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An economic approach to assessing the value of recreation with special reference to forest areas.

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AN ECONOMIC APPROACH TO ASSESSING THE VALUE OF RECREATION WITH SPECIAL REFERENCE TO FOREST AREAS

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ABSTRACT

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Different methods of estimating the value of recreational areas are discussed with particular attention being given to socioeconomic methods - the survey method and Clawson's method. Aspects of consumer's surplus and aggregating welfare measures have been dealt with. A Clawson method has been applied to empirical data from a forest area in Wales and data from a region in Denmark. In the case from Wales, it was found that 73% of all visitor groups in the sample were on holiday. In addition, for many visitor groups (48%) the visit to the forest area was just one part of the day's outing. Therefore, it was considered necessary to modify the Clawson method. Problems with the weighting of points for the trip demand curve have been given considerable attention. The data from Denmark give rise to consideration of the problem of substitute areas and a classification system was used to select population zones for the Clawson analysis. Different models for the trip demand curve have been tested and the exponential was found to be the most appropriate.

Key words:Recreation/ Consumer's surplus/ Welfare/ Clawson's method/ Weighting/ Models

Preface

The work presented here has been undertaken as a Ph.D. study under the supervision of Dr. Colin Price at the Department of Forestry and Wood Science, University College of North Wales, Bangor, during the period May 1979 to January, 1982.

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A,B,C,D	Population zones (centres)
c_i, c_{ij}, C_i	Travel costs (for visitor group j) from zone i
CM	Travel costs per mile
CS	Consumer's surplus
	CSI CS on individuals
	CSP CS per predicted visitor group
	CSR CS regulated to observed no. of visitor groups
	CSZ CS on zone basis
CV	Compensating variation
D_i	Distance from zone i
	D^1_{ij} distance from home to the recreation area
	D^2_{ij} distance from home to the startpoint for the day
	D^3_{ij} distance from startpoint for the day to the recreation area (for visitor group j in zone i)
EV	Equivalent variation
E(x)	Expected value of x
f	function
F	Attractiveness of recreation centre
G	Attractiveness of population centre
HCDC	Hicks' compensated demand curve
l	Length of stay
L	Length of holiday
m	Number of recreation sites
max	Maximum
	$\max_i D_i$ maximum distance to any zone, i.e. the furthest away
n	Number of visitors, visitor groups
	Income elasticity of demand
N	Population
ODC	Ordinary demand curve
ovg	Observed number of visitor groups
p	Price, entrance fee
PFAF	Project Forest and Folk
pvg	Predicted number of visitor groups
q	Quantity, number of visitors, visitor groups
Q	Number of predicted visitor groups
r_i	Distance from zone i to R_1
R_1, R_2	Recreational areas
$t(r_i)$	Travel costs at distance r_i
T	Time costs
v	Individual's visit rate
V	Population's visit rate
Var(x)	Variance of x
Y	Income

1. INTRODUCTION

1.1 General Background

During the last two decades, researchers and planners have become increasingly interested in multiple use forestry. Forest areas have always produced a variety of products such as timber, fuelwood, forage, game, grazing etc. although the importance of each of these products has changed over time The problem now is a growing demand for the 'production' of additional goods, especially forestry recreation. This good is not priced in the normal market system and hence no commercial value has been put on it. This has become a problem as the demand for recreation grows with the steady increase in leisure time, income and thereby, mobility. In order to estimate the level of supply which should be aimed for, it is first necessary to estimate the value of recreation. In Denmark, the yearly number of forest visits has been estimated at 100 - 150 million (Koch 1978) which "indicates that the recreational value of woods in Denmark is far above the value as a production factor of trees" (Groes 1979). It is, therefore, important to find methods which can be used in a planning process to optimise the mix of outputs from forest areas in order to maximise social welfare and, thereby, hopefully minimise conflicts between different groups of interest.

1.2 Valuation of Recreation Forestry

To be able to make a thorough valuation of recreation forestry, one needs to know about the costs and benefits that accrue from providing the good, recreation. Of these two items, the benefits are the more difficult to measure, as in that case we are trying to measure the value of a good which is not priced in the normal market system. The cost side is somewhat easier to estimate as we can get the direct costs of providing certain goods such as picnic places. etc. We can also find the opportunity costs from either not growing any trees in a particular area or only growing hardwoods where conifers would be the more profitable. Thus, the cost side is not too difficult to handle and there are several works from Scandinavia which do exactly that : measure the opportunity costs of providing certain facilities to the public (See 5.2). The opportunity cost can be calculated as : the net present value under optimum private management minus the net present value given the restrictions proposed. This measure would be appropriate for a negotiation with the government concerning compensation for restrictions put on forestry under private management. However, this work is concerned with how the government initially decides that it wants to put certain restrictions on forest use or perhaps rather to provide certain facilities to the public. This means that, in addition to the previously mentioned opportunity costs we have to provide the decision makers with a measure for the benefits of a particular plan. Combining these two measures will then give an estimate for the changes in social welfare due to a given plan.

Therefore the purpose of this work is to explain the concepts behind welfare economics and various methods for estimating recreation benefits. to try to solve some of the problems occurring when applying the methods to empirical data.

1.3 Plan

A short outline for the thesis is:

Chapter 1: An introduction to the methods of evaluating recreation economics.

Chapter 2· On welfare economics - the theory behind consumer's surplus and the aggregation of welfare will be dealt with.

Chapter 3 Socioeconomic methods - the survey method and Clawson's method are discussed.

Chapter 4: A Clawson method is applied to data from a forest area (Gwydyr Forest) in Snowdonia. A revised model of the method is developed.

Chapter 5: Economics of recreation in a region of Denmark - in addition to a literature review of previous works in Scandinavia. a Clawson analysis is carried out on forests in North Zealand.

Chapter 6: Final conclusions and recommendations for further research.

1.4 Methods of Assessing the Economic Value of Recreation.

In this section a brief summary will be given of the methods which have been most commonly employed when evaluating recreation. The systematization has been adopted from Gundermann (1976)

1.4.1 Empirical Methods

Empirical methods are those which use data obtained by analysing a particular area. They can be divided into pure economic methods and socioeconomic methods.

1.4.1.1 Pure Economic Methods

The most important of these is the 'opportunity cost method' which finds the cost of providing certain recreational facilities to the public. This has been the method most often used in Scandinavia (See 5.2) which can probably be explained by the close relationship between the forestry education and the private forestry sector in these countries. However as pointed out in Section 1 3. this method does not provide a guide for selection among alternatives as it considers only the cost of providing facilities.

1.4.1.2 Socioeconomic Methods

Socioeconomic methods attempt to measure the benefits to society, i.e. the changes in welfare, according to a given project The most important of these methods are the 'survey method' and 'Clawson's zone method'. Both have a measure of consumer's surplus as a base which is discussed more fully in Chapter 2. The survey method is based on a questionnaire or an interview which attempts to reveal people's willingness to pay for the good while the Clawson method derives the same thing from people's behaviour. The result from both methods is a demand curve from which the consumer's surplus can be calculated. The two methods are explained and discussed in Chapter 3

Another socioeconomic method is the 'gross expenditure method' which measures the benefits from recreation as the total costs incurred by the users, including both travel and on-site costs. "the justification for this approach is that these costs must represent at least a lower bound to the value the recreationist places on the activity for otherwise if it was worth less than these costs to him, he would not undertake it. This argument is valid as far as it goes, but it does not go far enough" (Binkley 1977). The gross expenditure method is considered unacceptable as it is "the margin above the cost of taking advantage of the recreation opportunity which measures the real monetary value that would be lost, if the recreation opportunity were not available" (Clawson and Knetsch 1966. p.225). A fourth socioeconomic method is the 'property value method' in which an attempt is made to relate property value as a function of distance from the recreational area. The method has several shortcomings, which are reviewed in Price (1978). and it is not considered useful in this case For recreation evaluation in urban areas. where travel distances are shorter, this method may be more useful.

1.4.2 Normative Methods

"The concept of normative methods includes assessments realized on the basis of uniformly predetermined standard values or rules of thumb" (Gundermann 1976).

1.4 2.1 Rules of Thumb

The most simple normative method is the one referred to as the 'cost method' (Clawson and Knetsch 1966). The method was popular in the 1950's and assumes that the value of an outdoor recreation resource is equal to the cost of generating it or even. in some case to a multiple of that (Ibid.,p.225).

The method is quite unacceptable, as it automatically justifies any project and it does not provide a guide for ranking alternatives except in that the most expensive one is the best

Another normative method is the 'market value of fish method' where it is assumed that the value of sport fishery equals the market value of the fish caught (Crutchfield 1962). He, himself, points out the major objection to this method : the fact that it is implied that obtaining meat is the objective of angling He goes on to conclude "in another sense. however, the commercial value of the sport catch could legitimately be regarded as a minimum estimate"(Ibid.,p.150). This might not be true in some cases.

1.4.2.2 Standards

The normative method called the 'market value method' is probably the most common and has often been used in the United States by Federal agencies. It consists of attributing certain predetermined values per visit or per recreation day. Then the attributed value multiplied by the attendance can be used as an estimate for the value of the site The chosen value is normally related to prices charged at privately owned recreation areas, but it is "precisely because private areas are not fully comparable with public areas that users are willing to pay fees or charges" (Clawson and Knetsch 1966.p.227). Furthermore, the value found in this way might vary quite considerably from the consumer's surplus measure as it must be assumed that a private owner tends to maximise profit.

1.4.3 Methods Based on Auxilliary and Substitutive Values.

One of the most interesting methods in this group is that of Iljew and Gordienko (1973)[1]. who have found a relationship between enhancement of man's working capacity and recreation. They found an annual increase in an individual's working capacity of about 3 percent.

In some works, simple scaling methods in non-economic terms have been applied (Helliwell 1969)

1.5 Conclusion

It is the author's belief that the way to proceed is by using the socioeconomic methods (either the survey or the Clawson method) because they measure the contribution to social welfare in a way which is both commensurate with other economic values, and compatible with the theory of welfare economics. They will, with further refinements, provide a reasonable tool for ranking public alternatives. Nevertheless, there are many difficulties. First is the dispute in welfare economics about the interpretation of consumer's surplus, how it is to be measured, and how to aggregate consumer' surplus for different individuals. This is the subject of Chapter 2. The reader who is familiar with this debate can proceed directly to Chapter 3. In that chapter will be examined the many problems that have been identified in the theory and application of the survey and Clawson methods. Some of the attempts to solve these problems will be discussed, and the contribution which this thesis hopes to make will be outlined.

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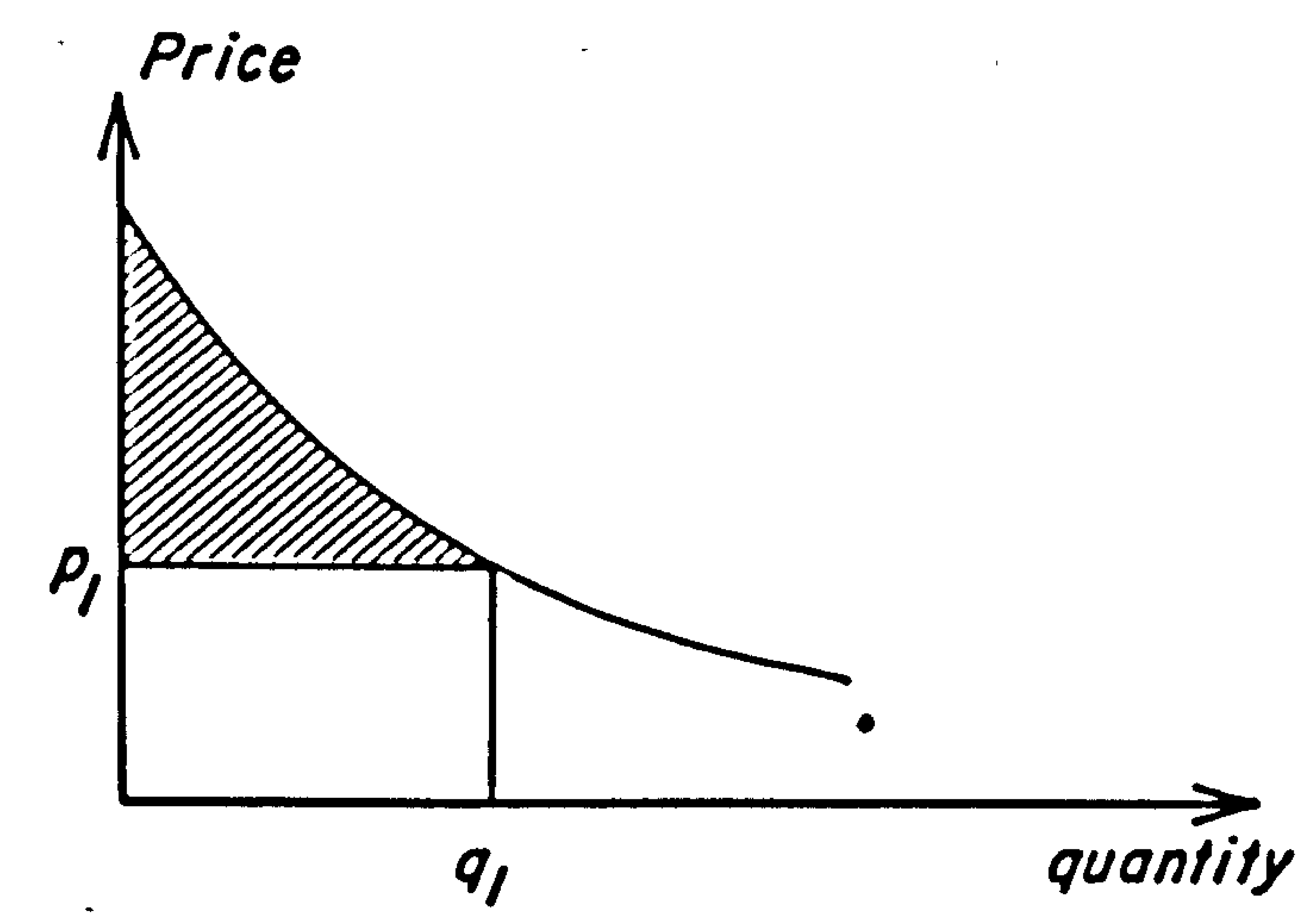
1. Here from Gundermann (1976).

2. WELFARE ECONOMICS

2.1 Consumer's Surplus

The Clawson method as well as all other socioeconomic methods which are used to estimate the benefits derived from recreational areas, is based on consumer's surplus measurements. Consumer's surplus can be described as the difference between what people are willing to pay for a good and what they actually do pay. Figure 2.1 shows the demand curve for a good, X_1. For a given price, p_1, people will buy a quantity q_1 of good X_1. The shaded area in the Figure is equal to the consumer's surplus and can be interpreted as the contribution to increase in social welfare by introducing that good.

Figure 2.1 : Demand curve for good X_1



The consumer's surplus measure is a crucial concept in cost-benefit calculations because " for all except marginal changes in the amount of a good, the market price prevailing in a perfectly competitive setting is an inadequate index for the value of a good." (Mishan 1975,p.24).

Unfortunately, however. it is very difficult to estimate consumer's surplus because the shape of the demand curve for most goods is either unknown or known only for a small area around the established market price. Probably because of that, most manuals for cost-benefit analysis of projects do not use the consumer's surplus concept but have other measures as numeraire (Little and Mirrlees 1974; UNIDO 1972; Squire and van der Tak 1975). Little, in fact, goes so far as to say that consumer's surplus is a totally useless theoretical toy (Little 1957, p.180). Nevertheless, in the evaluation of recreational facilities, the consumer's surplus is a convenient tool and it is used throughout this study.

" Consumer's surplus " is a somewhat ambiguous term itself although other commonly used terms have evolved from it. Therefore, the remainder of this Chapter is concerned with the development and the concept of consumer's surplus.

2.2 Development

Dupuit (1844) first described the notion which Marshall (1924) referred to as consumer's surplus : "....he thus derives from a purchase a surplus of satisfaction. The excess of the price he would be willing to pay, rather than go without the thing, over that which he actually does pay, is the economic measure of this surplus of satisfaction It may be called consumer's surplus " (Marshall 1924. p.124)

In addition to baptising the concept, Marshall gave the very important qualification that the accuracy of the above measure requires the marginal utility of income to be constant. The topic was examined by Hicks and he stated

"...the best way of looking at consumer's surplus is to regard it as a means of expressing in terms of income, the gain which accrues to the consumer as a result of a fall in price. Or better, it is the compensating variation in income, whose loss would just offset the fall in price and leave the consumer no better off than before " (Hicks 1946,p.40)

Henderson (1941) pointed out that the definitions above differ in the sense that the Marshallian definition does not allow quantity adjustments while the latter does. After this comment Hicks reconsidered the whole problem and defined four different consumer's surpluses (Hicks 1943).

These four measures, viz. compensating variation, equivalent variation, compensating surplus, and equivalent surplus are explained below by using indifference curves. In a later section, the concept of the Marshallian demand curve adjusted for income effects will be discussed.

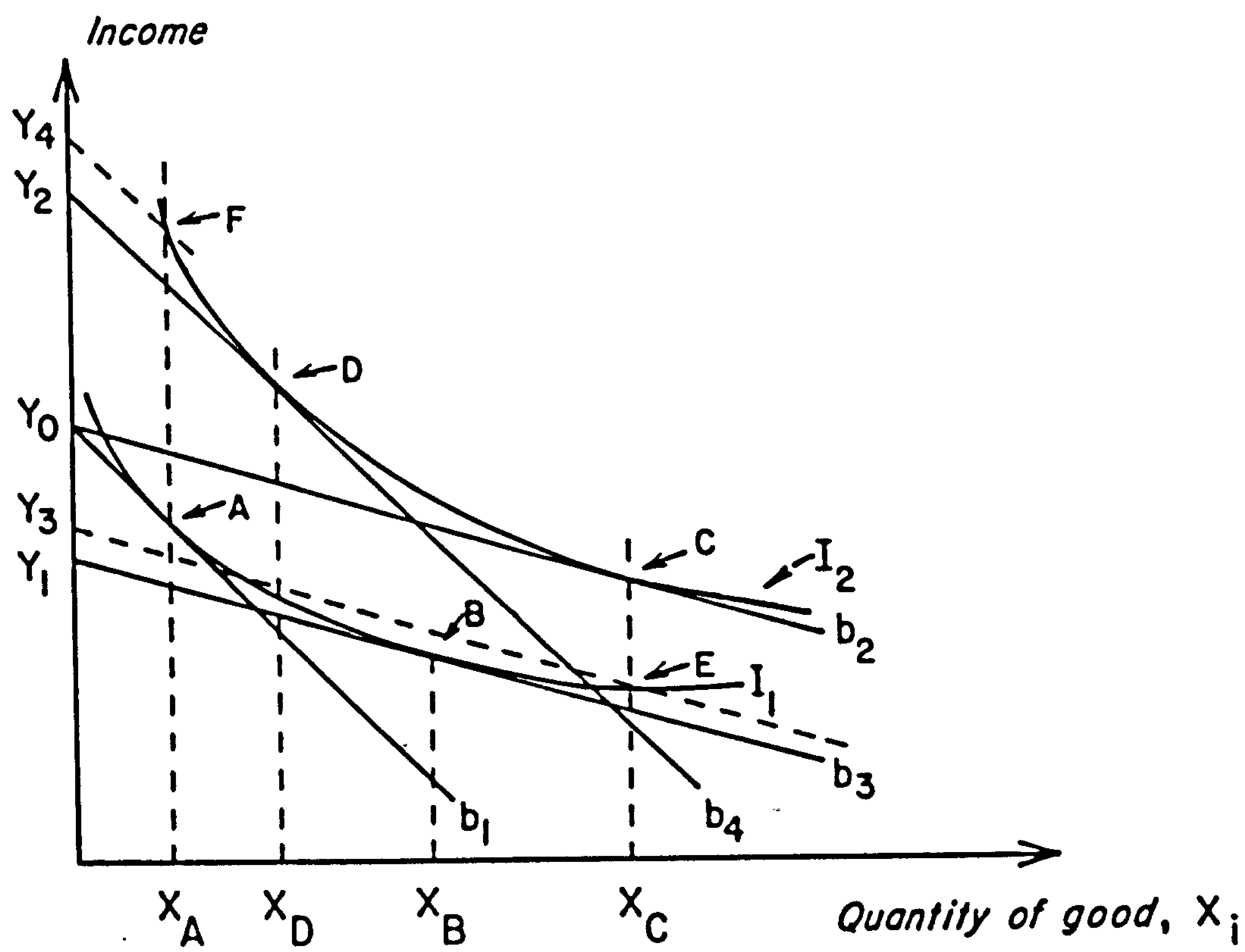
2.3 The Four Consumer's Surpluses

2.3.1 Compensating Variation (CV)

This measure was introduced by Hicks (1939) and as quoted in Section 2.2, it is, for a price fall, the loss of income which would just offset the fall in price, leaving the consumer no better off than before. For a price increase, the compensating variation is, of course, the increase in income which will maintain the consumer's utility level.

The compensating variation is illustrated graphically in Figure 2.2, with the aid of indifference curves. The horizontal axis refers to the holding of a good X_i and the vertical axis to the income Y_i (or all other goods). Each indifference curve represents combinations of amounts of X_i and income Y_i which provide equal utility for the individual in question. For example, the points A and B on curve I_1 provide equal utility. Points C and D on curve I_2 provide equal utility as well but at a higher level than provided by A or B.

Figure 2.2 · Indifference curves for quantity of good X_i and income Y_i



Consider Y_0 as the individual's initial income when the good X_i has a given price structure p_1. Then, b_1 is the individual's budget line for income Y_0 and quantity of X_i In order to maximise his utility, the individual will buy the amount X_A of X_i, that is the amount corresponding to the point A where an indifference curve just touches the budget line. If the price for the good. X_i, is lowered to a new price structure. p_2. it follows that the individual now can buy corresponding to line b_2 and that he will be able to reach a higher utility level, i.e. the point C on the indifference curve I_2. The line b_3 parallel to b_2 shows the income Y_1 necessary to leave the individual at the same utility level I_1 as he was on before the price change but now he will be consuming the quantity X_B of the good X_i. The compensating variation is the difference Y_0-Y_1, i.e. the amount the individual can lose after the price fall without being worse off. The same argument can be applied to a price increase.

Another notation for the concept of compensating variation is the one used by Willig (1976) He defines the indirect utility function as

$$l(p,Y) = U[X^1(p,Y),X^2(p,Y),\ldots,X^n(p,Y)] \qquad (1)$$

where $X^i(p,Y)$ are assumed to be differentiable demand functions derived by maximising the quasi-concave utility function $U(X)$ of the consumption mix, $[X = X^1.X^2\ldots,X^n]$, subject to the budget constraint $p_i{*}X^i = Y$, where Y is income and p_i is price. Then, the compensating variation can be expressed as

$$l[p_2,(Y_0 - CV)] = l(p_1,Y_0) \qquad (2)$$

That is the utility from the new price ,p_2, and the old income, Y_0, minus the compensating variation will equal the utility level which was attained by the old price and the old income.

2.3 2 Equivalent Variation (EV)

This measure can be defined as " the gain in income which, if experiencel without the price falling, would make the consumer as much better off, as he is male by the fall in price without any change in money income." (Hicks 1943.p.34-35). The opposite can, of course, be applied for a price increase

This measure can also be explained with the aid of Figure 2.2 . If the price was lowerel to p_2, then the individual would be able to increase his utility to level I_2, consuming the amount corresponding to point C , i.e quantity X_C. With the prevailing price , he must have an income Y_2 to reach the same utility. Line b_4 is parallel to line b_1 and the individual maximises his utility at point D where b_4 is tangent to I_2 . The difference, $Y_2 - Y_0$ is the equivalent variation or the sum that must be given to the consumer to leave him as well off as if there had been a price change from p_1 to p_2 without any change in income.

Using the same notation as in 2.3.1, we can express the equivalent variation as·

$$l[p_1,(Y_0 + EV)] = l(p_2,Y_0) \qquad (3)$$

Here, too, the opposite argument can be applied to a price increase. The equivalent variation for a price increase will have the same consequence as a confiscation of the income difference $Y_0 - Y_1$ or equal to the compensating variation for a price decrease from p_1, i.e., the income which consumers at C are willing to forgo in order to avoid the price increase to p_1 is equal to the sum we can confiscate from consumers at A if we lower the price to p_2 .[1]

1. This is easily seen by changing (3) to the equivalent variation from a price income from p_2 to p_1 . which compared with (2) gives EV = CV.

2.3.3 Compensating Surplus [2]

" Compensating surplus is the amount of compensation, paid or received, that will leave the consumer in his initial welfare position following the change in price, if he is constrained to buy at the new price in the absence of compensation " (Currie et al. 1971, p.746).

From Figure 2.2 we can see that after a fall in price from the initial price, p_1, at point A to price p_2, the individual will buy an amount X_C corresponding to point C . In order to buy the amount X_C and keep the welfare he previously had, the individual now only needs an income equal to Y_3 . The difference $Y_0 - Y_3$ is the compensating surplus or, in this case, the amount that we can confiscate leaving the consumer at the same utility level as before the price decrease. For a fall in price the compensating surplus is always less than the compensating variation.

2.3.4. Equivalent Surplus [3]

" Equivalent surplus is the amount of compensation, paid or received, that will leave the consumer in his subsequent welfare position in the absence of the price change, if he is constrained to buy at the old price the quantity he would have bought at that price in the absence of compensation " (Ibid ,p.746)

In Figure 2 2, the equivalent surplus is the sum equal to AF, i.e., $Y_4 - Y_0$, because if the price had fallen to p_2, the individual could have reached the utility level I_2. In order to let him reach that level and

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2 Hicks called this the quantity compensating variation.
3. The measure is what Hicks called the quantity equivalent variation.

still consume the same quantity, he needs an income. Y_4. For a price fall, this measure is bigger than the equivalent variation.

2.4 An Evaluation of the Consumer's Surpluses

Hicks (1943) shows that a fall in price implies compensating surplus < compensating variation < equivalent variation < equivalent surplus.

But which of these measures should then be used ?

Mishan (1948) argues that out of these five measures[4]. only two can be used the compensating variation and equivalent variation The compensating surplus and equivalent surplus are unjustified as they " allow " people to consume at an other than optimal level. That is the compensating surplus is calculated in point E (Figure 2.2). However, consuming less of the good. X_i with the same income could bring more satisfaction to the consumer. The consumer should consume where the budget line is tangent to an indifference curve. Freeman (1979, p.37) states that " the compensating surplus and equivalent surplus measures are too restrictive in their assumptions to be useful." So most authors have accepted that the discussion must be between the use of compensating variation, equivalent variation or simply the area under the Marshallian demand curve -which, in Section 2.5.1 will be shown to lie between these two measures (Dwyer et al. 1977 : Gordon and Knetsch 1979 ; Bockstael and McConnell 1980).

4. A fifth measure was suggested by Knight (1944)

Mishan (1975) argues that the basic concept by reference to which gains and losses are to be estimated is the compensating variation. However, in a later paper, (Mishan 1976) he states that the equivalent variation (EV) concept is no less a valid basis than the compensating variation (CV) concept for cost benefit analysis. Thus, the choice must depend upon what the measure is to be used for because " we can equal willingness to pay to compensating variation for price decreases and to equivalent variation for price increases. Similarly, willingness to sell is equivalent variation for price decreases and compensating variation for price increases " (Bockstael and McConnell op. cit., p.56).

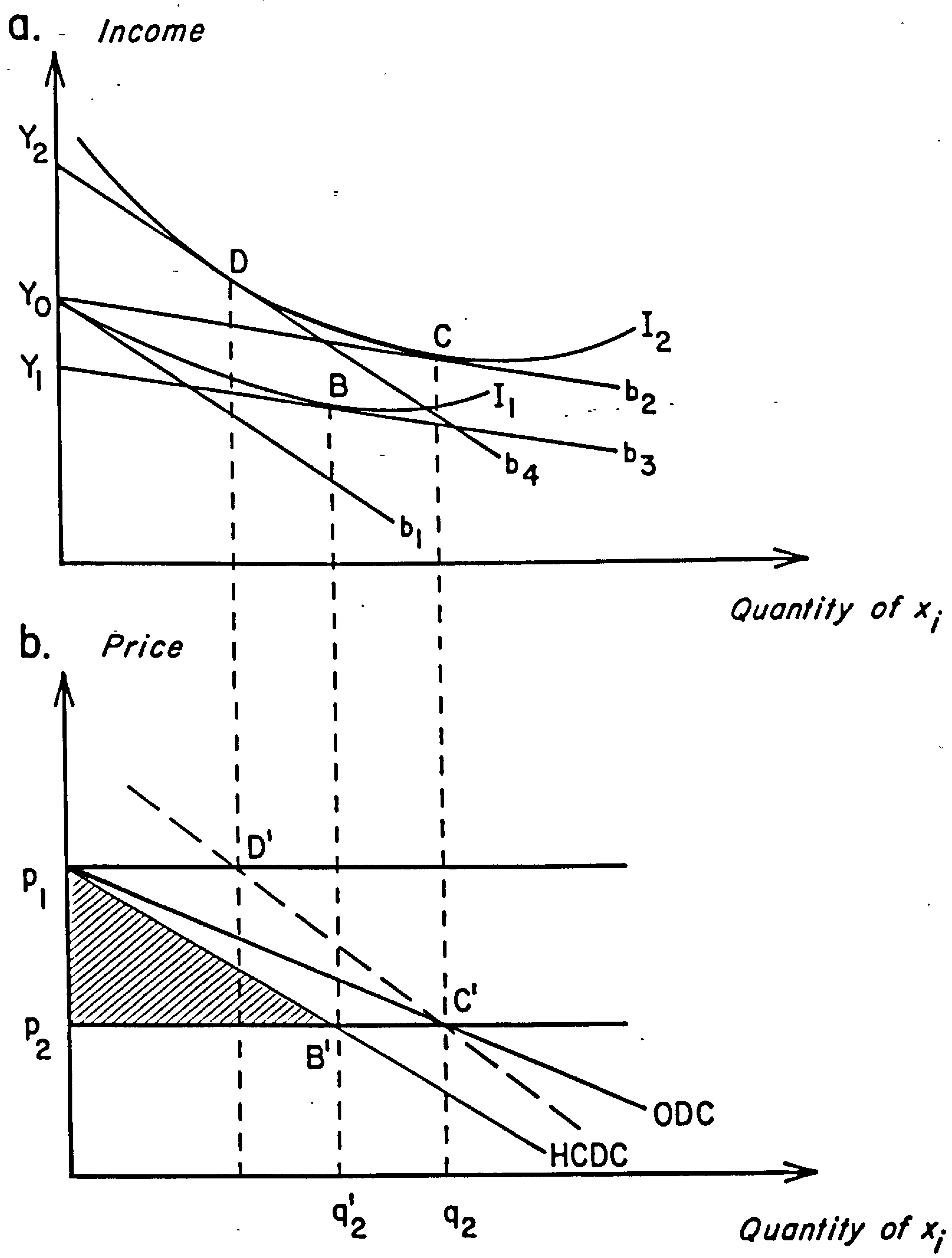
2.5 Compensating Variation, " Consumer's Surplus " or Equivalent Variation ?

2.5.1 The Hicksian Compensated Demand Curve (HCDC)

This section deals with the relationship between the area under the ordinary demand curve (in the following called consumer's surplus) and the compensating variation and the equivalent variation respectively.

The ordinary demand curve (ODC), or the Marshallian demand curve, gives the quantity/price relationship for a given income. The HCDC curve gives the quantity/price relationship assuming that income is adjusted according to the initial indifference curve.

Figure 2.3 : The Hicksian compensated demand curve



The ODC and the HCDC curves can be derived from the indifference curve system shown in Figure 2.3a. The budget line, b_1, for price p_1 is tangent to the indifference curve I_1, through the point Y_0 on the ordinate axis, that is for income Y_1 and price p_1 for the good X_i, no units of X_i are bought. If the price is lowered to p_2. the consumer buys q_2 units, i.e. he is consuming at point C where the line b_2 is tangent to the indifference curve I_2. If the consumer's income is adjusted so that he maintains the utility level previous to the price decrease (i.e. lowering the income to Y_1 by confiscating the compensating variation) then he buys less units - in this case, q_2' units. It is shown by Hicks (1956) that the shaded area p_1p_2B' in Figure 2.3b is equal to the amount $Y_0 - Y_1$, i.e. a measure for the compensating variation.

The equivalent variation can be found by deriving the HCDC curve from the indifference curve which the consumer would have reached following a price change, and finally, integrating the area under the curve and between the two price lines. In Figure 2.3b the equivalent variation for a price decrease from p_1 to p_2 is the area $p_1D'C'p_2$. Figure 2.3b also shows that the consumer's surplus under the ODC is to be found somewhere between the compensating variation and the equivalent variation.

It is evident that if the income effect is zero (indifference curves are parallel) then the ODC curve and the HCDC curves will coincide and all three measures will yield the same result.

2 5.2 Willig's Approximation Formulae

As shown in the previous section, an exact measure of welfare changes requires knowledge about the compensated demand curves, i.e. we need to know the marginal utility of money so that we can derive the compensated demand curve from the demand curve observed in the market in question.

But Willig (1976;1979) provides formulae for upper and lower limits on the percentage error of approximating the compensating variation and equivalent variation with consumer's surplus. His " result implies that consumer's surplus is usually a very good approximation to the appropriate welfare measures." (1976 p.589). In addition to giving the exact formulae. Willig offers rules of thumb which can be used when the following conditions are met :

$$\text{if} \quad |\bar{\eta}\, CS/2Y_0| \leq 0.05$$
$$|\underline{\eta}\, CS/2Y_0| \leq 0.05$$
$$\text{and} \quad CS/Y_0 \leq 0.9$$
$$\text{then:} \quad \underline{\eta}\frac{|CS|}{2Y_0} \leq \frac{CV-CS}{|CS|} \leq \bar{\eta}\frac{|CS|}{2Y_0}$$
$$\text{and} \quad \underline{\eta}\frac{|CS|}{2Y_0} \leq \frac{CS-EV}{|CS|} \leq \bar{\eta}\frac{|CS|}{2Y_0}$$

where:

CS = consumer's surplus under the ordinary demand curve and between the two prices in question

CV = the compensating variation corresponding to the price change

EV = the equivalent variation corresponding to the price change

Y_0 = the consumer's base income.

$\bar{\eta}$ = the largest income elasticity of demand in the area.

$\underline{\eta}$ = the smallest income elasticity of demand in the area.

These results have been used to justify the use of consumer's surplus as the correct welfare measure. Dwyer et al.(1977) states : " using the area under the demand curve (the ODC)[5] as an approximation of willingness of users to pay is satisfactory only under certain conditions, but these conditions are almost always met for the recreation output of resource management alternatives "(Ibid.,p.11)

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5. My comment

Freeman (1979) also argues in favour of this approximation and says that " the differences among the measures appear to be small and almost trivial for most realistic cases "(Ibid.,p.47)

Bockstael and McConnell (1980) argue that although " Willig's results are unquestionably correct, they are not a panacea for applied resource economists for a number of reasons "(Ibid.,p.59). Their argument is, basically, that resource economy is often concerned not with small price changes but rather with the provision or elimination of a resource and therefore often large CS or η values. Furthermore, they show that often Willig's bounds are nonexistent.

Explicit estimations of compensating variation or equivalent variation using Willig's formulae have not, to this author's knowledge, been published. However some authors (Hammack and Brown 1974 ; Banford et al. 1977) have found considerable difference between compensating variation and equivalent variation. They have used the survey method and this may be the reason why the difference has occurred. This will be discussed later in Section 3.1 on the survey method.

2.6 Aggregation of Welfare Changes

According to Freeman (1979) there are basically four different ways in which we can aggregate the changes in social welfare due to a certain project. They will be described briefly in the following [6]

2.6.1 Pareto Optimality

The traditional criterion in welfare economics is the Pareto criterion which states that no policy shall be accepted unless at least one person is made better off and no individual is made worse off. By this strictness, the criterion is the rule of 'unanimity'. The unanimity rule is clearly unexceptionable; the real problem is that it hardly, if ever, has relevence to actual decision making processes (Dasgupta and Pearce 1978) and in situations where some individuals prefer state x to state y and others prefer state y to state x, the criterion does not offer any guidance to decision makers.

2.6.2 Kaldor-Hicks-Scitovsky Criterion

Kaldor (1939) extended the Pareto criterion to situations in which people both benefited and lost. He stated it to be an improvement if those who benefited were so much better off that they could afford to compensate the losers and yet still be in a better position than before the change. This compensation principle that Kaldor described was slightly changed by Hicks (1939) who pointed out the contradiction that in some cases A would

6. For a thorough discussion see Price (1978), Sugden (1981), and Mishan (1960).

be better off than B and also that B would be better off than A. He, therefore, suggested a more negative criterion: that the 'losers' should not be able to compensate the 'gainers' and still be better off than they would have been after the change. Scitovsky (1941-2) showed that both Kaldor's and Hicks' conditions need to be met if a change should be declared to be an improvement This is known as the Kaldor-Hicks-Scitovsky criterion.

2.6.3 Little's Criterion

Price (1978) points out that by accepting the personal assessment of changes in utility in money terms, the economist accepts that the distribution of income is satisfactory. Little (1957) was aware of this and suggested a criterion in which in order to be accepted, a project had to both pass the Kaldor-Hicks-Scitovsky criterion and to improve the distribution of income. Although this criterion focuses on the distributional problem. it is not very operational as it does not offer any suggestions for how to measure whether one distribution is better than another.

2.6.4 Explicit Equity Considerations

Little's criterion is of limited use as it does not quantify the distributional effects (Pearce and Nash 1981). Therefore, the newest approach is to make a specific social judgement regarding equity and to introduce equity considerations systematically in the evaluation of social policy. The most common way to do this is to introduce weights to the individual welfare changes, e.g. explicitly to weight income according to the income group to which it accrues (Squire and Van der Tak 1975).

2.7 Conclusion

The previous sections of this chapter have shown that the appropriate measure for estimating the benefits or costs is either the compensating variation or the equivalent variation. However. the question of how to quantify these measures remains unanswered. It does not seem suitable simply to rely on Willig's approximations and it may be that the survey method to be discussed in the next chapter will prove to be a useful alternative method.

Concerning which of the measures. compensating or equivalent variation, to use, it is interesting to add as a comment to section 2.4 that by introducing a new recreational area, the equivalent variation measure could be used as a mesure for the benefits. This would certainly give a higher value than obtained from the compensating variation measure and the justification should be that the opening of the park is a reestablishment of human rights to nature or, as Mishan (1976) states : " The pro-environmental economist would, of course. like to use the CV test in order to defer projects that destroy amenity and to use the EV in order to encourage projects that create amenity. And it is interesting to reflect that he could in effect have it both ways in a society that recognized constitutional amenity rights for its citizens covering a specific range of environmental goods."(Ibid ,p.195).

3. SOCIOECONOMIC METHODS

3.1 Survey Method

Survey method, in the context of this study. is understood to mean the estimation of the demand for a recreational facility through non-market means such as surveys, questionnaires bidding games and voting. Freeman (1979) gives three approaches to the problem of revealing consumer's preferences[1]

Get people to state their willingness to pay (for a given quantity of consumption).

Get people to state how much of a good they would demand at a given price.

Get people to vote on alternative programmes.

Approach 1 has been used for estimating recreational benefits (Davis 1963; Hammack and Brown 1974). The problems when applying the survey method are : can people assign a value? and can people be induced directly or indirectly to reveal their preferences without behaving strategically?

These problems have been investigated theoretically by several authors and methods which should induce people to give 'honest' answers have been suggested (Bohm 1971; Tideman 1972; Kurz 1974). Bohm (1972) tested five different approaches tied to a payment scheme to reveal stated willingness to pay and found no significant differences between the methods. A sixth

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1 The approach will be interpreted here as both willingness to pay and willingness to sell.

approach which did not involve any payment was however. significantly different from the others. In that one, people were simply asked to estimate their maximum willingness to pay. Bohm concluded that "this result may be seen as still another reason to doubt the usefulness of responses to hypothetical questions, in general..." (Ibid.,p. 125) and he concludes that if questions are asked with "counterstrategic" arguments, people do not use "cheating strategies". He suggests that two approaches should be used - one which can be expected to produce an overstatement and one which will give an understatement - in order to get an interval for the willingness to pay. This work has later been critisised by Vaux and Williams (1977) for:

1. its relatively small sample size,
2. the relatively small sums of money involved, and
3 the fact that the experimental procedures may have biased the participants' responses in a crucial way (Ibid..p. 496).

Davis (1963) used a bidding game technique where the initial value was determined by the distance people had to come. Brookshire et al. (1976) also used a bidding game technique and found that " it is important to note that the two applications of a bidding game technique are impressively consistent " (Ibid.,p. 339). They concluded that when consumers act rationally they will only overstate their willingness to pay if they believe their personal willingness to pay is above average, or understate it if they believe it is below average. This should lead to a bimodal distribution of willingness to pay if they are answering questions strategically. They find no evidence of this in their results. Therefore they suggest that, if carefully designed and applied, the bidding game technique is feasible for valuation of consumer's preferences. Randall et al. (1978) have applied this result to evaluating development of a coalfield.

Moeller et al. (1980) suggested an informal interview technique for recreation research. The method is very expensive and Christensen (1980) argues against the method for ethical reasons, since the interviewed person is being deceived about the interviewer's intentions.

Hammack and Brown (1974) found considerable differences when asking people about their willingness to pay and willingness to sell, i.e. the price they would demand to give up their right to an area (247 dollars and 1044 dollars per season)

An attempt to use approach 2 - that of getting people to state how much of a good they would demand at a given price has been made by Humphreys (1981) but visitors found it difficult to quantify.

In Chapter 4 some results are presented from a study at the Department of Forestry and Wood Science, University College of North Wales, U.K. in which four different prompting methods were used in order to reveal visitors' willingness to pay. In this study, we found significant differences between the prompting methods used (See 4.3.1.1).

The third approach, using voting for preferences, has been used by, among others, Price (1979) in relation to congestion management programmes. However, the voting approach has the problem that it does not allow expression of intensity of preference by visitors.

3.2 Clawson's Method

The idea underlying this method was first suggestel by Professor Hotelling in a letter to Prewitt (1949) :

" If we assume that the benefits are the same no matter what the distance, we have, for those living near the park, a consumer's surplus consisting of the difference in transportation costs "[2]

In that statement, Hotelling assumes that the overall demand curve will be horizontal, i.e. that the total willingness to pay will be constant for all users

The method was applied to an area in the Sierra Nevada Mountains by Trice and Wood (1958). They divided the areas from where the visitors came into zones and the contribution to the consumer's surplus was the sum of the differences between the maximum travel cost and the travel costs of the visitors from each zone. Trice and Wood used the 90th percentile as the bulk line value The consumer's surplus can be expressed as

$$CS = \sum_i (\max_i c_i - c_i)*n_i \qquad (1)$$

where :

c_i = the travel costs from zone i to the recreation area

$\max_i c_i$ = the maximum travel costs spent by an individual to get to the recreation area.

n_i = the number of people in zone i visiting the recreation area.

2 From Brown et al. 1964.

The method had one obvious major weakness as Trice and Wood pointed out themselves. " In Professor Hotelling's approach it is assumed that people enjoy parks to a similar if not identical extent ..." and the ones, who visit the area from furthest away have in fact established the value of recreation to everyone " (Ibid., p.203)

This shortcoming was corrected by Clawson (1959). He used the same concentric zone method as the previous authors did but he assumed that the last visitor from each zone to a given area was the marginal user in the sense that his total travel cost just equalled his estimate of total satisfaction.

By that method, Clawson first obtained a curve for the total recreation experience and from that one, a second curve was obtained which gave him the demand for the recreation opportunity per se
A short example should clarify the solution :

Example 1

The area we want to examine is shown in Figure 3.1. In the centre is the recreation area R_1 and around that area are four zones from which visitors come. By doing a survey at R_1, the numbers of visitors[3] coming from each zone are determined as shown in Table 3.1. Also found in this Table are the estimated travel costs from each zone to the recreation area and the total population per zone. Finally, the number of visitors per 1000 inhabitants is calculated. It is assumed that no visitor came from further than zone D and that there was no initial entrance fee.

3. It could also be number of visits rather than number of visitors which is determined. This would take into account the same person making more than one visit.

Figure 3.1 · The investigated area

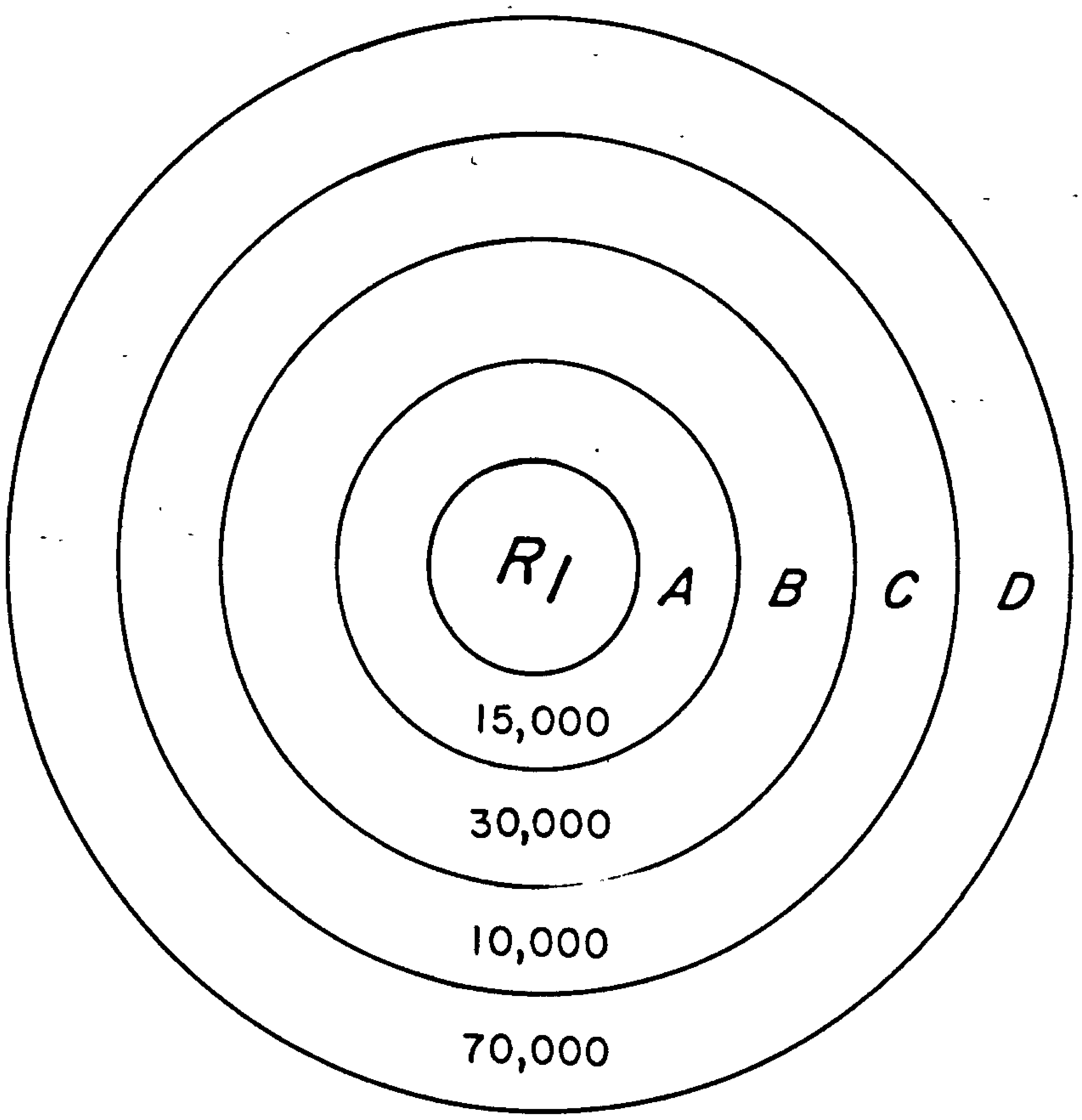


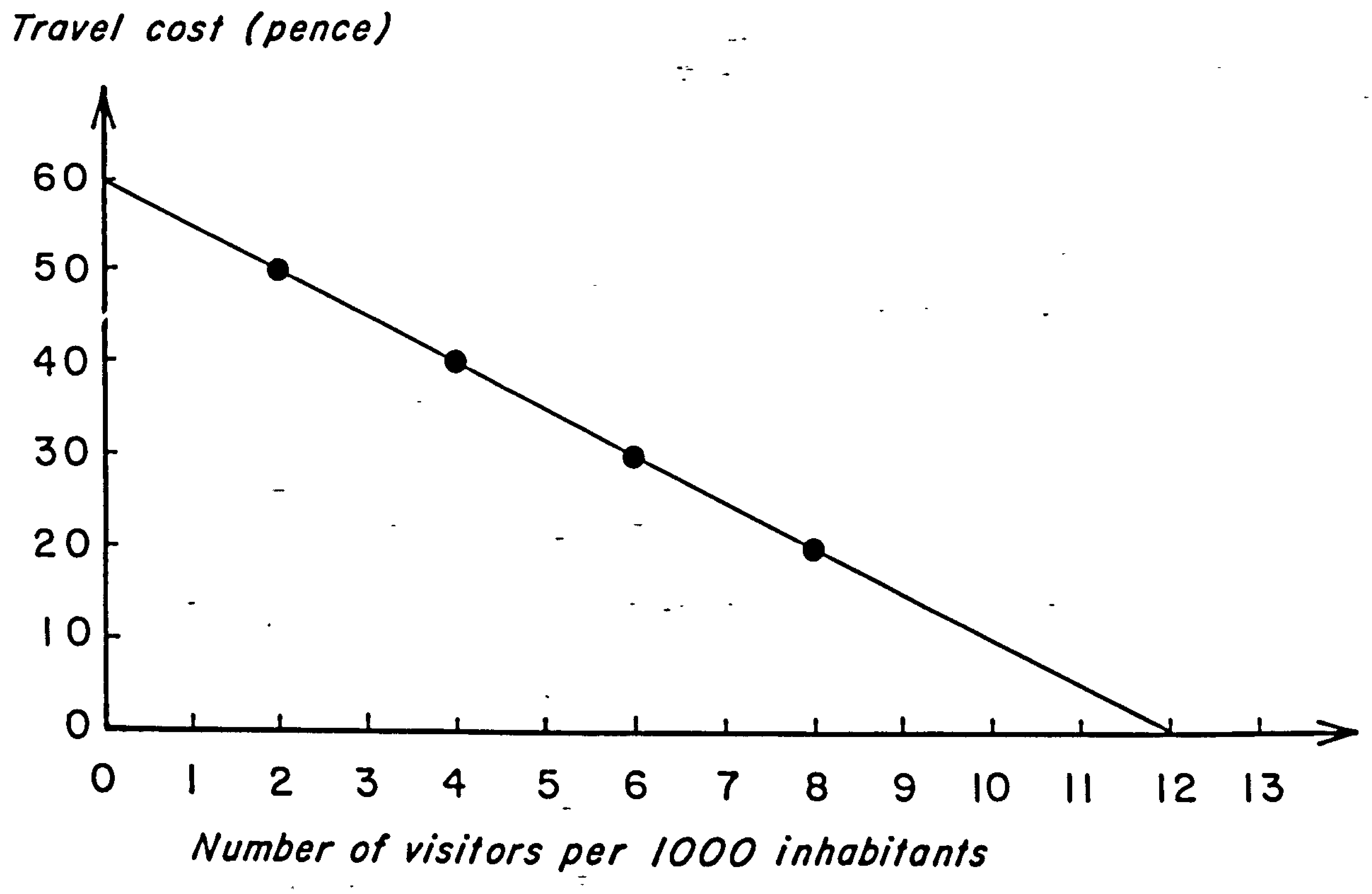
Table 3.1 : Data for trip demand curve for area R_1

	Zone A	Zone B	Zone C	Zone D
No. visitors from zone	120	180	40	140
Population in zone	15,000	30,000	10 000	70,000
Visitors/1000 inhabitants	8	6	4	2
Travel costs (pence)	20	30	40	50

Now the trip demand curve which relates the travel costs to the number of visitors per 1000 inhabitants can be drawn. This is shown in Figure 3 2.

Here, the demand curve has been represented as a straight line in order to simplify the example. In practice it might well be a curve convex to the origin. It should be noted that the curve shows the demand for the total trip package : travel costs and entrance fee, which in this case is zero.

Figure 3.2 : The trip demand curve.



A curve for the actual demand for the area R_1 can be derived from Table 3.1 and Figure 3.2. It is done by assuming that visitors react to the introduction of an increase in entrance fee in the same way as they would react to an increase in travel costs. Introducing different entrance fees, we get the results shown in Table 3.2.

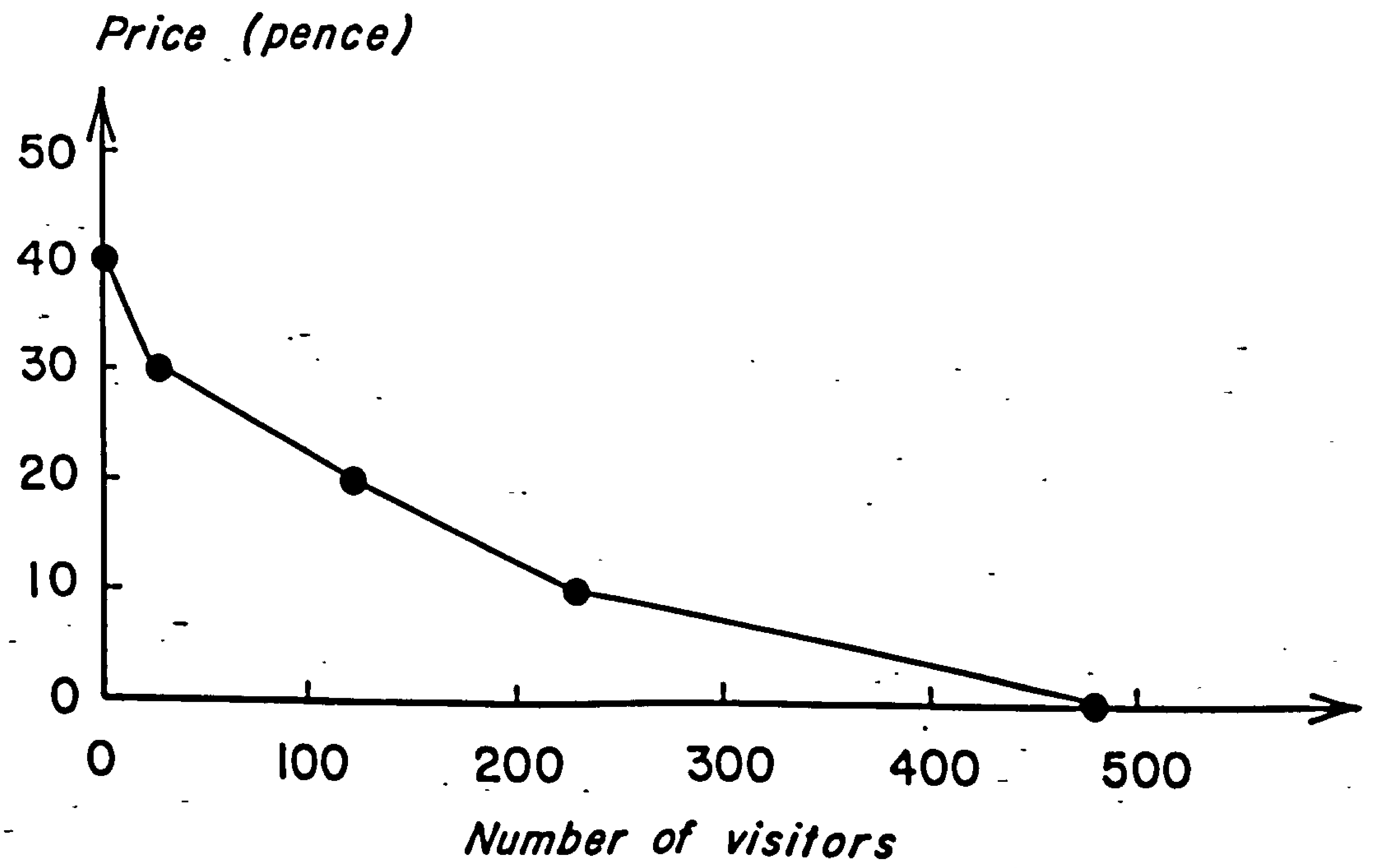
Table 3 2 : Data for aggregate demand curve for area R_1

Entrance Fee (pence)	Visitors from zone A	B	C	D	Total
0	120	180	40	140	480
10	90	120	20	-	230
20	60	60	-	-	120
30	30	-	-	-	30
40	-	-	-	-	-

A value of 120 visitors from Zone B at an entrance fee of 10 pence is found by the following reasoning: Travel costs from Zone B to the recreation area total 30 pence according to Table 3.1. With an entrance fee of 10 pence, the total expenditure will be 40 pence. From Figure 3.2, we find that 4 out of every 1000 people will visit the area, R_1, at the total cost of 40 pence. The population of Zone B is 30,000. Therefore, 120 people will visit the area R_1 from Zone B.

The results from Table 3.2 are plotted in Figure 3.3 as the total number of visitors for different entrance fees. The curve is called the aggregate demand curve.

Figure 3.3 The aggregate demand curve



The aggregate demand curve is interpreted as follows · if the entrance fee is zero. 480 persons will visit the area. If the entrance fee is increased to 20 pence, 120 people will visit the area and so on.

Clawson's paper was primarily concerned with estimating the demand curve - rather than actually trying to evaluate the consumer's surplus and he, in fact, defined the value of the recreational area as an amount equal to the maximum that a non-discriminating monopolist could gain setting a single charge for all users. He stated the following ·

" From the second type of demand curve (the aggregate demand curve)[4], it might be possible to calculate the level of entrance fees and the method of development and management of the area that would yield the maximum net revenue to the owner of the area. This would certainly provide one basis of comparison with other possible uses of water and other resources in the same area."(Ibid.,p.36)

In the above example. this revenue would be approximately 26.27 pounds gained from 170 visitors each paying approximately 15.45 pence. The exact figures showing the optimization procedure can be found in Appendix A3.1.

Clawson takes a private owner's view to the problem and in the same paper, he questions the whole idea of consumer's surplus :

" In fact the usefulness of estimating consumer's surplus is questionable in any situation. Under almost any circumstances some users of outdoor recreation will gain more from it than they would have been willing to pay if necessary. This may be taken for granted; but can you capture it, would public policy permit you to try, and what is to be gained

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4. My addition

from estimating its amount ?"(Ibid..p.31).

The above misunderstanding was corrected by Knetsch (1963) when he reformulated the value concept stating that " the value or benefit, in an economic sense, which is derived from a given use of resources is simply the value it has for the consumer and is measured by his willingness to pay for it."(Ibid.,p.392). In our example, the value of the area R_1 will then simply be the total area under the curve, which is equal to 62 pounds.[5]

For an early discussion of the value concept, see Seckler (1966) who also criticizes Clawson's approach of using the maximum revenue obtainable by a non-discriminating monopolist. See also R.J.Smith in Searle (1975).

The two results given above for the value of the recreation site can be contrasted with that given by the method employed by Trice and Wood (1958). They would assume that the gross benefit of recreation is the 90th percentile of travel cost = 50 pence. Deducting actual travel costs from each zone from this sum, we find a consumer's surplus of 76 pounds.

The Trice and Wood method need not always estimate net benefit, but, because it assumes a high gross benefit for every visitor, it tends to do so The method does not have a correct theoretical justification. and it will not be used. Instead, the Clawson method will be examined in more detail.

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5 In Appendix A3.2, the consumer's surplus is calculated following Equation (3).

Mathematically, the Clawson method can be expressed as :

$$V = f(p + t(r_i)) \qquad (2)$$

where :

V = the rate of visits

p = the entrance fee

$t(r_i)$ = the travel cost from zone i at distance r_i from the recreation area R_1.

And the consumer's surplus can be written [6]

$$CS = \sum_i \left(N_i * \int_0^{\bar{p}-t(r_i)} f(p+t(r_i))*dp \right) \qquad (3)$$

where ·

N_i = the population in zone i at distance r_i.

$\bar{p}$ = the maximum price (toll and travel cost) that will be paid by an individual $(t(\max_i r_i) = \bar{p})$

The above formulation is more or less the one still being used although the demand function (2) has been extended to include more variables. The method is described by Clawson and Knetsch (1966) and Dwyer et al. (1977). For theoretical discussions of the methodology see, among others, Mansfield (1971), Vickerman (1975), Searle (1975), Common (1973) and Flegg (1976). A major review of the theory of measuring the benefits of recreation by methods related to the Clawson method has been carried out by Baxter (1979a), while a more general review on cost-benefit methods in recreation can be found in Curry (1980).

6. The mathematical derivations of consumer's surplus measure in recreation is shown in Appendix A3.3.

Since its introduction, there have been numerous applications of the method, particularly in the United States. In the U.K., early applications of the method were for trout fishing at Grafham Water (Smith and Kavanagh, 1969; Smith, 1971) and for recreation in the Lake District (Mansfield, 1969; 1971).

In the following sections, problems and defects of the method, together with some suggestions which have been made to improve it, will be discussed.

3.2.1 Problems and Defects in the Clawson Method

The major problems of the method are:

Certain limitations on its application:

1. It is only easily applicable where travel costs occur, e.g. not so suitable for sites close to or within urban areas, or when people value the option to participate but do not actually visit.

Questionable assumptions underlying the method:

2. The assumption of identical preferences between zones.
3. The assumption that the only good the visitor gets from his visiting expenditures is the recreational experience within the area investigated, i.e. no utility from the travel itself or from other sites visited in a trip.
4. The assumption that the visitor reacts in the same way to a higher admission fee as to an increase in travel cost.

Omission of certain factors which may influence participation:

5. Valuation of time spent in travel to and recreation at the site.

6. The effect of subsitute sites on recreation demand.

7. Capacity constraints and the effect of congestion.

8. The functional form, i.e. the mathematical expression which best represents the data. This may be affected by the approach used to substitution effects, and in its turn may affect the valuation of time.

9. The degree to which data are to be disaggregated.

Some more extended comments will now be given on each of these points.

3.2.2 Urban applications

If the forest area is so close to an urban area that no travel costs occur or no people from far away attend due to substitute areas, the survey method might prove a better guide (See 3.2.6). An application of the method in an urban situation has been made by Harrison and Stabler (1981). Tucker (1983) has also applied the Clawson method to urban parks using travel time rather than monetary cost, and overcoming the substitutes problem by defining market boundaries for recreation sites.

In the case of option demand, i.e. that people are willing to pay for an option on later use, the Clawson method also fails to estimate part of the net benefit. This is dealt with by Weisbrod (1964). Long (1967) has argued that option demand is just another way of measuring consumer's surplus, but he has not distinguished the concept clearly. Price (1978) discusses the various elements of option demand and proposes that some of them may represent double-counting, while others have to be measured separately.

3.2.3 Homogeneity of populations

The assumption of identical preferences might be shown to be inappropriate if there are considerable differences in social characteristics, i.e. income, education, or if some zones have different recreation alternatives. For a theoretical discussion of the effect of income, see Seckler (1966;1968) who argues that, if one corrects for inequalities in income, one will get a flatter demand curve. Burt and Brewer (1971) and Lewis and Whitby (1972) are among those who have attempted to allow for income effects by including an income variable in their models. McConnell (1975) discusses the relative merits of this procedure as opposed to separate Clawson analysis for each income group. Pearse (1968) has also used income group data in a method of recreation evaluation, but this is similar to Trice and Wood's method (1958) and ignores the refinements introduced by Clawson.

In addition, even within the same zone and income group, visitors may have different preferences with respect to, for example, one-day trips versus weekend trips. This is actually a question relating to aggregation, and Flegg's results (1976) suggest that the orthodox practice of not estimating separate demand functions for holders of daily and seasonal permits is unsound (Ibid.,p.362). This point about aggregation is further discussed in Chapter 4.

3.2.4 Multiple benefits from trips

Many authors have argued that the benefits of the recreation experience are not confined to the destination site. Cheshire and Stabler (1976) have questioned " whether visitors to recreational sites regard their journey as pure costs or even costs at all " (Ibid.,p.350). In their survey of travel to a recreation site in south England they find some evidence against that view.

In a survey of the Forest of Dean, Colenutt (1969) found that " more than 70 per cent of the trippers from the major centres of trip generation, Bristol, Newport, Cardiff and Birmingham, do not take the shortest route to the Park either on the outward or on the return journey. " (Ibid.,p.45). He concludes that distance is not a simple disutility and, instead of minimizing travel time, it seems that the tripper tries to maximize the recreational benefits he can obtain from both travel time and time spent on stopping points.

In a similar study, Elson (1975) found that 31% of all trips included at least two stops (i.e. a stop in addition to the destination) and, of this group, 41.5% made two stops in addition to the destination.

If there is benefit from the travel in itself, or if some other site is visited on the trip, the Clawson method will overestimate the benefits attributable to the site under investigation.

3.2.5 Reaction to site entrance fees

The mathematical formulation of the Clawson method (see equations (2) and (3) above) proposes that a reduction in the number of visits that would be brought about by a given entrance fee is equal to the reduction brought about by the same cost of travel. However, this need not always be true.

Various reasons can be found which might explain the inconsistency between reaction to entrance fee and travel cost. For example, as will be discussed in 3.2.5., time is a part of travel cost. The rate at which recorded visits decline with increasing distance is due to increase in both money and time costs. The decline will not be so rapid if it is only money cost that increases. Therefore responses derived from the money and time costs of travel will underestimate the visits that would be made when entrance fees are postulated.

In addition, the effect of a capacity constraint is dealt with by McConnell and Duff (1976). They show that, under conditions of excess demand, more than one trip is required on average to gain one admission. Therefore response to cost defined in relation to a single trip will again underestimate the visits that would be made if an entrance fee was added to travel cost.

In addition, people may simply differ in the way they respond to different types of cost, or may not have a very clear idea of what some classes of costs are. In a survey of canal-based recreation, Harrison and Stabler (1981) find that " the results show that motorized visitors perceive leisure travel expenditures independent of other leisure expenditures. " They conclude this " also means that the concept of using a consumers surplus deduced from the visit rate demand curve cannot be justified. " (Ibid.,p.356).

Some efforts to solve the time and capacity problems will be described in 3.2.5 and 3.2.7., normally working along the lines of more detailed specification of the model. Incorrect or unclear perception of travel costs raises important problems which are discussed later, though it is probably true that on longer journeys to forest recreation sites it becomes more difficult to ignore the travel costs.. If however response to entrance fees differs from response to travel costs only because people are expressing ethical objections to the idea of charging (as we found in our survey, described in Chapter 4), the Clawson method may still be valid. We might not be able to use it to estimate how people would respond to an entrance fee (e.g. if we wanted to prevent overuse of the site) but if we want to interpret willingness to pay as utility, the method can still be useful.

3.2.6 Time Bias

As the number of visits expressed in Equation (2) is only a function of entrance fee and travel costs based on distance and does not include any variable for time, a bias arises when calculating consumer's surplus.

For a major study on the theory of allocation of time see Becker (1965) who has built his theory on the " assumption that households are producers as well as consumers; they produce commodities by combining inputs of goods and time according to the cost-minimization rules of the traditional theory of the firm. " (Ibid.,p.516). Although Becker's work is concerned with the work/leisure trade-off, the same principles apply here.

The reason for not including a time factor in many recreation studies is that travel time is highly correlated with travel distance and it is, therefore, not possible to estimate both factors accurately at the same time. Instead, the obtained trip demand curve is, in fact, an observation of trip response to both time and travel costs, but it is treated as a response to money costs only. This leads to the observed demand curve being consistently biased to the left of the true demand curve. causing the consumer's surplus to be underestimated. Knetsch (1963) explained the problem by describing the inverse situation : " If we could somehow reduce the money cost of the more distant group to that of the less distant one, the number of visits would increase. But it would almost certainly not increase to the rate of the second group because they still need to spend some more time than this group and many could not or would not take the time to travel to the area ". (Ibid.,p.395). Another way to treat the problem is to look at each zone as having its own demand curve ·

$$v_i = f_i(D_i, T_i, P) \qquad (6)$$

where ·

v_i = the visit rate from distance zone i.

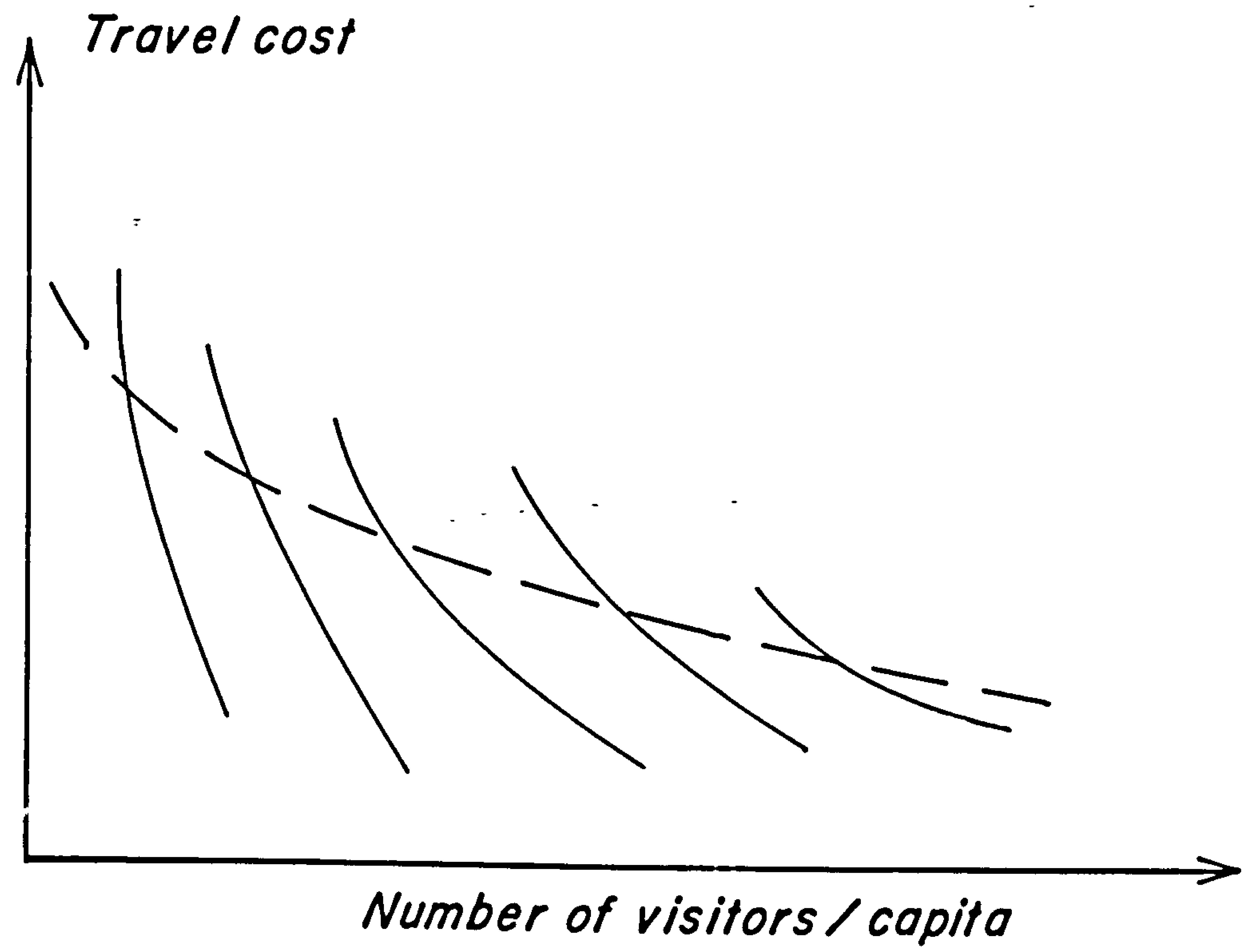
T_i = the time from zone i.

D_i = the distance from zone i to the recreational area.

P = the entrance fee.

So the number of visits is a function of the travel costs. time costs and entrance fee. The curves are shown in Figure 3.4., one curve for each zone, in such a way that the curves become more and more inelastic the further the distances.

Figure 3.4 : Separate demand curves for each zone



This follows Knetsch's research (1964) where he found "...results are consistent with the expectation that recreation resources exhibit elastic demand curves for users within close proximity to recreation facilities. where a dollar change in price has a large effect on low visit costs with more inelastic curves for users at greater distances, where a similar price change would have less effect on already high cost visit."(Ibid.,p.1153).[7]

What will be observed in a Clawson analysis is actually the dotted line in Figure 3 4 or the intersection points, i.e. the marginal user from each zone. It is obvious that by using this curve we will underestimate

7. It is not clear whether Knetsch distinguishes correctly between slope and elasticity.

the true value for consumer's surplus.

Cesario and Knetsch (1970) proposed a trade-off function between time and money costs of the following form :-

$$\text{Travel costs} = C^{*}T \tag{7}$$

where

C = money costs

T = time costs

The above function (7) ensures convexity as is normal for welfare trade-off functions but "..though the original bias is not present. the new formulation does require an assumption concerning the trade-off function between time and money. There is no guarantee, without some empirical verification, that the slope indicated by this particular formulation of the trade-off between time and money is correct."(Ibid.,p.704).

In a later work the same authors (Cesario and Knetsch 1976) estimated travel cost by using two alternative forms, one convex like the one above (7) and another one linear Testing the models, they found no substantial differences between estimates obtained by using alternative formulations except that the convex one always gave benefit exceeding the linear one.

The results of using a linear trade-off function for time in the previous example are shown below, though it must be emphasized that this is only one possible functional form.

Example 2 :

We extend Example 1 by adding time costs to the travel expenditure. The shadow price for time is given as 60 pence per hour for the sake of illustration. Taken together, the costs rise as shown in Table 3.3 below :

Table 3.3 : Data for trip demand curve when time costs are included

Zone	Travels costs (pence)	Time for travel	Time costs (pence)	Total costs (pence)
A	20	10	10	30
B	30	15	15	45
C	40	20	20	60
D	50	25	25	75

From Table 3.5, we can calculate the demand curve and as shown in Appendix A3.7 the consumer's surplus will now be 93.00 pounds or an increase of 50 %.

In the same way as we may underestimate consumer's surplus by ignoring time costs in our calculations, we may overestimate the consumer's surplus if the shadow price for time is too high. For example, many studies have shown that non-work time is actually valued far below the hourly wage rate (e.g. Beesley 1965). Cesario (1976) found : "...that on the basis of evidence collected to date the value of time with respect to non work travel is between one quarter and one half of the wage rate."(Ibid.,p.37).

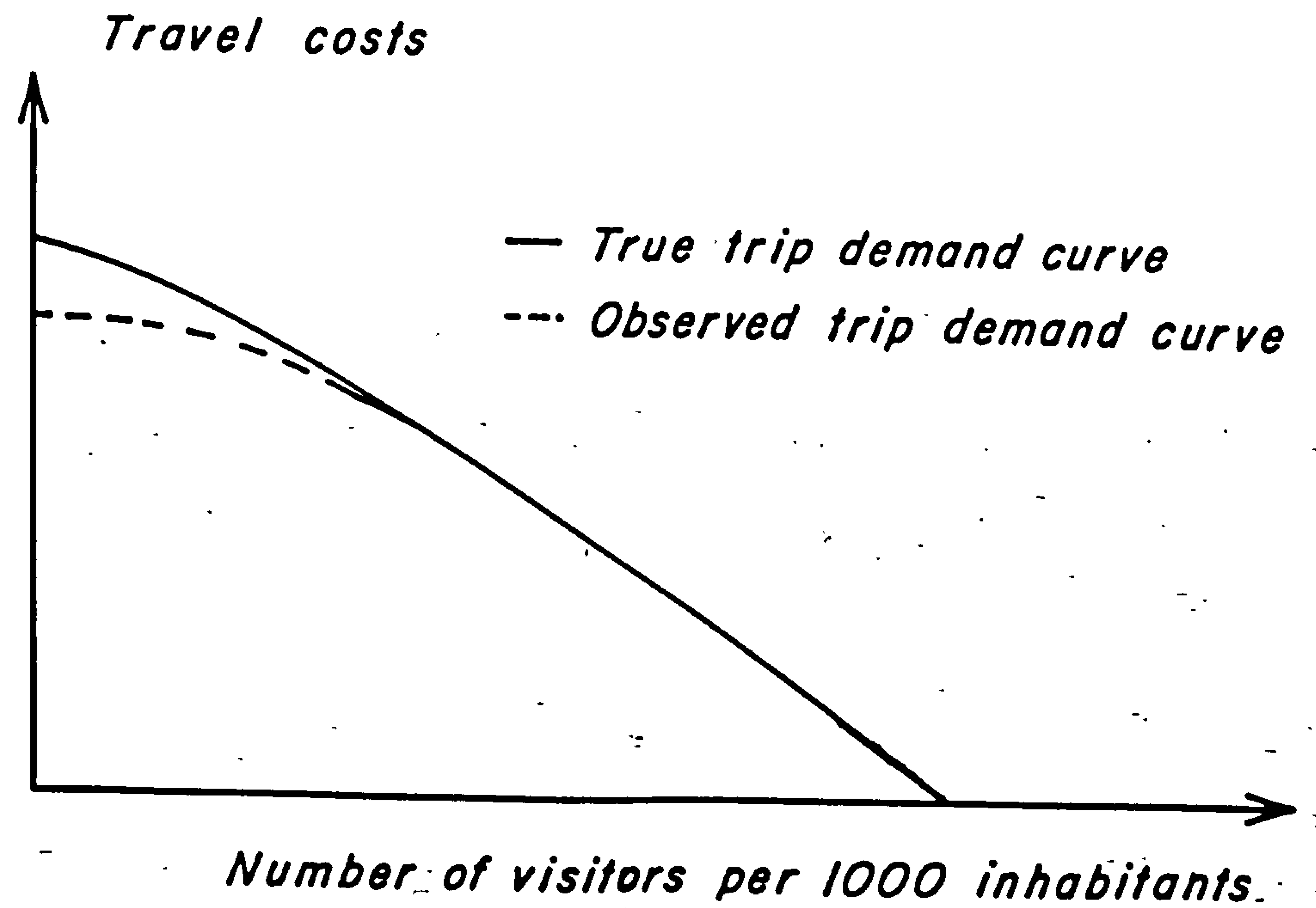
This can be partly because people are comparing time saving with post-tax wages. Also Collings (1974) stated that the value of travel time savings is the resource cost offset by the enjoyment derived from travel time. This does not much help us in solving the problem, because we might want to use some technique based on the Clawson method to determine the enjoyment derived from travel time. Common (1973) has suggested an econometric method to value travel time for recreation journeys, but it means we have to assume a given functional form for the value of time.

Valuation of time is a very general problem in studies of leisure, not just for informal outdoor recreation, and there are no really good solutions to it. The many studies that have been made of travel time saving have mostly related to savings on journeys to work or on business trips rather than on leisure trips. If we take what has been said in this section together with the points made about benefits from travel in 3.2.3, travel time may be a net cost, or a net benefit, or the effects may cancel.

3.2.7 Substitutes

The further away people are living from a given area, the higher the probability is that there exist some substitute recreation areas closer to them, i.e. there is a positive correlation between distance to a specific area and the number of available substitute recreation areas. This results in the demand curve shown in Figure 3.5.

Figure 3.5 : The curtailed demand curve.



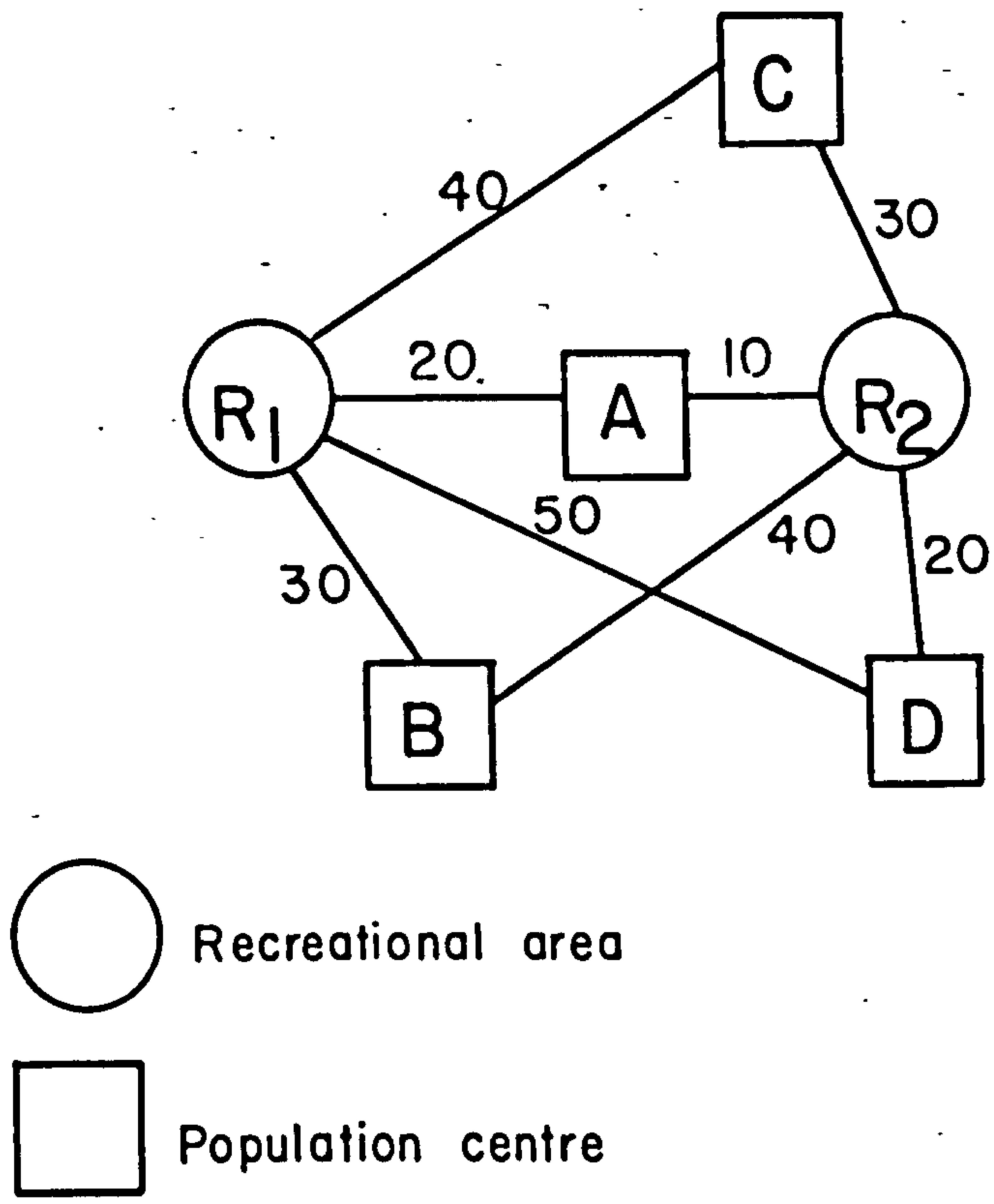
The problem implies that the value for p, the maximum sum of willingness to pay or the maximum travel cost used in Equation (3) will be underestimated and that this will cause the total consumer's surplus to be underestimated as well.

An overestimation of an area's value can also occur if the influence of the substitute area is ignored when deriving the aggregate demand curve. This can happen if people from an area A have an identical recreation area to that analysed at a distance from the recreational area to which the additional transportation cost is, say, 10 pence. When, from the observed trip demand curve, we derive the aggregate demand curve, we then have to take into account the fact that the people from area A will never be willing to pay an entrance fee increase of more than 10 pence. Otherwise they will just shift to the area further away. The following example, which continues from the previous one, will serve to illustrate the problem.

Example 3.

We will now extend Example 1. In order to make it easier to illustrate the problem, we will change the previous assumptions so that the four zones, A,B,C,and D now are interpreted as four population centres. This makes no theoretical or practical difference. We now plan to introduce another recreational area, R_2 in addition to the already existing area R_1. The situation is illustrated in Figure 3.6 along with the given travel costs from population centres to recreational areas. The two areas R_1 and R_2, are supposed to have the same recreational quality

Figure 3.6 · A recreation system with substitute areas



30 Travel cost from population centre to recreational area (in pence)

The problem is now to try ex ante to estimate the value of the planned area R_2 In Example 1. we have already established the demand for recreation which is shown in the trip demand curve in Figure 3.2. From Figure 3.6, we can see that people from C will now go to area R_2 instead of R_1 because travel costs to R_2 are 30 pence as opposed to the 40 pence they were spending to go to R_1. However, people from C will only go to R_2 as long as the entrance fee is less than or equal to 10 pence - otherwise they will switch back to R_1. This is summarized in Table 3.4.

Table 3.4 : Data for trip demand curve for area R_2

	Zone A	B	C	D
Will go to R_2	+	–	+	+
Population	15,000	30,000	10,000	70,000
Travel costs to R_2 (pence)	10	(40)	30	20
Travel costs to R_1 (pence)	20	(30)	40	50
Will shift to R_1 when fee at R_2 }	10	(-10)	10	30

The data for the imputed demand curve are derived below in Table 3.5.

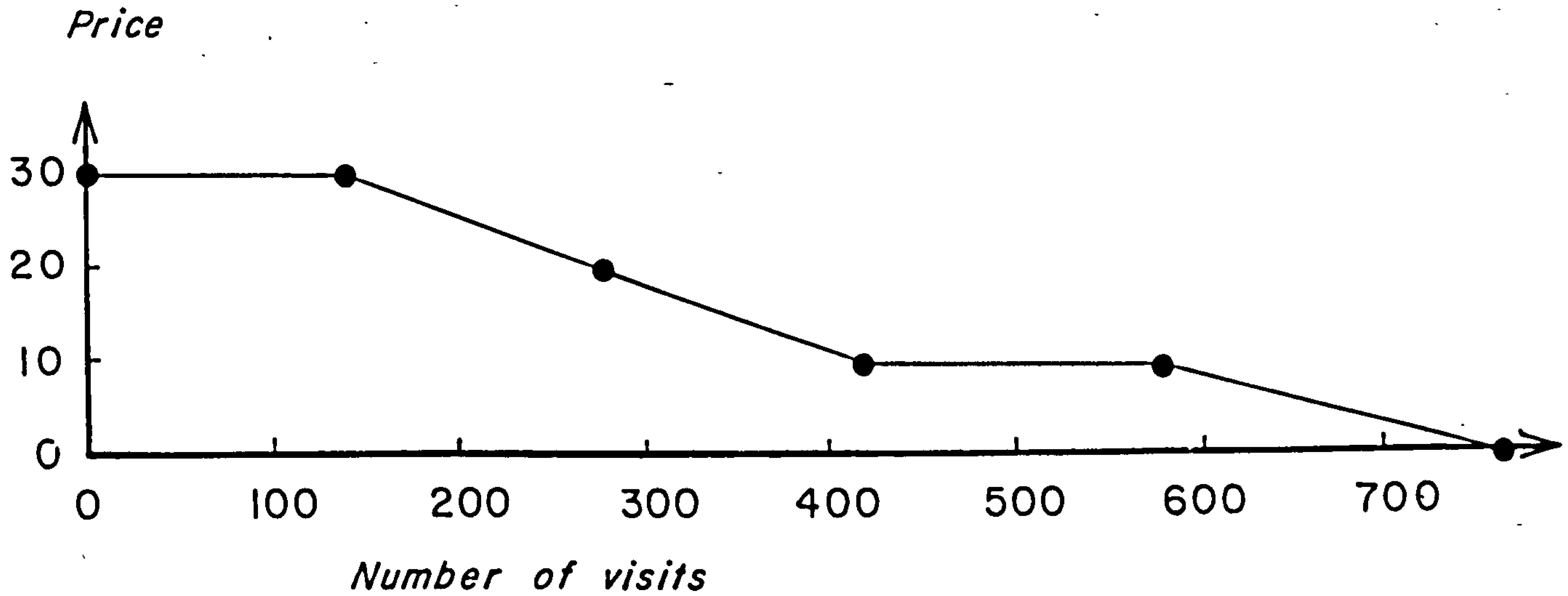
Table 3.5 : Data for aggregate demand curve for area R_2

Entrance Fee (pence)	Number of visits from A	B	C	D	Total
0	150		60	560	770
10	120		40	420	580
>10	-		-	420	420
20	-		-	280	280
30	-		-	140	140
>30	-		-	-	-

The aggregate demand curve, which is seen to be stepped, is shown in Figure 3.7 and from that, we can find the consumer's surplus to be 123.50 pounds.

The problem can also be solved with a normal microeconomic approach. From Figure 3.6, we can see that the people from C going for recreation now save 10 pence per visit which makes a total of 4 pounds (Table 3.2 tells us that there are 40 visitors). The same procedure for A and D makes a total of 58 pounds in saved travel costs. Then, from Figure 3.2, we see that a decrease in travel costs from 40 pence to 30 pence generates two more visits per 1000 inhabitants or, a total of 40 more visits from C. The consumer's surplus from these 20 people will be 1 pound since the average is 5 pence per person. Again, applying the same procedure to C and D gives a total of 65.50 pounds from new visitors and the total consumer's surplus from introducing R_2 will be 58.00 + 65.50 = 123.50 pounds.

Figure 3.7 : Aggregate demand curve for area R_2



It is noted that in the above example, " the loss in value that befalls an old facility can and should be ignored in the net gain attributable to a new facility but the measure of the gain to the new, if it is to provide a proper guide, must take appropriate account of existing facilities." (Knetsch 1977,p. 129) At first glance, this may seem strange but returning to the example we can see that the value of R_1 and R_2 must be 62.00 + 123.50 = 185.50 pounds. The same value is found if we calculate the benefits for R_1 and R_2 together as shown in Appendix A3.4. Even more interesting is that if we calculate the value of R_2 assuming that R_1 does not exist, we will get a value of 170.50 pounds as shown in Appendix A3.5. If we want to find the real value of R_2, we must subtract the opportunity costs which are, in this case, equal to the value of R_1 before R_2 was introduced minus the value of R_1 after R_2 was introduced.[8] So the value of R_2 equals 170.50 - (62.00 - 15.00) = 123.50 pounds as we found before.

Howe (1977) has also addressed the problem, and states the principle "that we want to measure the differential willingness of former users of the old facility to pay for the new, i.e. the increase in their willingness to pay. For all users who for the first time are attracted to recreation at the new facility, total willingness-to-pay is appropriate." (Ibid.,p.496).

Mansfield found that "there is a considerable discrepancy between estimates of the benefits to be derived from new recreation facilities, as calculated by the 'crude' Clawson method of estimating them from some other recreation sites of comparable size and type, and estimates which take account of potential diversion from other areas." (Ibid.,p.68). He also draws attention to the problem of evaluating the relief of congestion in other areas with the introduction of a new recreation area.

The problem in practice is that we do not usually have an estimate of the "true" demand curve for the recreation experience because some subsitutes probably exist already when we estimate demand for the old facility. Price (1979c) provides a solution " by the simple expedient of basing visit rates, not on visits per year per 1000 population, but on visits per year per 1000 population for whom this is the nearest facility of its type "(Ibid.,p.278).[9] However, this might lead to a part of the

---

8. The calculation of the value of R_1 after R_2 is shown in Appendix A3.6.

9. A method proposed by Bouma (1976) tries to avoid the problem by taking the residential area as the centre of attention. This might not solve the problem as, although some people might visit forests further away than others, this may not be a true observation on willingness to pay. If we had rational consumers, they all ought to visit the same (nearest) forest unless there were qualitative differences or congestion, etc.

curve not being estimated at all.

3.2.7.1 Substitutes and attractiveness

If not all substitute sites are equally attractive, the substitution is more complex than has been described above.

Elson (1975) found a distribution of trip distances which " can only be explained by the fact that attractiveness of the destination is of more importance than the distance travelled and the time used provided that the journey is less than 40 miles. " (Ibid.,p.168).

Baxter (1979b) discusses the potential consequences of modelling perceived destination attractiveness in certain types of trip distribution models and finds that modifying the distance or cost terms or even specifying additional distance or cost components can, in some cases, lead to markedly improved model performance.

On the other hand, Talhelm (1980), while working on substitute angling sites, found that if any two sites offer the same product they are "perfect" substitutes so anglers go only to the most convenient (i.e. least expensive) site.

One way to correct for the distortions from substitute areas, including ones that have different attractiveness, is to use multiple linear regression analysis methods, as done by Burt and Brewer (1971). They estimated a system of five interrelated demand equations of the following form :

$$q_{ij} = a_j + \sum_{k=1}^{5} b_{jk} * p_{ik} + d_j * Y_i + e_{ij} \qquad (4)$$

where :

q_{ij} = the visits by individual i to the site of type j

p_{ik} = the trip costs for i to reach nearest site of type k

Y_i = the family income of individual i

a_j, b_{jk}, d_j = coefficients to be estimated where the matrix b is symmetric, i.e. $b_{jk} = b_{kj}$

i = 1,2,....,n (observations)

j,k = 1,...,5 (types of sites)

e_{ij} = the random error.

Cesario and Knetsch (1976) used a single equation model of the structure shown below :

$$v_{ij} = \theta * G_i * F_j * \exp(b * c_{ij}) * \left(\sum_{k=1}^{m} F_k * \exp(b * c_{ik})\right)^a \qquad (5)$$

where

v_{ij} = the number of visits per unit time made to site j from population centre i

G_i = characteristic of the population centre

F_j = characteristic of the recreation centre

c_{ij} = the travel cost from i to j

k = 1,...,m (specific sites)

θ,a,b = parameters.

The above equation includes both an attractiveness index and the location of substitutes. An increase in attractiveness or accessibility of competing sites will reduce visits to the analysed site. In this Cesario and Knetsch improve on the logic of the method of Burt and Brewer, which allows coefficients to have perverse signs, i.e. an increase in accessibility of a site can lead to fewer visits being predicted (Price, 1983)

Both methods have the problem, that they do not explain why visits to a site should be influenced by a substitute in the way shown.

3.2.8 Congestion

The aggregate demand curve shown in Figure 3.3 assumes that, in the normal non-charging case, there will come the number of visitors indicated by the demand curve's intersection with the X-axis. However, this might not be the optimal number of visitors as the marginal user might diminish the utility and, therefore, the willingness to pay of the users already there more than it benefits the marginal user himself. This means that the congestion occurring becomes a negative externality to the original users. Stankey (1972) showed that solitude was an important factor in creating satisfaction with the recreation experience and, in his sample, 82% felt that " solitude - not seeing many other people except those in your own party " was desirable (Ibid.,p.100-101). Cicchetti and Smith (1976) have studied stated willingness to pay for reduced congestion using a questionnaire technique. Recent questionnaire results (e.g. by Shelby, 1980), have cast some doubt on the strength of the relationship between satisfaction and congestion. However, the weak relationship can largely be explained in terms of interview bias when crowd-tolerant visitors replace crowd-averse visitors in times and places of high-intensity usage (Burton, 1973). Vaux and Williams (1977) concluded after performing a Clawson analysis] that " solitude is not an attribute of overriding importance " (Ibid.,p. 602) but this does not mean that congestion is unimportant. Price (1983) has shown how Vaux and Williams's results may arise as a consequence of differential congestion between substitute sites.

Overuse can be related to physical, ecological and perceptual capacity (Price 1979a, p. 3), all of which may cause the same kind of problems explained in the following two sections:

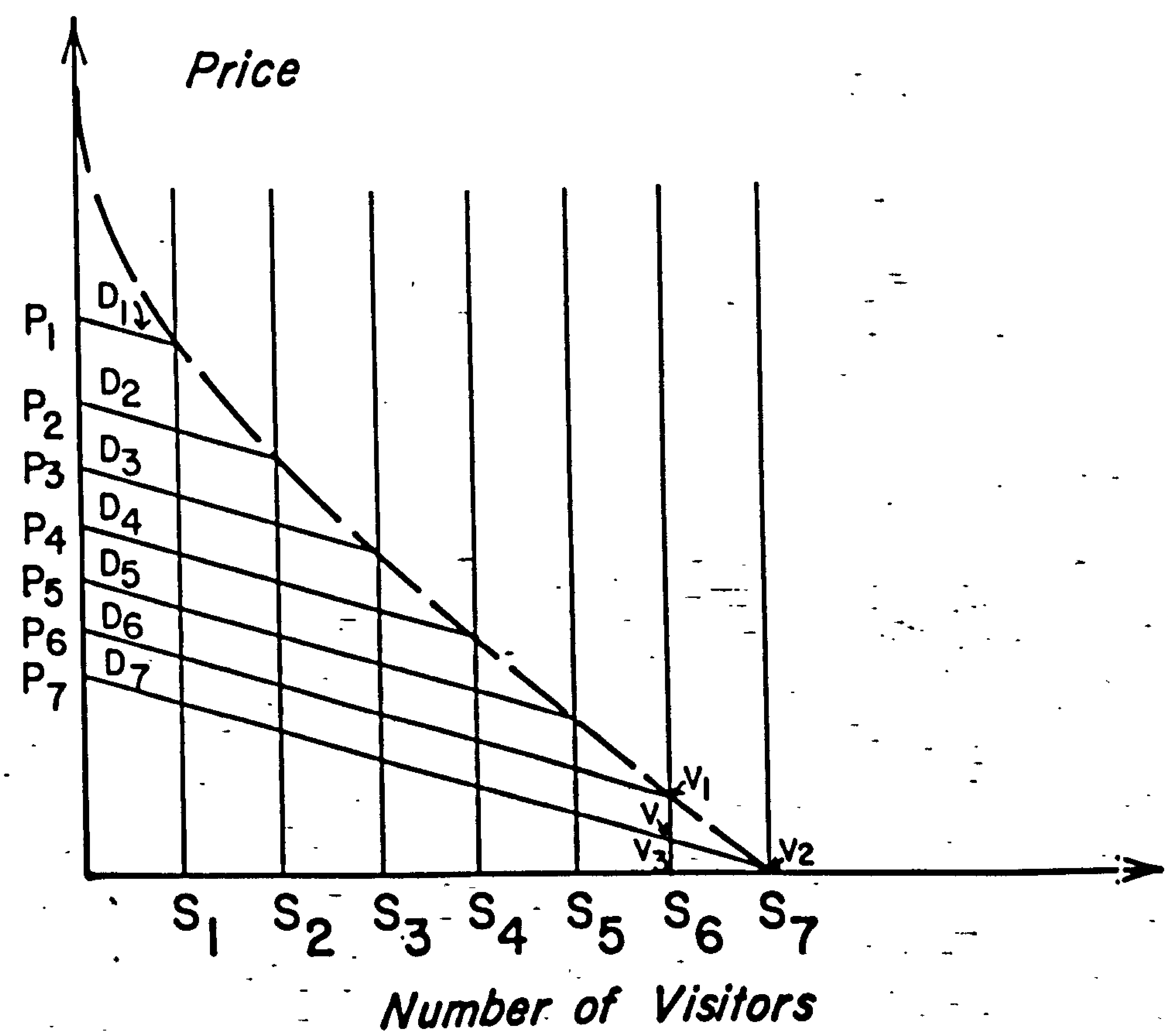
a) How are we going to estimate the value of a specific area when congestion or excess demand is present? and

b) how are going to adjust the use to the optimal or 'desired' level?

3.2.8.1 Estimating the Value of Recreation under Congestion

Fisher and Krutilla (1972) worked on the theory of optimal capacity and produced a figure as shown below (Ibid., p. 121):

Figure 3.8 : Demand curves under congestion



Here, they have shown a system of demand curves for different levels of supply. The system is represented as being discrete, but a continuous system of demand and supply curves yielding the demand function - the dotted line in Figure 3.8 - can be imagined.

The problem occurring when we apply the Clawson method to an area is that we have a given level of congestion and we obtain only one set of demand curves, e.g. D_7 or perhaps a combination of curves if people did not know the level of congestion before starting out on their trip Reducing the visit rates from S_7 to S_6 would benefit the remaining users by an amount equal to the area $P_7VV_1P_6$ for a cost of VV_2V_3 for the users S_7 - S_6. The problem of how to reduce the visit rates will be discussed further in the next Section.

McConnell and Duff (1976) extended the explanation of congestion and showed that the Clawson zone method underestimates the total benefits of a recreation facility when excess of demand leads to some visitors being excluded, because on average one return trip produces less than one admission to the site Using the concepts of Equation (3) they found (Ibid.,p.228):

$$\frac{\delta \pi x}{\pi p} = f'[t(r)/\pi + p] \tag{8}$$

where: π = a function of perceived excess demand; i.e. is the visitor's perceived probability of admission.

Equation (8) shows that the response to price changes (entrance fees) will be different from the response to travel and transfer costs under conditions of excess demand. This means that the obtained demand as shown in Figure 3.3 will underestimate the consumer's surplus if excess demand is present. The discussion of the problem has been simplified by Price (1979b).

What happens when we extend the previous example assuming an excess demand is shown below:

Example 4.

Take the same data as shown in Table 3.1. In addition, we assume to be 0.8, i.e. visitors perceive the chance of being admitted to the recreational area R_1 as 80%. The data are shown in the Table below.

Table 3.6: Data for trip demand curve in the case of congestion.

	Zone A	Zone B	Zone C	Zone D
No. visitors from zone	120	180	40	140
Population in zone	15,000	30,000	10,000	70,000
Visitors/1000 inhabitants	8	6	4	2
Travel costs $t(r)$	20	30	40	50
Travel costs per visit $[t(r)/qT]$	25.0	37.5	50.0	62.5

From Table 3.6, we can find the trip demand curve as shown in Appendix A3.8 and the consumer's surplus will now be 77.50 pounds.

3.2.8.2 The Technique of Exclusion

If the Clawson analysis is carried out in order to estimate the value to be introduced as a fee to keep the number of visitors under a certain level (carrying capacity), the following should be kept in mind :

1. A perceived cost should be used. For example, if it is a derived technique in use, then the estimated travel distance should be multiplied

by the actual petrol costs (marginal costs for the individual).

2. Net time costs should be included if possible.

3. It has been shown that consumers may not respond to a fee as they do to travel costs.

4. Our example in 3.2.6 shows that the measured demand curve will estimate the numbers who divert to substitute sites as well as those who no longer are making any trip at all.

Also we have to decide on the basis for how to exclude, i.e. do you actually charge or do you choose to make a simple exclusion by either pre-obtaining free tickets or closing the gate when the area is filled? These types of questions must be left to the politicians to decide and the goal of the 'experts' should only be to identify possible alternatives and to predict their consequences. Price (1981) has shown that the distributional effects of charging contra excluding are not so clear as the politicians might think.

3.2.9 The functional form of the demand function

The mathematical form of the function to be used to fit the observations has been reviewed by Baxter (1976) and theoretically discussed among others by Flegg (1976) and Cheshire and Stabler (1976) who have considered different forms.

Linear forms have been widely used because of their convenience and simplicity. See for example Bowes and Loomis (1980). Flegg (1976) looks into the use of a multiplicative model and an exponential model and concludes "that the multiplicative form conventionally postulated for recreational demand functions has no advantages and some disadvantages over the exponential form" (Ibid.,p.355).

The choice of the right mathematical form can often be determined by the use of well-established statistical procedures, but this choice might not necessarily be satisfactory. Cheshire and Stabler (1976) point out that in some cases there might be a finite value for maximum cost - "when using a log linear implies no upper limit to either the visitor rate or the distance that visitors travel" (Ibid.,p.346). They also point out that using an exponential function implies that there are " visitors travelling impossible distances " (Ibid.,p.347).

In this study a linear function, a 2nd degree polynomial, a log linear function and an exponential function are tested. These are forms that have been used by earlier workers, and they have the characteristics required to fit the data. A great deal of attention has been put onto the question of weighting the observations explicitly on the basis of assumptions about their statistical distribution.

3.2.10 Aggregation of data

The traditional Clawson method has worked on a high level of aggregated data (few zones), but many works have shown the advantages of using more disaggregated data in the sense that the variables included in the demand function will tend to be less correlated: "One of the original motives for using disaggregated data was that the distinction between the monetary cost of travel and travel time could be maintained since the correlation between these variables is much reduced if individual data rather than zonal averages are used - facilitating the use of both variables in the estimated demand function" (Baxter 1976. p.24).

Disaggregation can assist us in separating the influence of monetary cost and travel time if, for example, a concentric zone can be divided in such a way that significant differences of travel time occur between the subdivided zones. Also, if time costs are to be combined with money costs the trade-off function can be applied to individual data.

Flegg (1976) is critical of the practice of aggregating data into a few zones. which he argued produces misleading improvement in the apparent explanatory power of a given model by "averaging out" variation. It can also produce substantial differences in parameter values. He states that if aggregation is undertaken one must use the method of "weighted least-squares" or else equalise the numbers of local authority areas included in the aggregated zones in order to prevent heteroscedastic estamates: we pursue this theme further in Chapter 4. However, Flegg stresses "that an even more precise estimate can be obtained using disaggregated data" (Ibid.,p.358)

Disaggregation eventually leads to a large number of zones from which no visitors are recorded, and introduces excessive variability to the regression. To avoid this. we have investigated the effects of aggregation by combining zones in different ways in Chapter 4. We also deal with different methods of treating zones with zero visits in Chapters 4 and 5.

3.3 Conclusion

The Clawson method has been criticized since it was proposed in 1959 because of its limitations, its assumptions and its oversimplifications. Common (1973), with reference to the works of Smith and Kavanagh (1969) and Mansfield (1969) found that it is essential that the sensitivity analysis be paid at least as much attention as any final number selected to represent surplus. In addition, he states that it may be necessary effectively to abandon the Clawson approach although " if the simplicity of the Clawson approach is lost, cost benefit analysis looks a lot less attractive. " (Ibid.,p.406).

Other methods are being developed, for example survey methods are becoming increasingly popular and have been used in a number of recent studies. The findings in Chapter 4. however, indicate that survey methods may not be appropriate to studies where visitors are not accustomed to paying for entry to sites There was not the data available to assess the appropriateness of the survey technique in the case of the Danish data used in Chapter 5. In that study, the only data available pertained to the visitors' behaviour, i.e travel distances. In both the British and the Danish forests, there is the problem that access to state forests has traditionally been free. while in Denmark there is now a right of free access even to private forests. This makes some political difficulties in applying the survey method. both because people may react against the idea of a charge, and because the forestry organizations may not like such questions being asked. Even though the purpose of the survey is not to set a charge, but only to assess benefits, nevertheless people will be suspicious of the reasons for the survey. Questions about "willingness to sell" (Meyer, 1981) may give a very different response, but still people will be suspicious. The survey method might prove a useful alternative to the Clawson method in other circumstances but it still needs further research into the techniques of how to reveal the willingness to pay.

The use of the household production function, which focuses on the origin of the trip rather than the destination, has been recommended by some authors. In their research on congestion, Deyak and Smith (1978) adopted a two-step method " since it seems reasonable to expect that congestion may well have different implications for the decision to participate and the level of participation. " (Ibid.,p.71).

Bockstael and McConnell (1980) used the household production function for measuring the benefits of wildlife recreation and discussed problems of how the approach can be used to capture not only net benefits of wildlife recreation but also the relationship between public actions and private decisions. These authors also discussed the empirical issue of how to estimate the household production function.

The household production function offers some good insights into some aspects of recreation. e.g. congestion and substitution, but in other ways it just involves looking at trip distribution patterns from the opposite end to the Clawson approach In fact, the method will encounter many of the same problems as Clawson. The household production function is appropriate in evaluating outdoor recreation in general and in relation to national policy. However, for examining land use problems at a particular site the Clawson method may be better.

In spite of all the criticisms, then, the Clawson method is widely regarded as the best available method for evaluating recreation at an individual site. It has the advantage of referring to revealed willingness to pay rather than stated willingness to pay, which is in line with the beliefs of economists generally. By contrast with the earlier consumer's surplus method, it allows that there is a distribution of willingness to pay in the population of recreationists. It can be employed by collecting data at the site of interest, and the data are then specific to that site. No alternative method seems to offer all these advantages The required data are rather easy to collect and in fact such data can often be found in secondary sources. This proved a decisive advantage in our case, as suitable data for recreation in forests were already available In particular, the Danish data included many forests and several thousand visitors, and were available only because of large-scale funding for a previous project. Being site-specific, and containing information on zone of origin of visitors, this data set was ideal for application of Clawson analysis. Also, because data existed for all the important recreation forests in a region it was possible to investigate substitution. The data were recorded on magnetic tape, so there were minimal problems of feeding it into a computerised Clawson analysis.

Because of its elegance and simplicity, the Clawson method has drawn the attention of many researchers, and consequently many problems with the method have been identified. However, it is obvious from what has been said above that many authors are working to try to solve the problems and improve the method.

It would not be possible in one thesis to develop new conclusions in each of the problem areas that have been discussed. Therefore, two problems that are especially important to forestry have been considered in depth.

1. In the U.K., many of the new forests lie at a very long distance from major population centres They are mostly visited when people are on holidays. Such holidays are not directed only to the forests but include visits to many other recreation sites Thus we have the problem outlined in 3 2.3, i.e. how much of the benefits of the whole trip can we assign to the forest? This problem is addressed in Chapter 4.

2. In Denmark, there are many forests close to major population centres. Therefore the problem of substitution occurs. In Chapter 5, an attempt has been made to measure the demand for individual sites. while remembering that there are substitutes, and to consider the effect of different attractiveness of site in an empirical way.

We consider also problems which are more general for the Clawson method, in particular. those noted below.

1 Which system of weights should be considered most valid for the points in demand regressions? Unweighted points. and points weighted by the square of zone population and by the zone population over visit rate are considered. In addition the case for weighting to reflect the duration of visit is discussed.

2. What is the effect of the way in which data are aggregated on the estimated benefit? This question is tackled by rezoning the origins of visitors to see what effect this will have on calculated benefit.

3. Which functional form is to be used in estimating the demand curve? Linear, log linear, 2nd degree polynomials and an exponential function are

tested.

4 On what basis should we integrate the consumer's surplus of the visitors to the forest? Should it be on the basis of the aggregated visitors from each zone, or the individual visitor? By trying different approaches to these four problems, we take up Common's suggestion given above - that we should pay attention to sensitivity analysis. We also introduce the measure consumer's surplus per predicted visitor. and show that this usually reduces the variability of the results from different approaches

4. A SURVEY IN GWYDYR FOREST

4.1 Introduction

As a preliminary study for the more advanced Clawson analysis shown in Chapter 5, the opportunity arose to use and analyse data collected in connection with a University College of North Wales (U.C.N.W.) undergraduate project carried out by Humphreys (1981).

The data are 237 interview questionnaires collected in Gwydyr Forest (SH 770 590) during the period 15/6/80 until 12/10/80. These interviews were carried out at 5 different locations as shown in Table 4.1.

Table 4.1 Distribution of interviews to sites.

		No. of interviews	% of Total
1.	LLYN CRAFNANT	45	19.0
2	LLYN GEIRIONYDD	41	17.3
3.	DIOSGYDD	44	18.6
4.	TY'N LLWYN	49	20.7
5.	OTHER PLACES	58	24.5
		237	100.0

Interviews at sites 1 to 4 were carried out at picnic places while Site 5 indicates questionnaires which were collected by different students during June 1980, when they were in the forest collecting data for their management plans. The questionnaires on sites 1 to 4 were mainly collected by Humphreys during the months of July to October.

Visitors were interviewed according to the questionnaires in Appendix B.Q and the main questions asked concerned: the visitor's activities, the number in their party, the length of their stay, whether they had made a special trip to visit the forest, where else they had been during the day, whether they were on holiday, their occupation, their willingness to pay, their income, their reactions to changes in travel costs the time of travel, and entrance fee.

Despite the limited number of questionnaires and the poor quality of some of the interviews carried out at site 5. it was considered worthwhile to use the data in an effort to point out some of the problems which arise when an attempt is made to estimate the economic value of the recreational output from forest areas.

4.2 Methodology

This section is divided into two parts Part One is concerned with the purely descriptive statistics collected from the questionnaires and the analyses carried out on these data. Part Two deals with the application of the Clawson analysis to the sample where a value is derived from the observed information.

4.2.1 The Descriptive Statistics

As the questionnaires were to be used both for an undergraduate project and this study, the questionnaire design was a compromise between the requirements for both projects and only a few of the questions are of direct use in this work. Only these are described here. The remainder can be found in Humphreys (1981). A copy is given in Appendix B.Q.

After the data were collected, a coding scheme was developed and the information punched onto cards. When the data were checked and corrected, the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975· Nie and Hull 1977) and SCSS (Nie et al. 1980), an interactive version of SPSS, were used to analyze the data. In addition to providing summaries of the observed data the analyses used were mainly analysis of variance and regression analysis.

All of the original data are stored in the file GWYD.DAT. Also, a master file (systems file) is available (GWYD.MAS) for use in SPSS and SCSS. The responses to the original questionnaires are stored in the Department of Forestry and Wood Science, U.C.N.W.

4.2 2 A Clawson Analysis

It soon became obvious that a traditional Clawson analysis could not be successfully applied to the data as 73% of all of the visitor groups in the sample were on holiday. Therefore, it would be incorrect to apply the travel costs from home to the holiday area to a particular forest visit, as some of these costs are attributable to visits to other sites. In addition, it was considered incorrect to take the travel cost from home even when a visitor group was not on holiday owing to the different lengths of stay in the forest as shown in the following table 4.2 :

Table 4.2 : Length of stay in forest.

		No. of visitor groups	% of Total
1.	Less than 1 hour	35	14.8
2.	For 1-2 hours	26	11.0
3.	For 2-3 hours	51	21.6
4	For half a day	37	15.7
5.	For 1 day	70	29.7
6.	For more than 1 day	17	7.2
		236	100.0

When a group stays for less than one hour and during the same day visited somewhere else (as did 48.1% of all visitor groups), only a proportional part of their total travel costs can be related to the forest visit. These considerations led to a revision of the traditional Clawson method which is considered to be more appropriate.

4.2.2.1 A Revised Clawson Method

The revised method can be formulated as·

$$\bar{c}_i = 1/n_i \sum_{j=1}^{n_i} c_{ij} \qquad (1)$$

where

$\bar{c}_i$ = the average travel cost for all visitor groups from zone i

n_i = the number of visitor groups from zone i, and

c_{ij} = the revised travel costs for visitor group j from zone i.

The value c_{ij} is found as·

$$c_{ij} = l_{ij} * (D^2_{ij}/L_{ij} + D^3_{ij}) \qquad (2)$$

where

l_{ij} = the length (as a proportion of the day) of stay in the forest for visitor group j from zone i. The value of l_{ij} is dependent upon whether the visitor group visits somewhere else in the same day (see 4.2.2.3.3)

L_{ij} = the holiday length (in days) for visitor group j from zone i.

D^2_{ij} = the travel costs from home to the holiday area for visitor group j from zone i

D^3_{ij} = the travel costs from the starting point of the day to the forest for visitor group j from zone i.

The normal procedure can then be applied to find the relationship:

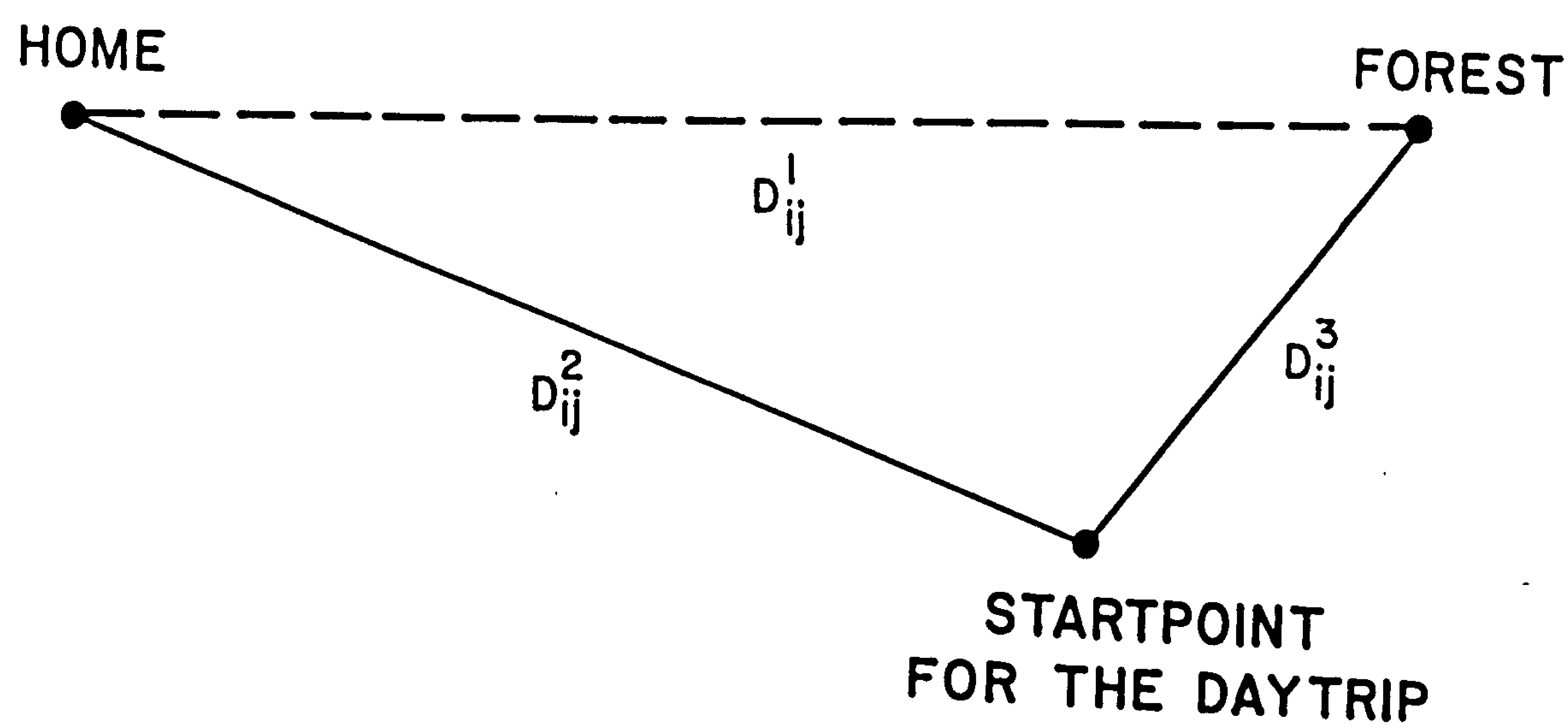
$$V_i = f(\bar{c}_i) \qquad (3)$$

where V_i = the visitor rate from zone i
The kind of function (f) to be used will be discussed later in this section.

When the above relationship (3) has been established. the aggregate demand curve can be found by increasing c_i by a hypothetical fee. For each increase the new number of visitor groups from each zone can be calculated (see 4.2.2.1 6).

It can be seen from equation (1) and (2) that the revised travel cost for each visitor group is based in part on the initial holiday costs and in part on the daily costs of the visitor group This idea is illustrated in the following Figure 4 1 :

Figure 4.1 · The separation of travel costs used in the revised Clawson analysis.



Unfortunately, the distance on which D^2_{ij} is based is measured from home to the forest (dashed line) and not from home to the starting point for the day. However, as can be seen from the following list of starting point distances (D^3_{ij}) and home distances (D^1_{ij}) for the interviewed groups, most of the holiday visitors were staying in close proximity to the forest area. Thus, the use of D^1_{ij} instead of D^2Dij was not considered to affect the application of the revised Clawson method appreciably.

Below in Table 4.3 is shown the distribution of starting point distances (D^3_{ij}) and home distances (D^1_{ij}):

Table 4.3 : Starting point distances and home point distances

Starting point distances (D^3_{ij}):

36.4%	10 miles
84.0%	25 miles
mean	= 20.6 miles

Home distances (D^1_{ij}):

1.3%	10 miles
11 5%	25 miles
45.5%	100 miles
67.2%	190 miles
mean	= 143.7 miles

These distributions show that the mean starting point distance is much shorter than the mean home distance. Therefore, the bias using D^1_{ij} instead of D^2_{ij} does not greatly affect the result as $\left|D^1_{ij} - D^2_{ij}\right| < D^3_{ij}$.

The traditional Clawson method prescribes the use of a fixed travel cost from each zone. In this case however, it is wrong to assume that all visitors would incur the same travel costs (some, for example, are using more expensive means of travel than others). Therefore, this revised Clawson method employs an average rather than a fixed travel cost from each zone.

This analysis is also based on the number of visitor groups per capita in the zone and not on the number of visitors per capita as is used in the traditional Clawson method. There are two main reasons for this. Firstly, having the group as the unit is believed to make the variability in the travel cost less compared with the travel cost for an individual. For example, 2 persons visiting in an expensive car compared with 6 in an inexpensive car would cause a high variation in the travel cost if the individual was the unit. Secondly, it is believed that travel costs are not shared among a visitor group. The decision for a family to go to the forest might not be made by four individuals deciding to spend 1.50 pounds each but rather by one individual deciding to spend 6.00 pounds for the family to visit the forest. Furthermore using group visits to an area rather than individual visits will not alter the results of the analysis as long as the average cost for travel from the zone is used and the group size pattern does not change from one zone to another.

The set of points used to determine the trip demand curve as in equation (3) is defined as:

$$(n_i/k, \bar{c}_i) \qquad (4)$$

where k = a parameter e.g. 1000's of inhabitants in the zone.

The problem in deriving a trip demand curve is which function to use and what effect it will have on the aggregated demand curve and thereby the consumer's surplus. In order to investigate this problem both a linear regression and a second degree polynomial have been applied. These applications are described in the following models.

4.2.2.1.1. Models for the Trip Demand Curve

The mathematical formulation of a general linear model (GLM) is:

$$Y_i = a+b*X_i+e_i \quad , \{e_i\} \quad N(0,\sigma^2) \qquad (5)$$

where

Y_i = the dependent variable

X_i = the independent variable

a,b = coefficients (parameters)

e_i = random error (residual)

The procedure is to minimize e_i^2, hence the name least squares method. The above model (5) is a straight line with an intercept equal to a and a slope equal to b.

Often convex to origin shapes have been found for the trip demand curve Therefore, one model which could be considered is:

$$Y_i = a/X_i^{b} * e_i \tag{6}$$

which is a non-linear function However, when transformed, the relationship can be estimated with a general linear model procedure:

$$\ln(Y_i) = \ln(a) - b * \ln(X_i) + \ln(e_i), \quad \{\ln(e_i)\} \; N(0, \sigma^2) \tag{7}$$

The method was used by Clawson in his 1959 paper. The problem with the transformation is that it is complicated to work with unless transformed back. What is worse, however, is that it is $\{\ln(e_i)\}$ which is supposed to be normally distributed and not $\{e_i\}$. In addition, the model will have an unacceptable form near zero for as x approaches 0, ln(x) goes to - infinity.[1]

A second degree polynomial can be written as:

$$Y_i = a + b_1 * X_i + b_2 * X_i^2 + e_i \qquad \{e_i\} \; N(0, \sigma^2) \tag{8}$$

This model can result in a concave or a convex curve depending on the parameters. Although we would expect a convex form, a concave form can be justified as the trip demand curve can be expected to be truncated due to substitution effects (Price 1978).

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1. Instead an exponential curve fit could be used as explained in 4.4

4.2.2.1.2. Weighting of the Trip Demand Curve

The points upon which the trip demand curve is being determined do not have the same reliability since the points originate from samples of varying sizes of different populations. That is, there are differences in numbers of visitors from different zones and differences in zone population.

The points are independent estimates of visit rate with unequal precision attached and when a combined estimate is desired they must, therefore, be weighted according to their precision.

A general rule (Snedecor and Cochran 1976) " is to weight each estimate inversely as its variance."

Let n_i be the estimated number of visitor groups per predetermined unit of time for zone i and N_i the zone population. Then:

$$V_i = n_i/N_i \qquad (9)$$

is the estimated number of visitor groups per capita from zone i.

If we assume that n_i is Poisson distributed[2] with parameter λ_i (average number of visitor groups per unit time from zone i).

It follows, then. that:

$$E(n_i) = \lambda_i \text{ and } Var(n_i) = \lambda_i{}^{3} \qquad (10)$$

---

2. A standard derivation shows that under certain mathematical conditions, the number of occurrences of a certain phenomenon in a fixed period of time or a fixed period of space follows a Poisson distribution. (DeGroot, 1970,p.35)

3. A randon variable, X, has a Poisson distribution with a mean $\lambda > 0$ if X has a discrete distribution whose probability function is·

$$f(x|\lambda) \begin{cases} \frac{e^{\lambda} * \lambda^{x}}{x!} & \text{for } x = 0\ 1,2,3,\ldots.. \\ 0 \text{ otherwise} \end{cases}$$

(DeGroot 1970,p.35)

and

$$E(V_i) = \lambda_i/N_i \text{ and } Var(V_i) = \lambda_i/N_i^2 \qquad (11)$$

(N_i is fixed for the i^{th} zone)

In order to balance the variances, we then want to use a weight, w. equal to $1/Var(V_i)$ and it follows·

$$1/Var(V_i) = N_i^2/\lambda_i \simeq N_i^2/n_i = N_i/V_i \qquad (12)$$

As we can approximate λ_i with n_i in equation (12), it follows that we will weight proportionally to the number of potential visitors (zone population) if the visit rates were equal and inversely proportionally to the visit rates if the zone populations were the same. (See also Chapter 5)

The problem, according to Bowes and Loomis (1980) is " a straight forward example of heteroskedasticity introduced by grouping of observations " (Ibid ,p.465). They explain the problem essentially as follows·

$$Var(v_j) = \sigma^2 \qquad (13)$$

where:

v_j = the individual's visitation rates.

Then. when all visits are observed·

$$Var(V_i) = \sigma^2/N_i \qquad (14)$$

where:

V_i = mean visits per capita from zone i

N_i = population in zone i

If we transform with the square root of N_i, then the new weighted observations will have equal variances:

$$Var(V_i*\sqrt{N_i}) = N_i*Var(V_i) = \sigma^2 \quad (15)$$

Thus, their conclusion must be that we will have to weight by N_i, that is, proportionally to the zone population.[4]

" Utilizing this 'corrected' form to estimate the per capita demand curve results in predicted number of trips at zero price exactly equal to actual number of trips " (Ibid.,p.468). This statement is only true if they accept negative visit rates. Normally negative visit rates are not accepted but rather adjusted to zero (See also 4.2.2.1.6)

That Bowes and Loomis predict the actual number of observed visitors is not surprising as can be seen from the following:

If the linear model (5) is transformed by N_i as suggested we get:

$$V_i*\sqrt{N_i} = b_0*\sqrt{N_i} + b_1*C_i*\sqrt{N_i} + e_i*\sqrt{N_i} \quad (16)$$

and hence

$$\sum(\sqrt{N_i}*e_i)^2 = \sum(V_i*\sqrt{N_i} - b_0*\sqrt{N_i} - b_1*C_i*\sqrt{N_i})^2 \quad (17)$$

In order to minimize $\sum(N_i*e_i)^2$ we differentiate equation (17) with respect to b_0 and b_1 , and the two normal equations will be:

4. Bowes and Loomis gave the weighting factor as the square root of the origin's population (Ibid.,p.468). However, they mean that they transformed by the square root of N_i which is equivalent to weighting by N_i.

$$\sum(V_i*N_i - b_0*N_i - b_1*C_i*N_i) = 0 \qquad (18a)$$

$$\sum(C_i*V_i*N_i - b_0*C_i*N_i - b_1*C_i^2*N_i) = 0 \qquad (18b)$$

Using equation (18a) and that $V_i*N_i = n_i$ we get·

$$\sum n_i - \sum N_i*(b_0 + b_1*C_i) = 0 \qquad (19)$$

but as

$$E(b_0 + b_1*C_i) = E(V_i) = \hat{V}_i \qquad (20)$$

we see that

$$E(\sum n_i) = \sum N_i*E(V_i) \qquad (21)$$

From (21) we see that predicted number of visitors will equal actual observed number of visitors.[5]

Edwards et al. (1976) mention the problem of weighting briefly and in their disaggregated model they weight by n_{ij} . where n_{ij} is the number of observations (recreation groups) in the sample in the $(i,j)^{th}$ income-distance class.

The justification for the weighting was that the coefficient of variation for the number of recreation days

$$\sqrt{Var(d_{ij})} \,/\, E(d_{ij}) \qquad (22)$$

was assumed to remain relatively constant

5. This is further discussed in Christensen and Price 1982.

4.2.2.1 3. A Comparison of the Weighting Methods

The calculated points for the trip demand curve were transferred to an SPSS programme to test the weighting procedures and to check how they would influence the differences recorded between actual and predicted numbers of visitor groups. A FORTRAN programme was written to calculate the number of predicted visitor groups on the basis of the parameters estimated in the SPSS programme.

A linear model was used:

$$V_i = a + b^*C_i + e_i \qquad (23)$$

where:

V_i = visit rate from zone i

C_i = average travel cost from zone i

i = number of zone. i = 1,2,3,.......,10

e_i = residual

When the model (23) was fitted using a least squares method, the following weights were used with the results as shown below in Table 4.4:[6]

Table 4.4 · A comparison of weighting methods

		ESTIMATED PARAMETERS		NUMBER OF VISITOR GROUPS		
Model No.	Weight type	a	b	predicted		actual
				inc.neg	excl.neg.	
1	No weighting	25.22248	-0 05421	-407.8	937.5	225
2	Zone pop/vis rate	2.20908	-0 00396	138.2	138 2	225
3	Zone pop.	3.73928	-0.006736	225.0	225.0	225

6. Other models that were tried (weighting according to number of visitors, to the square root of N_i, etc.) did not provide results of interest or importance.

Model numbers 2 and 3 seem to be the most appropriate judging by the number of visitor groups predicted. The visitor groups predicted is a very important parameter as the calculation of consumer's surplus depends upon it and will reflect any overestimation or underestimation. Model 3 seems especially suitable when the entire distribution of predicted number of visitor groups is considered . The results of the three models are shown below in Table 4.5 :

Table 4.5 : Predicted number of visitor groups

		PREDICTED NUMBER OF VISITOR GROUPS		
Zone no.	Actual No. of vis	Model 1	Model 2	Model 3
1	2	1.7	.2	.3
2	7	8.2	.8	1.3
3	17	12.0	1.2	2.0
4	13	7.7	.9	1.5
5	17	15 3	2 1	3.6
6	45	259.5	45.3	75.5
7	31	181.3	23.6	39.5
8	31	407.9	43.4	73.0
9	51	43 8	9.5	15.8
10	11	-1345.3	11.4	12.6
SUM	225	-407.8	138 2	225.0
	SS	2050313	2591	4586

The last line in the Table 4 5 gives the sum of squares for predicted minus observed. It shows that model 2 has the lowest value but that this model underestimates the total number of users by about 39% The value of weighting does not allow us on the available data to carry out a test of suitability of the different weighting systems. The fact that a model predicts the actual number of visitors at zero price is no proof that the model is correct. If our main aim was to predict the actual number of visitors, we could either use model 3 or a model of the following type as suggested by Dwyer et al. (1977.p.77).

$$n_i = a + b_1{*}c_i + b_2{*}N_i + b_{12}{*}c_i{*}N_i + e_i \tag{24}$$

where:

n_i = the number of visitors from zone i

c_i = travel cost from zone i

N_i = the population in zone i

$a_1 . b_1 . b_2 , b_{12}$ = parameters

e_i = error term

This model was estimated using an SPSS programme and it gives a prediction of 225 visitor groups for the 10 observations for the given costs.

Although the total number of predicted visitor groups by this model was correct, the model behaved badly when it was used to estimate consumer's surplus.

The estimated parameters were:

a	-0.3038960×10^{1}
b_1	$0\ 8199646 \times 10^{-1}$
b_2	0.9470222×10^{-5}
b_{12}	$-0.1911512 \times 10^{-7}$

One way to find the consumer's surplus would be to increase the cost c_i for each zone until the predicted number of visitor groups decreased to zero. A programme was written for that purpose but it failed to give any results. This can be explained by examination of the estimated parameters above. These show that the model did not behave logically as only the constant and the interaction are negative which will lead to a steady increase in n_i for increasing c_i as $b_{12}*N_i < b_1$

It would probably be correct to choose a model which predicts the actual number of people observed if the consumer's surplus is taken directly and not corrected for differences between predicted and observed number of visitor groups. This will be discussed under the section on integration (4.2 2.1.6)

4.2.2.1.4 Bias due to Length of Stay

If we consider the questionnaire sampling to be random with respect to the date and the time of day, then the visitor who stays for a long time period has a higher probability of being sampled than the one who stays for a short time period. Take the following example In a forest there are two populations,

A which consists of 1000 visitors each staying in the forest for one hour uniformly distributed over an 8 hour day (125 visitors/hour) and

B : which consists of 200 visitors each staying in the forest for 4 hours uniformly distributed over the 8 hour day (100 visitors/hour).

A random sampling of the visitors present in the forest would yield a ratio of population A : B of 5 · 4 when, in fact, the ratio of the two populations was 5 : 1 .

This problem has been mentioned by Lucas (1963) who described the implications of calculating an average length of stay. He points out that it is necessary to weight by

$$1/l_j \qquad (25)$$

where: l_j = the length of stay for visitor j.

If 90 visitors from the populations described above were sampled randomly and asked about their length of stay, the following result might be obtained:

		Hours
	50 visitors of 1 hour	50
	40 visitors of 4 hours	160
Total	90 visitors	210

This would yield an average length of stay of 2.33 hours but if the weighting suggested by Lucas is adopted, the following result would be obtained:

50*1/1	= 50 visitors for 1 hour	50 hours
40*1/4	= 10 visitors for 4 hours	40 hours
Total	= 60 visitors	90 hours

This gives an average stay length of 1.5 hours. The same result is obtained by calculating for the whole population.

$$(1000*1+200*4)/1200 \text{ hours} = 1.5 \text{ hours}$$

The result from Gwydyr gives an average unweighted stay time of 3.8 hours and an average weighted stay time of 1.8 hours.

Lucas pointed out that an interview conducted of people leaving a forest will not be biased as everyone is leaving only once regardless of their length of stay[7] He also stated that " estimates of social or economic characteristics or attitudes of groups such as campers, if based on an on site sample are biased if the characteristics in question are associated with length of stay " (Ibid.,p.913) and this is relevant to this work.

In a traditional Clawson analysis as well as in the revised method, problems arise if stay time is related to home distance (ie. zones). If a positive correlation was found such that people from farther away stayed in the forest longer, it would lead to an overestimation of the number of visitors from the furthest zones, thereby pushing the trip demand curve upwards. This will not happen when all visitors are sampled (when a visitor admission list is used, for example).

The relationship between home distance and stay time was examined for the respondents in this study by regression analysis. The variable " stay time " was converted as shown in Table 4.6 :

7. There will still be some bias as the long stay visitors will be more concentrated during the end of the day and it is unlikely that anyone staying for six hours will be sampled in a car leaving between 10 am and noon.

Table 4.6 : Conversion of length of stay to hours

	Y
<1 hour	0.5
1-2 hours	1.5
2-3 hours	2.5
1/2 day	3 5
1 day	5.5
>1 day	8.0

The regression model

$$Y = a+b*X+e \tag{26}$$

where Y = stay time as shown above

X = home distance in miles

was not found to be significant. Therefore, it was concluded that the problem discussed above did not bias our sample

However, in the revised Clawson model costs are directly related to stay time as defined in formula (2).

This means that an overestimation of c_i (the average travel cost for all visitors from zone i) will occur since all of the points for the trip demand curve are based on an average of a sample in which there are too many high values. One way to correct for this would be to weight the travel costs according to $1/l_{ij}$ as shown earlier when the average travel cost for each zone was calculated. This weighting system does not imply that visits are assumed to be of equal value but rather that some (long stay) visits are represented more often than others of equal frequency and are therefore reduced.

In this study, the problem of the overestimation of c_{ij} was solved by creating an option in the programme for Clawson analysis in which the calculations of average travel cost were weighted as described above The weights to be used were shown in Table 4.4. (Program GWTR3.FOR created the new file HOM5.DAT.)

This led to the result in Table 4.7 :

Table 4.7 : Average travel costs for zones

Zone number	Average cost (pence)	Average cost weighted (pence)
1	6.4	8.0
2	112.3	90.4
3	221.8	183.0
4	294.1	178.4
5	362.7	305.4
6	398.3	342.6
7	346.0	223.2
8	261.4	206.6
9	417.7	293.2
10	548.8	311.5

The importance of this change in the calculation of consumer's surplus is dealt with in 4.3.2 1.

4.2.2.1.5 Zoning

The traditional zoning method is based on a series of concentric zones. However. there is no reason why some other system such as postal zones could not be used as long as the average distance from the gravity point of the zone to the forest can be defined (see Chapter 3) in order to obtain the travel costs. The only requirement which must be fulfilled is that we must be able to expect the different subpopulations to behave consistently. To accomodate different zoning systems, an option is built into the programme which allows the operator to use either distance or some alphanumeric constants as zone identifiers.

Those individuals who live even further from the forest than the furthest zone defined could simply be excluded from the calculations. Another possibility is to include them as a point $(0.c_f)$ where c_f stands for the average cost for all visitor groups from outside the furthest defined border. Thus, an option is built into the programme to either include or exclude these visitor groups from the calculations.

Also, when no visitor groups come from a defined zone to the forest, it has been found more correct to exclude the observation from the calculations rather than include it as the point (0,0) as it would be according to equation (1). However, when using concentric zones it should be attempted to choose the zoning system so that all zones have a recorded frequency visit > 0 . When the zoning is based on some other system (e.g. postal codes) certain areas may not contribute any visitors to a given forest owing to some substitution area. These should, therefore simply be excluded from the calculations.[8]

8. If there is no substitute area it is an observation of zero visits for that cost and should be included (See 5.4.8).

The following zoning system of concentric circles was adopted for the study in Gwydyr Forest:

Table 4.8 · Zoning system for visitors to Gwydyr Forest

Zone No 1	0 - 5 miles	Population	5168
Zone No 2	6 - 10 miles	Population	3571
Zone No 3	11 - 20 miles	Population	41085
Zone No 4	21 - 30 miles	Population	91234
Zone No 5	31 - 50 miles	Population	82571
Zone No 6	51 - 70 miles	Population	275824
Zone No 7	71 -100 miles	Population	7147034
Zone No 8	101 -150 miles	Population	2804152
Zone No 9	151 -200 miles	Population	3690580
Zone No 10	201 -250 miles	Population	1700105
Zone No 11	251 -300 miles	Population	29696401

4 2.2.1 6. Calculation of Consumer's Surplus

When the gross demand curve or trip demand curve has been established, then the next problem is how to derive from it the net demand or aggregate demand curve. The consumer's surplus can be derived by simple integration of the net demand or aggregate demand curve.

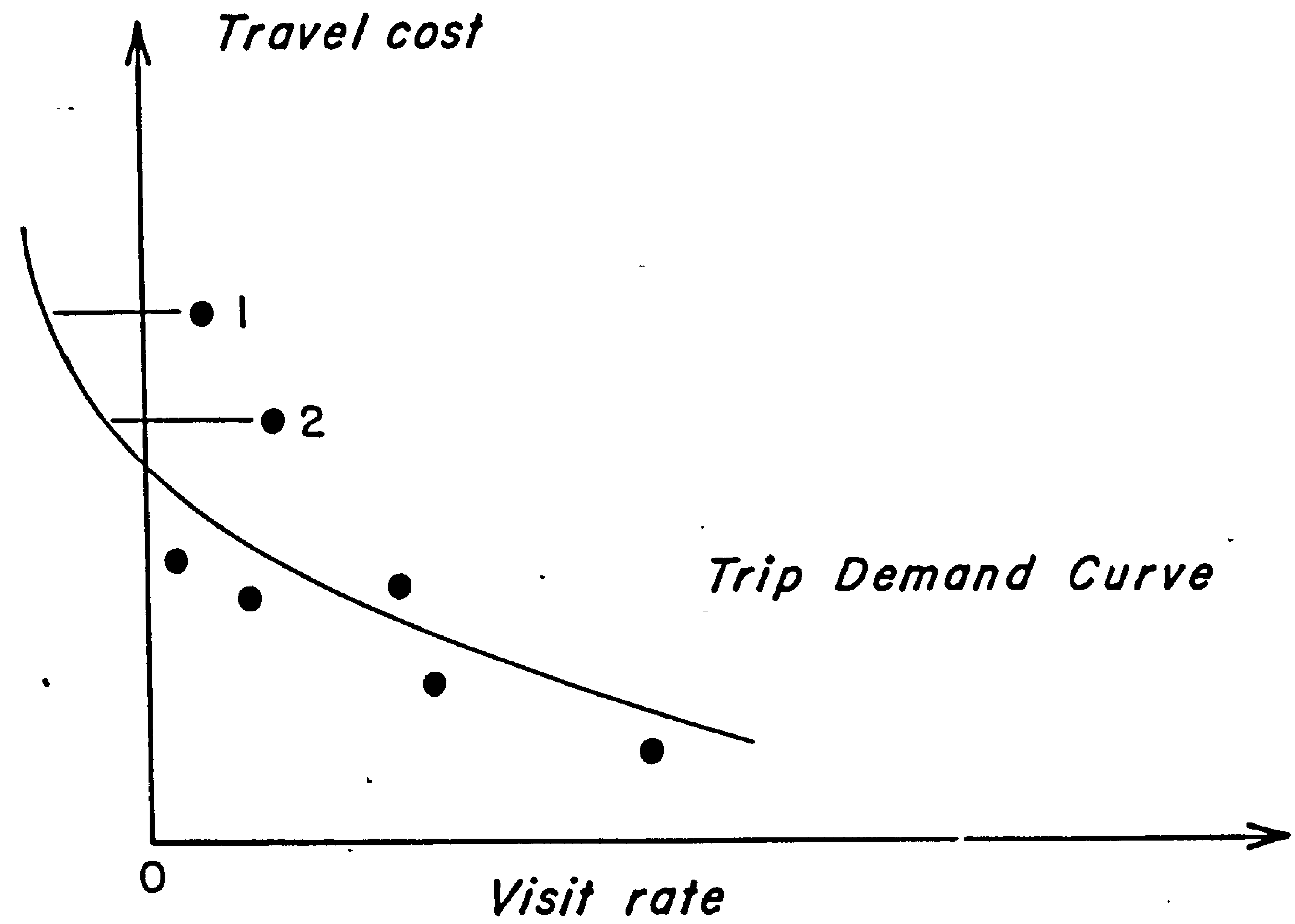
There are two different methods by which a measure of the consumer's surplus can be obtained which will be discussed in this section. One method is zone based. the other based on the individual. The zone based method can be applied in several ways . Therefore, a total of four different methods of calculating consumer's surplus will be described.

1. The traditional method of calculating consumer's surplus is to apply a zone based method as follows: For Zone i, find the expected visit rate by using the relationship established in Equation (3): $V_i = f(c_i)$. The number of visit groups is V_i*N_i. Then a hypothetical fee of, for

example. 5 pence is added to c_i The calculation is repeated with this new cost to find the new number of visitor groups and so on with each newly calculated fee until the number of predicted visitor groups is zero. When this has been done for all of the zones, the number of visitor groups from each zone is summed for each different fee. The pairs of values (total number of visitor groups , given fee) are the points on the aggregated demand curve which is also called the demand curve for the site The consumer's surplus is the integral of the aggregated demand curve.

A problem with this method is that the number of predicted visitors for the observed cost (zero entrance fee) does not equal the actual number of observed visitor groups as discussed in the section on weighting (4.2.2.1.2) There are two reasons for this. Firstly, the model establishes a relationship between price and visit rate rather than between price and number of visitor groups. Secondly. there is a tendency to overestimate the consumer's surplus as negative visit rates are not accepted. Negative visit rates arise in this method of establishing the consumer's surplus when the trip demand curve intersects the Y-axis (travel cost) at. for example, a point $(0.Y_{max})$. In that case. zones with a recorded average travel cost greater than Y_{max} will have a negative visit rate for any fee When this is the case, a visit rate of zero will be attributed. This is illustrated in the following example :

Figure 4.2 : Trip demand curve with negative visit rates



In the above figure, points 1 and 2 will have a negative visit rate according to the observed travel cost and the fitted trip demand curve. This will lead to an overestimation of consumer's surplus as the trip demand curve is a function of visit rate on travel costs When fitting the curve we assume that the residuals [e_i] are normally distributed and independent. As points 1 and 2 have big positive residuals, there must be some points with lower travel costs which have negative residuals. Negative residuals mean that the regression line overestimates predicted visitors compared with observed As this overestimation is not balanced by underestimation of the CS for points 1 and 2, there is some estimated negative CS which is simply being ignored. This leads to the overall CS being overestimated

2. A simple method of reducing the effect on our calculations of the consumer's surplus being based on predicted rather than observed values would be to convert the consumer's surplus as calculated above according to the following:

$$CS' = CS*ovg/pvg \tag{27}$$

where: CS' = the new consumer's surplus measure

CS = the consumer's surplus as calculated above in method 1

ovg = total number of visitor groups observed

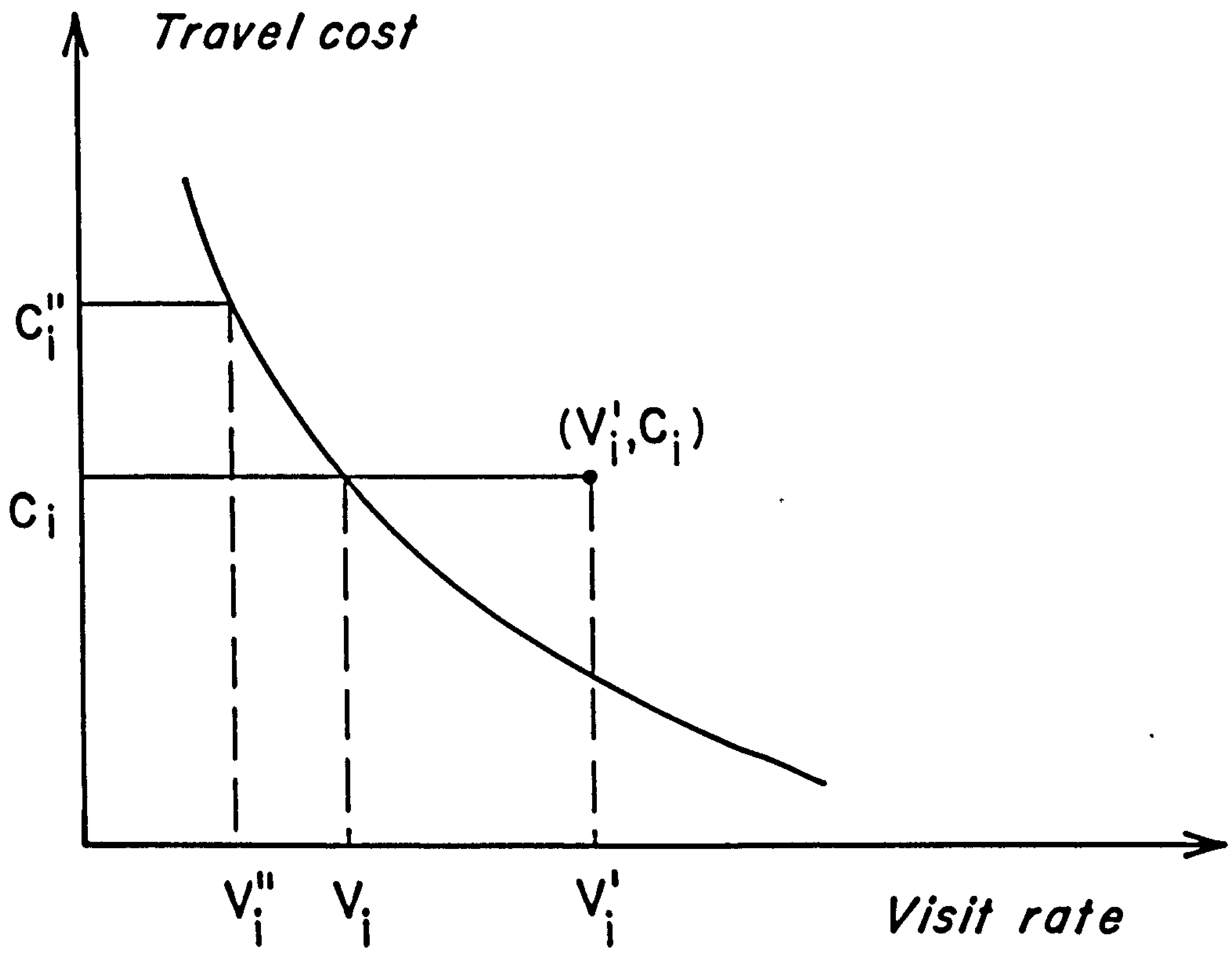
pvg = total number of visitor groups predicted for the observed travel cost.

This measure of the consumer's surplus still suffers from the fact that one zone can contribute with consumer's surplus from, for example. 400 visitors when only 40 were observed and, in this way, it may bring the value for CS' very close to the value of CS/pvg which that particular zone is contributing.

3. A method by which the predicted number of visitor groups can be adjusted to actually observed number of visitor groups with consequent change of the consumer's surplus in which one zone does not bias the result, is to convert the consumer's surplus as in 2 but on the zone level. This means that we still accept the curve shape of the trip demand curve but include a conversion factor which for each zone at each step in the procedure as described in 1 (above) will adjust predicted to the actual number of visitor groups.

The following Figure 4.3 illustrates the problem.

Figure 4 3 : Conversion of Consumer's surplus



The travel cost from zone i has been observed as C_i On the basis of this, we estimate the number of visitors as N_i*V_i . In actuality, we observed a visit rate of V_i' and when the consumer's surplus is calculated we can convert to the actual number of visitors equal to V_i*N_i*k , where k is a conversion factor:

$$k = V_i'/V_i \qquad (28)$$

This measure will probably give a smaller consumer's surplus than method 2 (above). the former method tends to overestimate the consumer's surplus since no visitor group can contribute with a value of zero to the consumer's surplus. In method 3, a zone will contribute with a zero value to the consumer's surplus if the average travel cost, c_i, for the zone is greater than the value $\hat{C}_{max}$ where the trip demand curve intersects the Y-axis.

The above procedure should be justified from the point of view that although the estimated demand curve might be 'right' as a general demand curve for the region, the one zone from which only 40 visitor groups were observed is only contributing this small number of observations due to the effect of some sort of substitute area

4 The final method to be discussed for estimating consumer's surplus is based on the individual observations. The method is in fact. quite similar to method 3 (above). Using the same Figure (4.3), C_i is now visitor group i's travel cost and the total consumer's surplus the visitor group (individual) will gain is·

$$CS_i = \int_{C_i}^{\hat{C}_{max}} f(C)/f(C_i)*dC \tag{29}$$

where·

CS_i = consumer's surplus for visitor group i

C_i = travel cost observed

$\hat{C}_{max}$ = max. travel cost predicted (intercept)

f = estimated function

A result is that points above $\hat{C}_{max}$ will not contribute anything to consumer's surplus. This may represent a few points as the variation in travel cost within the zone is rather big. Therefore. this measure can be expected to yield a consumer's surplus smaller than method 3 but for a smaller number of predicted visitor groups. When we look at this measure for predicted number of visitor groups. it will possibly be higher than any of the others.

4 2.2.1.7. Evaluation

The different models and weighting systems described in the previous sections are difficult to evaluate with respect to which combination results in the 'right model'. Because of the small size of the sample, it is impossible in this case to split the sample into two groups and use one for estimation and one for test. In addition, our sample is very biased from statistical sampling methods.(See Section 4.2.2.1.2 on weighting)

One method which might provide some guidance in the selection of the best model to use is application of the PRESS function (Hocking. 1976). The PRESS - "prediction sum of squares" is given by the following:

$$PRESS = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 \qquad (30)$$

where: PRESS = prediction sum of squares

Y_i = observed value

$\hat{Y}_i$ = predicted value of Y_i. This point is estimated from a function of all points except Y_i.

This function estimates for a new point how closely this new point would have been predicted by all of the other points.

A small PRESS value for a given model tells us that the model is a good predictor which, in effect, is what we are interested in when we are calculating the consumer's surplus. Unfortunately, the theory behind PRESS is not very well developed and there are no standard programs for its use.

Therefore a subroutine was written to calculate the PRESS values. However the PRESS values should be used with care as the functions are weighted. Instead, it might be more useful to observe the SS residuals.

4.2.2.1 8. Alternative Methods

One of the weaknesses with the traditional Clawson method is that it is difficult to disaggregate, i.e. to introduce socioeconomic factors into the analysis. Some improvements have been achieved using multiple linear regression methods (Burt and Brewer 1971). However, this modification requires many observations. Also, it is sometimes difficult to establish the average values for the society which must be used in the estimated model (such as average income in zone, average holiday length, etc.).

An alternative to the revised Clawson method suggested here would have been to conduct separate Clawson analyses for each holiday length and/or length of stay. The distribution of holiday visitor groups is shown below in Table 4.9 :

Table 4.9 Distribution of holiday length

HOLIDT LENGTH OF HOLIDAY IN DAYS

Value	N	Tot%	Nm%	Cum%
2	1	0.4	0.6	0.6
3	26	11.0	15.4	16.0
4	5	2.1	3.0	18.9
5	2	0.8	1.2	20..1
7	67	28.3	39.6	59.8
8	1	0 4	0.6	60.4
9	1	0 4	0.6	60.9
10	7	3 0	4 1	65.1
12	2	0.8	1.2	66 3
14	50	21.1	29.6	95.9
18	1	0 4	0 6	96.4
21	1	0.4	0.6	97.0
28	3	1.3	1 8	98.8
40	1	0 4	0.6	99 4
42	1	0 4	0 6	100.0
OM*	68M	28.7M	NA	NA

TOTAL N = 237 VALID N = 169

* = MISSING = DAY VISITORS

This could lead to separate Clawson analyses for each group shown in Table 4 10

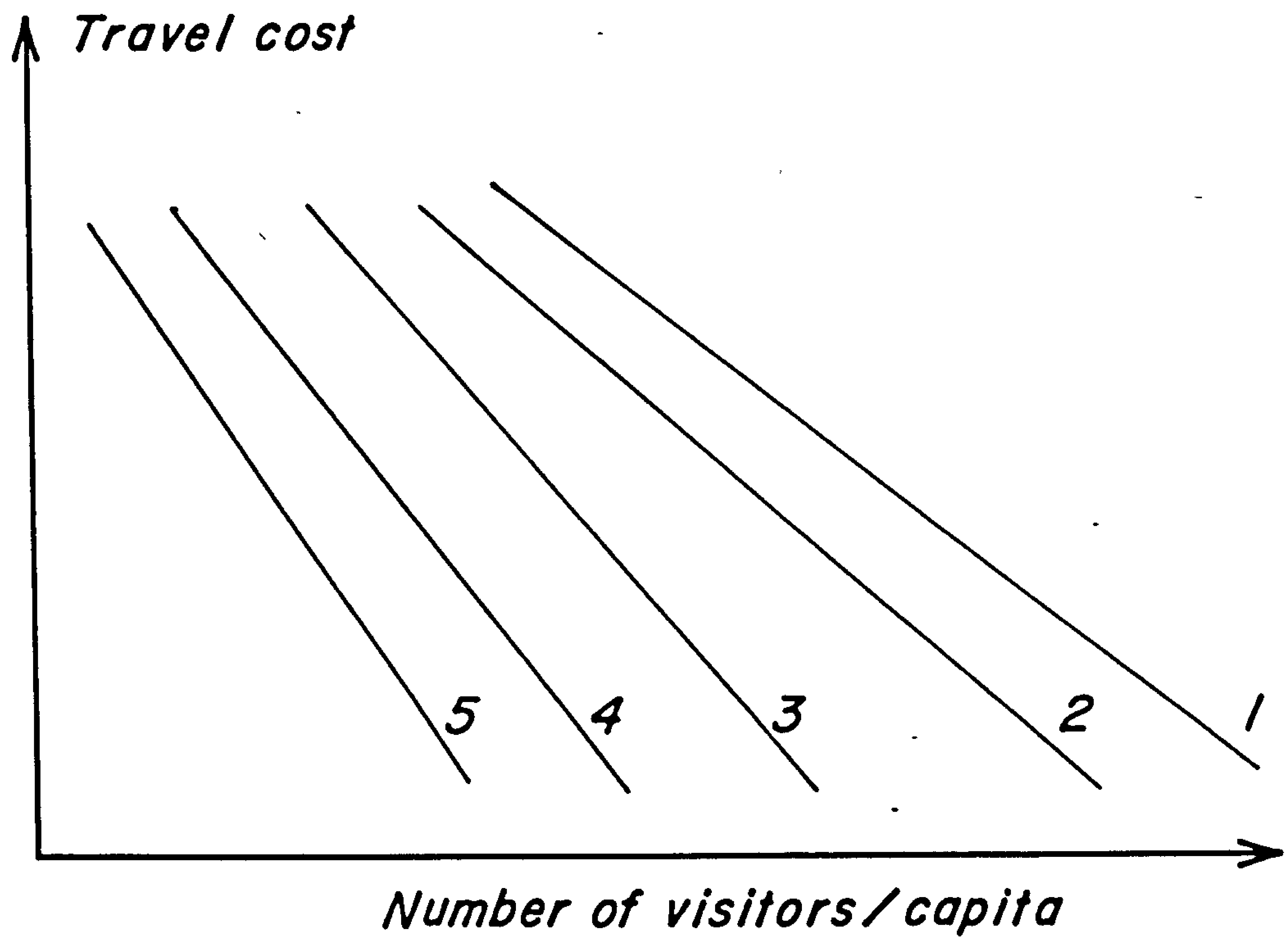
Table 4 10 Grouped holiday length

	No. of Visitor Groups	%
1 One day visitors*	68	28.7
2· Weekend visitors (2-3 days)	27	11.4
3: One week visitors (4-7 days)	74	31.2
4: Two week visitors (8-15 days)	61	25.7
5· Three week visitors (>15 days)	7	3.0
	237	100.0

* length of stay in the area (holiday time)

In this case the demand curve could be estimated for each group (1-5) in the above table and a curve system like the one below in Figure 4.4 could be obtained.

Figure 4.4 : Trip demand curves disaggregated by holiday length



From this system, we could find each group's aggregated demand curve which could then be added for all groups to give the overall value of the site

The problem with using a method like the one suggested above is the amount of data needed. It is not considered possible to estimate the curves from the data base that we have available (Table 4 10,4.11). Another problem, which has already been mentioned, is that it would be difficult to find a yearly value for the distribution of visitors' length of stay as we do not know the proportion between the groups over the year unless we accept the one found in this small sample.

4.2 2.2. A Traditional Clawson Method

In addition to the revised Clawson analysis (4.2.2.1), it was decided to carry out a traditional Clawson analysis on the data to identify the differences which might occur between the two methods. The travel cost for each zone was calculated according to the following formula·

$$C_i = 2*D_i*CM \tag{31}$$

where C_i = travel cost from zone i to visited area

D_i = average distance from zone i to the visited area (in miles)

CM = travel cost per mile

The D_i term could be based on an unweighted middle distance to the zone. For example, when the zones are concentric and B_i is the distance from the visited area to the nearest border of zone i, then

$$D_i = B_i+(B_{i+1}-B_i)/2 \tag{32}$$

It would however be better if we could identify the gravity point for the population density, i.e. the distance to the centre of the population

As a compromise, we have, in this study, used a zone distance as if the zone population was uniformly distributed over each zone. This leads to the following formula for X_i (for the median)[9].

---

9. The true mean is $D_i = 2/3\ (B_{(i+1)}{}^3 - B_i{}^3)/(B_{(i+1)}{}^2 - B_i{}^2)$

$$D_i = \sqrt{1/2*(B_{i+1}{}^2+B_i{}^2)} \qquad (33)$$

The formula (33) gives slightly bigger distances than (32).

For the weighting of the points of the trip demand curve the same methods as for the revised Clawson analysis were employed (see 4.2.2.1.2.).

The consumer's surplus can be calculated either zonewise or zonewise with visitor numbers regulated to those observed, i.e. methods 1-3 as described in Section 4 2.2.1.6.

4.2 2 3. The Computer Programme

To analyze the data as described in the previous sections using both the revised and the traditional Clawson methods, a programme was written in FORTRAN10 using the NAG-lib routines and the GINO-F subroutines for plotting

The intention was to make the programme as general as possible and more or less to create an interactive package which allows the user the possibility of changing zoning. types of curve fits, weightings, plots, etc. The programme can accomplish the modified analysis with all of its described options and a traditional Clawson analysis where the travel cost for each zone is given. The zoning can be by distance or by zone identifier. The latter is necessary when, for example, post codes are used to identify visitors.

The programme automatically does scaling etc. and takes an unlimited number of observations and up to 20 zones. It carries out the plotting of the trip demand curve and fits the described models either weighted or unweighted. In addition, it calculates the consumer's surplus from the trip demand curve either on a zone basis or using individuals The aggregated demand curve can also be plotted. The programme together with the necessary modification of the data files are shown in Appendix A4.1 and A4.2.

4.2.3. Total Willingness to Pay

In order to compare the consumer's surplus derived from the Clawson analysis with the stated willingness to pay as given on the questionnaire. a programme, TES2 FOR was written. This programme simply sorts willingness to pay by increasing size, plots the curve of stated willingness to pay and numbers of persons and finally, sums the stated willingness to pay.

The total willingness to pay calculated as above ought to be comparable to the consumer's surplus if both were correctly estimated. That is, the additional sum, after travel costs, that people are willing to pay should equal the consumer's surplus derived from the Clawson analysis.

Unfortunately, it is difficult to reveal people's preferences without the people behaving strategically (see Chapter 3). As described in 4.3.1.1, we have found a rather discouraging result in that those interviewed appeared to be responding to the interviewer's prompt. Therefore, the exercise of asking for people's preferences may be rather futile in this context.

4.3. Results

4 3.1 The Descriptive Statistics

In this study, only a few of the analyses carried out will be referred to as much of the information gathered is not considered relevant to this discussion.

4 3.1.1. Stated Willingness to Pay

In order to reveal whether there was any relationship between stated willingness to pay (FEES) and prompting method (Q17) four different prompting methods were tested.

The question asked was:

"Free access is the policy of the Forestry Commission to State owned forests but to help me assess how much you value Gwydyr as a recreational area. I would like to ask you what you personally would be willing to pay as an entry fee."

Option 1 : open (nothing stated from the interviewer)

Option 2 : would you be willing to pay 25 pence?

Option 3 : would you be willing to pay 1 pound ?

Option 4 : would you be willing to pay 2 pounds ?

Options 2-4 were followed by the question "How much?" and the answer was written down [10]

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10 This was only done for the questionnaires on sites 1-4. The students (site 5) used a hierarchical approach. Their results are not included here in order not to bias the test. The questionnaires here (sites 1-4) were done primarily by the same interviewer.

When the interviews were carried out, it would have been desirable that a uniform distribution of prompting methods at each site was attempted. The distribution in Table 4.11 was presented:

Table 4.11 · Distribution of prompts on sites

	OPTION				
SITE	1	2	3	4	(SUM)
1.LLYN CRAFNANT	15	11	12	6	44
2.LLYN GEIRIONYDD	15	10	13	3	41
3 DIOSGYDD	23	3	16	2	44
4 TY'N LLYN	18	6	11	13	48
(SUM)	71	30	52	24	177

The first model tried was a simple one-way analysis of variance (ANOVA):

$$Y_{ij} = a_i + e_{ij} \qquad (34)$$

where

Y_{ij} = the willingness to pay of individual j when prompted by method i

a_i = coefficient for promptirg method i i = 1-4

e_{ij} = the random error, $\{e_{ij}\}$ N(0, ^{2})

The model was highly significant ($p<0.001$) which is very interesting as it means that these results directly contradict Bohm (1972) (see Chapter 3). In contrast to Bohm's, this study shows that people do not seem to have a clear idea about their willingness to pay and instead. let themselves be guided by the interviewer.

The means for the four options were

Open:	44.6 pence
25 pence:	38.5 pence
1 pound	85.1 pence
2 pounds	139.6 pence.

There is no reason to believe that because options 1 and 2 are very close, that option 1 the "open" option is the most valid . This underlines the point that although consistent methods can be found, this does not necessarily prove that the methods are correct.

In order to find out whether we had interviewed different kinds of groups of people or if there were differences between sites, we carried out a 4-way ANOVA without interactions. The model was:

$$Y_{ijklm} = a_i + b_j + c_k + d_l + e_{ijklm} \qquad (35)$$

where in addition to the variables in (34),

b_j = site for interview j = 1-4

c_k = income group, k = 1-6

d_l = holiday, l = 1-2, (1 = yes, 2 = no)

There were 134 cases where all the data were available These were processed and the only variable found to be significant was the prompting method (Q17) where $p<0.001$. Income was the next most important ($p<0.098$)

According to the interviewer, a number of respondents interrupted before she had finished the prompt to say they would not pay on principle. Unfortunately, these cases were recorded under prompt 1 (open) and cannot be identified They should rightly either all have been omitted or recorded under the prompt that she intended to use at the beginning of the interview.

To try and correct for flaws in the interview procedure, the 4-way ANOVA as in (35) was done but omitting both student questionnaires (SITE = 5) and prompting method 1 (Q17 = 1). However, this did not change the result of the ANOVA. The prompting method was still significant ($p<0.001$) and the next most important factor was income ($p<0.096$).

Thus, there seems to be no reason to object to the model described in equation (34) and the conclusion must be that in an attempt to estimate the socioeconomic value of the forest visits, it is preferable to use methods based on actual behaviour rather than a questionnaires trying explicitly to reveal willingness to pay.

As income had some importance, it would be interesting to include this variable in a travel cost model when the distribution of income is not the same for each zone.

It would also be interesting to test stated willingness to pay against actual behaviour when a fee was introduced. The fee would increase the total travel cost and it should be possible to see whether people reacted according to their stated willingness to pay. As the actual observed behaviour is the correct measure, it might be possible to derive conversion factors between the "true" consumer's surplus and the total stated willingness to pay for each of the different prompting methods.

4.3.1.2. Estimated Running Costs for Cars

As with the willingness to pay question, four different prompting methods were used when asking about the running costs (in pence per mile) for the car visitors. The question was (Q12b):

"Can you tell me how much it (the car) costs to run?"

Option 1: open (nothing stated from interviewer)

Option 2: Does it cost you 10 pence per mile?

Option 3: Does it cost you 20 pence per mile?

Option 4: Does it cost you 30 pence per mile?

Options 2-4 were followed by the question "How much?" if the answer was no to the first prompt.

The result from a one-way ANOVA was that running costs varied highly significantly with the prompting method ($p<0.001$) for a model similar to (34).

The questionnaire should probably have clarified more precisely whether it was the average cost (i.e. including interest depreciation, maintenance, etc.) or the marginal cost (fuel consumption) that we wanted them to estimate. For an economic analysis of the social value it would be ideal if we could establish a trip demand curve from people's perceived costs and then use average costs when calculating the consumer's surplus.

It could be argued that the average cost which is then wanted is not the same as the average cost that a visitor faces. This is due to the inclusion of taxes and it might be more correct if we had a shadow price free of taxes and including the externalities of driving

If we were to reduce use to a certain level, and we wanted to do it by charging visitors, the marginal costs should be used to establish the fee as we must expect marginal costs to be close to perceived costs.

4.3.2 Results from a Clawson Analysis

In the following discussion, the names in brackets, e.g. [CLAW2] refer to the files for a particular run of the computer programme described in 4.2.2 3. Files which have been used to generate results are input files with the extension .INP, e.g. CLAW2.INP. The corresponding output files have the extension .OUT. e.g. CLAW2.OUT.

4.3.2 1 Results from a Revised Clawson Method

The first run [CLAW1] of the model was carried out using the zoning shown in Table 4.8 in Section 4.2.2.1.5. This zoning resulted in one of the zones (Zone 2) contributing zero visitors which led to the point (0,-). This was then excluded as discussed earlier (section 4.2.2.). Due to the lack of visitors from Zone 2 in this zoning pattern, the population zones were changed so that Zone 1 was extended to 8 miles and Zone 2 went from 9-20 miles.

With this change included [CLAW2], the following results were obtained:

Table 4.12 Points for the trip demand curve

Number of Visitors/100000 Inhabitants in Zone:

Zone 1	28.7604	Average cost	6	pence
Zone 2	16.3281	Average cost	112	pence
Zone 3	18.6334	Average cost	221	pence
Zone 4	15.7440	Average cost	294	pence
Zone 5	6.1634	Average cost	362	pence
Zone 6	0.6296	Average cost	398	pence
Zone 7	1.1055	Average cost	345	pence
Zone 8	0 8400	Average cost	261	pence
Zone 9	2.9998	Average cost	417	pence
Zone 10	0 0370	Average cost	548	pence

8 observations (3 43%) of all observations are outside the outer Zone and are excluded

Although excluded here. the 8 observations outside the furthest Zone are included in a later run [CLAW11]. The 10 pairs of values in the Table 4.12 are the points upon which the trip demand curve is estimated.

The results from the three different curvefits and various summation methods are summarised in Table 4.13 but are discussed here as well. The regression fit without weighting gave the line

$$Y_i = 25\ 223 - 0.054*X_i \qquad (36)$$

where·

Y_i = number of visitor groups per 100000 inhabitants in zone

X_i = average travel cost in pence for zone i

This led to a consumer's surplus of 669 pounds when the integration was done by the traditional zone based method (hereafter abbreviated as CSZ). A consumer's surplus of 211 pounds was obtained when the integrating was done individually (CSI) as described in Section 4.2.2.1.6. Finally, a consumer's surplus of 135 pounds resulted when each zone was regulated to actual observed number of visitor groups (CSR). The model (36) predicts

Table 4.13: Results from CLAW2

Curvefunc.	Weight	SS-res.	CSZ	CSI	CSR	pvg	CS/pvg
Linear regr.	none	257.74	668.00			937.	0.71
				210.92		173.	1.22
					134.82	214.	0.63
	zonep/vis.	1469.99	140.36			138.	1.02
				294.44		188	1.57
					235.07	225.	1.04
	zonepop.	1300.05	231.33			225.	1.03
				291.27		187.	1.56
					231.33	225.	1.03
2nd dg.polyn.	none	222.16	657.30			808.	0.81
				208.07		177.	1.18
					159.82	214.	0.75
	zonep/vis.	1737.15	-			-	-
				-		-	-
					-	-	-
	zonepop.	1737.92	-			-	-
				-		-	-
					-	-	-
Log lin.regr.	none	817.59	7279.61			1092.	6.67
				1247.41		225.	5.54
					1391.54	225.	6.18
	zonep/vis.	8872.92	114.43			137.	0.84
				181.73		190.	0.96
					188.88	225.	0.84
	zonepop.	-	154.09			187.	0.83
				185.79		193	0.96
					201.01	225.	0.89

937 visitor groups compared with the actual 225 observed.[11]

For the individual integration, 173 observations contributed to the calculation of consumer's surplus. For the third method, 214 observations contributed. This higher value with the third method results from the fact that Zone 10 has an average travel cost bigger than the value 467 pence where the line from (36) and the X-axis (price) intercept

The linear regression weighted by zone population/visit rate decreased the consumer's surplus to 140 pounds for CSZ and 294 pounds for the CSI method while the CSR method gave a result for consumer's surplus of 235 pounds. Using this weighted linear regression the predicted number of visitor groups was only 138 by the CSZ method. Weighting by zone population gave a consumer's surplus of 231 pounds for CSZ , 291 pounds for CSI and, finally 231 pounds when regulated. When this weighting was employed. the CSZ method gave the correct prediction of 225 visitor groups as expected

At first glance there seems to be some difference between the two weighting methods. However, when we introduce the measure of consumer's surplus per predicted visitor group (CSP), the two weighting methods give very similar results[12].In this case, they both give 103 pence per predicted visitor group.

11 See discussion in 4 2.2.1.3.

12. This measure is discussed in 4.2.2.1 6.

The CSI method gives a higher consumer's surplus than the two other integration methods. This is due to the fact that for the CSI method the trip demand curve is estimated on the basis of average values with a considerable variance within the zone. As a result, the CSI method integrates some extremely low values while ignoring all of the values greater than the intercept between the demand curve and the price-axis.[13]

It can be seen from the following Table 4.14 that the unweighted model for calculating consumer's surplus is unsuitable.

Table 4 14 Number of visitor groups distributed to zones

Number from Zone	1	2 Visitor groups
Number from Zone	2	7 Visitor groups
Number from Zone	3	17 Visitor groups
Number from Zone	4	13 Visitor groups
Number from Zone	5	17 Visitor groups
Number from Zone	6	45 Visitor groups
Number from Zone	7	31 Visitor groups
Number from Zone	8	31 Visitor groups
Number from Zone	9	51 Visitor groups
Number from Zone	10	11 Visitor groups

In the unweighted method, equal reliance is placed upon a point which is based on 2 visitor groups (as in Zone 1) as on a point based on 51 visitor groups (as in Zone 9).[14]

13. See also Section 4.2.2 1.6.

14. See 4.2.2.1.2

The second curvefit a second degree polynomial, gave in the unweighted version a very similar result to that generated by the linear model (here, 657 pounds). The model was estimated as:

$$Y_i = 28.7333 - 0.0920*X_i + 0.0007*X_i^2 \qquad (37)$$

where

Y_i and X_i are the same as in equation (36)

Unfortunately, the two weighted models did not. using a 2nd degree polynomial, give any curvefit from which a consumer's surplus could be derived.

The third curvefit the log-linear model, gave the following line for the unweighted situation:

$$\ln(Y_i + 1) = 5.1726 - 0.6442*\ln(X_i + 1) \qquad (38)$$

where:

Y_i and X_i are the same as in Equation (36)

This gave a consumer's surplus of 7280 pounds for 1092 visitor groups with the CSZ method which is equal to 6.67 pounds per predicted visitor group. Weighted according to zone population/visit rate, this model gave a result of 114 pounds for 137 visitor groups and of 0.84 pounds per predicted visitor group . The same result was found when adjusting to the actual observed number of visitor groups. Weighting by the zone population gave a consumer's surplus of 154 pounds for 187 visitor groups and 0.83 pounds per predicted visitor group.

The trend seen earlier in the application of the linear regression model where the two weighting methods give similar results for consumer's surplus per predicted visitor group is also apparent in the application of the log-linear model.

The disadvantage of the log-linear model is that points are weighted according to the transformation as discussed in Section 4.2.2.1.6. In our case, we could say, have used number of visitors per 4 million inhabitants in the zone instead of number of visitor per 100,000 inhabitants. This would have prevented any of the visit rates being less than 1 and resulted in a completely different "weighting" pattern

An attempt was made to run the programme with the transformation ln(X) instead of ln(X + 1). In the unweighted model, this led to a result where the consumer's surplus was equal to 1099 pounds for 659 visitor groups or 1.67 pounds per predicted visitor group. In the two weighted models, a consumer's surplus of 0.27 pounds per predicted visitor group was found

The above example underlines the problems of using a log-linear transformation, and users would be advised to rely instead on the results from the linear regression model and the second degree polynomial.

In the examples dealt with so far , no consideration was given to the fact that a bias in estimating the average travel costs had occured owing to differences in the length of stay of the sampled visitor groups The problem is explained in section 4 2.2.1.4. Run number 3 [CLAW6] corrected for this via an option in the programme The result of this correction was much lower average travel costs as shown in Table 4.7 in Section 4.2.2.1.4. When these lower values were used for estimating the trip demand curve.

this again led to a decrease in consumer's surplus as shown in the results in Table 4.15.

Again. it must be emphasised how relatively consistent the results are when it is the consumer's surplus per predicted visitor group which is being considered. For the linear regression model (when individual integration is ignored) the weighted cases yield a consumer's surplus per predicted visitor group of about 0.40 pounds. Values in the same range are obtained by using the log-linear transformed model in the two weighted cases. In this run [CLAW6] it was again impossible to derive any results from the second degree polynomial when trying to weight.

In the above run, the 8 observations outside the furthest zone were excluded. The following run [CLAW15] included these observations as a point (0,287), where 287 was the average weighted travel cost in pence as described in Section 4 2.2 1.5. For the unweighted linear regression, this changed the consumer's surplus from 398 pounds to 350 pounds and the number of predicted visitor groups from 1032 to 865 which resulted in a consumer's surplus per predicted visitor group equal to approximately 0.40 pounds.

The weighted models cannot be carried out without modification of the weighting procedures as the zone population is not defined for this new observation and neither is the visit rate. A modification was built in which automatically sets the weightings to 1 when this happens. This did not lead to results different from the ones already obtained in [CLAW6]. This is because the weightings for some of the bigger zones are in the range of 10^9, and a new point with the weighting of 1 does not affect the results.

Table 4.15: Results from CLAW6

Curvefunc.	Weight.	SS-res.	CSZ	CSI	CSR	pvg	CS/pvg
Linear regr.	none	236.24	398.17			1032.	0.39
				99.96		140.	0.71
					78.76	180.	0.44
	zonep/vis.	1537.95	24.56			61.	0.40
				96.13		137.	0.70
					73.80	180.	0.41
	zonepop.	1266.57	88.74			229.	0.39
				108.66		144.	0.75
					89.69	180.	0.50
2nd dg.polyn.	none	216.38	508.47			1217.	0.42
				106.74		154.	0.69
					100.28	225.	0.45
	zonep/vis.	-	-			-	-
				-		-	-
					-	-	-
	zonepop.	-	-			-	-
				-		-	-
					-	-	-
Log lin.regr.	none	781.00	4299,85			1184.	3.63
				727.05		223.	3.26
					781.62	225.	3.47
	zonep/vis.	1001.94	21.31			59.	0.36
				67.28		141.	0.48
					62.55	180.	0.35
	zonepop.	6167.94	68.34			162.	0.42
				85.36		155.	0.55
					97.72	225.	0.43

Table 4.16: Results from CLAW15 and CLAW15B

Curvefunc.	Weight	SS-res.	CSZ	CSI	CSR	pvg	CS/pvg
Linear regr.	none	245.16	35o.6o			865.	o.41
				98.74		141.	o.7o
					74.72	188.	o.4o
(Zone 11 = o,287)	zonep/vis.	1537.99	24.56			61.	o.4o
				99.o9		142.	o.7o
					75.15	188.	o.4o
	zonepop.	1267.o4	88.74			229.	o.39
				112.11		15o.	o.75
					91.76	188.	o.49
Linear regr.	zonep/vis.	1741.63	-			-	-
(Zone 11 = zone 1o)				-		-	-
					-	-	-
	zonepop.	1369.83	48.88			124.	o.39
				1oo.68		143.	o.7o
					77.23	188.	o.41
Linear regr.	zonep/vis.	1699.57	8.37			21.	o.4o
				12o.48		155.	o.78
					1o3.67	233.	o.44
(Zone 11 = zone $\frac{(8+9+1o)}{3}$)	zonepop.	132o.84	66.19			173.	o.38
				1o6.54		149.	o.72
					84.78	188.	o.45

Instead, the built-in subjective weighting feature was used in an attempt to make use of the observations outside the furthest zone. Two different methods were used [CLAW15B]. The first one gave Zone 11 the same weighting as Zone 10 and the second gave Zone 11 a weighting equal to the average of Zone 8 9.and 10. The results are summarised in Table 4.16 for the linear regression model.

In the first case. no result could be obtained for the linear regression when weighted by zone population/ visit rate In every other case, the results obtained for consumer's surplus per predicted visitor group were very similar to the results obtained without the inclusion of the new point. This is hardly surprising as the value, 287. is in the same range as the rest of the further zones, i.e zones with low visit rates.

To test the sensitivity due to zoning, the next run [CLAW17] of the model was done with the zones pooled into equidistant zones of 50 miles as shown below in Table 4.17.

Table 4.17 · Equidistant zoning system

Zone 1	0 - 50 miles	Population:	223630
Zone 2	51 - 100 miles	Population:	7422858
Zone 3	101 - 150 miles	Population·	2804152
Zone 4	151 - 200 miles	Population:	3690580
Zone 5	201 - 250 miles	Population·	1700105
Zone 6	251 - 300 miles	Population:	29696401

This gave as a result the 6 points for the trip demand curve shown in the following Table 4.18:

Table 4.18 : Average travel costs with equidistant zoning

Number of Visitor Groups/ 100000 Inhabitants in Zone:

Zone 1	17.4395	Average cost (weighted):	148.10
Zone 2	0.8353	Average cost (weighted):	335.37
Zone 3	1.1055	Average cost (weighted):	223.23
Zone 4	0.8400	Average cost (weighted):	206.63
Zone 5	2.9998	Average cost (weighted):	293.19
Zone 6	0.0370	Average cost (weighted):	311.46

8 observations (3.43% of all observations) are outside the outer zone and are excluded.

The results from the calculation of consumer's surplus are summarised in Table 4 19 The consumer's surpluses are generally smaller when calculated by CSZ. CSI. and CSR but are about the same value as in [CLAW6] when we consider only consumer's surplus per predicted visitor group (CSP). The second degree polynomial yields a smaller value for consumer's surplus in the case of the unweighted model than it did in [CLAW6] and yielded no results for the weighted cases. The log-linear model behaves better here than in [CLAW6] and gives results in the same range as the linear regression.

Another run [CLAW16] where the zones were pooled to 20,50.100.200. and 300 miles gave results in the same range as above for the weighted models. For the unweighted models. all results varied considerably except for the consumer's surplus per predicted visitor group.

4.3.2 2. Results from a Traditional Clawson Method

A traditional Clawson analysis was carried out by using constant travel cost for each zone. The travel costs were based on the formula (31).

Table 4.19: Results from CLAW17

Curvefunc.	Weight	SS-res.	CSZ	CSI	CSR	pvg	CS/pvg
Linear regr.	none	112.57	228.75			468.	0.49
				90.05		1.	-
					66.91	163.	0.41
	zonep/vis.	274.12	27.82			67.	0.42
				95.07		1.	-
					72.74	163.	0.45
	zonepop.	228.52	86.65			225.	0.39
				106.91		144.	0.74
					87.99	225.	0.39
2nd dg.polyn.	none	29.23	35.41			211.	0.17
				36.68		103.	0.36
					21.00	101.	0.21
	zonep/vis.	-	-			-	-
				-		-	-
					-	-	-
	zonepop.	-	-			-	-
				-		-	-
					-	-	-
Log lin.regr.	none	93.15	177.86			420.	0.42
				70.15		157.	0.45
					90.91	225.	0.40
	zonep/vis.	260.81	23.36			62.	0.38
				64.32		138.	0.47
					61.30	163.	0.38
	zonepop.	237.71	69.42			162.	0.43
				83.82		155.	0.54
					97.77	225.	0.43

The formula is discussed in Section 4.2.2.2. The value of CM is calculated from the petrol price which was valid at the time of the survey (136 pence/gallon) and from the average mileage per car (29 miles/gallon). The following result, Table 4.20 was obtained [CLAW14] for the trip demand curve of the number of visitors per 100000 inhabitants in the zone and the new travel cost.

Table 4.20 · Points for the trip demand curve

Number of Visitor Groups/100000 Inhabitants in Zone:

Zone 1	28.7604	Travel costs	53 pence
Zone 2	16.3281	Travel costs	143 pence
Zone 3	18.6334	Travel costs	239 pence
Zone 4	15.7440	Travel costs	387 pence
Zone 5	6.1634	Travel costs	571 pence
Zone 6	0.6296	Travel costs	810 pence
Zone 7	1.1055	Travel costs	1196 pence
Zone 8	0.8400	Travel costs	1658 pence
Zone 9	2.9998	Travel costs	2123 pence
Zone 10	0 0370	Travel costs	2590 pence

8 observations (3.43% of all observations) are outside the outer zone and are excluded.

The distribution of willingness to pay is very wide. that is, there is a high maximum value. Therefore, the programme automatically increases the increment in price in the calculation of the consumer's surplus as there are only approximately 200 steps allowed in the procedures.

The results obtained using the above travel costs are summarised in Table 4.21. Notice that the results from the two methods of calculating consumer's surplus do not differ considerably when the consumer's surplus per predicted visitor group is being considered.

Table 4.21: Results from CLAW14

Curvefunc.	Weight	SS-res.	CSZ	CSR	pvg	CS/pvg
Linear regr.	none	369.55	6198.46		1145.	5.41
				925.56	163.	5.68
	zonep/vis.	1545.82	879.83		119.	7.39
				1602.33	225.	7.12
	zonepop.	1402.02	1639.49		225.	7.29
				1639.47	225.	7.29
2nd dg.polyn.	none	132.17	1003.53		470.	2.14
				303.69	132.	2.30
	zonep/vis.	-	-		-	-
				-	-	-
	zonepop.	15654.40	19567.70		3915.	5.00
				197.29	214.	4.19
Log lin.regr.	none	351.20	4246.93		528.	8.04
				1799.56	225.	8.00
	zonep/vis.	1186.55	638.31		108.	5.91
				1182.56	225.	5.26
	zonepop.	947.07	1051.06		169.	6.22
				1354.29	225.	6.02

Table 4.21: Results from CLAW14

Curvefunc.	Weight	SS-res.	CSZ	CSR	pvg	CS/pvg
Linear regr.	none	369.55	6198.46		1145.	5.41
				925.56	163.	5.68
	zonep/vis.	1545.82	879.83		119.	7.39
				1602.33	225.	7.12
	zonepop.	1402.02	1639.49		225.	7.29
				1639.47	225.	7.29
2nd dg.polyn.	none	132.17	1003.53		470.	2.14
				303.69	132.	2.30
	zonep/vis.	-	-		-	-
				-	-	-
	zonepop.	15654.40	19567.70		3915.	5.00
				197.29	214.	4.19
Log lin.regr.	none	351.20	4246.93		528.	8.04
				1799.56	225.	8.00
	zonep/vis.	1186.55	638.31		108.	5.91
				1182.56	225.	5.26
	zonepop.	947.07	1051.06		169.	6.22
				1354.29	225.	6.02

Table 4.22: Results from CLAW18

Curvefunc.	Weight	SS-res.	CSZ	CSR	pvg	CS/pvg
Linear regr.	none	136.83	5255.26		820.	6.41
				1098.93	214.	5.14
	zonep/vis.	269.01	1062.31		140.	7.59
				1574.30	225.	7.00
	zonepop.	249.95	1665.43		225.	7.40
				1665.43	225.	7.40
2nd dg.polyn.	none	71.31	1649.30		578.	2.85
				387.80	132.	2.94
	zonep/vis.	-	-		-	-
				-	-	-
	zonepop.	3445.27	37901.07		5457.	6.95
				1565.38	225.	6.96
Log.lin.regr.	none	81.95	2911.61		471.	6.18
				1364.00	225.	6.06
	zonep/vis.	239.76	757.04		128.	5.91
				1169.29	225.	5.20
	zonepop.	228.87	1127.90		176.	6.41
				1420.84	225.	6.32

The consumer's surpluses are bigger overall when using this method rather than the revised Clawson method. This applies for any model of curvefit and weighting method This is what we would have expected as the traditional Clawson method in fact attributes the main holiday travel costs to the visit area under concern. The revised method only attributes a proportion of the total expenditures as a measure of willingness to pay.

The same rezoning as shown in Table 4.17 was tried with the traditional Clawson method [CLAW18] to test how sensitive this model was to rezoning. The results are summarised in Table 4 22 It can be seen that rezoning in this case results in higher values than in [CLAW14] when the consumer's surplus on a zone basis is being considered However, when we consider the consumer's surplus per predicted visitor group, the results are quite similar to those obtained in [CLAW14].

The traditional Clawson method is not very sensitive to the described rezoning because of the extraordinarily heavy weighting of the most distant zones which does not change in the rezoning. If, however, we rezone in such a way (Table 4.23) that the zones farthest from the forest are increased in size then we will find that the consumer's surplus decreases.

Table 4.23 Rezoned zoning system

Zone 1	0 - 20 miles	Population:	49825	Travel costs: 133
Zone 2:	21 - 50 miles	Population:	173805	Travel costs: 357
Zone 3:	51 - 70 miles	Population:	275824	Travel costs 571
Zone 4:	71 - 100 miles	Population:	7147034	Travel costs: 810
Zone 5:	101 - 200 miles	Population:	6494732	Travel costs: 1483
Zone 6	201 - 300 miles	Population:	31396506	Travel costs: 2391

The results from the run using this rezoning pattern [CLAW19] are summarised in Table 4 24 Except in the case of the transformed linear model when weighted. the consumer's surpluses are smaller than those

Table 4.24: Results from CLAW19

Curvefunc.	Weight	SS-res.	CSZ	CSR	pvg	CS/pvg
Linear regr.	none	146.52	4108.42		860.	4.78
				802.96	163.	4.93
	zonep/vis.	581.06	1101.49		163.	6.76
				1792.49	225.	7.97
	zonepop.	513.99	1411.90		225.	6.28
				1411.91	225.	6.28
2nd dg.polyn.	none	48.05	673.83		365.	1.86
				258.15	101.	2.56
	zonep/vis.	7288.04	-		-	-
				-	-	-
	zonepop.	3215.11	5138.00		1667.	3.08
				403.81	163.	2.48
Log.lin.regr.	none	146.66	1502.14		318.	4.72
				851.06	225.	3.78
	zonep/vis.	521.98	1383.92		156.	8.87
				2027.66	225.	9.01
	zonepop.	443.99	1381.98		190.	7.27
				1629.97	225.	7.24

obtained in [CLAW14]. This is due to the lower travel costs from the furthest away zones

4.4 Summary of Methods and Results

The preceding sections in this Chapter have emphasised various problems which should be considered when the task of producing a measure of the benefits from recreation is undertaken. In this section, the major problems will be summarised and discussed.

Questionnaire design. The fact that our analysis was based on secondary data of variable quality has been useful in that it highlighted some problems. In particular for the Clawson analysis the meaning of the cost we wanted was not clear to the visitors. Also missing values reduced the size of the data-set. We will discuss more the problem of questionnaire design in Chapter 6. Some of the problems we have been able to solve with statistical methods, however.

Survey methods vs. Travel cost methods: The results from a questionnaire conducted in Gwydyr Forest clearly indicated a correlation between prompting method and stated willingness to pay. In addition, some visitors would not be willing to pay on principle, even though they place a large value on the opportunity for free access. This led us to believe that in this case the survey method would be unreliable and that the best way to proceed in the estimation of recreational benefits was to undertake a travel cost method (Clawson method) in which the benefit is derived from observations of actual behaviour. Even then, it has become clear that prompting method has influenced people's response to questions about the cost of running their car.

Traditional vs. Revised Clawson method. The traditional Clawson method was found to be unsatisfactory in this case: it greatly overestimated the consumer's surplus. This was due to the fact that 73% of the visitor groups interviewed were on holiday at the time of their forest visit; it would be wrong to attribute all the cost of travel from home as willingness to pay for the forest visit. The revised Clawson method takes this into consideration by basing the visitor group's travel cost (imputed willingness to pay) on a formula based on mileage cost, home distance, holiday length, and length of stay in the forest. This results in smaller travel costs than the traditional method and, thus, a smaller consumer's surplus. The revised method also has the advantage that it can combine different means of transportation into one study: in this and other studies the data-set is too small to give useful results if it is split up for separate analysis. The method is further discussed in Christensen, Humphreys and Price (1985).

Length of stay in the forest: When randomly sampling on a site interviewers will get an overrepresentation of those visitor groups who are staying in the area for the longest periods of time We found a correlation between the length of stay and the travel cost used in the revised model. Therefore, it was considered necessary (as suggested by Lucas, 1963) to weight the travel cost by the reciprocal of the length of stay. An option was therefore built into the developed programme which weighted the travel cost when we calculated the average from each zone. This led to a decrease in the consumer's surplus.

Curve fitting Three models were used in this part of the study, a linear regression, a second degree polynomial, and a log transformed linear regression. The log-linear model is not recommended as the points are actually weighted by the transformation process. Also, considerable variation results from the units used for the visit rate (e.g. visits per thousand contra visits per million) when this arbitrary weighting is employed.

The second degree polynomial was, in some instances, unable to yield a result partly because our sample was not as good as expected. This model can, like the log-linear model, give us infinite consumer's surplus. The normal linear regression model in most cases was able to yield a result. Despite the traditional interpretation of a demand curve as being non-linear, application of the linear regression model proved useful in this study.

In an early stage of the study, an exponential curve fit was included. However, its use was abandoned as it could not be weighted in a satisfactory way. This problem has later been solved (See 5.4.9).

The task of deciding which model is "best" in this case is not easy. The SS-residuals have been calculated and so have the PRESS values. The SS-residuals can be used to compare different models if they are weighted equally. In this instance, the second degree polynomial will always give the smallest value indicating the best fit but this is simply due to the fact that it has one more degree of freedom to describe the data. The PRESS value which indicates how good the model is as a predictor can give some guidance on the choice of model because we can justify selecting a good predictor which has some importance when we are calculating the consumer's surplus. The PRESS values are often lower for the linear regressions than for the second degree polynomials. However, this can also be caused by an uneven distribution of points. The SS-residuals for the weighted models cannot be compared with the SS-residuals for the unweighted models as we have deliberately forced the curve to go closer to some points and to ignore others in the weighting procedures. The topic of functional form is discussed further in Chapters 5 and 6.

Weighting of points for the trip demand curve: It is shown that considerable variation can be obtained in the results as a consequence of the weighting system employed. It is not considered to be appropriate to use an unweighted model as equal weight is then attributed to all zones despite a wide variety in the number of visitor groups and in zone populations. The weighting which we consider most appropriate is zone population/ visit rate. This might not lead to the predicted number of visitor groups being equal to the observed number but the right number of total predicted visitor groups is not a goal in itself. Weighting by zone population does give the correct number of visitor groups if negative visits are included, but it is not considered to be statistically correct (4.2.2.1 2).

The right zoning: It has been shown that the zoning pattern can influence the consumer's surplus and it is recommended to try different zoning systems. Ideally, zones with a small range of travel cost should be used, but this is not usually possible with the revised Clawson method. Even in the traditional method where average travel costs per mile are used, narrow zones lead to problems because the number of visits from each zone can be too small. As a compromise consumer's surplus could be taken as an average value of the consumer's surpluses derived from different zoning systems.

Integration of Consumer's surplus· Three different integration methods were tested for the revised method. Method a/ is the normal method based on zones. Method b/ is a method based on individuals and method c/ is a method based on zones but regulated to actual observed number of visitor groups for each zone. The methods did not give the same result. This was primarily due to the fact that they predicted different numbers of visitor groups. In some cases, method a/ gave a consumer's surplus based on a prediction of more than 1000 visitor groups compared with the actual number of 225 observed. This led to the belief that, rather than concentrate on total consumer's surplus, we should focus on the consumer's surplus per predicted visitor group. By doing so, quite consistent results were obtained using methods a/ and c/ even for different curve fits. Method b/ tended to overestimate the consumer's surplus even when we concentrated on the consumer's surplus per predicted visitor group· the reasons were explained in Section 4 2.2.1.6. This method will be further discussed in Chapter 6.

This study has yielded a consumer's surplus per visitor group's visit to Gwydyr Forest Our estimated trip demand curve could be overestimated due to the perceived cost being smaller than the actual. On the other hand, as a lot of demand has not been observed due to substitute areas the demand curve could be overestimated. Our data do not allow us to decide which effect will be stronger.

To obtain an overall consumer's surplus, we would need the number of visitor groups per year. Then, provided our sample is a good representation of the population of forest visitors over the year, we could multiply our consumer's surplus per predicted visitor group by this yearly value. (It would also be necessary to adjust for the 3.43% of the visitor groups that we excluded from the study). This yearly value could be capitalized in the normal way if the government's (society's) discount rate is known.

5. THE ECONOMICS OF FORESTRY RECREATION IN A REGION OF DENMARK.

5.1 Introduction

A research project, " Project Forest and Folk (PFAF) " was set up in 1975 funded by the Danish Agricultural and Veterinary Research Council. The project's aim was to provide a better basis for decisions in the field of forestry recreation. This has, so far, resulted in two reports being published (Koch 1978,1980) giving a description of the population's use of forests and the use of the forests considered regionally. The two reports give no economic measures, but a further report (Part VII) is planned in which economic measures will be considered.

The present study should yield some ideas as to how a better basis for economic decisions concerning forestry recreation can be achieved. It is the aim of this work to present some of the data from the above project and show the measures which can be derived as future guidelines for PFAF.

5.2 Previous Work in the Field of Forestry Recreation Economics in Scandinavia [1]

The first major important work on recreation economics was by Strand (1967), who discussed different theoretical problems such as collective consumption, non-tradeability and joint public and private supply of recreational goods, as well as the possibilities of a better allocation in

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1. Section 5.2, 5.3 and 5.4.1 have been partly published in Christensen (1981). Section 5.2 is based on the author's contribution to Kaiser and Marchetta (1981).

the production of recreational goods.

The most interesting part, though, in relation to the development of recreation economics in Scandinavia, is probably the section on 'Measures for describing recreation' where a very critical discussion of the travel cost method and the assumptions behind it is presented. Strand opposed, among other things, the assumption that the only benefit from the travel is gained inside the visited area, and he concluded:

> " for individual problems one will probably not be able to indicate practicable methods with such properties that they might lead towards an optimum of social welfare " (Ibid.,p.180).

Instead, the applied works carried out in both Norway and Sweden developed along the line of the opportunity cost method, that is, estimating the loss to production forestry through providing recreational facilities. In this way Haakansson and Haegglund (1969) estimated the costs of preserving the objects of scientific, aesthetic and social importance in a forest area (2105 hec.) SE of Stockholm. They separated costs into three groups:

1. Costs due to the fact that restrictions inhibited management to maximize gains (Forgone revenues)
2. Investment costs
3. Maintenance costs

It was found that 10% of the total cost was due to category 1 above, and a net present value (NPV) of costs was calculated as 526 Sw.Cr. per hectare using a discount rate of 4% p.a. (Approx $ 100/hec.).

In the same way Johannesen (1970) applied an opportunity cost approach to a forest area (407 hec.) near Oslo. He found the difference between NPV when a production management plan was undertaken and NPV from practising the proposed recreation plan worked out as 1830 N.Cr. per hectare using a discount rate of 3.5% p.a. (approx. $360/hec.). Most of the decline in NPV was due to extension of the rotation age beyond optimum.

Hoejer (1971), like Strand, argues against quantitative evaluation of recreation unless the area concerned has intensive use as a recreation area, so actual or derived visit frequency can be used as a base for calculations. However, it is suggested that a calculation should always be undertaken of the opportunity costs which commercial forestry has to face. (Ibid. p.263)

Kardell (1973) applied eight different evaluation methods to two areas near Stockholm, including a method based on physical use, Clawson's zone method, and an opportunity cost method. He follows Strand in the criticism of the Clawson method, especially on the assumption that 'all visitors despite travel distance have identical preferences' (Ibid. p.31). That is, Kardell seems to believe that the Clawson method is based on each visitor having identical willingness to pay. But what the zone method actually requires is that each zone has <u>the same distribution of preferences within its population</u> not identical preferences. His conclusion is that none of the methods are generally applicable and most of the discussed methods suffer from theoretical shortcomings. Finally, a-method based on more qualitative measures is suggested.

Conflicts between recreational and commercial groups over land use are, according to Qvigstad (1974), to be solved by establishing a " market ". In this " market ", restrictions on use of zones can be priced. A model applied to an area of Oslomarka finds that the recreational value has to be equal to at least 50-60,000 N.Cr. per year to justify the area as it is today (approx. $11,000). The idea behind the method used can still be described as an opportunity cost approach.

Kardell and Ericson (1975) have evaluated three different management plans for an area outside Stockholm, using an opportunity cost method. The three alternatives were:

1. Production forestry
2. Extensive recreation
3. Intensive recreation

The extensive programme was estimated to cost approx. 40 Sw.Cr. per hectare per year, (approx. $10 /hec/year) or about 1 Sw.Cr. (approx. 25 cents) per visit. The more intensive recreation plan increased losses to 50-100 Sw.Cr. per hectare per year (approx. $13-25/hec/year). The largest amount (60%) was due to lowered yield values and retention costs.

The result of forestry management restrictions proposed by the government's physical planning schemes of 1975 has been evaluated by Lindgren (1976). It has been estimated that 1.9 mill hectares will be affected and that annual yield from that area will have to be lowered by 1.4 mill m^3. Due to lack of data it was found impossible to calculate the benefit of recreation and the report is, therefore, mainly concerned with the costs accruing to the forestry sector. Two extreme cases have been considered :

1. When only primary forestry is influenced
2. When external effects are spread to the rest of the forest industries

The first alternative is estimated to cost 90-180 mill.Sw.Cr. per year (approx. $25-45 mill) and the second alternative will cost 200-500 mill Sw.Cr. (approx. $50-125 mill). The real costs are believed to be in the range of 200-400 mill Sw.Cr. per year before tax (approx. $50-80 mill).

The general theoretical problems behind multiple use have been described by Joergensen (1974), Loennstedt (1975) and Helles (1977). The theory has been applied to Katnosa-Spaalen, a part of Oslomarka (Hofstad 1976), where a number of restrictions were put on timber production in order to increase the recreational value of the area. The restrictions were chosen from the results of interviews and behavioural studies. No quantitative recreation benefits were estimated and the political decisions were to be based on the estimated opportunity cost values.

In Finland[2], Mikola (1973) discusses the economic consequences of recreation and Saastamoinen (1972) has measured visitor expenditures. The same author (Saastamoinen 1978) estimated the value of mushrooms and

2. Based on Reunala's (1979) work for the "Worldwide annotated bibliography concerning the economics of recreation".

berries gathered in the period 1860-1965. Vesikallio (1974) applied an opportunity cost approach to timber harvesting in an area, when restrictions were put on due to recreation. He found timber harvesting on average 30% more expensive in the recreation area than in production forest.

Most recently, Strand (1981) has used a traditional Clawson analysis for calculating the socioeconomic value of sport-fishing in the Gaula river-system in Norway for the year, 1979. He found the consumer's surplus for the fishing to be 7.5 million N.Cr. (approx. $1.25 million). This is Approx. 1150 N. Cr. (approx. $190) for the 'average fisherman'. With a basis of the estimated number of trips to Gaula in 1979 (approx.$ 31,200), he found that the 'average trip' contained a willingness to pay equal to 240 N. Cr. (approx. $60).

5.3 Project Forest and Folk

"Project Forest and Folk" was set up in 1975. The Project's aim was to provide a better basis for decisions in the field of forestry recreation.

Part I (Koch 1978) is based on a mailed questionnaire survey spread over the period June 1976 to June 1977. The sample size was 3087 persons (age 15-76 years) selected in a random way using the Central Person Register, and the response was 2807 persons (91.4%).

The main results in the report include:

The number of forest visits per year per capita.
The length of stay - group size - activities.

Percentage who arrive by car for a given travel distance.

Differences between motorists' and non-motorists' use of the forest.

Name of the forest last visited.

Part II (Koch 1980) is based on the following:

1. Counting of parked cars on 318 different counting areas, divided into 1419 subareas making up 446 forest areas with a total area of approx. 187,000 hec. (approx. 40 % of all forest area in Denmark). Counts were carried out at all counting areas at the same 22 points in time distributed over the period April 1976 to May 1977.
2. At each counting a questionnaire was attached to the windscreen of parked cars or a sample of the parked cars. In this manner 44,846 questionnaires were handed out. The response was 24,076 (53.7%) as it was impossible to use follow-ups. (The effect of the non-response was estimated and partly corrected for using three different methods.)

The above information was combined with part I and with automatic recordings at 4 counting stations of the number of cars present every 15 min. over the period August 1976 until October 1979 (planned to be published in a forthcoming part III).

The main results presented are:

Total use in visitor hours and visits for the 446 forest areas including non-motorists.

For each forest area the number of car visitor hours per year, for peak periods, different seasons of the year and for weekdays and weekends.

In addition, average group size, length of stay, activities, travel time and travel distance for the car-borne visitors are given.

By using data from part I and a further questionnaire survey (a forthcoming part IV), the relative use intensity has been established for 230 forest districts. This, in combination with the above results, has been used to estimate the absolute use intensity for approx. 274.000 hec. or 3/4 of the area of all forest properties of 50 hec. or more.

5.4 Methodology

5.4.1 Aims of this Study

The following is a brief introduction and all the topics included will be discussed in greater detail in subsequent sections.

The method suggested is a travel cost method mainly based on the questionnaire information from part II (Koch 1980). This means that it is only benefits accruing to the car visitors which will be estimated in this preliminary study.

The region chosen is North Zealand, which has the advantage that nearly all forests in the region are investigated, and that the relatively dense population produced many responses to the questionnaires.

The unit of visitation will be household visits, hereby assuming that each car visiting is coming from one household, and the value is not distributed across individuals. Using that method it can be assumed that travel cost from each zone to each forest is relatively constant for all visitor groups coming from the zone.

As a zoning unit, post codes are used. These were given on the questionnaires. A cross-tabulation giving average distance from each forest to each post zone can be constructed.

The following analyses can be carried out:

1. Clawson analysis for a particular forest based on the actual number of visitors.
2. Clawson analysis for a particular forest based on the visitors for whom that is the nearest forest.
3. An integrated Clawson analysis, i.e. first find the gross demand curve for all forests as one, then simultaneously apply this to all the forests.
4. Clawson analysis for a particular forest, when alternative areas are taken into consideration, i.e. using diversion of demand as the "entry charge" is raised.
5. Use of the overall gross demand curve estimated in 3 to calculate the value of a new hypothetical forest. [3].

The validity of the relatively simple models suggested depends on the use of the measures: Is it the overall social value for all forests in the region, or the value of one particular forest that is wanted ? The main

3. There will naturally be aesthetic differences between the forests and differences in facilities, etc. which more refined methods might take into account.

intention in this preliminary study is to show the kinds of results which can be obtained from the available data. Hopefully this can give ideas on the direction in which to proceed and provide the decision makers with information such as:

1. An economic measure of the additional benefits accruing to the society due to the Forestry Commission's provision of forestry recreational facilities.
2. The social value of establishing a new forest in a particular area.
3. The loss to society by closing a forest in the area.

The above information will provide the kind of measures searched for in the introduction, and will also be of use in the local planning procedures.

If there are any opportunity costs these should naturally be deducted as mentioned in Section 1.2.

It might also be possible to extract information such as : What fee should be introduced in a forest X to keep use down to a certain carrying capacity ? However this raises the question of perceived costs contra actual costs. It would, therefore, be interesting through further research to analyse the relationship between consumer's surplus found by this measure and actual behaviour when a charge is introduced e.g. at a new car park.

More complicated models could have been suggested but as qualitative data on both forests and socioeconomic factors[4] have not been gathered, this is not directly possible without further expensive surveys.

Nevertheless, the data base on actual visitors is large and very thorough. It is not the aim of this study to describe the number of visitors so much as simply to estimate the value of the actual visits recorded from the available data.

5.4.2 The Region Investigated

The area chosen in which the forests are situated is North Zealand including Hornsherred peninsula and the island Amager. To the southwest the border is a line from Greve north of Roskilde up to Skibby.
The reasons for chosing this area are :

1. It is well defined as it is surrounded by water except for the southwestern borderline. The total area is approx. 1966 km^2 and the population approximately 1.54 million (Danmarks Statistik 1981). It is divided into two counties :

   County of Copenhagen (KBH)

   County of Frederiksborg (FRB)

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4. Occupation is available and might provide a guide.

Table 5.1: The Investigated Forests

County of Copenhagen (KBH):

1	Trørød Hegn	7	Geel Skov
2	Kohaven m.v.	8	Nørreskoven
3	Jægersborg Dyrehave og Hegn m.v.	9	Åsevang m.v.
4	Charlottenlund Skov	1o	Hareskovene og Jonstrup Vang
5	Kongelunden	11	Vestskoven Vest
6	Søllerød Kirkeskov		

County of Frederiksborg (FRB):

1	Horneby Sand	23	Grønnæsse m.v.
2	Hornbæk Plantage	24	Sonnerup Skov
3	Teglstrup Hegn og Hellebæk Skov	25	Lyngby Skov
4	Klosterris og Horserød Hegn m.v.	26	Freerslev Hegn
5	Gurrevang	27	Brøde Skov
6	Nyrup Hegn	28	St.Dyrehave og Tokkekøb Hegn m.v.
7	Egebæksvang	29	Grønholt Vang m.v.
8	Danstrup og Krogenberg Hegn	3o	Knorrenborg Vang
9	Munkegårds Hegn	31	Grønholt Hegn
1o	Kelleris Hegn	32	Lave Skov
11	Krogerup og Babylone Skov	33	Stasevang
12	Snevret	34	Sjælsølund
13	Gribskov og Stenholt Vang	35	Folehave
14	Sørup	36	Rude Skov
15	Aggebo og Græsted Hegn	37	Bistrup Hegn
16	Valby Hegn	38	Lystrup Skov
17	Høbjerg Hegn	39	Ravnsholt og Sønderskov
18	Tisvilde Hegn m.v.	4o	Uggeløse Skov
19	Brødemose Skov	41	Slagslunde
2o	Avderød Skov	42	Krogelund
21	Nejede Vesterskov	43	Ganløse Eget
22	Ullerup Skov	44	Ganløse Ore og Farum Llvang m.v.

2. Most forests in the region are included in the study. In the area 55 forests are investigated directly :

   11 in KBH and 44 in FRB

   These forests are the primary outdoor recreation facilities (except sea-shore) and the total area of the directly investigated forests is approximately 22700 hec. which is approximately 80% of the total forest area in North Zealand. (Danmarks Statistik 1979, Danske Forstkandidaters Forening 1979)[5]

3. The region is densely populated, resulting in many visits and, therefore, many questionnaires (approximately 30% of the population of Denmark lives in this area).[6] The total number of questionnaires for all parts of Denmark was 44846 with a response of 24076 equal to 53.7 %. The number of questionnaires in the above region was 16512 and the response 8758, equal to 53.0 % (Koch 1980,p.270-273). The above figures show that although the area of North Zealand is only approximately 4.6 % of the total area of Denmark, it is by far the best investigated area.

4. One of the permanent and automatic counting stations (See 5.3) was situated in the area in forest no. 28 in FRB (Koch 1976).

Table 5.1 contains a list of all the investigated forests and in Figure 5.1 a map is shown of the investigated area on which the forests are marked

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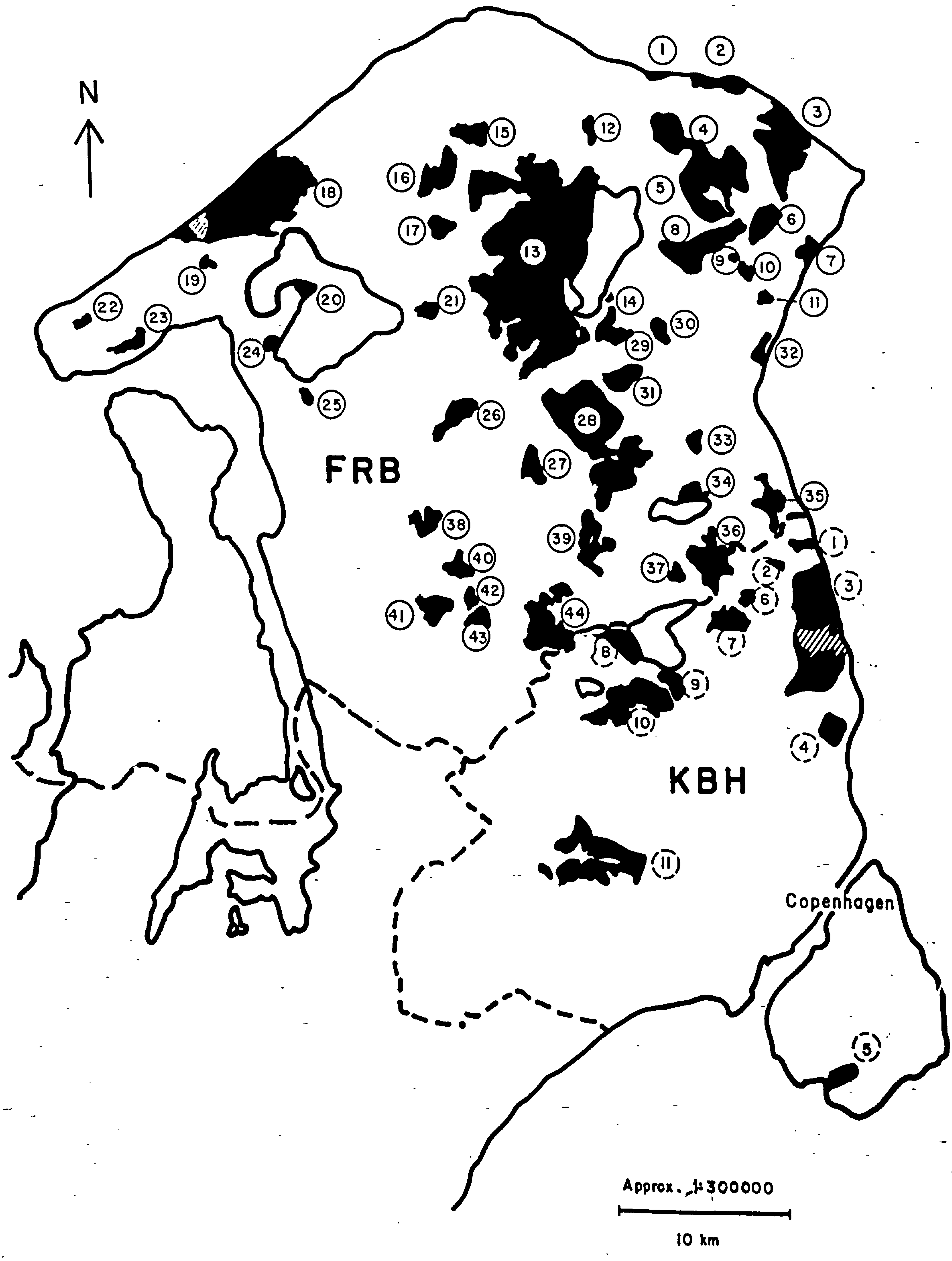
5. The figures have been reduced by the area of four lakes.
6. The figures are excluding Greenland and the Faroe Islands.

Figure 5·1

Map of North Zealand with investigated forests marked



according to Table 5.1 .

5.4.3 Unit of Visitation

The unit of visitation used is visitor groups per household and not, as usual, visits per capita. This is done for the following reasons:

1. One car-borne visitor group is probably one household coming to the forest.

2. The decision to come to the forest is probably made on the assumption that it costs the family x amount to drive to the forest and not that it costs x' amount per member of the visitor group.

3. This will lead to less variability in the travel cost, as it now is the cost per car which is the travel cost, despite the fact that some cars bring 5 persons and some bring 1 person, which would give higher variability in the travel cost within a given zone.

4. The number of households is accessible for each postal area, while it would be more difficult to find the number of inhabitants for each postal area (See 5.4.4).

5.4.4 Zoning Unit

The postal codes were used for grouping visitor groups into population zones instead of the traditional method of concentric zones. The postcodes were chosen because:

1. The postal codes for startpoint (Koch 1980,p.381) were given on all questionnaires, which made it a very easy measure to obtain.

2. The Post and Telegraph service could provide a booklet (Postaeog Telegrafvaesenet 1976) with the number of households within each postal area.

The above mentioned booklet defines all households as : ' All private residences, apartments, rooms with name sign and individual letterbox or other separate delivery possibility. It includes apartments in blocks, houses, terraced houses and farms, but not summerhouses and weekend cottages.' (Ibid.,p.14)[7]

The problem with summerhouses could bias the result as some people at e.g. 'Hornbaek Plantage' (Forest no.2 in FRB) have presumably started out from their summerhouses a few kms away , and the visit rate for that postal area will then be overestimated. The problem cannot be overcome by asking whether visitors are on holiday because many people live more or less permanently in their summerhouses over the summer and probably would respond negatively to the question.

7. Author's translation

Table 5.2: Postal Areas and Number of Households

Postal code		No.of househ.	Postal code		No.of househ.
1000	København K	22424	3000	Helsingør	14191
1500	København V	39361	3050	Humlebæk	3382
2000	København F	29628	3060	Espergærde	3869
2100	København Ø	47598	3070	Snekkersten	1389
2200	København N	43698	3080	Tikøb	444
2300	København S	52995	3100	Hornbæk	1604
2400	København NV	26948	3120	Dronningmølle	389
2450	København SV	10410	3140	Ålsgårde	1269
2500	Valby	27546	3150	Hellebæk	234
2600	Glostrup	13498	3200	Helsinge	4492
2610	Rødovre	17963	3210	Vejby	768
2620	Albertslund	12148	3220	Tisvildeleje	520
2630	Tåstrup	11209	3230	Græsted	2697
2635	Ishøj	6794	3250	Gilleleje	2208
2640	Hedehusene	4472	3300	Frederiksværk	5370
2650	Hvidovre	23600	3310	Ølsted	631
2660	Brøndby Strand	6580	3320	Skævinge	1176
2670	Greve Strand	8385	3330	Gørløse	370
2680	Solrød Strand	3578	3340	Brødeskov	232
2690	Karlslunde	2362	3360	Liseleje	413
2700	Brønshøj	22949	3370	Melby	270
2720	Vanløse	16789	3390	Hundested	2967
2730	Herlev	13905	3400	Hillerød	11545
2740	Skovlunde	5309	3450	Allerød	5600
2750	Ballerup	12223	3460	Birkerød	7751
2760	Måløv	4294	3471	Høvelte	45
2770	Kastrup	16413	3480	Fredensborg	3937
2791	Dragør	5731	3490	Kvistgård	530
2800	Lyngby	18161	3500	Værløse	6368
2820	Gentofte	10000	3520	Farum	5820
2830	Virum	8440	3530	Farum Kaserne	35
2840	Holte	6055	3540	Lynge	1407
2850	Nærum	3125	3550	Slangerup	2442
2860	Søborg	17108	3600	Frederikssund	5544
2880	Bagsværd	7488	3630	Jægerspris	2306
2900	Hellerup	10488	3650	Ølstykke	3759
2920	Charlottenlund	10634	3660	Stenløse	2288
2930	Klampenborg	2088	3670	Veksø Sjælland	733
2942	Skodsborg	804	4000	Roskilde	27051
2950	Vedbæk	2697	4050	Skibby	2228
2980	Rungsted Kyst	2171	4070	Kirke-Hyllinge	1478
2970	Hørsholm	6419	4621	Gadstrup	1041
2980	Kokkedal	3549	4622	Havdrup	1206
2990	Nivå	1567			

To make a more well defined border than the one defined in 5.4.2, five postal areas on the southwestern borderline are included although they are not actually in either of the two counties. These zones have few households and no forests.

In Table 5.2 is a list of postal areas and the number of households. Figure 5.2 shows the postal areas, and the population densities. The data are stored in PSOF.BB.

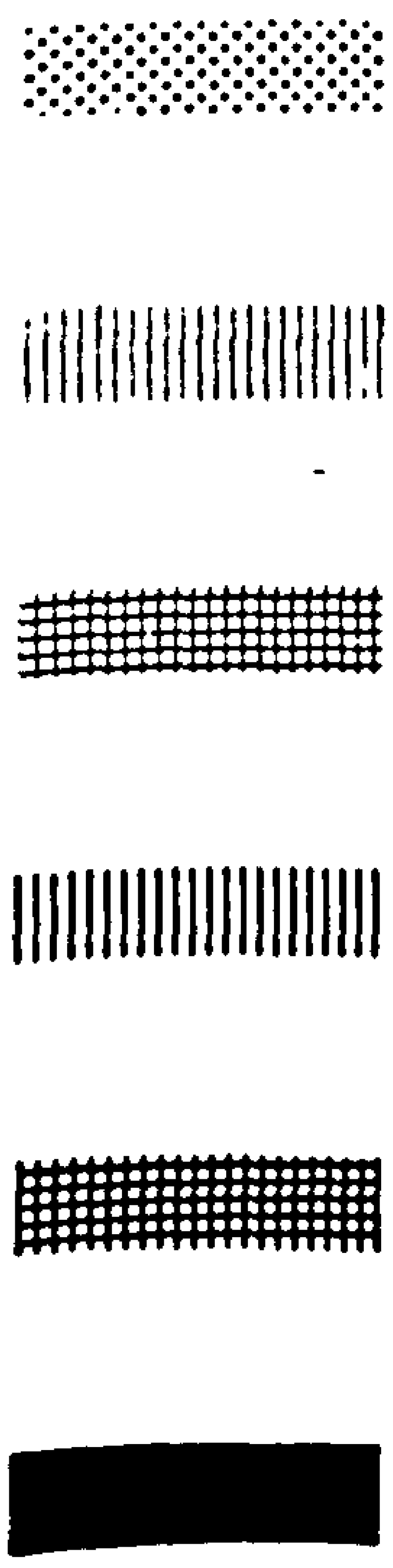
5.4.5 Unit of Travel Costs

The primary unit of the calculations will be kilometres. This is done in order not to introduce another source of inaccuracy. It was felt that it was easier to calculate all consumer's surpluses in the unit of kilometres and then finally show what a given kilometre price would mean to the surplus. The inaccuracy occurs for two main reasons: (1) The means of transport differ and (2) the perception of costs differs. This last point is especially difficult to handle. However, as it is the visitors' willingness to pay that we want to measure, it is considered that it should be the perceived costs that we use. But, are perceived costs the marginal costs or the average costs? It is assumed here that most visitors, when considering making a trip, consider their marginal costs or variable cost.

The variable costs for driving a car during the period 1976 - 1977 can be taken to vary from approximately 44 oere to 76 oere per kilometre (approx. 3 - 5.5 pence per kilometre) depending on the size of the car (Truelsen 1977). A good average would be 60 oere per kilometre (approx. 4 pence/km). The price if fixed costs and depreciation were included could

Figure 5·2

North Zealand: Postal areas and Population Density



Households per km^2

< 50

50-200

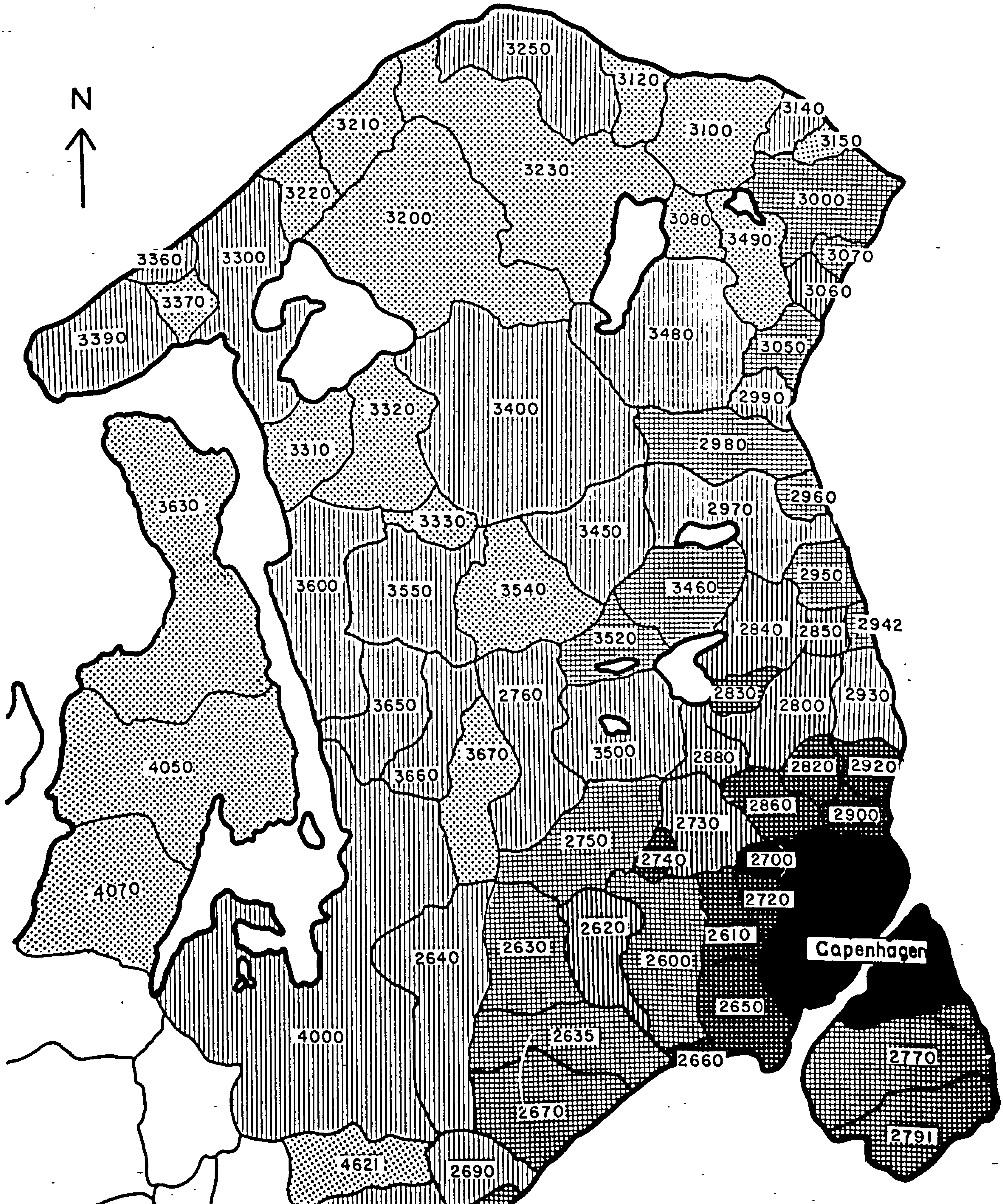
200-500

500-1000

1000-4000

> 4000

(Within the area of Copenhagen there are several postal areas)


N
3250
3120
3140
3210
3100
3150
3230
3220
3000
3200
3080
3490
3360
3300
3070
3370
3060
3390
3480
3050
2990
3320
3400
3310
2980
3630
2960
2970
3330
3450
3600
3550
3540
3460
2950
2942
2840
2850
3520
3650
2760
2830
2800
2930
4050
3670
3500
2880
2820
2920
3660
2860
2900
2730
2750
2740
2700
4070
2720
2620
2610
2630
2640
2600
Capenhagen
2650
4000
2635
2660
2770
2670
2791
4621
2690
4622
2680
Approx. 1:300000
10 km

vary from approximately 78 oere to 372 oere per kilometre (approx. 6 - 26 pence per kilometre) all depending upon the make of the car and yearly use (Truelsen 1977)[8].

The Directorate of Roads gives a cost as of 1 July 1977 of 52.1 oere/km (approx. 3.5 pence/km). This price is the variable cost and based on weighted costs for different cars according to the amount sold in the year, 1976 (Vejdirektoratet 1977).

5.4.6 The Data from PFAF

In Denmark the data from PFAF are analysed mainly by using a statistical package, SAS (Barr et al. 1976) and the data made available for this study were produced by a programme using SAS (prg A1711). For each forest investigated, it gives a frequency distribution of the yearly number of car-borne visitor groups distributed according to postal codes. The data have been created in the following manner as shown in Figure 5.3: On the 20 stratified sampling occasions, the number of parked cars were counted in each of the investigated forests. By using the sample weights according to the stratification (Koch 1980, Table A.1.3), the yearly numbers of car-borne visitor groups have been estimated. On each sampling

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8. For a car in the price range of 51 - 65,000 D. kr. (approx. 3,600 - 4,600 pounds) and running 15,000 kilometres per year, the marginal costs are 56.8 ore/km (4 pence/km) - if fixed costs are added, 90.9 ore/km (6.5 pence/km) and if interest and depreciation are included, 165.5 ore/km (12 pence/km) (Truelsen 1977, p. 47).

Figure 5·3

The Data from PFAF

1. Manual counting of parked cars on 20 different occasions between 1/4/1976 and 1/4/1977.

2. The sample weights according to the stratification.

3. Total number of carborne visitor groups to each forest per year.

4. Handed out questionnaires on the 20 different occasions described in 1 asking for the postal code of the visitor group's starting point.

5. For each forest, a frequency distribution of the yearly number of carborne visitor groups distributed to postal codes.

PSOF.AA

occasion, questionnaires were handed out. These have given a percentage frequency distribution for each forest of visitor groups according to postal areas. Combining these two data sets has, for each forest, given a frequency distribution of the yearly number of visitor groups according to postal codes.

The above data are not corrected for any missing samples, which were very few (Koch 1980, Appendix B.4). However, this means that for some forests, the total number of visitor groups may have been slightly underestimated.

One way to correct for this is to use the regression estimate for the yearly number of forest visitor groups. For each forest, this is based on a multiple linear regression of the number of cars counted on each of the four permanent sample plots.[9] The following model has been used (Koch 1980, p. 205 and 230 -233).[10]

$$Y_i = b_0+b_1*X_1+b_2*X_2+b_3*X_3+b_4*X_4 \quad +e_i \qquad (1)$$

---

9. There are 22 observations, i.e. the 20 sampling occasions and 2 additional countings.

10. A slightly different model was used including two dummy variables in cases where a forest had been closed due to a fire risk (Koch 1980, p. 233).

where: X_1, X_2, X_3, X_4 = the 4 permanent and automatic counting stations

Y_i = the number of cars counted in the forest

b_0, b_1, b_2, b_3, b_4 = parameters

On these permanent sample plots, the numbers of parked cars were measured every 15 minutes between 1/8/1975 and 1/10/1979. When the regression coefficients were estimated, the average values for the whole period were used to find the value for the investigated period.[11] The regression estimate is thus dependent upon any trends during the period 1976 to 1979. The regression as shown in (1) is not weighted with relation to the number of cars or the sample weights. Therefore, in this study, the main base will be the sample estimate which covers the same period as the one in which the distribution according to postal areas was obtained. However, comparisons will be carried out with analysis done on the regression estimate for some of the forests.

In Appendix A5.1 both estimates are given for the investigated forests.

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11. The automatic counters did not work consistently until the spring of 1977 (Koch 1980, p.111).

5.4.7 Distances

5.4.7.1 Distances for Visitor Groups

The forests and the postal areas were identified on maps on the scale of 1:50000 (Geodaetisk Institut 1514 I,II,III,IV and 1513 I and IV). A gravity point for each forest and postal area was determined. For the forests, it was chosen on basis of knowledge of accessibility, parking places etc., and for the postal areas it was selected by judging between the number of households in town and countryside as given in the booklet (Ibid.,1976).

As some forests only had observed visitor groups coming from the nearest zones surrounding them, not all distances from each forest to each postal area were measured. Instead the following procedure was adopted :

1. The distances were measured with a " Curvimeter Map Measurer " along the most obvious road choice from each forest to each postal area from which visitor groups were observed.
   The above distances are in file PSOF.CC.

2. Then the maximum distance for each forest to a postal area with number of visitor groups > 0 was found. Distances were then measured to postal zones from which no visitor groups were observed if the postal zone lies within a circle where r = the maximum distance as defined above. These distances are in file PSOF.EE.

Afterwards some distances were randomly chosen for control measure and it was found that repeat measurements were always within 5% of the first.

5.4.7.2 Logical Distances

When measuring the distances above on the maps from where visitor groups had come it became clear that the forests could be divided into 3 groups as follows :

1. Forests of national interest

2. Forests of regional interest

3. Forests of local interest

An example of 1 could be taken as 'Jaegersborg Dyrehave og Hegn' (Forest no.3 in KBH), which is a famous forest park just north of Copenhagen. People would come from more or less all over the region to this forest.

Examples of 2 could be taken as 'St. Dyrehave og Tokkekoeb Hegn m.v.' (Forest no.28 in FRB) or 'Rude Skov' (Forest no.36 in FRB), which are both well known forests of medium size. People will travel quite a bit, but it seems as if they are indifferent to which of them they go to. That is, they travel to the nearest, - i.e. the forests can substitute for each other.

This means that in 'St. Dyrehave og Tokkekoeb Hegn m.v.' one will find visitors from Hilleroed (postal code 3400) and Alleroed (postal code 3450), but not any from the postal areas around 'Rude Skov'.

An example of 3 could be 'Groenholt Hegn' (Forest no.31 in FRB) which is an example of the smaller local forest type, which serves the local residents.

To be able to distinguish these forest types it was decided to identify an approximate distance to the nearest forest(s) from the postal areas and a distance from postal areas within which people would find a reasonable variety of forests including at least one of type 2. These distances (two for each postal area) are stored in PSOF.DD .

In this manner, it is possible to select observations so we, for example , can do an analysis for a particular forest based only on the visitors for whom that is the nearest forest etc.

5.4.8 Weighting

The weighting described in 4.2.2.1.2 is also believed to be the correct weighting to use in this analysis. The argument was that the number of visitor groups n_i from a given zone of origin observed within a given forest was assumed to be Poisson distributed with parameter λ_i. Then the variance of the visit rate will be :

$$Var(V_i) = \lambda_i/N_i^2 \qquad (2)$$

where :

V_i = estimated visit rate from zone i

N_i = zonepopulation in zone i

In order to balance the variances when estimating the trip demand curve each observation should be weighted by :

$$N_i^2/\lambda_i = N_i/E(V_i) \tag{3}$$

In Chapter 4 equation (3) was set approximately equal to :

$$N_i/V_i \tag{4}$$

This is not assumed to be correct in this section as some of the observed values are zero (See 5.4.7.1). In these cases the weighting factor (4) is not defined. Instead of joining postal areas so all $V_i > 0$ it was decided to keep the zoning system. This was particularly important as we believed that an observation of one zone having a visit rate of 0 % should have more weight than one zone having a visit rate of 4 % , ceteribus paribus, - and a conglomerate zone with visit rate of 2 % if the zone populations were of equal size would thus not be acceptable. Therefore it was found appropriate to apply a two stage model as :

1. On the basis of all observations (including the zeros) a model was fitted using ordinary least squares. From the estimated parameters the predicted visit rate could be calculated. The weights W_i can then be calculated :

$$W_i = N_i/E(V_i) \simeq N_i/V_i \tag{5}$$

2. The model was fitted again and this time each point was weighted by W_i .

The assumption that the observation of number of visitor groups are Poisson distributed is still valid despite the transformation described in 5.4.5 to number of yearly visitor groups.

5.4.9 Selecting a Model for the Trip Demand Curve

5.4.9.1 Models of Interest

Three models were considered of general interest to be used for estimating the trip demand curve. They were :

1. A linear regression :

$$Y_i = a+b*X_i+e_i \tag{6}$$

2. A 2nd dg polynomial :

$$Y_i = a+b_1*X_i+b_2*X_i^2+e_i \tag{7}$$

3. A negative exponential curvefit :

$$Y_i = a*e^{b*X_i}+e_i \tag{8}$$

These three models were chosen because they could all be expected to have an acceptable form. Especially interesting though is the exponential curvefit, which ensures that no negative visit rates will be predicted for any given cost.

In order to select the best model of these three. a programme was written in GENSTAT (Alvey et al.,1977) using the two stage model described in 5.4.8 . The programme worked in the following manner :

1. An exponential model was fitted to all observations (unweighted) to give the predicted values to be used as weights in step 2.

2. The three models were fitted using the weights from 1.

The above procedure using an exponential model in the first step was chosen in order not to get 'negative' and infinite weights which could have been the case using the two other models. Furthermore a comparison of the models using different weights would not have been meaningful.

The test described above has been applied to some of the forests and to all the observations together, i.e. for an overall demand curve (See 5.4.10)

In all the cases the exponential model was found to have the smallest SS-residual and this model was chosen for the analysis in the rest of this study.

Possibly other nonlinear models could have been tried, but the reason for choosing the exponential will be explained below.

5.4.9.2 The Advantages of Using Exponential Curvefits

The advantages of using an exponential model are several:

1. At no price is a negative visit rate predicted and neither, therefore, is a negative consumer's surplus. This is a very important feature; other works have used linear regression and have had to ignore negative visit rates or else they have used negative visit rates when calculating total number of predicted visitors for zero additional entrance fee, but ignoring the 'negative' consumer's surplus (Bowes and Loomis, 1980).

(The logical argument)

2. It also has the smallest SS-residual for the models compared in this study (5.4.9.1). Other models could have been tried and, using more variables, we could have got a smaller SS-residuals. (The numerical argument)

3. Also the calculation of consumer's surplus gets simplified :
For zone i with travel cost c_i the consumer's surplus is

$$CS_i = N_i * \int_{c_i}^{\infty} a * e^{b*x}\, dx = N_i * a/b \left[e^{b*x} \right]_{c_i}^{\infty} \qquad (9)$$

But as $e^x \longrightarrow 0$ for $x \longrightarrow -\infty$ and $b < 0$ (9) can be reduced to

$$CS_i = -N_i * a/b * e^{b*c_i} \qquad (10)$$

The number of predicted visitor groups Q_i from zone i is :

$$Q_i = N_i * a * e^{b*c_i} \qquad (11)$$

From (10) and (11), it follows that the measure CS/(predicted visitor group) which was introduced in 4.2.2.1.6 is :

$$CS_i/Q_i = -1/b \qquad (12)$$

Equation (12) means further that in most cases where the total number of predicted visitor groups is close to total number of observed visitor groups an easily obtained measure for the consumer's surplus for an area is :

$$CS = -n_i/b \tag{13}$$

where : n_i = total number of observed visitor groups

5.4.10 Methods

5.4.10.1 Database

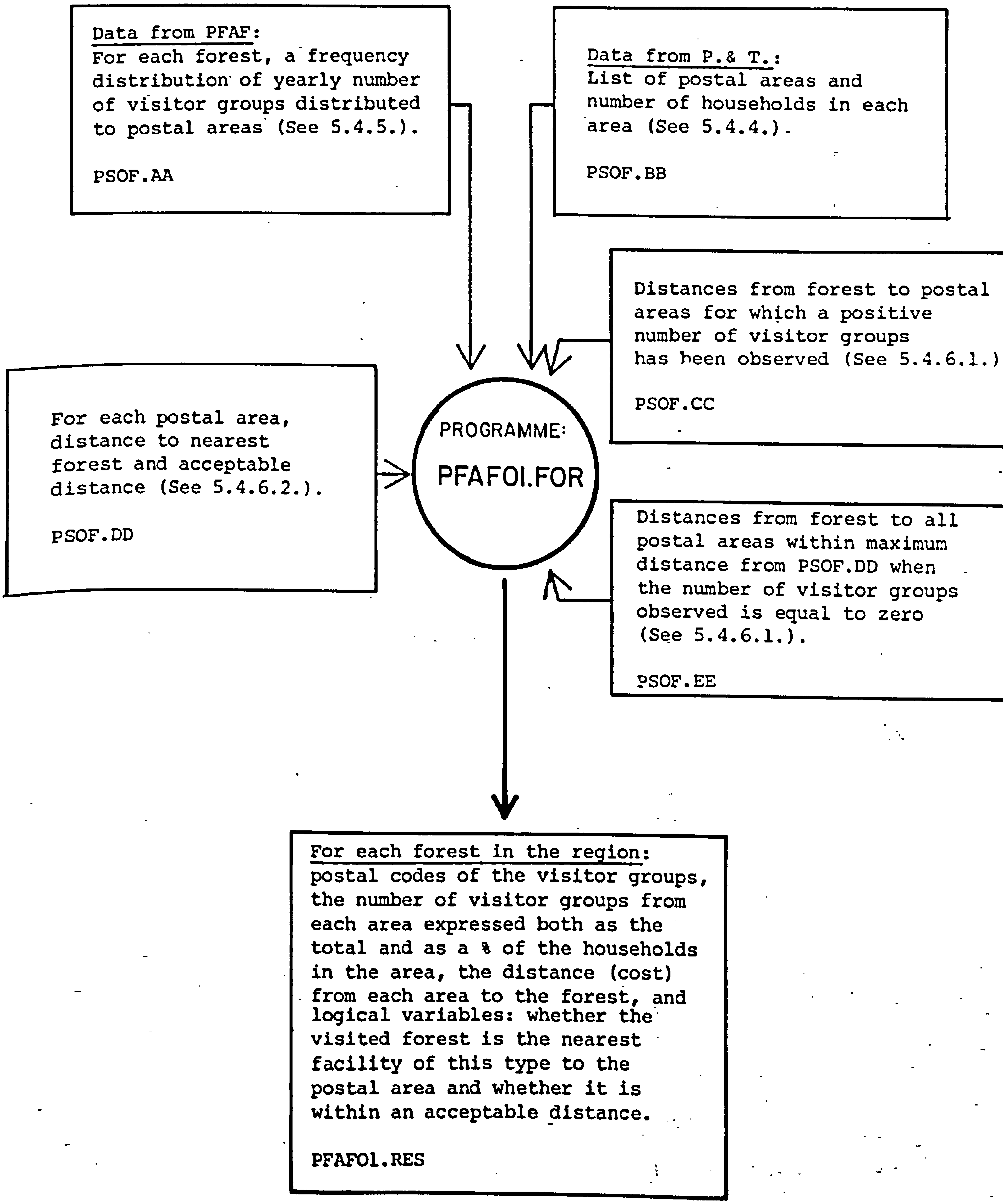
The data described in the previous sections were combined into one file PFAF01.RES to be used as a database for the analysis to follow. The procedure for this is shown in Figure 5.4. The programme which combines the information is PFAF01.FOR shown in App.A5.2.

The working file gives for each forest a heading with county, forest number in county, forest name, number of postal areas which are included for the forest, global forest number, average staytime in forest, total number of yearly visitor groups, the number of excluded visitor groups and maximum distance from which a visitor group has been observed; then for each postal area a line with : postal code, the yearly number of visitor groups to the forest, the zone population, the visit rate, cost of travel, and the two logical variables concerning distance as described in 5.4.6.2.

Besides the working file, the programme produced various control files checking that all the needed information was available, and it produced one plot for each forest with all the available points for the trip demand

Figure 5·4

The Creation of the Database



curve. An example of such a plot is shown in Figure 5.5 for 'Hareskovene og Jonstrup Vang' and 'St.Dyrehave og Tokkekoeb Hegn'.

5.4.10.2 Clawson Analysis

As mentioned in the introduction to this chapter the aim of this study is to give guidance on how the available data from PFAF can be used. Therefore different models have been applied.

For each forest the following Clawson analysis can be carried out based on the zoning system described in 5.4.4 :

1. A Clawson analysis using all the postal areas within the distance up to and including the one zone furthest away from which visitor groups have been observed.

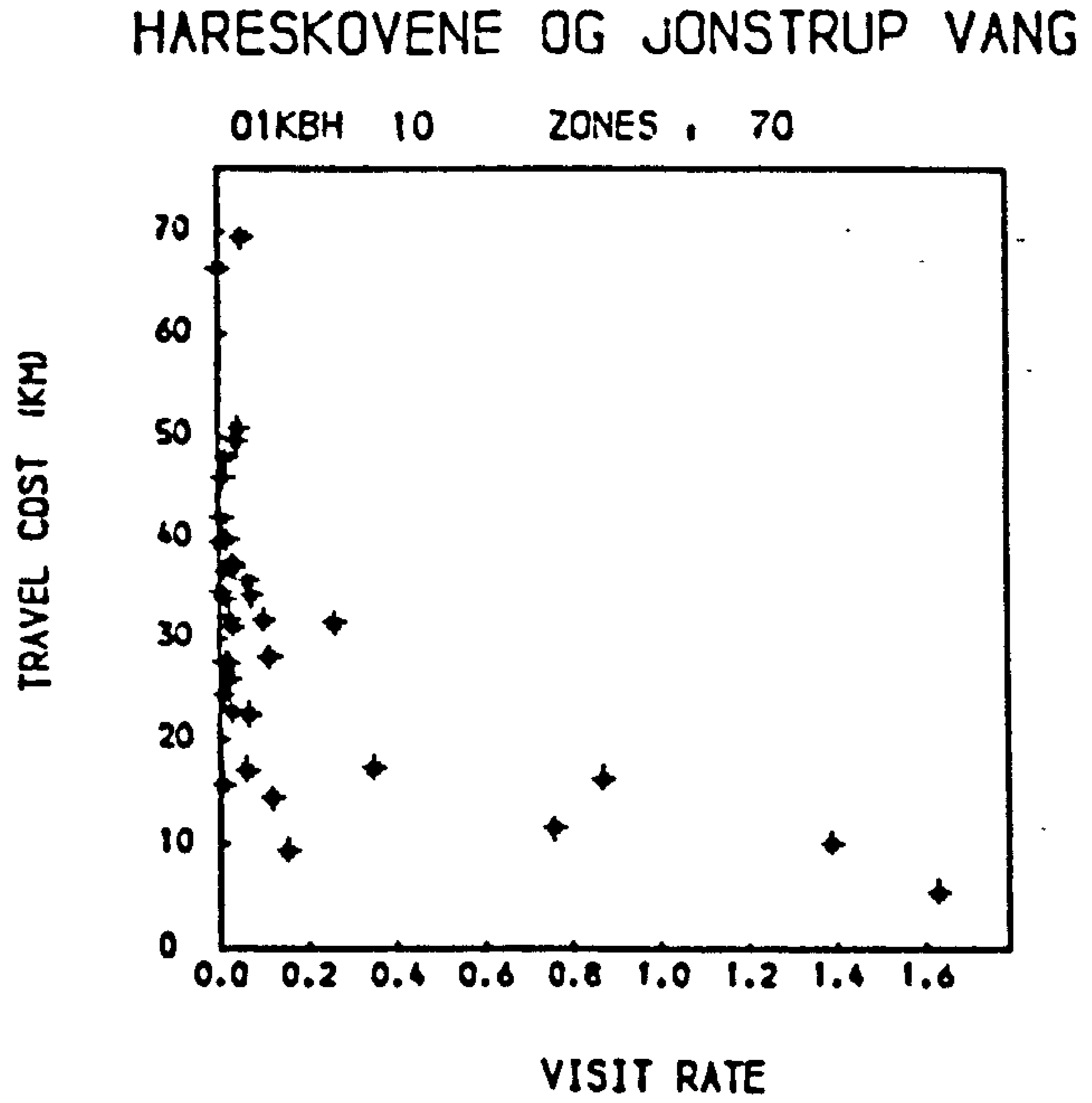
2. A Clawson analysis using all the postal areas for which the forest investigated is within an 'acceptable' distance as described in 5.4.6.2.

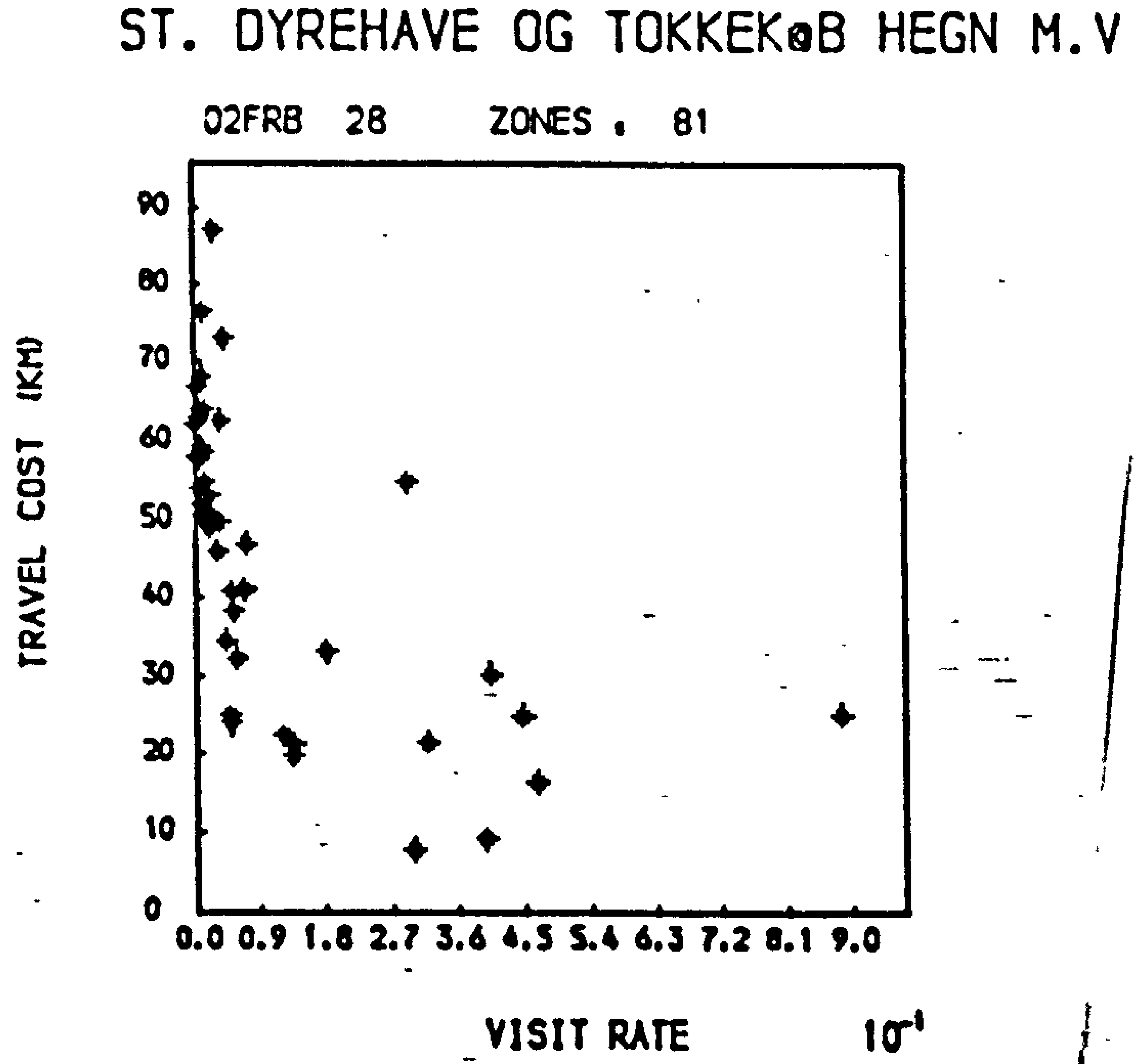
3. A Clawson analysis using all the postal areas for which the forest investigated is the nearest forest.

4. A rezoned Clawson analysis rezoned in the traditional manner of concentric zones.

For all the forests as one forest, i.e. aggregating all forests observations as if they were all from the same forest, the same analysis as above can be done. From this we would expect a general demand curve for recreation.

Figure 5.5 : An example of trip demand curves .





5.4.10.3 Computer Programmes

The computer programmes for undertaking the analysis above in 5.4.9.2 are written in FORTRAN using GHOST plotting routines and the curvefits are done with the use of GENSTAT. The programmes are linked together via MIC files and the following are being used :

1. PFAF1.MIC for Clawson analysis for separate forests

2. PFAF2.MIC for rezoned Clawson analysis

3. PFAF3.MIC for analysing all forest as one

The programmes calculate the consumer's surplus and plot the trip demand curves. All programs are in Appendix A5.3.

5.5 Results

For the economic analyses of the individual forests. only those forests with more than 5000 estimated car-borne visitor groups annually have been selected. This procedure leaves us with 25 forests and is done in order to get a reliable distribution as in many of the other cases, visitors from only 2 postal areas have been observed. This criterion may, in future calculations, be changed as some of the local forests of type 1 (See 5.4.7.2) can be expected only to have visitor groups from the nearest one or two postal areas. Thus, for example, an estimated 4000 visitor groups to a forest of type 1 might give a more reliable distribution than 8000 visitor groups to a type 2 forest coming from 6 zones. In that case, a selection on the basis of the number of questionnaires returned in proportion to the estimated number might be more appropriate. When the

Table 5.3: Consumer's surplus for 'Hareskovene og Jonstrup Vang'.

Model	No.of zones	No.of visitor groups predicted	No.of visitor groups observed	Consumer's surplus	CS/pvg
1	7o	56,16o	59,1o4	452,535	8.o6
2	43	56,214	58,96o	457,952	8.15
3	22	52,193	52,229	345,294	6.62
4B	7	53,679	59,1o4	511.564	9.53
4C	7	46,847	59,1o4	498.879	1o.64
4D	7	45,154	59,1o4	484,6o1	1o.67
4D'	7	49,669	59,1o4	234,427	4.72
5	1o	58,262	59,1o4	434,991	7.47

demand for all of the forests as one is calculated, all 52 forests are included despite the above criterion.

As described in Section 5.4.5, travel costs are calculated in kilometres which are, in the following, referred to as 'units'.

5.5.1 A Comparison of Methods

In the following, the results for two forest areas in particular will be described: 'Hareskovene og Jonstrup Vang' (Forest No. 10 in County of Copenhagen) and 'Jaegersborg Dyrehave og Hegn m.v.' (Forest No.3 in County of Copenhagen). This is done in order to clarify the difference between the variations of the applied method.

5.5.1.1 'Hareskovene og Jonstrup Vang'

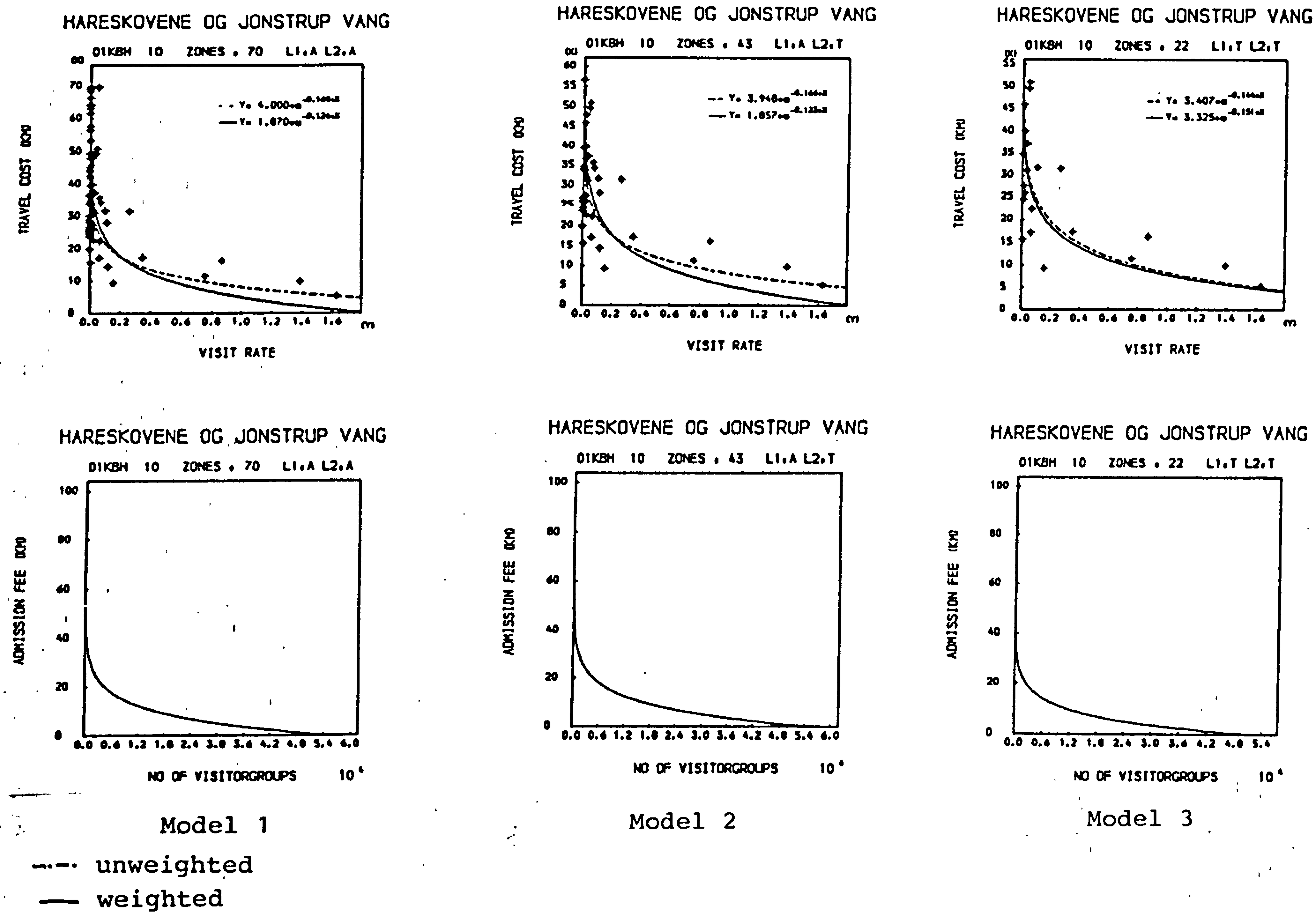
All the results from this forest are summarised in Table 5.3 and Figure 5.6 shows the trip demand curves and the aggregate demand curves for the three basic models discussed below.

Basic Models.

1. When all the zones are used (in total 70) the consumer's surplus is calculated to 452,535 units for a predicted number of visitor groups of 56,160. The actual number of visitor groups (i.e. the sample estimate from PFAF) was 59,104. The consumer's surplus per predicted visitor group (pvg) is 8.06 units. (Figure 5.6 a)

2. When only the postal zones for which the forest was within an acceptable range (See 5.4.7.2), 17 zones were excluded thus leaving 43

Figure 5.6 : Trip demand and aggregate demand curves for 'Hareskovene og Jonstrup Vang'.



observations for estimating the demand curve. The consumer's surplus was calculated to 457,952 units or 8.15 units/pvg for the 56,214 visitor groups predicted. The difference between model 1 and model 2 is not very big. From Figure 5.6, it can be seen that it is mainly the furthest distances which have been omitted. (Figure 5.6 b)

3. When only those postal areas for which the forest is within the distance to the nearest forest are selected, we are left with 22 zones. In this case, the consumer's surplus is 345,294 units or 6.61 units/pvg, which is approximately 28% less than the results derived above.

It should be noted how well the predicted number of visitor groups in the three models matches the actual number of visitor groups. This is even true for the individual zones as can be seen in Appendix A5.4 where output from the model is shown. (Figure 5.6 c)

Rezoned Models

In the rezoned models, the postal areas are rezoned according to a chosen zone width in more or less concentric zones and, in this way, the method becomes very similar to the traditional Clawson analysis. The rezoning works in the following way: the maximum distance, i.e. the distance to the postal area furthest away from which a positive number of visitor groups has been observed is found. For 'Haveskovene og Jonstrup Vang', this is equal to 34.8 km. The width of the zone interval is chosen and the number of zones is calculated as:

$$\text{Number of zones} = \text{ROUND}\ (\max D_i/z_i + 0.5) \qquad (14)$$

where

ROUND = a function which rounds the argument to the nearest integer.

z_i = width of the zone interval.

If the width of the zone interval is chosen to be 5.0 km, the above equation gives the number of zones to be 7 which means that all postal areas up to a distance of 35.0 km are used in the analysis. For each of the 7 new zones, the cumulated number of visitor groups and zone population will be calculated and from those figures, the visit rate can be found.

The travel costs can be calculated using one of the following three models:

B) 'Normal costs' which is the distance to the middle of the zone.

C) 'Uniform costs' which is the distance calculated with the assumption that the population is uniformly distributed over the zone (For B and C see also 4.2.2.2).

D) 'Weighted costs' which is the average distance to the postal areas within the zone weighted according to the number of households (zone population) in each postal area.

For model 4B, a consumer's surplus of 511,564 units is calculated for 53,679 visitor groups which is equal to 9.53 units/pvg. Models C and D give similar results. C gives 498,879 units for 46,847 visitor groups or 10.64 units/pvg and D gives 484.601 units for 45,154 visitor groups or 10.67 units/pvg. Models C and D are, for the total consumer surplus, quite similar to models 1 and 2. However, as the predicted numbers of visitor groups are smaller for C and D, it makes the consumer's surplus/pvg slightly bigger.

It should be noted that these models are still weighted similarly to the individual models by zone population/visit rate. If we did not weight, the consumer's surplus would decrease as shown in model 4D' which consists of the same data as 4D but where no weighting has been applied. This results in a consumer's surplus of 234,427 units for 49,669 visitor groups or 4.72 units/pvg.

If, instead of using a zone width of 5.0 km, we used 3.5 km, thereby establishing 10 zones, we will get the results shown in model 5. This gives a total consumer's surplus of 434,991 units for 58,262 visitor groups or 7.47 units/pvg.

Which model is, then, the 'right' one? This forest can be taken as an example of a type 2 forest i.e. a forest of regional interest. Therefore, model 2 ought to be the most representative although, in this case, the difference between models 2 and 3 is very small and the number of visitor groups declines by only approximately 6000 when the postal areas nearest the forest are used.

5.5.1.2 'Jaegersborg Dyrehave og Hegn m.v.'

This forest, on the outskirts of Copenhagen, is by far the most important recreational area in North Zealand and is the most frequently visited with an estimated annual number of visitor groups of 381,685.[12] This is a forest of national importance (See 5.4.7.2). All of the results for this forest are summarised in Table 5.4.

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12. See Appendix A5.2. The regression estimate is 515,236 and the sample estimate 398,324 (before exclusion of zones).

Table 5.4: Consumer's surplus for 'Jægersborg Dyrehave og Hegn m.v.'

Model	No. of zones	No. of visitor groups predicted	observed	Consumer's surplus	CS/pvg
1	87	375,789	381,685	12,573,819	33.46
2	42	270,696	357,775	15,299,526	56.52
3	19	262,320	262,530	2,385,562	9.09
4B	12	341,685	381,685	11,822,601	34.60
4C	12	318,629	381,685	12,896,367	40.47
4D	12	245,748	381,685	15,381,372	62.59
4E	4	262,302	262,530	2,363,033	9.01
4F	8	310,330	357,775	11,128,336	35.86

Basic models

1. When it was attempted to include all of the 87 zones, no convergence in the non-linear procedure was obtained. This was due to the inelasticity of the exponential curve as this forest had some recorded visit rates with very high travel costs. Later in this study, the data for this case were divided into two groups and an exponential curve fitted to each group. The consumer's surplus was then calculated on these combined. This was accomplished using a non-linear procedure in SAS (Barr et al. 1976, Secondary Appendix PSOF.PFO4). The result was a consumer's surplus of 12,573,819 units for a predicted number of 375,789 visitor groups which gives a CS/pvg equal to 33.46 units. However, since this result was not derived in the manner of all of the others, it should be regarded with some care. In future research, it should be investigated whether this inelasticity is a major disadvantage in using the exponential curvefit.

2. When all the zones for which the forest was within an acceptable range were selected, a consumer's surplus of 15,299,526 units was found for a predicted number of visitor groups of 270,696 or 56.52 units/pvg.

3. When only the zones for which the forest is the nearest are considered, we are left with 19 zones. This gives us a result of 2,385,562 units for 262,320 visitor groups or a CS/pvg equal to 9.09 units.

Rezoned models

The different methods of calculating the costs are discussed in 5.5.1.1.

When we use the same zones as in model 1 but rezone in 5 km intervals, we get 12 zones and the consumer's surplus is 11,822,601 units for 341,685 visitor groups or 34.60 units/pvg. This was with the 'normal costs' (4B) but if we weight the costs according to zone population (4D), the consumer's surplus increases to 15,381,372 units and the number of predicted visitor groups decreases to 245,748 leading to a consumer's surplus/pvg of 62.59 units. If we rezone model 3 with 10 km intervals and use 'weighted costs' (4E) we get a CS/pvg of 9.01 units which is very similar to what was found using model 3.

If we rezone model 2 with a zone interval of 7.5 km (4F) and again use 'weighted costs', we get a consumer's surplus of 11,128,336 units for 320,330 predicted visitor groups or a CS/pvg of 35.86 units.

Summary

The results from 'Jaegersborg Dyrehave og Hegn m.v.' show that this forest area is more important than 'Hareskovene og Jonstrup Vang'. It is interesting to see that, at a national level, it has a much higher value than when it is simply considered as a local forest. The rezoned models give results similar to models 1,2, and 3 but it should be remembered that they are, in fact, quite similar as the points are still weighted according to Section 5.4.8.

A reasonable value to put on this forest would be in the range of 35 -60 units per predicted visitor group.

5.5.2 Comparison of the Forests

Table 5.5 summarizes the results from the 25 forests with more than 5000 estimated yearly visitor groups (as explained in Section 5.5). Those which are left blank are the ones for which no convergence could be obtained. For those forests, a consumer's surplus could probably have been derived if a rezoned model had been used. However, this was not attempted in this study. Instead, it was considered more interesting to concentrate on looking at the differences between some of the forests.

'Troeroed Hegn'

This forest is a typical small local forest and only when the two zones for which the forest is nearest are considered do we get a result. This result yields a low value for CS/pvg.

'Jaegersborg Dyrehave og Hegn m.v.'.

This forest has already been described in detail in Section 5.5.1.2. It should be noted that, as expected, we derive a very high value for CS/pvg for this forest except when only the nearest zones are considered.

'Charlottenlund Skov'.

This forest has slightly higher values for CS/pvg than the average for this type of local forest. However, this may be due to the fact that there is a museum and a beach adjoining the forest.

Table 5.5: Consumer's surplus for all forests investigated in this study.

Forest	County	Model	No. of zones	No. of visitor groups predicted	observed	Consumer's surplus	CS/pvg
Trørød Hegn	KBH o1	1	76	-	-	-	-
		2	36	-	-	-	-
		3	2	[3,8o4	3,8o4	23,886	6.28]
Jægersborg Dyrehave og Hegn m.v.	KBH o3	1	87	375,789	381,685	12,573,819	33.46
		2	42	27o,696	357,775	15,299,526	56.52
		3	19	262,32o	262,53o	2,385,562	9.o9
Charlottenlund Skov	KBH o4	1	66	89,934	62,863	1,336,828	14.86
		2	39	5o,645	61,552	1,2o6,824	23.83
		3	18	54,433	56,673	342,956	6.3o
Kongelunden	KBH o5	1	46	-	-	-	-
		2	24	21,393	24,7o3	2o5,o77	9,59
		3	11	22,2o8	22,561	159,1o7	7,16
Søllerød Kirkeskov	KBH o6	1	76	-	-	-	-
		2	42	4,144	4,1o5	21,729	5,24
		3	6	1,43o	1,426	3,882	2.71

Forest	County no.	Model	No. of zones	No. of visitor groups predicted	No. of visitor groups observed	Consumer's surplus	CS/pvg
Geel Skov	KBH o7	1	54	12,293	15,167	8o,722	6.57
		2	4o	8,4o2	1o,168	38,798	4.62
		3	11	5,839	6,961	47,2o6	8.18
Nørreskoven	KBH o8	1	77	-	-	-	-
		2	46	13,139	14,457	15o,46o	11.45
		3	1o	7,o83	7,139	47,o25	6.64
Åsevang m.v.	KBH o9	1	59	-	-	-	-
		2	46	-	-	-	-
		3	2o	17,346	25,838	537,o22	3o.96
Hareskovene og Jonstrup Vang	KBH 1o	1	7o	56,16o	59,1o4	452,535	8.o6
		2	43	56,214	58,96o	457,952	8.15
		3	22	52,193	52,229	345,294	6.62
Vestskoven Vest	KBH 11	1	38	1o,829	1o,834	43,oo3	3.97
		2	27	1o,34o	1o,327	35,o31	3.39
		3	2o	1o,237	1o,231	35,175	3.44

Forest	County No.	Model	No. of zones	No. of visitor groups prodected	observed	Consumer's surplus	CS/pvg
Hornbæk Plantage	FRB o2	1	78	3o,413	51,777	892,625	29.35
		2	8	28,144	28,326	153,341	5.45
		3	3	-	-	-	-
Teglstrup Hegn og Hellebæk Skov	FRB o3	1	81	33,551	34,122	457,o64	13.62
		2	11	26,734	26,49o	253,52o	9.48
		3	3	[21,439	21,271	95o,514	44.34]
Klosterris og Horserød Hegn m.v.	FRB o4	1	65	-	-	-	-
		2	11	-	-	-	-
		3	1	-	-	-	-
Egebæksvang	FRB o7	1	71	-	-	-	-
		2	12	6,9o5	6,43o	56,787	8.22
		3	3	[5,7o2	5,7o2	25,75o	4.52]
Danstrup og Krogenberg Hegn	FRB o8	1	82	-	-	-	-
		2	13	6,o55	6,o49	48,323	7.98
		3	1	-	-	-	-

Forest	County No.	Model	No. of zones	No. of visitor groups predicted	No. of visitor groups observed	Consumer's surplus	CS/pvg
Gribskov og Stenholt Vang	FRB 13	1	86	23,4o1	24,289	419,746	17.94
		2	11	14,11o	14,1o9	211,o8o	14.96
		3	1	-	-	-	-
Tisvilde Hegn	FRB 18	1	87	6o,41o	63,253	1,o62,37o	17.59
		2	1o	41,126	41,148	31o,186	7.54
		3	4	[29,752	29,389	242,ooo	8.13]
St.Dyrehave og Tokkekøb Hegn m.v.	FRB 28	1	81	-	-	-	-
		2	2o	17,o29	16,942	43o,731	25.29
		3	3	-	-	-	-
Folehave	FRB 35	1	69	-	-	-	-
		2	21	17,559	17,983	129,819	7.39
		3	3	[15,268	15,263	74,333	4.87]
Rude Skov	FRB 36	1	82	-	-	-	-
		2	46	2,77o	8,381	163,252	58.94
		3	3	-	-	-	-
Lystrup Skov	FRB 38	1	43	7,442	7,451	37,433	5.o3
		2	12	6,37o	6,369	29,689	4.66
		3	3	[5,3o1	5,297	48,o64	9.o7]

Forest	County No.	Model	No. of zones	No. of visitor groups predicted	No. of visitor groups observed	Consumer's surplus	CS/pvg
Ravnsholt og Sønderskov	FRB 39	1	71	-	-	-	-
		2	39	-	-	-	-
		3	2	-	-	-	-
Slagslunde	FRB 41	1	68	5,989	6,200	51,048	8.52
		2	19	4,509	4,508	31,822	7.06
		3	5	[3,500	3,500	37,518	10.72]
Ganløse Eget	FRB 43	1	63	5,195	5,321	25,938	4.99
		2	28	5,086	5,088	28,927	5,69
		3	4	[2,652	2,607	32,969	12.43]
Ganløse Ore og Farum Lillevang m.v.	FRB 44	1	84	11,706	16,941	58,887	5.03
		2	42	10,850	16,269	51,628	4.76
		3	2	-	-	-	-

'Kongelunden'.

This a forest of regional importance and, as such, is similar to 'Hareskovene og Jonstrup Vang'. It has a smaller 'catchment' area but this might, to some extent, be counteracted by its 'traditional' use as a recreation area.

'Soelleroed Kirkeskov'.

This is a small local forest and no result is obtained until model 2 is applied, i.e., selecting the zones for which that forest is within an acceptable distance. The CS/pvg value is, as expected. quite low.

'Geel Skov'.

This is a forest of regional interest. The upward tendency in CS/pvg when applying model 3 could be caused by the fact that here we are excluding zones from which we get small visit rates due to a large number of recreational alternatives in the area (See 3.2.2).

'Noerreskoven'.

When model 2 is applied, this forest yields a value for CS/pvg around the average for a forest of regional importance.

'Aasevang m.v.'

Neither model 1 nor model 2 worked for this forest and it would seem that model 3 has overestimated the CS/pvg.

'Hareskovene og Jonstrup Vang'

This forest has already been described in detail in Section 5.5.1.1. It is a forest of regional importance.

'Vestskoven Vest'

Although this forest might one day be of regional interest, it is still so new that no long-term use pattern has developed.

'Hornbaek Plantage'.

This forest is located near the sea and is used as a beach resort. Therefore, we get a high value for CS/pvg using model 1. If we select the zones for which the forest is within an acceptable distance, i.e. use model 2, the value for CS/pvg drops. However, it should be noted that, in a way, it is not the same product because the visitors may be coming for the beach.

'Teglstrup Hegn og Hellebaek Skov'.

The value for CS/pvg for this forest is similar to others of regional to local interest. Model 3 yields a high value for CS/pvg but it is only based on 3 zones.

'Klosterris og Horseroed Hegn'.

No results were obtained for this forest. A rezoned model could be attempted.

'Egebaeksvang'.

For this forest, no result is obtained for CS/pvg until we use model 2 when the calculated value of CS/pvg is within the expected range for a forest of this type.

'Danstrup og Krogenberg Hegn'.

Model 1 did not work. However, model 2 gave a result for CS/pvg which was similar to that for other forests of regional to local interest. For model 3, only one observation was left.

'Gribskov og Stenholt Vang'.

This forest should probably be ranked as being of regional to national importance and the CS/pvg value is higher than the average for regional forests. For model 3, only one observation was left.

'Tisvilde Hegn'.

This forest is also of special interest due to its popular beaches. As for Hornbaek Plantage, we notice a drop in CS/pvg when using model 2. The discussion under Hornbaek Plantage applies here as well.

'St. Dyrehave og Tokkekoeb Hegn m.v.'.

Here, only model 2 yields a result. This result is surprisingly high for a forest of regional interest.

'Folehave'.

This is a forest of local interest and the values found for CS/pvg are consistent with those found for other local forests.

'Rude Skov'.

As with 'St. Dyrehave og Tokkekoeb Hegn m.v.', only model 2 yields a result and, again, this leads to a surprisingly high value for CS/pvg. This may be due to an underestimation of the number of visitor groups to the forest.

'Lystrup Skov'.

This is a typical local forest which the results also show. Model 3 is only based on 3 zones and, therefore, should not be given much weight.

'Ravnsholt og Soenderskov'.

No results were obtained for this forest. A rezoned model could be tested.

'Slagslunde'.

This is a local forest but the values for CS/pvg are slightly higher than for other local forests. This may be caused by the fact that Burre Lake is next to the forest.

'Ganloese Eget'.

This a forest of local interest and the values for CS/pvg are as expected for such a forest.

'Ganloese Ore og Farum Lillevang'.

This is a forest of mainly local interest and, again, the CS/pvg values found are typical of such a forest.

5.5.3 All Forests as One.

The results from the model as explained in 5.4.10.2 using all of the available points will be described here. The results are summarized in Table 5.6. When model 1 is applied, we get a very high CS/pvg (76.92 units). This is probably due to the fact that there are some very long distances included in this model which affect the shape of the trip demand curve. High visit rates at low cost benefit from this. Model 2 gives a much lower value for CS/pvg (10.17 units). Model 3 yields a result similar to model 2.

If we rezone all of the points (4), we get a result similar to model 1 but if we do not weight these points (4') the CS/pvg decreases to 8.90 units (5 km zone intervals and normal costs).

If we rezone model 2, we get CS/pvg equal to 12.90 units (4B) and if that one is not weighted (4B'), the value for CS/pvg again decreases (9.02 units (5 km and normal costs). When model 3 is rezoned (4D), we get a CS/pvg of 11.80 units and if the points are not weighted (4D'), CS/pvg equals 10.37 units.

Table 5.6: Consumer's surplus for 'all forests as one'.

Model	No. of zones	No. of visitor groups predicted	observed	Consumer's surplus	CS/pvg
1	1902	406,273	958,138	31,251,705	76.92
2	767	825,162	825,904	8,391,778	10.17
3	208	593,663	595,016	6,110,862	10.29
4	14	408,859	958,138	32,131,750	78.59
4'	14	798,191	958,138	7,201,009	8.90
4B	8	795,046	825,904	10,253,800	12.90
4B'	8	762,921	825,904	6,879,077	9.02
4D	6	594,527	595,016	7,015,063	11.80
4D'	6	582,674	595,016	6,040,552	10.37

5.6 Summary

In Chapter 5, a Clawson analysis has been applied to data from Denmark. This section will summarise and discuss the major problems encountered and the findings of the study. Some of the assumptions used in the application of the Clawson method to this data result from the findings discussed in Chapter 4.

Previous works: Most workers in Scandinavia who have tried to estimate the recreational value of forest areas have used the opportunity costs method. However, it is not logical to consider that the benefit of recreation is always equal to cost of providing it. For reasons explained in Chapter 3, this author considers the Clawson method more appropriate and its application in Denmark has been attempted in this work. Recently, a Clawson analysis has been used for estimating the value of sport-fishing in the Gaula River system in Norway.

Project Forestry and Folk: Data pertaining to visits to forest areas have been collected during the study period April, 1976 to April, 1977. For this study, data from the region of North Zealand have been made available. For each forest, the data relating to the annual number of car-borne visitors to postal areas are investigated. As with the Gwydyr data (Chapter 4), the visitor group was chosen as the visit unit.

Zoning system: Postal areas were used as the basic zoning system, especially because this information was coded on the data-base. Also, the number of households in each zone was available.

Distances: It was decided to attribute 'logical' variables to the observations on visit rate and price in order to distinguish between visitor groups. In this way, it becomes possible, for each forest, to do a Clawson analysis :1) using all postal areas up to the furthest zone from which visitors were observed, 2) using postal areas for which the forest area is within an 'acceptable ' distance, 3) using the postal areas for which the forest is the nearest forest.

Cost function: the cost function was simply determined by measuring the distance on a map from the forest to each postal area. In this way, no allowance was made for time costs. However, no long time periods are involved in travelling within this area and if a time cost was to be included, it would have to be approximately proportional to the distance. This means that we can always multiply the final consumer's surplus by a constant in order to include time costs.[13]

Curve fitting: Three different models for the trip demand curve were were tested - a linear regression, a 2^{nd} degree polynomial and a negative exponential curvefit. The negative exponential model was found to have the smallest SS-residuals and it was also considered to be the most 'logical' as it has some important advantages which will be discussed in Chapter 6.

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13. The Directorate of Roads uses as time costs 20% of the average hourly wage for trips from the home to somewhere else and 10% if the driving is considered to be a part of the purpose of the trip (Vejdirektoratet 1977, p. 9.).

Weighting of points for the trip demand curve: The weighting used is discussed in Chapter 4 (zone population/visit rate). As there were some zones with an observed visit rate of zero, a two stage model was applied. First, an unweighted model was fitted to the data and, in the second stage, the predicted values from this curvefit were used to calculate the weights.

Methods: the data were organized in a data base on which several programmes could be used. It was possible to do a Clawson analysis on each forest individually in three different ways dependent on which zones were selected as explained above. It was also possible to rezone for an individual forest. Finally it was possible to calculate a consumer's surplus for 'all forests as one', i.e. using all possible information.

Results : Comparisons have been done between the different variants of the Clawson method in detail on two forest areas. The result for 'Jaegersborg Dyrehave og Hegn m.v.' varied quite considerably according to the model used.

For all forests with an estimated number of yearly visitor group of more than 5000 it has been attempted to calculate the consumer's surplus. The values obtained for the different forests vary according to what one would expect from knowledge of the forests. In fact the subjective classification of forests given in 5.4.7.2 seems to be confirmed. For forests of local interest, values for Model 3 tend to be higher than those for Models 1 and 2, while the reverse is true for forests of regional or national interest. This is because of the way zones are excluded or included in the models. For local forests, no visits are expected from zones for which it is not the nearest forest. Therefore, including such zones will bias the demand curve to the left, especially as these zero or small values will be heavily weighted by the procedure described above. Using only zones for which the forest investigated is the nearest one helps us to correct for the effect of substitute opportunities in depressing the apparent value of the forest.

On the other hand, for forests of national interest, inclusion of the more distant zones, from which many visits are recorded, puts emphasis on the really high values which may be experienced in these forests. Omitting these zones leads to underestimation of value.

The best known forest of national interest has a consumer's surplus (CS/pvg) in the range of 30-60 units which is equal to approximately 18-36 Dkr. or 120-140 pence per visitor group. This makes a value of around 10 million Dkr. (approximately £666,000) for the total number of annual car-borne visitor groups. It should be emphasised that these values do not include time costs and only car-borne visitor groups have been considered. In addition, no expenditures for maintaining such a high visitor rate have been deducted. It would be possible to calculate the NPV by dividing by the proper discount rate in order to get a value for the forest use as a recreational facility.[14] Most forests of regional interest have a CS/pvg of around 10 units which is around 6 Dkr. or 40 pence per visitor group. Forests of local interest have CS/pvg values of less than 10 units.

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14. See also the general discussion in Chapter 1.

When calculating the consumer's surplus for 'all forests as one' the results vary considerably dependent on the model used. A reasonable value for the average visitor group (CS/pvg) would be about 10 units, which is equal to approximately 6 D.Cr. (approx. 40 pence). However, the large variation in value between individual forests casts doubt on the idea of a 'general forest recreation value'. We need at least to classify forests, as has been done here, in order to set an approximate value for consumer's surplus per predicted visitor group.

The results presented in this chapter were based on data collected in Denmark from 1976 to 1977. The data only took car-borne visitor groups into consideration and in order to get the right valuation non-car-borne visitor groups should also be considered. It should be investigated whether or not the non-car-borne visitor groups have the same demand curve as the car-borne visitor groups, i.e. the same willingness to pay, or whether we are dealing with another group of users who have a different consumption pattern.

The results from this study present a static picture of the situation in 1976-77. The rate of visits might have changed. According to Koch (personal communication) the number of cars on the permanent sample plots has gone down by approximately 24% between 1976 and 1982. This is mainly due to the steady increase in travel costs during this period. It should be investigated whether this has resulted in an increase in the number of persons per car and also whether the visitor groups have the same distribution by postal areas as in 1976-77 or if the the visit habits have changed to become more local.

6. FINAL CONCLUSIONS AND RECOMMENDATIONS

In the conclusion to Chapter 3, several problems of the Clawson method were identified for investigation and treatment. In this chapter, the findings of this investigation will be drawn together in recommendations for the way in which future analyses of forest recreation might be carried out. At the same time the findings are assessed in relation to other work in the general field of recreation economics. Topics are highlighted which have been identified in the course of the investigation as requiring further research. Finally implications for forest decision-making are reviewed.

6.1 Multi-site visits

Where a recreation site is visited as part of a recreation trip which includes many sites, the traditional Clawson method cannot give a realistic value to the site. In general it will greatly overestimate benefit of an individual site, especially if the visit is part of a long holiday. Apart from the discussion of benefit from travel as was described in 3.2.3, the literature does not make much reference to this practically important problem. However, after the work in Chapter 4 had been completed, Haspel and Johnson (1982) described an approach to allocating values for multi-site visits in North American National Parks. They tested several multiple regressions in which total trip distance was combined in various formulations with number of trip destinations. On this basis they obtained a better estimate of participation rates than was given by simple regression of participation rate on total trip distance. This approach has been criticized as follows by Christensen, Humphreys and Price (1985).

"First, testing a number of alternative regressions, each containing several variables, increases the probability that an apparently significant regression will be generated by chance. Second, multiple linear regression requires that the influence of independent variables upon dependent variable is additive and separable. In fact on p.369 Haspel and Johnson give reason to suspect some degree of collinearity between three of the variables included in their most successful regression, but they offer no indication of why the separable influences of these variables should be additive. Thus, while each variable in this regression would be expected to affect participation rate in some way, there is no a priori justification for the functional form of the relationship tested."

The revised Clawson method described in Chapter 4 should be used in preference to the traditional Clawson method for forests (or recreation sites of other types) in holiday areas, because here many, or probably most visits will be made not from home but from the holiday base. In addition, as shown in Christensen, Humphreys and Price (1985), the revised Clawson method enables us to account for travel modes having different costs.

6.2 Substitution between sites

In the results of Chapter 5 it has been shown to be incorrect to take a general value for "forest recreation", as has been done in one study of British forestry (Treasury 1972). On the contrary, the value of a forest visit depends on the individual character of the forest. For forests of national importance, the value of a visit seems to be several times the value of a forest which does not provide any special experience. Our subjective classification of the importance of forests in North Zealand seems to have been confirmed by values calculated for them.

On the other hand all forests can be to some extent a substitute for others, and this explains why few or no visits from long distances have been recorded to forests of only local interest in North Zealand. The effect of substitution is to bias the upper parts of the demand curve strongly to the left, indicating that no visitor is ever deriving great value from local forests.

No really satisfactory solutions to the substitutes problem have so far been offered, though as described in 3.2.6 many authors have proposed methods. As a result of this work, it is recommended that logical distances as defined in 5.4.7.2 are used to define the limit of zones to be used in deriving the demand function for a site: when a forest is simply of local interest, only those zones are included for which the forest is the closest one, whereas for forests of national importance all zones should be used. However, application of all the different models can give some indication of which type of forest we are dealing with, since for forests of national importance we expect a higher value using all zones.

The different models (i.e. models 1, 2 and 3) used in the Danish study can be viewed as a way of classifying the visits. For example, many visits to a specific area might be due to an adjacent beach and not to the forest itself where the cars are parked: this was the case in some areas of North Zealand. But by using a model where only zones for which that forest is the nearest (i.e. only local visits) will filter out the long-distance beach visitors, and in that way yield a more accurate value of consumer's surplus per predicted visitor-group for the forest itself. The above classification could have been carried out more explicitly if we had divided the visitors into groups according to what activity they pursued from the parking area where they were counted, but this was not possible with the secondary data available.

6.3 Weighting of data

It has been shown that not all points for the demand regression are equally reliable The solution to this problem given by Bowes and Loomis (1980) is not generally correct, as pointed out by Christensen and Price (1982). The correct weighting is visit rate/zone population. But sampled visit rate is not the best estimate of this variable. The visit rate should be estimated first from an unweighted regression, and the first estimate of visit rate used in weighting the second-stage regression. This has the advantage that zones with a recorded zero visit rate can be used in the analysis which would otherwise be impossible due to their infinite weighting. It is important that such zones should be able to be included and not completely ignored, since they represent valid data on the distribution of willingness to pay within the population.

6.4 Aggregation of data

In this study it has been shown with both British and Danish data that different zonings can affect the calculated consumer's surplus. Accordingly, it is recommended that different zonings should be tried and an average taken. When analysis is performed by means of computer, rezoning can be done very easily.

As for Flegg's claim (1976) that heteroscedasticity problems may arise from certain aggregations of origins, this has been solved by the weighting procedures in least-squares regression, as have been described.

As for the suggestion that a high degree of disaggregation of origins leads to better statistical estimates, we eventually encounter the problem that origins may not supply any visits at all. This can give a statistical problem when we weight by zone population, but we believe we have solved this through the two-stage estimation process.

6.5 Functional form of the demand regression

Comments on this important matter have already been given in 4.4 and 5.6. The results from different forms do vary, and the conclusions can be summarized thus.

Linear form: This often appears to fit the data well, there are no problems with transformation of residuals and it is easy to use. However, the form of the relationship is not logical because it implies that there should be negative visit-rates above a certain cost. Not only can this not happen in practice, it also can create statistical problems in two-stage weighting of data points.

Second degree polynomial: This is a more flexible curve-fit, which can represent the data more exactly than the linear form. However, there are different problems here when the curve is extrapolated. For example, when the curve is convex to origin, the area below the curve, which shows gross benefit, may be undefined. Therefore this form cannot be recommended.

Log-linear form: This form also yields indefinite gross benefits. The demand curve does not intersect either axis, implying there is not a limit to visit rate at zero cost or to the distance visitors are prepared to travel. These problems can be overcome by adding arbitrary constants to the variables, but then the answer is very sensitive to the chosen constant and this is not very satisfactory. Also the distribution of the residuals and the weighting of the data-points is changed during transformation of the data to logarithmic form.

Negative exponential form: In spite of some initial problems with fitting a regression line, this functional form was found to have important advantages. Unlike the log-linear form, the curve can be fitted without affecting the distribution of residuals. Unlike the linear form, it does not predict negative visit-rates: this is logical, and it also makes sure that positive weightings can be given in two-stage estimation procedures for the demand curve. Unlike log-linear and 2nd degree polynomial forms, a finite gross benefit is given by integration under the curve. In statistical tests also this curve-fit gave the smallest residual sum of squares and it was very successful in correctly estimating the total number of visitor-groups. Using the exponential function however implies, as pointed out by Cheshire and Stabler (1976), that there are " visitors travelling impossible distances " (Ibid.,p.374). We do not believe that this is an overwhelming criticism. On the contrary, because there is no intersection of the demand curve with the cost axis we do not have the problem of negative visit rates. The absence of visitors from very long distances can be explained by substitution effects. On the other hand, if there were not any substitutes, a small proportion of visitors would be prepared to travel very long distances. Thus the very large consumer's surplus for a small proportion of visits is not at all impossible, and in fact reflects the reality of recreational experiences. If it was wanted, a maximum willingness to pay could be defined arbitrarily, although this actually makes the integration under the demand curve somewhat more difficult to handle.

In summary, either the functional form reaches and crosses the cost axis, in which case illogical negative visits are predicted and correct weighting cannot be achieved, or it does not reach the axis, in which case for a small proportion of visits a very high value is predicted. We believe the second case is more realistic, provided the functional form does not lead to indefinite consumer's surplus.

The negative exponential form is recommended on these grounds, but with the caution that not all statistical packages are able to provide an untransformed negative exponential curve-fit. Also, as mentioned in Chapter 5, it seems that the exponential curve fit does not produce a result in all situations, and further research might investigate whether this is a general problem, and if so whether it is due to the data or whether it is because of the particular curve-fit.

6.6: Integration of consumer's surplus

In connection with the revised Clawson method, the integration of consumer's surplus was attempted with three different methods. If the revised Clawson method is used, it can be argued that integration of the individual's consumer's surplus is most valid, since each consumer faces different costs. The problem is that the various methods of integration often lead to very different results for the total value of the site. To overcome this problem, the measure consumer's surplus per predicted visitor group was introduced. This was found to produce much more consistent results. In the case of the negative exponential, this measure was found to be very simply related to the parameter of the exponential, independently of the cost of visiting. Extending this result to the revised Clawson method, we should expect identical value for consumer's surplus per predicted visitor group whichever integration method we have used.

It is recommended that consumer's surplus per predicted visitor group is used in evaluation of sampled visits, and that this figure is multiplied by the recorded or the predicted number of visits to give an annual value of recreation.

6.7 Some outstanding problems

Many of the problems described in Chapter 3 have not been investigated in this thesis. Where we have investigated problems, we have shown that there are needs for further research in certain identified areas. It would be useful to repeat the studies described in Chapter 4 and Chapter 5 to see if similar results were found for other data. In addition, it would be interesting in future research if a 'quality value' for the different forests obtained from a preference study could be included with the behaviour study and the population densities. Some problems identified in the course of the studies need to be addressed. For example, the whole basis of the Clawson method is travel cost, but it is not agreed which definition of cost should be used. It is argued that perceived cost is relevant in determining willingness to pay, but visitors do not clearly perceive their costs of travel by car, as was shown by the bias in response to the Gwydyr questionnaire. Most often people estimate their costs as being petrol costs only, but this is different both from average and marginal costs of running a car. Also in this study it was assumed that people consider their costs as a group, not as individuals, which is why we used visitor-group as the unit of visitation. Considering the central importance of this figure in outdoor recreation evaluation, it has not received much attention from recreation researchers. The traditional Clawson method has always had the problem that a uniform travel cost from each zone must be used. The revised Clawson method does not have this restriction and therefore can include variation in perceptions.

In future research, the problem of the survey method versus the Clawson method should also receive more attention. In the case of the Danish study, no data were available which would enable the survey method to be used. However, as discussed in Chapter 3, there are situations where the Clawson method is inappropriate and the only possible way to yield an estimate is by the survey method.

It would be interesting to test the hypothesis of people's willingness to pay, i.e. do they react in the same way to an increase in fee as to an increase in travel costs? Charging would be a useful tool in managing congested areas but it would be a rather discouraging measure as we do not have a tradition of paying fees in order to visit forest recreational areas and we might, therefore, experience a reluctance to pay for the use of such areas.

6.8 The evaluation of forest recreation

In spite of some deficiencies. it proved possible to use secondary data sets in this study. By their use, problems relating to the evaluation of recreation forestry have been dealt with. In particular, we have discussed the necessity for an economic evaluation in order to compare recreation with other sources of benefit from a multiple-use managed forest.

Recreation, being one of many outputs from forestry, might affect the utility of the other outputs. In this study, we have tried to derive demand curves for forests as recreational goods and, thereby, estimate the value of the consumer's surplus. This has been done in a static situation giving us an idea about how people would react to an increase in travel costs and fees. However, further research is still needed on the substitutional effects between recreation and the other outputs from forestry. Ideally, we would estimate the transformation curves between all the outputs involved and then, given the right price curve, we could optimise the mixture of outputs if we had established this n-dimensional trade-off space. Although a lot of data is required to investigate and establish the transformation curves exactly, it would nevertheless be of importance just to know about the curve shapes to get an idea of the relationship between different parameters.

The presented study has shown that it is possible to get estimates of the value of recreation and it is our belief that it is important to have these values or, as discussed earlier, curves for the demand for recreation in these forests. Not only are the absolute values necessary when we wish to compare recreation with other 'investment' alternatives but also the relative values are important to the state forestry administration in deciding where to expand its services.

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Copenhagen, December 1985.

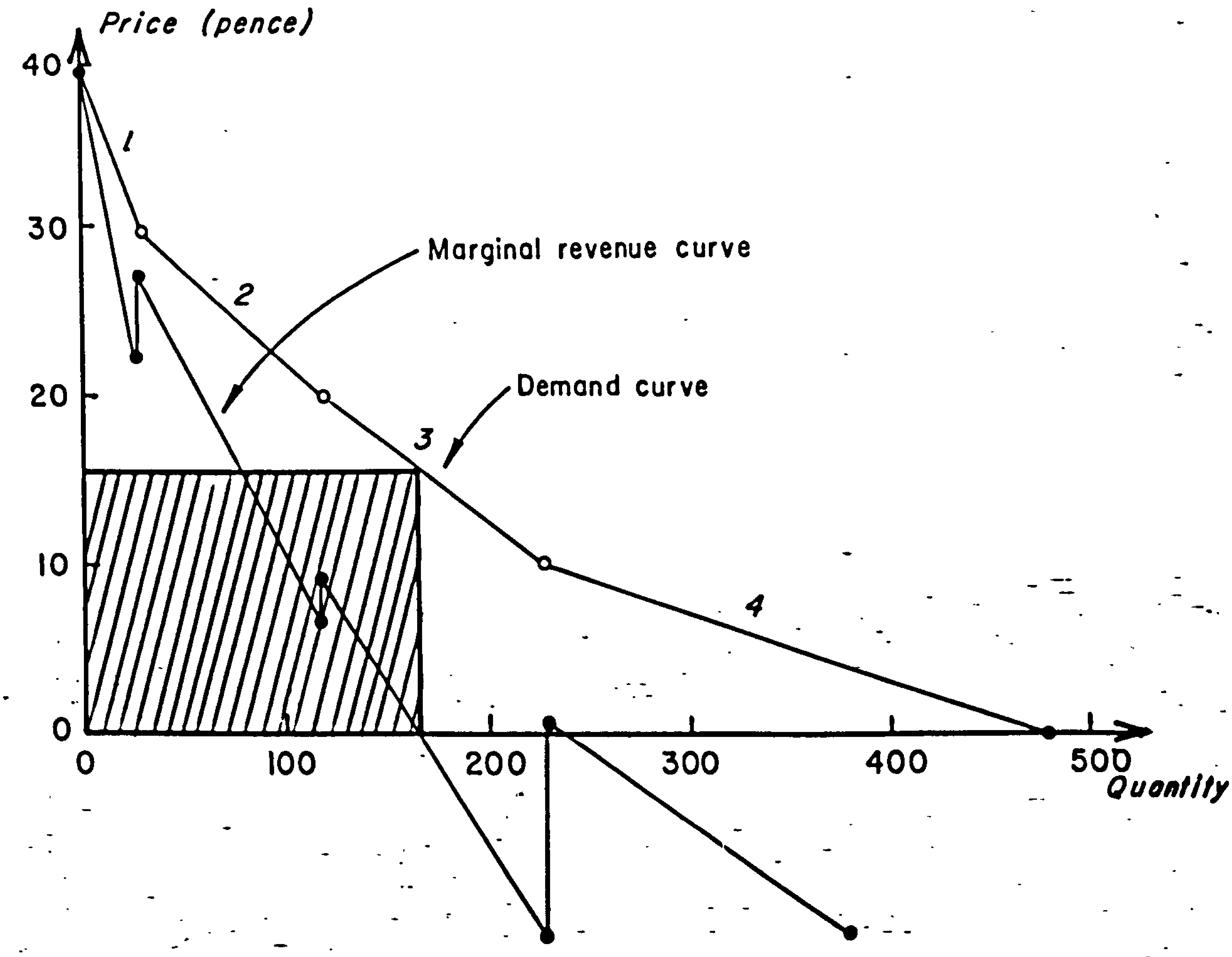
Jens Bjerregaard Christensen

Appendix A3.1

Calculating Clawson's surplus from recreation

As described in Section 3.1, Clawson (1959) recommended a non-discriminating monopolist's maximum possible profit as a measure for the value of a recreational area.

This value is found using a normal optimization approach, i.e., the quantity to be 'sold' is that which makes the marginal costs (MC) equal to the marginal revenue (MR). If MC is assumed to be zero, the problem can be illustrated as in Figure 1 for the data shown in Table 3.2:



The profit is equal to the hatched area. A numerical solution of the problem is found by solving the line equations.

The equation section 3 of the fractured demand curve is:

$$y = 340/11 - 1/11\ x \qquad (1)$$

Then the equation for the MR[1] must be:

$$y = 340/11 - 2/11\ x \qquad (2)$$

As the equation for the marginal costs is:

$$y = 0 \qquad (3)$$

we find the intercept to be:

$$x = 170 \qquad (4)$$

If we insert (4) into (1), we find the price:

$$y = 170/11 \simeq 15.45 \qquad (5)$$

and then the total revenue is:

$$170/11 * 170 = 28900/11 \simeq 2627.27 \text{ pence.}$$

1. For linear equations, MR curves have the double slope of the demand curve as: $q = k + \alpha p$

$$\text{Revenue} = pq = p \cdot k + \alpha \cdot p^2 \Rightarrow MR = \frac{d(pq)}{dp} = k + 2\alpha p$$

Appendix A3.2

Calculating consumer's surplus for R_1

The equation for consumer's surplus is given in Chapter 3 (3). From the trip demand curve Fig. 3.2 we find the rate of visits V per 1000 inhabitants to be:

$$V = 12 - 0.2*(p + t(r_i))$$

and we find:

$$\bar{p} = 60$$

The integral from Equation 3(3):

$$\int_0^{60-t(r_i)} f(p + t(r_i)) dp$$

can be solved as

$$\Big[12p - 0.1p^2 - 0.2p*t(r_i) \Big]_0^{60-t(r_i)}$$

and hence

$$CS = \sum_{i=1}^{4} (N_i \cdot \Big[12p - 0.1p^2 - 0.2p*t(r_i) \Big]_0^{60-t(r_i)}) = \underline{6200}$$

For zone 1 :

$$N_i = 15000$$

$$\bar{p}-t(r_i) = 60 - 20 = 40$$

$$CS_i = 15000(12*40-0.1*1600-0.2*40*20)/1000 = 2400$$

Zone 2 to 4 are calculated in the same way, and the total CS is 62 pounds.

Appendix A3.3

A mathetical approach to consumer's surplus measure in recreation

The following is mainly built on McConnell & Duff (1976) and Couch (1975).

The utility function for an individual consumer can be expressed as:

$$U = x_1^{\theta} x_2^{\psi} \qquad (1)$$

U = ordinal utility function

x_1 = number of visits to recreation area

x_2 = quantity of all other goods

θ, ψ = parameters

The budget constraint can be expressed as:

$$E = (p_1 + p_t\omega)x_1 + p_2x_2 \qquad (2)$$

where:

E = the allocated proportion of income,- here it is all income as x_2 represents all other goods

p_1 = admission fee to the area

p_t = travel expenditure p er distance unit

ω = distance from home to recreation area

p_2 = price of all other goods

Then (1) can be maximized under constraint (2) using the Langrangian multiplier method.

The expression to maximize is:

$$W = x_1^{\theta}x_2^{\psi} + \lambda(E-(p_1+p_t\omega)x_1-p_2x_2)$$

$$\left.\begin{aligned} \frac{dW}{dx_1} &= \theta x_1^{\theta-1}x_2^{\psi} - \lambda(p_1+p_t\omega) \\ \frac{dW}{dx_2} &= x_1^{\theta}\psi x_2^{\psi-1} - \lambda p_2 \end{aligned}\right\} \quad \text{Optimum when } \frac{dW}{dx_1} = \frac{dW}{dx_2} = 0 \quad \Rightarrow$$

$$\left.\begin{aligned} \theta x_1^{\theta-1}x_2^{\psi} &= \lambda(p_1+p_t\omega) \\ x_1^{\theta}\psi x_2^{\psi-1} &= \lambda p_2 \end{aligned}\right\} \quad \Rightarrow$$

$$\left.\begin{aligned} x_1^{\theta-1} &= \frac{\lambda(p_1+p_t\omega)}{\theta x_2^{\psi}} \\ x_1^{\theta} &= \frac{\lambda p_2}{\psi x_2^{\psi-1}} \end{aligned}\right\} \Rightarrow$$

$$x_1 = \frac{\lambda p_2 \theta x_2^{\psi}}{\gamma x_2^{\psi-1}\lambda(p_1+p_t\omega)} = \frac{\theta p_2 x_2}{\gamma(p_1+p_t\omega)} \Rightarrow$$

$$(p_1+p_t\omega)x_1 + p_2x_2 = \frac{\theta}{\gamma}p_2x_2 + p_2x_2 = (1+\frac{\theta}{\psi})p_2x_2 \Rightarrow$$

$$E = (1+\frac{\theta}{\psi})p_2x_2 \quad \Rightarrow \quad p_2x_2 = \frac{E}{(1+\frac{\theta}{\psi})}$$

$$x_1 = \frac{E}{(\frac{\psi+\theta}{\gamma})\frac{\psi}{\theta}(p_1+p_t\omega)} = \frac{E}{(1+\frac{\psi}{\theta})(p_1+p_t\omega)}$$

which is the demand of x_1 for the individual.
If the population distribution $N(\omega)$ is known, the number of visits X_1 demanded by people living in a narrow band of width $d\omega$ at distance ω will be:

$$X_1 = N(\omega)x_1 d\omega$$

and

$$X_1^D = \int_0^k N(\omega)x_1 d\omega$$

$$X_1^D = \int_0^k \frac{N(\omega)E}{(1+\frac{\psi}{\theta})(p_1+p_t\omega)}$$

Appendix A3.4

The value of R_1 and R_2 together.

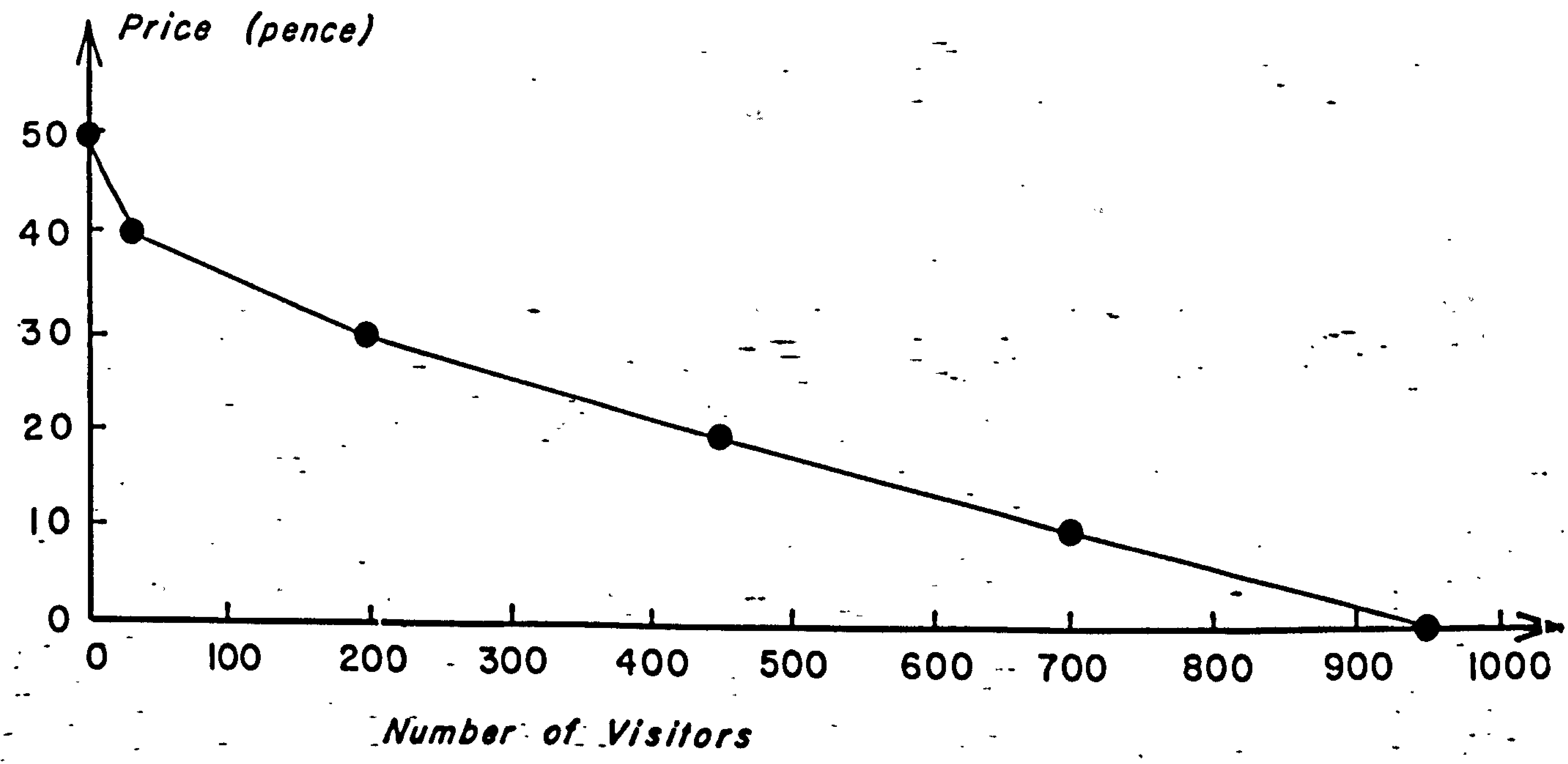
If we evaluate R_1 and R_2 together, i.e., impute entrance fees on both areas at the same time, then the initial travel costs to the nearest area are:

	Zone			
	A	B	C	D
Initial travel costs (pence)	10	30	30	20

We are now able to calculate the values for the aggregate demand curve.

Entrance fee (pence)	Number of visitors from zone A	B	C	D	Total
0	150	180	60	560	950
10	120	120	40	420	700
20	90	60	20	280	450
30	60	-	-	140	200
40	30	-	-	-	30
50	-	-	-	-	-

The aggregate demand curve looks like this:



and the consumers's surplus is £185.50.

Appendix A3.5

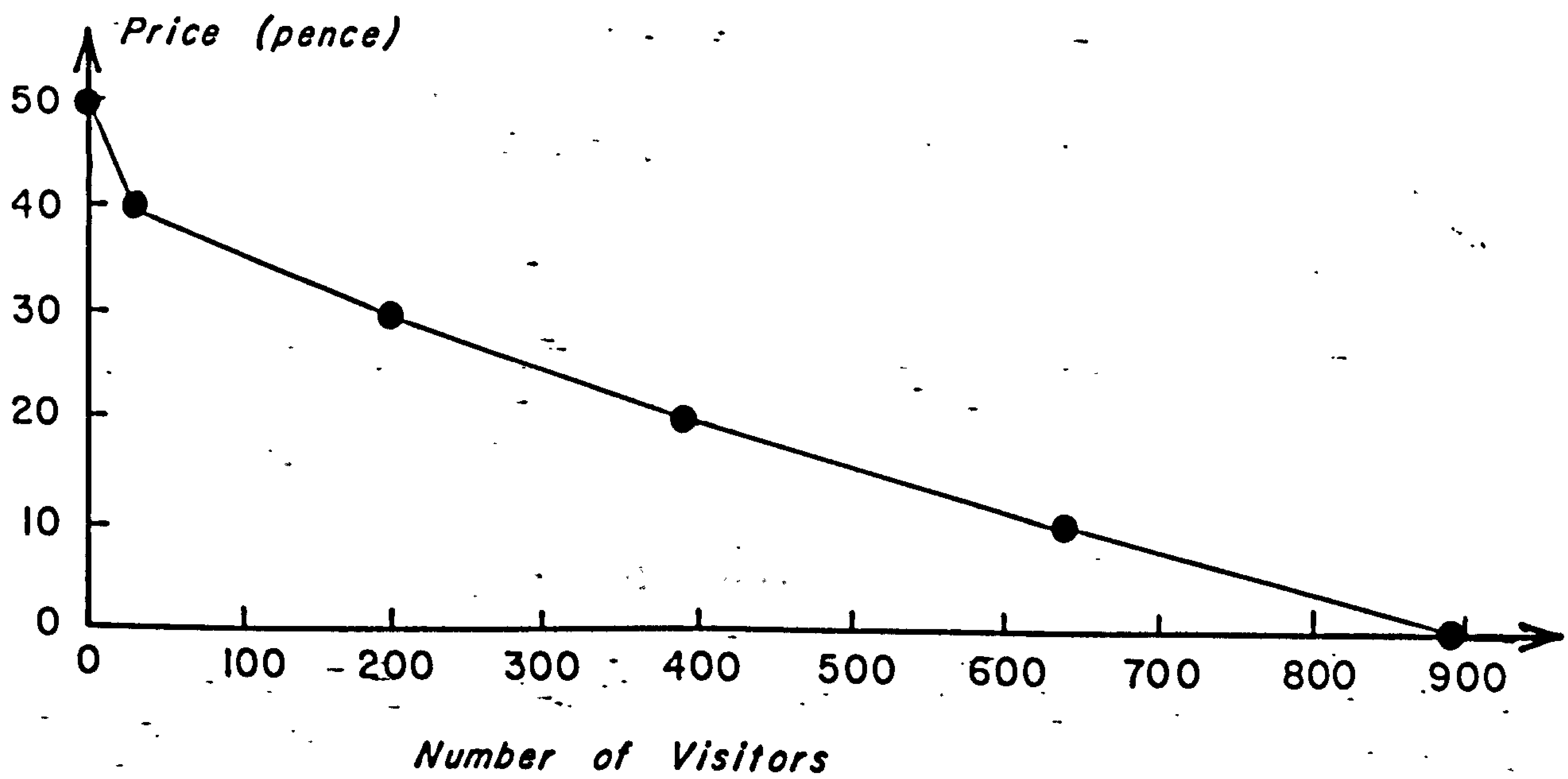
The value of R_2 when R_1 is closed.

	Zone A	B	C	D
Initial travel costs (pence)	10	40	30	20

Number of visitors from zone

Entrance fee (pence)	A	B	C	D	Total
0	150	120	60	560	890
10	120	60	40	420	640
20	90	-	20	280	390
30	60	-	-	140	200
40	30	-	-	-	30
50	-	-	-	-	-

The aggregate demand curve looks like this:



and the consumer's surplus is £ 170.50.

Appendix A3.6

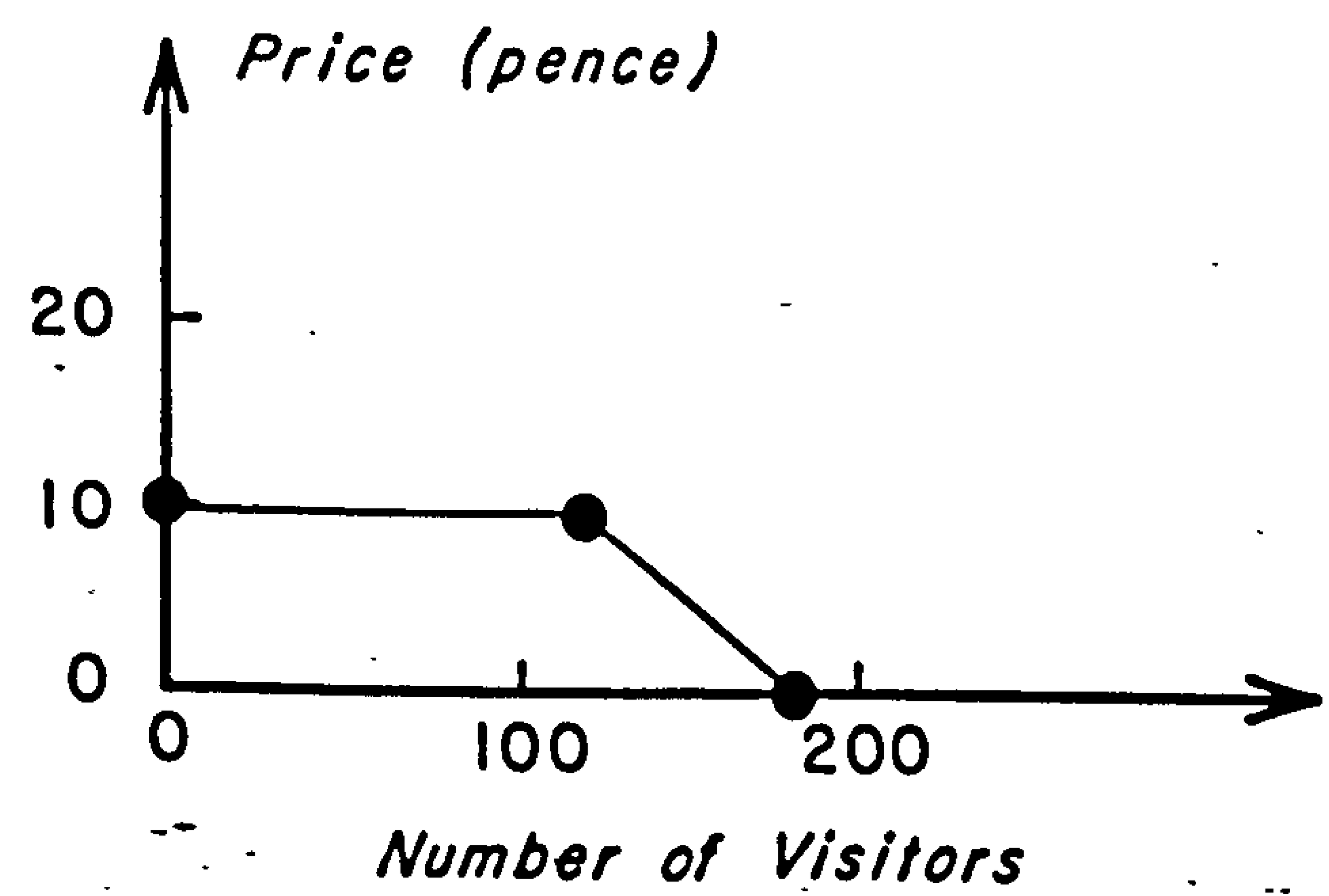
<u>The value of R_1 when R_2 is introduced.</u>

	Zone A	Zone B	Zone C	Zone D
Will go to R_1	-	+	-	-
Population	15,000	30,000	10,000	70,000
Travel cost to R_1	(20)	30	(40)	(50)
Travel cost to R_2	(10)	40	(30)	(20)
Will shift to R_2 when entrance fee at R_1 is	(-10)	10	(-10)	(-30)

Number of visitors from zone

Entrance fee (pence)	A	B	C	D	Total
0	-	180	-	-	180
10	-	120	-	-	120
>10	-	-	-	-	-

The aggregate demand curve looks like this:

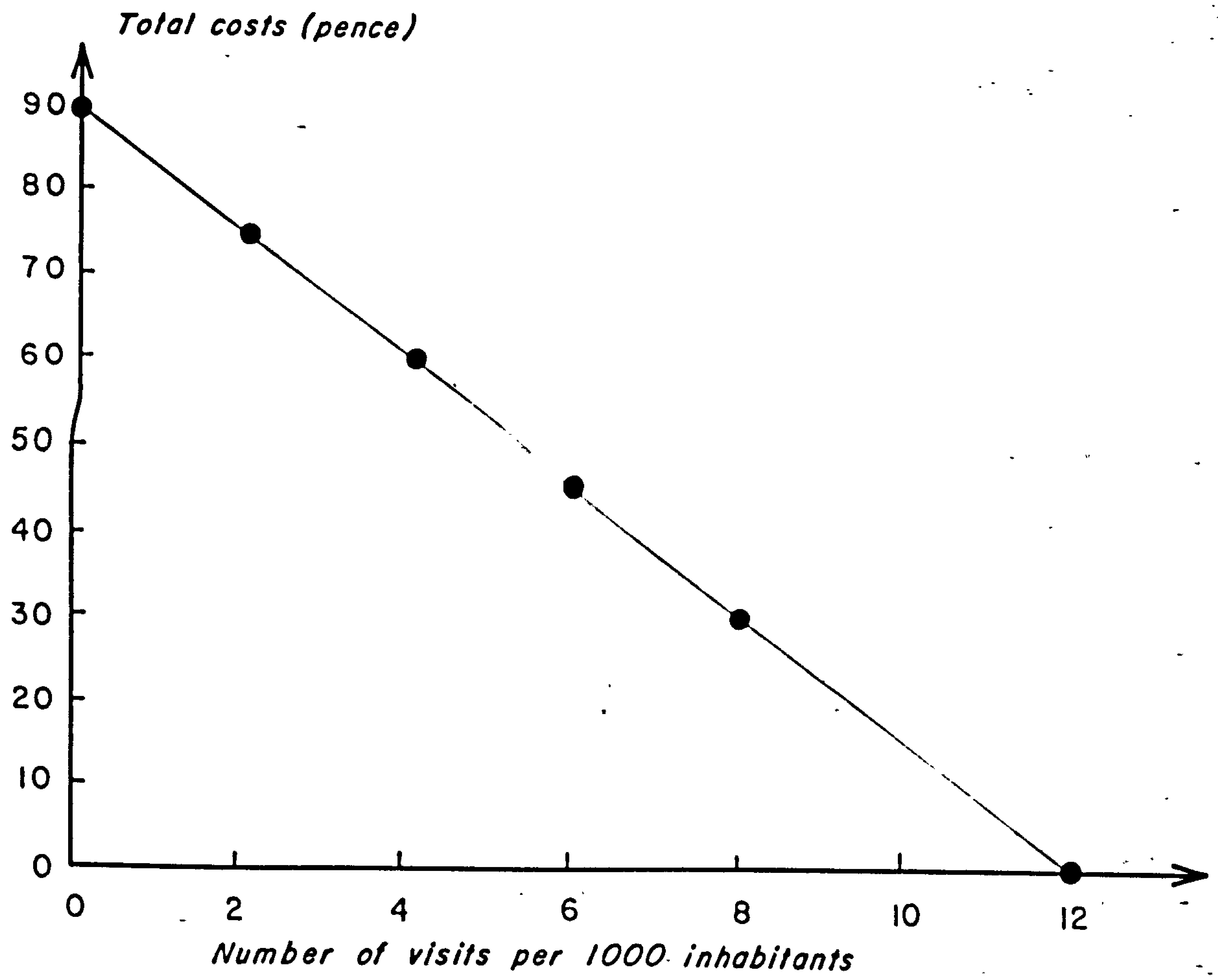


and the consumer's surplus is £15.00.

Appendix A3.7

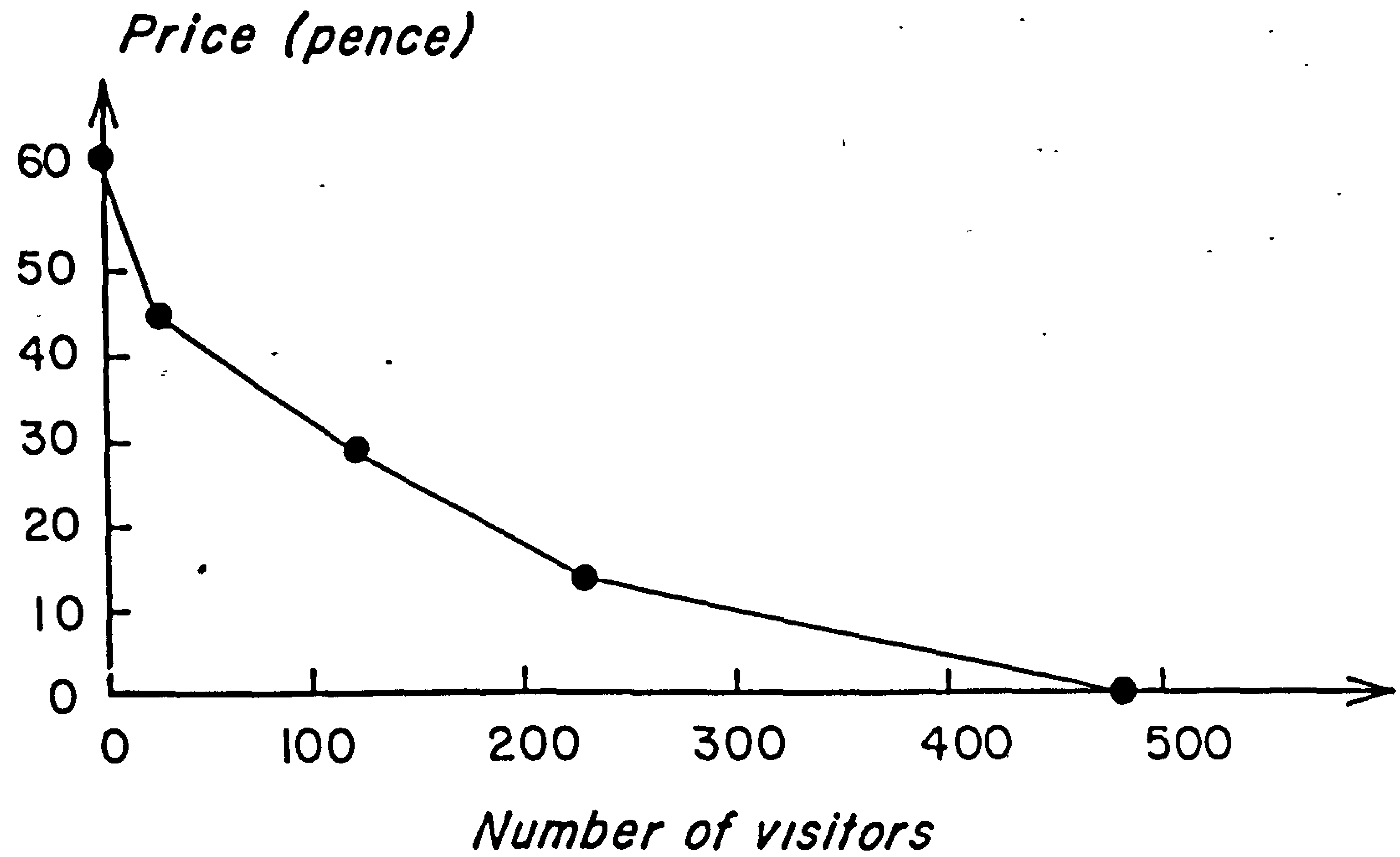
Including the cost of time in the valuation of R_1.

The new trip demand curve based on Table 3.5 is:



Entrance fee (pence)	Number of visitors from zone A	B	C	D	Total
0	120	180	40	140	480
15	90	120	20	-	230
30	60	60	-	-	120
45	30	-	-	-	30
60	-	-	-	-	-

The aggregate demand curve looks like this:

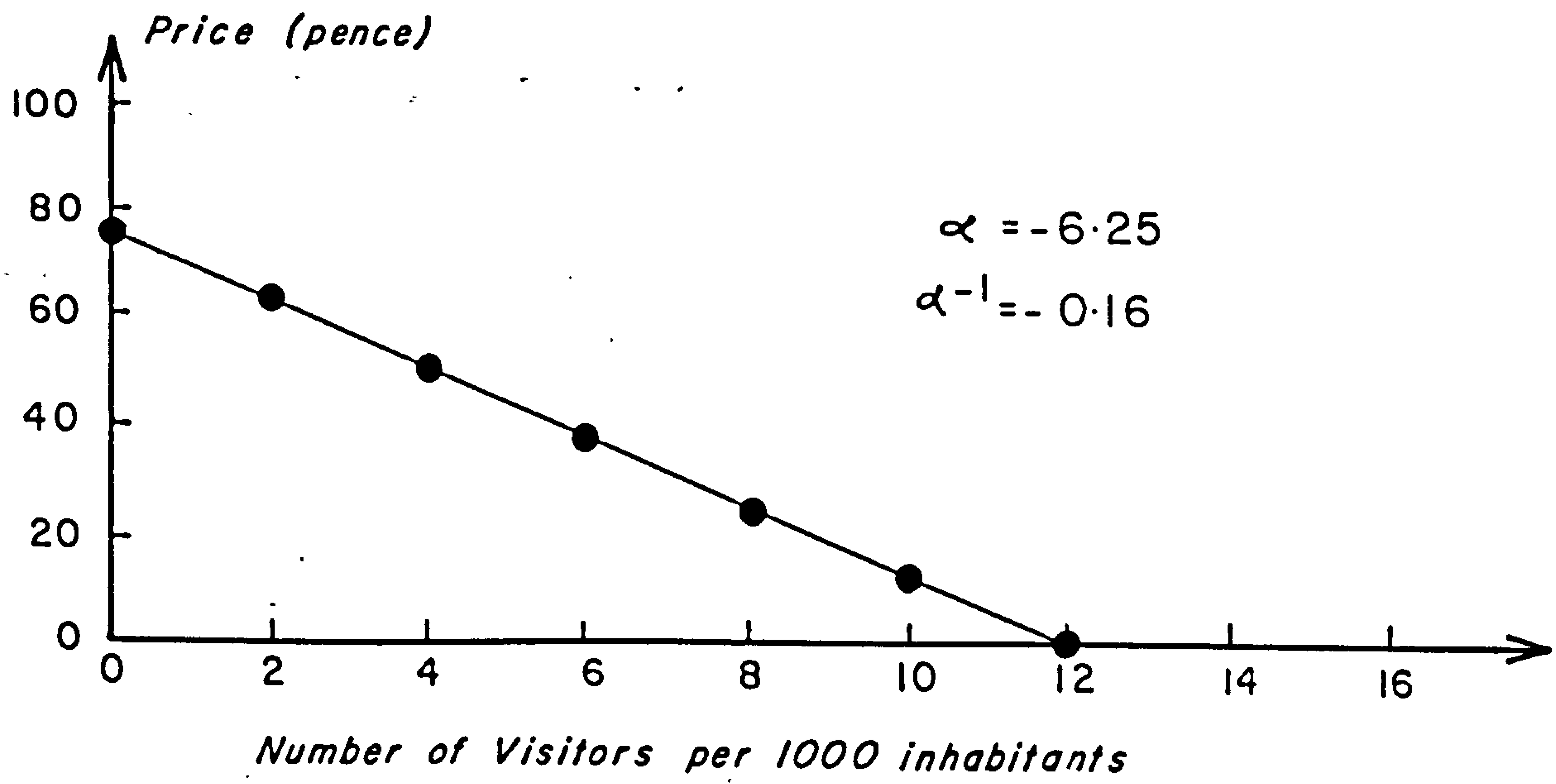


and the consumer's surplus is £ 93.00.

Appendix A3.8

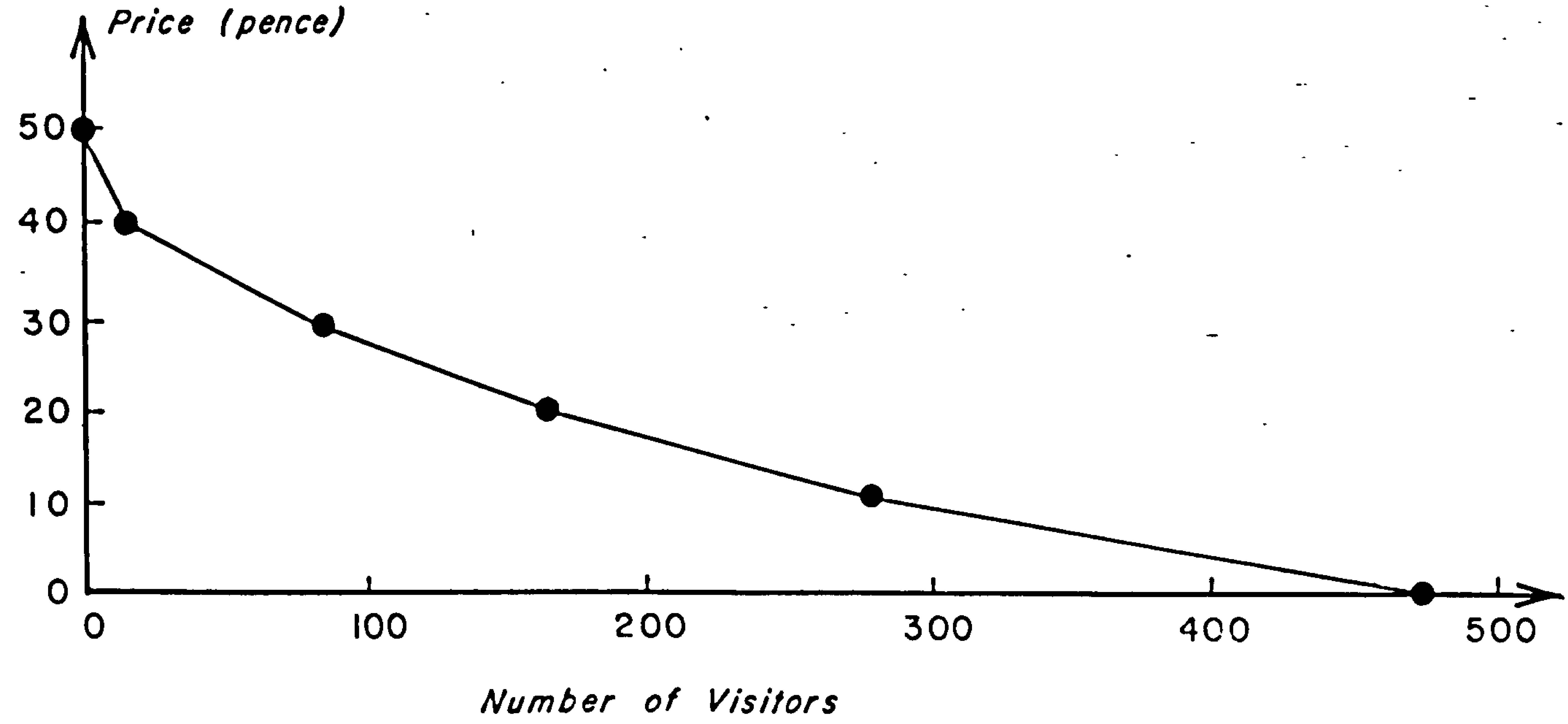
<u>The value of R_+ under excess demand.</u>

The data from Table 3.6 are assumed to be obtained and π, the perceived chance of being admitted is assumed to be 0.8.



Entrance fee (pence)	Number of visitors from zone A	B	C	D	
0	120	180	40	140	480
10	96	132	24	28	280
20	72	84	8	-	164
30	48	36	-	-	84
40	24	-	-	-	24
50	-	-	-	-	-

The aggregate demand curve becomes:



and the consumer's surplus is £ 77.50.

Appendix A4.1

Computer Programme Clawson.

The appendix is separately bound with the other programmes.

A4.2. Modification of the Data Files

The raw data base stored in GWYD.DTA was examined and modified for use in the Clawson analysis. For that purpose, the programme GWTR.FOR was written. The programme shown in Appendix B.P creates 3 new files,HOM1.DTA,HOM2.DTA and HOM3.DTA all described below.

GWTR.FOR

This program has been written to select the observations which can be used in the Clawson analysis and for each of these observations to calculate the travel cost according to the model in Section 4.2.2.1.

An observation is deleted if at least one of the following statements is true:

Home distance (HOMED):	Missing
On holiday? (Q9):	Missing
Means of transport (Q12):	Missing
Somewhere else today? (Q6):	Missing
Correct mileage/gal (CMILEC):	Missing

By the above procedure, 4 observations were excluded; 233 observations remained to be used in the analysis.

HOM1.DTA

This file is a test file and contains an output of all the variables read in by GWTR.FOR for comparison with the original questionnaires. The excluded observations are marked so that they can be rechecked.

HOM2.DTA

This file contains home distance, cost of visit, and original observation number for each observation not excluded by the above procedure in GWTR.FOR.

The cost of travel is calculated according to 4.2.2.1. from the following equations:

$$\text{If } Q9 = 1 : \quad C_i = \frac{HOMED*2*136*XSTA}{CMILEC*IHOL} + \frac{STPDC*2*136*XSTA}{CMILEC} \qquad (1)$$

$$\text{If } Q9 = 2 : \quad C_i = \frac{STPDC*2*136*XSTA}{CMILEC} \qquad (2)$$

where

Q9 = on holiday = 1; not on holiday = 2

C_i = cost to visit the forest for visitor group i

HOMED = home distance (miles)

IHOL = length of holiday

CMILEC = m.p.g. from official guide

STDPC = start point distance correct (miles)

XSTA = proportion of day spent on site.

Only 134 visitor groups answered the question pertaining to the estimated running cost of their car. Therefore, it was necessary to use CMILEC to estimate travel costs. CMILEC was also used because those visitors who answered the question were not able to give an adequate estimate of the cost of running their cars. For the 134 valid cases; a one-way ANOVA for estimated running cost (CMILE1) on prompting method (CMILEM) was carried out and was found significant at $p<0.001$ (see 4.3.1.2.). For this reason also, values for travel cost were taken from an "official" list: What car,October,1980, Fuel consumption list m.p.g. (An. 1980).

When we want to find the social value of the forest it must be the actual cost of travel that we are interested in and not the perceived cost. The perceived cost is important, however, when we want to find the fee required to keep use of the site down to a certain level.

Ideally, a demand curve based on perceived cost should be used and then integrated for the actual cost in order to find the social benefit. This would probably be very small as the actual cost is generally higher than the perceived cost.

STDPC, start point distance correct, is measured on a map and is used instead of the one estimated on the questionnaire as it was found (Appendix G.R) that:

$$\text{STPDC} = 2.69 + 0.83*\text{STPDE} \qquad (3)$$

$$p<0.001,\ r^2 = .90$$

where STPDE = estimated start distance.

Thus, if we used STPDE, we would get an overestimation of the start point distance. STPDE shou'd have been used if we wanted the perceived cost.

PCOST, the petrol price, is set to 136 pence/gallon which was the average price at the time of the survey. To get the return cost the one way travel cost was multiplied by 2.

XSTA, the proportion of the day spent on the site, is modified from the variable staytime (STAYT) according to the following procedure in Table A4.1 :

Table A4.1 : Conversion of staytime to proportion of day costs

If Q6 = 1 (Visitor group somewhere else today)

staying for the day	: XSTA = 1.0
staying for 1/2 day	: XSTA = 0.7
staying 2-3 hours	: XSTA = 0.5
staying 1-2 hours	: XSTA = 0.4
staying <1 hour	: XSTA = 0.3

If Q6 = 2 (Visitor group not somewhere else today)

: XSTA = 1.0

See also Section 4.2.2.1.4.

HOM3.DTA

This file contains two variables; the stated willingness to pay (FEES) and the observation number. The observations excluded by the procedure in GWTR.FOR are excluded here as well. The file is designed to be used for comparison with the results from the Clawson analysis via the programme TES2.FOR (see 4.2.3)

Appendix A5.1

Comparison of Sample Estimate and Regression Estimate.

A comparison of yearly carborne visitor groups estimated by the sample estimate and the regression estimate is presented here. The estimates are explained in Section 5.4.5. The regression estimate is calculated using Part II (Koch 1980, Appendix B.2) from which the yearly number of forest car visitor hours hours can be found (line 5 * line 22). This is divided by the average stay length per car visitor group which is calculated in a special programme (prg A 1811).

Only the forests investigated in Section 5.5 are included.

County of Copenhagen:

Forest	C no.	Number of yearly carborne visitor groups: Sample Estimate	Regression Estimate
'Troeroed Hegn'	1	6.612	6.664
'Jaegersborg Dyrehavn og Hegn m.v.'	3	398.324	515.236
'Charlottenlund Skov'	4	65.828	97.069
'Kongelunden'	5	25.383	27.548
'Soelleroed Kirkeskov'	6	5.752	7.382
'Geel Skov'	7	15.167	15.840
'Noerreskoven'	8	15.197	22.115
'Aasevang m.v.'	9	31.884	36.650
'Hareskovene og Jonstrup Vang'	10	61.010	76.916
'Vestskoven Vest'	11	11.508	8.021

County of Frederiksborg:

'Hornbaek Plantage'	2	56.323	50.053
'Teglstrup og Hellebaek Skov'	3	35.565	38.906
'Klosterris og Horseroed Hegn m.v.'	4	10.427	8.687
'Egebaeksvang'	7	7.633	10.115
'Danstrup og Krogenberg Hegn'	8	8.371	9.500
'Gribskov og Stenholt Vang'	13	24.916	37.199
'Tisvilde Hegn m.v.'	18	71.893	102.582
'St. Dyrehavn og Tokkekoeb Hegn m.v.'	28	32.068	36.398
'Folehave'	35	19.641	21.325
'Rude Skov'	36	8.821	11.887
'Lystrup Skov'	38	7.532	8.920
'Ravnsholt og Soenderskov'	39	9.234	10.749
'Slagslunde'	41	6.344	15.259
'Ganloese Eget'	43	5.445	7.169
'Ganloese Ore og Farum Lillevang m.v.'	44	17.608	19.032

Appendix A5.2

Computer Programme PFAF01.FOR

The appendix is separately bound with the other programmes.

Appendix A5.3

Computer Programme PFAF02.FOR and PFAF03.FOR

The appendix is separately bound with the other programmes.

Appendix A5.4

Example of Output

The appendix is bound separately with the programmes.

GWYDYR RECREATION QUESTIONNAIRE 1980

Can you spare five minutes to answer a few questions about your visit to this forest,Gwydyr? This is part of a research project carried out by the Dept. of Forestry & WoodScience, U.C.N.W., Bangor.

(1) Have you been interviewed before about a visit to Gwydyr?

(2) Have you come specially to visit the forest?

(3) Is this your whole party?

(4) What are you going to do during your visit?
Go for a walk, Sit to enjoy the view, Observe the wildlife,
Fishing, Sailing, Canoeing,.

(5) How long do you intend staying here?

(6) Have you/will you visit somewhere else today? Where?

(7)Have you been here before? How many times in the last year?

(8) Where do you live?

(9) Are you on holiday? For how long?

(10) Where did you start from today?

(11) About how far is that from here?

(12) How did you travel here?: Car, Bus, Train, Motorbike,
Minibus, Bike, Walk.

(a) Can you tell me the make, engine size, and age of the vehicle?

(b) Can you tell me how much per mile it costs you to run?

p10, p20, p30,.

(13) Have recent increases in petrol prices/public transport affected the no. of trips you make?

(14) If travel costs were to double in relation to wages would you make the same no. of trips?, or reduce the trips to ;

3 in 4, 2 in 4, 1 in 4, or stop almost all trips?

(15)How long approx did the journey here take today?

(16) If it took you 2/3 of the present time to get here would you;
Make the same no. of trips to Gwydyr?
Make the same no. of trips further afield?
Make more trips to Gwydyr ? How many more?