 4, from the canyon to the river mouth. Easy access from the airstrip or boat dock to this fishing area existed. Because this is where the fishing pressure was concentrated, most anglers camped in this lower river area. During this time period, only an occasional angler or group of anglers hiked to the upper river.

Throughout August and into September, the majority of camping anglers both camped and fished in zone 3 with an occasional group of anglers hiking further upstream along an old road into zones 2 and 1. Access to these upper river areas was mainly through Felix, although some anglers hiked from the lower river airstrip upstream to their camping areas. Because the old road along the Dean River was impassable after about mile 6, all fishermen were dropped off by Felix before this point. Most fishermen in August set up their camps between the top of the canyon (mile 2.5) and mile 5.

Angler pressure remained fairly light from the start of the survey until the first week of August. During this period, most anglers fished in zone 4 so the majority of interviews were completed in this area. After the first week of August, most anglers fished in zone 3 so most interviews were completed in this area. Only 1 group of anglers in each of zones 2 and 1 were interviewed as they were the only anglers encountered there.

Two licenced river guides operate camps on the upper Dean River. Most of the clients of these two guide camps are USA residents who make yearly trips to the Dean River. The guide camps opened in 1979 on July 11 and will operate until the river angling closure on September 30. Variable daily rates are charged to guided anglers depending on normal fishing success periods. These rates are as follows:

Hodson's Guide Camp (US Funds)

July 1 - 20	$125 per man day
July 20 - August 3	$150 per man day
August 3 - September 7	$175 per man day
September 7 - 30	$150 per man day

Stewart's Guide Camps (Canadian Funds)

Main Camp		Upper Camp
July 1 - 23	$125 per man day	August - September
July 23 - August 6	$150 per man day	$175 per man day
August 6 - September 10	$175 per man day	
September 10 - 30	$150 per man day	

These rates include jetboat transportation about the river, meals and accommodation. Guided anglers are moved about the river on jetboats so are not restricted in areas of the river in which they can fish. Because they are so mobile and often fish the upper reaches of the river, only 14 guided anglers were interviewed. No anglers were interviewed from Stewart's upper camp as access to the area (mile 18) was poor. All guided anglers were very friendly and cooperative when interviewed.

As well as these two guide operations, several charters were encountered on the Dean River. Most clients of these charters were German or Austrian anglers as mentioned earlier although one charter group consisting of 7 USA residents was encountered. Five of this group were interviewed.

From June 1 until approximately July 15, a substantial run of chinook salmon were fished in the Dean River. The idea of catching large chinook salmon as well as steelhead attracted many Cariboo residents as well as other anglers.

Steelhead catches were poor from June to August 1 while river conditions remained good. Fishing success did however pick up during the first two weeks of August.

4. Angler Response, Attitudes and Experience

Most anglers interviewed on the Dean River socio-economic steelhead angling survey were friendly and cooperative. Several arrogant anglers were however encountered. The number of argumentive anglers increased substantially during August. At this time, more experienced and better informed fishermen came to the Dean and began questioning this survey and other management work being done by the Fish and Wildlife Branch.

The most common complaints presented by Dean River fishermen were the incidental catches of steelhead in the commercial salmon fishery, too many American fishermen on the Dean River, presence of boats on the lower river and during June and July on the lower river, the low kill of steelhead permitted (two per calendar month).

The steelhead anglers through June and July would be considered of poor or average steelhead fishing experience. The same type of inexperienced angler encountered on the Atnarko-Bella Coola River was found on the lower Dean River during this period. However during August and into September, the majority of steelhead fishermen are well travelled and experienced in this sport fishery. Most of these anglers were fly fishermen. The majority of steelhead caught by these anglers were released rather than killed.

5. Angler Values

Almost all anglers placed a high value on the Dean River steelhead fishery. Factors such as the area's remoteness and scenery, cost of the trip and holiday atmosphere in the camps influenced this high value.

Most anglers made only one trip per year to the Dean River due to the cost and time constraints. Therefore if twice the opportunity of catching steelhead were possible here (question 7ii) very few anglers could find the extra time to fish any more days. As has been the case in other socio-economic surveys, very few anglers stated they could be compensated in money for a loss of their steelhead fishing rights on the Dean River (question 7iii).

Among guided anglers, many were quite willing to pay upwards of $100/day to fish the Dean River and none stated they could be compensated for their loss of fishing rights on this river. In almost all cases, however, these anglers had yearly incomes of $50,000 - $150,000/year.

6. Brief Comparison of Thompson, Cowichan, Nanaimo, Atnarko-Bella Coola and Dean River Socio-Economic Steelhead Angling Surveys

TABLE I. COMPARISON BETWEEN ANGLERS OF THE THOMPSON, COWICHAN, NANAIMO, ATNARKO-BELLA COLLA AND DEAN RIVERS*

Factor	Thompson River	Cowichan River	Nanaimo River	Atnarko-Bella Coola River	Dean River
Residency: local	20%	95%	60%	15%	0%
non-local	80%	5%	40%	85%	100%
Angler Value of River	good	poor	average	good	good
Angler Attitude to Survey	good	good	poor-average	good	average-good
Experience in Steelhead Fishing	good	poor	average	poor	average (good in August)
Fishing Success Based on Normal River Catches	average	poor	average	poor	poor (good in August)

*Based only on enumerator impressions and not on factual data.

APPENDIX V

A NOTE ON ALTERNATIVE DEMAND CURVE SHIFT MODELS

The first model to be briefly mentioned here is Kelvin Lancaster's (1966,1971) characteristics approach model. A second model estimating shifts in demand due to a negative quality change, congestion, was developed by Cicchetti and Smith (1976) and will be briefly outlined below.

The Lancaster model

Kelvin Lancaster in his model assumes "that consumption is an activity in which goods, singely or in combination, are inputs and in which the output is a collection of characteristics. Utility or preference orderings are assumed to rank collections of characteristics and only to rank collections of goods indirectly through the characteristics that they possess" (1966, 133).

In other words, the good (the Dean River, per se) does not generate utility for the consumer; rather, its characteristics (scenic beauty, size of fish, lack of crowdedness, etc.) give rise to utility. Enhancement would change one of these characteristics while keeping all others constant.

In his model, Lancaster maximizes the individual's utility subject to his budget constraint, in the following way:

$$(1) \quad \text{Max } U = (c) \quad \text{where } U^i = U^i(C_1, C_2, \ldots, C_n)$$

$$C_1 \leq g_1(X_1, X_2, \ldots, X_m)$$

$$(2) \quad \text{s.t.} \quad Y = \sum_{k=1}^{m} P_k X_k$$

$$\text{and} \quad X_k \geq 0 \text{ for all } k$$

$$C_j \geq 0 \text{ for all } j$$

where: U = utility

C = set of characteristics

P = vector of prices facing the consumer

Y = income

X = vector of goods

By use of the Kuhn-Tucker conditions[1], the first order conditions are analyzed to get the maximum utility (Cicchetti and Smith, 1976, 18).

$$(3) \quad M = U(C_1, C_2, \ldots C_n) + \sum_{j=1}^{n} \lambda_j (g_j(X_1, \ldots, X_m - C_j)$$

$$= \theta(Y - \sum_{k=1}^{m} P_k X_k)$$

where:

$\lambda_j \frac{\partial g_j}{\partial X_k} - \theta P_k = 0$ for all k and j; suggesting that the marginal product for the commodity must equal or be less than its costs.

$X_k(\lambda_j \frac{\partial g_j}{\partial X_k} - \theta P_k) = 0$ for all k and j

$\lambda_j(g_j(X_1, \ldots, X_m) - C_j) = 0$ for all j

$g_j(X_1, \ldots, X_m) - C_j \geq 0$ for all j.

} Allowing for corner solutions.

$Y - \sum_{k=1}^{m} P_k X_k = 0$

$\lambda_j \geq 0, \quad C_j \geq 0, \quad X_k \geq 0$ for all k and j.

Enhancement may then be defined by the way it affects the jth attribute measured by each λ_j; thus enhancement benefits will be a function of the λ_j's corresponding to the characteristics affected by having more fish - fish abundance, size of fish expected to catch and/or fighting quality of fish.

Collecting accurate and consistent data for each characteristic of a fishing day would be an extremely difficult and perhaps a futile task since each attribute will most likely have a different meaning for each individual if one successfully identified the different characteristics. An interesting application of the Lancaster approach was performed by Brown et al., (1978).

Cicchetti and Smith's congestion model

The Cicchetti and Smith model is one of the many models developed to measure the effects of congestion on individual's willingness to pay.

Their model consists in defining willingness to pay functions for encounters with backpacking parties (WBP) and encounters with horse-riding parties (WHP) as functions of the number of days spent on the trip, number of encounters on the trail per day, number of nights of camp encounters, income, weeks of paid vacation, and sex of the individual (education and age were found to be insignificant). The results supported their hypothesis stating that solitude is an important characteristic of wilderness and the encounters reflected the disruption of solitude (Cicchetti and Smith, 1976, 62-63).

To successfully reverse the argument from congestion to enhancement, it is essential to have data on the number of fish caught (whether they were released or kept) and perhaps data on the number of fish sighted. In this way instead of using the number of encounters as used above, one could use the number of fish caught to determine individual willingness to pay. Unfortunately such a model may not be estimated in this paper due to the lack of catch statistics.

FOOTNOTE

[1]The Kuhn-Tucker Theorem specifies that:
Given the nonlinear program
Maximize $U = f(C)$
s.t. $P_k X_k \leq Y \quad (k = 1,2,\ldots m)$
and $X \geq 0$
if the following conditions are satisfied:
(a) the objective function $f(C)$ is differentiable and concave in the nonnegative orthant
(b) each constraint function $C^i(X)$ is differentiable and convex in the nonnegative orthant
(c) the point $\bar{X}$ satisfied the Kuhn-Tucker maximum conditions
then $\bar{X}$ gives a global maximum of $U = f(C)$
(Chiang, 1974, 722).

APPENDIX VI

DATA FOR THE VARIABLES USED IN THE EMPIRICAL ESTIMATION DISPLAYED BY OBSERVATION

This Appendix displays the ten variables, by observation, used in the travel cost and willingness to pay methods' empirical estimation. The variables are displayed horizontally in the following order.

First line:
1. Number of angling days in the past year on the Dean.
2. Number of trips to the Dean River in the past five years.
3. Number of miles travelled to the Dean.
4. Costs of the trip to the Dean.
5. Individuals' gross annual income in thousands.
6. Maximum price individuals are willing to pay for an angling day.

Second line:
7. Number of angling days if the chances of catching a steelhead were doubled.
8. Travel costs.
9. Willingness to pay under present conditions.
10. Willingness to pay after enhancement.

The first 60 observations represent the British Columbia residents and the last 40 are the non-residents of British Columbia.

SUBPROBLEM NO. 1 SOLOMON 25 100 DEAN RIVER DATA BY OBSERVATION
VARS 12 13 14 15 18 19 20 21 24 25 PRINT
100 OBSERVATIONS

LISTING OF ALL INCLUDED OBSERVATIONS

1	2.0000	1.0000	185.00	165.00	25.000	5.0000
	7.0000	150.00	2.0000	23.000		
2	2.0000	1.0000	185.00	175.00	30.000	5.0000
	2.0000	150.00	2.0000	10.000		
3	2.0000	1.0000	185.00	165.00	30.000	5.0000
	4.0000	150.00	2.0000	15.000		
4	10.000	2.0000	185.00	130.00	22.000	10.000
	10.000	50.000	50.000	20.000		
5	10.000	2.0000	390.00	130.00	18.000	25.000
	10.000	50.000	188.00	200.00		
6	10.000	2.0000	390.00	130.00	25.000	25.000
	10.000	50.000	175.00	200.00		
7	10.000	2.0000	390.00	130.00	25.000	5.0000
	10.000	50.000	10.000	10.000		
8	18.000	9.0000	205.00	130.00	24.000	25.000
	18.000	45.000	200.00	200.00		
9	1.0000	1.0000	185.00	434.00	20.000	10.000
	1.0000	100.00	5.0000	5.0000		
10	1.0000	1.0000	35.000	15.000	25.000	15.000
	3.0000	15.000	50.000	160.00		
11	10.000	7.0000	185.00	100.00	25.000	15.000
	14.000	80.000	345.00	435.00		
12	12.000	3.0000	185.00	434.00	18.000	50.000
	12.000	100.00	1.0000	20.000		
13	1.0000	1.0000	185.00	20.000	25.000	10.000
	1.0000	20.000	8.0000	8.0000		
14	3.0000	1.0000	295.00	195.00	25.000	1.0000
	3.0000	100.00	1.0000	1.0000		
15	1.0000	1.0000	185.00	95.000	22.000	5.0000
	1.0000	50.000	20.000	140.00		
16	2.0000	1.0000	315.00	95.000	20.000	15.000
	5.0000	50.000	10.000	10.000		
17	2.0000	1.0000	315.00	95.000	24.000	10.000
	2.0000	50.000	21.000	800.00		
18	1.0000	1.0000	185.00	177.00	22.000	5.0000
	1.0000	127.00	1.0000	1.0000		
19	1.0000	1.0000	185.00	167.00	20.000	5.0000
	1.0000	127.00	5.0000	35.000		
20	1.0000	1.0000	185.00	177.00	25.000	10.000
	7.0000	127.00	5.0000	20.000		
21	1.0000	1.0000	160.00	280.00	35.000	10.000
	7.0000	100.00	15.000	135.00		
22	3.0000	1.0000	185.00	225.00	5.0000	100.00
	3.0000	180.00	15.000	80.000		
23	3.0000	1.0000	185.00	245.00	25.000	10.000
	10.000	180.00	10.000	50.000		
24	2.0000	1.0000	160.00	220.00	30.000	10.000
	7.0000	100.00	10.000	30.000		
25	2.0000	1.0000	185.00	183.00	25.000	10.000
	2.0000	65.000	100.00	100.00		
26	2.0000	1.0000	295.00	225.00	15.000	50.000
	2.0000	75.000	10.000	10.000		
27	2.0000	1.0000	270.00	155.00	18.000	10.000
	2.0000	100.00	30.000	30.000		
28	2.0000	1.0000	370.00	185.00	24.000	20.000
	0.0	100.00	40.000	60.000		
29	2.0000	1.0000	185.00	275.00	25.000	25.000
	2.0000	200.00	40.000	60.000		
30	2.0000	1.0000	185.00	275.00	25.000	25.000

	2.0000	200.00	150.00	150.00		
31	3.0000	1.0000	475.00	170.00	4.0000	50.000
	3.0000	100.00	50.000	100.00		
32	4.0000	1.0000	185.00	165.00	22.000	20.000
	10.000	65.000	3.0000	3.0000		
33	3.0000	2.0000	145.00	93.000	18.000	5.0000
	3.0000	13.000	1.0000	5.0000		
34	1.0000	1.0000	185.00	75.000	25.000	5.0000
	1.0000	50.000	1.0000	10.000		
35	1.0000	1.0000	185.00	75.000	40.000	5.0000
	2.0000	50.000	6.0000	6.0000		
36	6.0000	3.0000	205.00	175.00	40.000	5.0000
	6.0000	100.00	3.0000	3.0000		
37	3.0000	2.0000	205.00	125.00	25.000	5.0000
	3.0000	100.00	2.0000	2.0000		
38	2.0000	1.0000	315.00	225.00	22.000	5.0000
	2.0000	100.00	80.000	80.000		
39	6.0000	1.0000	475.00	190.00	23.000	20.000
	6.0000	100.00	20.000	60.000		
40	4.0000	1.0000	315.00	250.00	27.000	10.000
	4.0000	100.00	20.000	60.000		
41	3.0000	1.0000	145.00	220.00	25.000	1.0000
	3.0000	150.00	1.0000	0.0		
42	3.0000	1.0000	335.00	325.00	25.000	1.0000
	3.0000	250.00	15.000	15.000		
43	3.0000	1.0000	145.00	225.00	20.000	10.000
	3.0000	150.00	3.0000	3.0000		
44	3.0000	1.0000	365.00	325.00	25.000	5.0000
	3.0000	150.00	5.0000	5.0000		
45	2.0000	1.0000	185.00	54.000	18.000	15.000
	4.0000	30.000	40.000	80.000		
46	2.0000	1.0000	185.00	139.00	21.000	25.000
	4.0000	30.000	10.000	20.000		
47	1.0000	1.0000	185.00	25.000	35.000	50.000
	1.0000	25.000	120.00	565.00		
48	12.000	6.0000	185.00	25.000	30.000	20.000
	12.000	25.000	100.00	300.00		
49	25.000	5.0000	185.00	166.00	20.000	25.000
	25.000	45.000	10.000	10.000		
50	1.0000	1.0000	205.00	88.000	28.000	10.000
	1.0000	13.000	50.000	75.000		
51	1.0000	1.0000	205.00	68.000	30.000	50.000
	1.0000	13.000	400.00	410.00		
52	9.0000	3.0000	185.00	330.00	25.000	50.000
	9.0000	15.000	30.000	30.000		
53	2.0000	1.0000	390.00	380.00	25.000	5.0000
	10.000	230.00	20.000	40.000		
54	2.0000	1.0000	520.00	460.00	23.000	15.000
	2.0000	234.00	900.00	999.00		
55	7.0000	2.0000	250.00	183.00	18.000	5.0000
	7.0000	70.000	47.000	30.000		
56	7.0000	2.0000	250.00	183.00	20.000	10.000
	7.0000	70.000	10.000	10.000		
57	2.0000	1.0000	250.00	350.00	18.000	10.000
	15.000	200.00	10.000	140.00		
58	3.0000	1.0000	295.00	290.00	30.000	50.000
	3.0000	40.000	150.00	150.00		
59	2.0000	1.0000	105.00	295.00	40.000	30.000
	5.0000	250.00	50.000	250.00		
60	2.0000	1.0000	170.00	295.00	27.000	50.000
	0.0	250.00	100.00	250.00		
61	20.000	3.0000	550.00	145.00	14.000	5.0000
	20.000	117.00	20.000	20.000		
62	24.000	4.0000	550.00	145.00	22.000	5.0000

	24.000	117.00	24.000	24.000		
63	4.0000	1.0000	410.00	300.00	100.00	10.000
	7.0000	125.00	20.000	400.00		
64	2.0000	1.0000	410.00	300.00	30.000	10.000
	2.0000	200.00	60.000	60.000		
65	12.000	2.0000	410.00	300.00	30.000	10.000
	12.000	200.00	10.000	50.000		
66	21.000	7.0000	410.00	155.00	38.000	5.0000
	21.000	80.000	2.0000	100.00		
67	2.0000	1.0000	555.00	155.00	25.000	5.0000
	2.0000	80.000	1.0000	5.0000		
68	3.0000	1.0000	790.00	610.00	80.000	100.00
	3.0000	235.00	175.00	450.00		
69	3.0000	1.0000	790.00	610.00	80.000	100.00
	3.0000	235.00	20.000	100.00		
70	2.0000	1.0000	410.00	257.00	40.000	15.000
	2.0000	200.00	50.000	50.000		
71	2.0000	1.0000	410.00	257.00	25.000	25.000
	2.0000	200.00	370.00	340.00		
72	2.0000	1.0000	550.00	373.00	20.000	15.000
	2.0000	230.00	10.000	30.000		
73	2.0000	1.0000	550.00	410.00	17.000	10.000
	2.0000	230.00	20.000	30.000		
74	2.0000	1.0000	950.00	373.00	21.000	15.000
	2.0000	230.00	2.0000	50.000		
75	12.000	2.0000	410.00	422.00	150.00	250.00
	12.000	420.00	120.00	180.00		
76	2.0000	1.0000	2200.0	300.00	2.0000	10.000
	2.0000	260.00	7.0000	7.0000		
77	2.0000	1.0000	2200.0	300.00	17.000	10.000
	2.0000	260.00	75.000	300.00		
78	5.0000	1.0000	1100.0	950.00	40.000	20.000
	10.000	280.00	180.00	435.00		
79	5.0000	1.0000	1100.0	950.00	35.000	30.000
	5.0000	280.00	125.00	125.00		
80	5.0000	1.0000	1100.0	950.00	45.000	25.000
	5.0000	260.00	100.00	120.00		
81	2.0000	1.0000	1100.0	400.00	35.000	10.000
	2.0000	300.00	10.000	10.000		
82	5.0000	1.0000	1100.0	950.00	27.000	5.0000
	5.0000	280.00	5.0000	5.0000		
83	6.0000	1.0000	1100.0	2400.0	80.000	100.00
	6.0000	300.00	425.00	425.00		
84	6.0000	1.0000	1100.0	2400.0	60.000	100.00
	6.0000	300.00	450.00	450.00		
85	1.0000	1.0000	410.00	291.00	40.000	30.000
	1.0000	250.00	25.000	25.000		
86	2.0000	1.0000	2150.0	575.00	45.000	40.000
	2.0000	200.00	60.000	100.00		
87	2.0000	1.0000	410.00	617.00	40.000	50.000
	2.0000	250.00	100.00	150.00		
88	1.0000	1.0000	410.00	291.00	35.000	20.000
	1.0000	250.00	15.000	30.000		
89	6.0000	1.0000	1100.0	195.00	100.00	20.000
	6.0000	80.000	90.000	90.000		
90	6.0000	1.0000	1100.0	178.00	70.000	20.000
	6.0000	80.000	90.000	90.000		
91	6.0000	1.0000	1100.0	178.00	22.000	15.000
	6.0000	80.000	60.000	90.000		
92	2.0000	1.0000	1100.0	77.000	50.000	20.000
	2.0000	33.000	30.000	50.000		
93	2.0000	1.0000	550.00	82.000	28.000	15.000
	2.0000	33.000	20.000	30.000		
94	2.0000	1.0000	1100.0	1015.0	100.00	75.000

	14.000	290.00	60.000	715.00		
95	2.0000	1.0000	1100.0	665.00	125.00	100.00
	2.0000	290.00	150.00	200.00		
96	4.0000	1.0000	1100.0	775.00	90.000	50.000
	4.0000	65.000	200.00	200.00		
97	4.0000	1.0000	1100.0	775.00	150.00	500.00
	4.0000	65.000	999.00	999.00		
98	4.0000	1.0000	790.00	234.00	50.000	25.000
	4.0000	225.00	80.000	115.00		
99	4.0000	1.0000	790.00	234.00	33.000	30.000
	4.0000	225.00	100.00	115.00		
100	4.0000	1.0000	790.00	234.00	90.000	30.000
	4.0000	225.00	100.00	180.00		

VARIABLE NAME	NO.	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
PASTYEAR	12	4.4900	4.8835	23.848	1.0000	25.000
PAST5YRS	13	1.5000	1.3744	1.8889	1.0000	9.0000
TRAVEL	14	495.20	442.00	0.19536D 06	35.000	2200.0
COSTS	15	322.24	370.38	0.13718D 06	15.000	2400.0
INCOMEYR	18	35.470	27.500	756.25	2.0000	150.00
MAXPAYME	19	30.230	57.968	3360.3	1.0000	500.00
MAXDAYSE	20	5.4000	5.1405	26.424	0.0	25.000
TRAVELCO	21	140.69	91.903	8446.1	13.000	420.00
WTPNOW	24	82.380	155.72	24250.	1.0000	999.00
WTPTHEN	25	136.74	199.14	39658.	0.0	999.00

END OF SUBPROBLEM 1

END OF SUBPROBLEMS

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		to	

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Title of Thesis/Dissertation

Evaluation of Recreation Benefits Accruing to Steelhead Anglers on the Dean River.

Author [redacted]

Signature

Joan Patton

Name

April 30, 1980

Date